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Closure methods for laparotomy incisions for preventing incisional hernias and other wound complications (Review)

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[Intervention Review]

Closure methods for laparotomy incisions for preventing incisional hernias and other wound complications

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ABSTRACT

Background

Surgeons who perform laparotomy have a number of decisions to make regarding abdominal closure. Material and size of potential suture types varies widely. In addition, surgeons can choose to close the incision in anatomic layers or mass ('en masse'), as well as using either a continuous or interrupted suturing technique, of which there are different styles of each. There is ongoing debate as to which suturing techniques and suture materials are best for achieving definitive wound closure while minimising the risk of short- and long-term complications.

Objectives

The objectives of this review were to identify the best available suture techniques and suture materials for closure of the fascia following laparotomy incisions, by assessing the following comparisons: absorbable versus non-absorbable sutures; mass versus layered closure; continuous versus interrupted closure techniques; monofilament versus multifilament sutures; and slow absorbable versus fast absorbable sutures. Our objective was not to determine the single best combination of suture material and techniques, but to compare the individual components of abdominal closure.

Search methods

On 8 February 2017 we searched CENTRAL, MEDLINE, Embase, two trials registries, and Science Citation Index. There were no limitations based on language or date of publication. We searched the reference lists of all included studies to identify trials that our searches may have missed.

Selection criteria

We included randomised controlled trials (RCTs) that compared suture materials or closure techniques, or both, for fascial closure of laparotomy incisions. We excluded trials that compared only types of skin closures, peritoneal closures or use of retention sutures.

Data collection and analysis

We abstracted data and assessed the risk of bias for each trial. We calculated a summary risk ratio (RR) for the outcomes assessed in the review, all of which were dichotomous. We used random-effects modelling, based on the heterogeneity seen throughout the studies and analyses. We completed subgroup analysis planned a priori for each outcome, excluding studies where interventions being compared differed by more than one component, making it impossible to determine which variable impacted on the outcome, or the possibility of a

synergistic effect. We completed sensitivity analysis, excluding trials with at least one trait with high risk of bias. We assessed the quality of evidence using the GRADEpro guidelines.

Main results

Fifty-five RCTs with a total of 19,174 participants met the inclusion criteria and were included in the meta-analysis. Included studies were heterogeneous in the type of sutures used, methods of closure and patient population. Many of the included studies reported multiple comparisons.

For our primary outcome, the proportion of participants who developed incisional hernia at one year or more of follow-up, we did not find evidence that suture absorption (absorbable versus non-absorbable sutures, RR 1.07, 95% CI 0.86 to 1.32, moderate-quality evidence; or slow versus fast absorbable sutures, RR 0.81, 95% CI 0.63 to 1.06, moderate-quality evidence), closure method (mass versus layered, RR 1.92, 95% CI 0.58 to 6.35, very low-quality evidence) or closure technique (continuous versus interrupted, RR 1.01, 95% CI 0.76 to 1.35, moderate-quality evidence) resulted in a difference in the risk of incisional hernia. We did, however, find evidence to suggest that monofilament sutures reduced the risk of incisional hernia when compared with multifilament sutures (RR 0.76, 95% CI 0.59 to 0.98, I^2 = 30%, moderate-quality evidence).

For our secondary outcomes, we found that none of the interventions reduced the risk of wound infection, whether based on suture absorption (absorbable versus non-absorbable sutures, RR 0.99, 95% CI 0.84 to 1.17, moderate-quality evidence; or slow versus fast absorbable sutures, RR 1.16, 95% CI 0.85 to 1.57, moderate-quality evidence), closure method (mass versus layered, RR 0.93, 95% CI 0.67 to 1.30, low-quality evidence) or closure technique (continuous versus interrupted, RR 1.13, 95% CI 0.96 to 1.34, moderate-quality evidence).

Similarily, none of the interventions reduced the risk of wound dehiscence whether based on suture absorption (absorbable versus non-absorbable sutures, RR 0.78, 95% CI 0.55 to 1.10, moderate-quality evidence; or slow versus fast absorbable sutures, RR 1.55, 95% CI 0.92 to 2.61, moderate-quality evidence), closure method (mass versus layered, RR 0.69, 95% CI 0.31 to 1.52, moderate-quality evidence) or closure technique (continuous versus interrupted, RR 1.21, 95% CI 0.90 to 1.64, moderate-quality evidence).

Absorbable sutures, compared with non-absorbable sutures (RR 0.49, 95% CI 0.26 to 0.94, low-quality evidence) reduced the risk of sinus or fistula tract formation. None of the other comparisons showed a difference (slow versus fast absorbable sutures, RR 0.88, 95% CI 0.05 to 16.05, very low-quality evidence; mass versus layered, RR 0.49, 95% CI 0.15 to 1.62, low-quality evidence; continuous versus interrupted, RR 1.51, 95% CI 0.64 to 3.61, very low-quality evidence).

Authors' conclusions

Based on this moderate-quality body of evidence, monofilament sutures may reduce the risk of incisional hernia. Absorbable sutures may also reduce the risk of sinus or fistula tract formation, but this finding is based on low-quality evidence.

We had serious concerns about the design or reporting of several of the 55 included trials. The comparator arms in many trials differed by more than one component, making it impossible to attribute differences between groups to any one component. In addition, the patient population included in many of the studies was very heterogeneous. Trials included both emergency and elective cases, different types of disease pathology (e.g. colon surgery, hepatobiliary surgery, etc.) or different types of incisions (e.g. midline, paramedian, subcostal).

Consequently, larger, high-quality trials to further address this clinical challenge are warranted. Future studies should ensure that proper randomisation and allocation techniques are performed, wound assessors are blinded, and that the duration of follow-up is adequate. It is important that only one type of intervention is compared between groups. In addition, a homogeneous patient population would allow for a more accurate assessment of the interventions.

PLAIN LANGUAGE SUMMARY

What is the best way to close abdominal incisions following surgery?

What is the Issue?

Laparotomy, an incision through the abdominal wall to access the abdominal cavity, is performed for a variety of surgical procedures. Incisional hernia, infection, dehiscence (an opening of the wound or muscle layers) and chronic drainage from the wound, are potential complications of this procedure.

Why is it Important?

Incisional hernias affect up to 20% of people undergoing a laparotomy. Incisional hernias, as they enlarge over time, cause patient discomfort, which in turn, result in patients restricting their work and other physical activities. Cosmetic concerns may also arise.

We asked:

Does the type of suture material, or type of closure prevent these complications? We compared absorbable sutures (sutures that lose their tensile strength as they are dissolved by the patient's body) versus non-absorbable (permanent) sutures; mass closure (closure of all

anatomical layers of abdominal wall at once) versus layered closure (closing the anatomic layers individually); continuous closure (running suture) versus interrupted closure; monofilament sutures versus multifilament (braided) sutures; and slow absorbable sutures (those that maintain their tensile strength for more than 30 days) versus fast absorbable sutures (those that lose their tensile strength within 30 days).

We found:

A search of all relevant publications (up to date as of 8 February 2017) found a total of 55 studies with 19,174 participants to include in the review. The included studies differed greatly in the type of suture materials used, the closure technique and the type of underlying surgical procedures performed. We found that using monofilament sutures reduced the occurrence of incisional hernia. Absorbable sutures reduced the risk of chronic drainage from the wound (sinus or fistula formation).

This review included a notably large number of trials; however, we had concerns regarding their collective methodological design and scientific reporting.

This means:

Monofilament sutures can be considered for abdominal closure to reduce the risk of incisional hernia. Absorbable sutures can be considered to reduce the risk of chronic drainage from the wound.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Absorbable versus non-absorbable sutures for laparotomy incisions

Absorbable versus non-absorbable sutures for laparotomy incisions

Patient or population: patients undergoing a laparotomy
Setting: community and hospital-based, outpatient and inpatient, worldwide
Intervention: absorbable sutures for abdominal closure
Comparison: non-absorbable sutures for abdominal closure

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Quality of the evidence (GRADE)
	Risk with non-absorbable sutures	Risk with absorbable sutures			
Incisional hernia follow-up: 1 year	Study population		RR 1.07 (0.86 to 1.32)	4720 (17 RCTs)	⊕⊕⊕⊖ Moderate[1]
	107 per 1000	115 per 1000 (92 to 141)			
Wound infection at last follow-up	Study population		RR 0.99 (0.84 to 1.17)	8457 (29 RCTs)	⊕⊕⊕⊖ Moderate[1]
	107 per 1000	105 per 1000 (89 to 125)			
Wound dehiscence at last follow-up	Study population		RR 0.78 (0.55 to 1.10)	9004 (34 RCTs)	⊕⊕⊕⊖ Moderate[1]
	33 per 1000	26 per 1000 (18 to 36)			
Sinus or fistula formation at last follow-up	Study population		RR 0.49 (0.26 to 0.94)	5470 (19 RCTs)	⊕⊕⊖⊖ Low[1,2]
	35 per 1000	17 per 1000 (9 to 33)			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).
CI: confidence interval; **RCT**: randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect

Moderate quality: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
Very low quality: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

[1]Downgraded one level for serious risk of bias (includes at least one study with overall high risk of bias).
[2]Downgraded one level for inconsistency (I^2 = 52%).

Summary of findings 2. Mass versus layered closure for laparotomy incisions

Mass versus layered closure for laparotomy incisions

Patient or population: patients undergoing laparotomy incisions
Setting: community and hospital-based, outpatient and inpatient, worldwide
Intervention: en masse for abdominal closure
Comparison: layered closure for abdominal closure

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Quality of the evidence (GRADE)
	Risk with layered closure	Risk with mass closure			
Incisional hernia follow-up: 1 year	Study population		RR 1.92 (0.58 to 6.35)	1176 (5 RCTs)	⊕⊖⊖⊖ Very low[1,2,3]
	27 per 1000	51 per 1000 (15 to 169)			
Wound infection at last follow-up	Study population		RR 0.93 (0.67 to 1.30)	2926 (11 RCTs)	⊕⊕⊖⊖ Low[1,4]
	114 per 1000	106 per 1000 (76 to 148)			
Wound dehiscence at last follow-up	Study population		RR 0.69 (0.31 to 1.52)	2863 (11 RCTs)	⊕⊕⊕⊖ Moderate[1]
	23 per 1000	16 per 1000 (7 to 35)			
Sinus or fistula formation at last follow-up	Study population		RR 0.49 (0.15 to 1.62)	1076 (6 RCTs)	⊕⊕⊖⊖ Low[1,2]
	49 per 1000	24 per 1000 (7 to 79)			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **RCT**: randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
Very low quality: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

[1]Downgraded one level for serious risk of bias (includes at least one study with overall high risk of bias).
[2]Downgraded one level for inconsistency (I^2 = 61%).
[3]Downgraded one level for imprecision (overlapping no effect).
[4]Downgraded one level for inconsistency (I^2 = 50%).

Summary of findings 3. Continuous versus interrupted closure for laparotomy incisions

Continuous versus interrupted closure for laparotomy incisions

Patient or population: patients undergoing a laparotomy incision
Setting: community and hospital-based, outpatient and inpatient, worldwide
Intervention: continuous closure
Comparison: interrupted closure

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Quality of the evidence (GRADE)
	Risk with interrupted closure	Risk with continuous closure			
Incisional hernia follow-up: 1 year	Study population		RR 1.01 (0.76 to 1.35)	3854 (11 RCTs)	⊕⊕⊕⊖ Moderate[1]
	95 per 1000	95 per 1000 (72 to 128)			
Wound infection at last follow-up	Study population		RR 1.13 (0.96 to 1.34)	10,039 (23 RCTs)	⊕⊕⊕⊖ Moderate[1]
	86 per 1000	97 per 1000 (83 to 116)			
Wound dehiscence at last follow-up	Study population		RR 1.21 (0.90 to 1.64)	9228 (21 RCTs)	⊕⊕⊕⊖ Moderate[1]

	24 per 1000	29 per 1000 (22 to 40)			
Sinus or fistula formation at last follow-up	Study population		RR 1.51 (0.64 to 3.61)	5082 (10 RCTs)	⊕⊖⊖⊖ Very low[1, 2,3]
	24 per 1000	37 per 1000 (16 to 88)			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).
CI: confidence interval; **RCT**: randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
Very low quality: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

[1]Downgraded one level for serious risk of bias (includes at least one study with overall high risk of bias).
[2]Downgraded one level for inconsistency (I^2 = 57%).
[3]Downgraded one level for imprecision (overlapping no effect).

Summary of findings 4. Monofilament versus multifilament sutures for laparotomy incisions

Monofilament versus multifilament sutures for laparotomy incisions

Patient or population: patients undergoing a laparotomy incision
Setting: community and hospital-based, outpatient and inpatient, worldwide
Intervention: monofilament
Comparison: multifilament

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Quality of the evidence (GRADE)
	Risk with multifilament	Risk with monofilament			
Incisional hernia follow-up: 1 year	Study population		RR 0.76 (0.59 to 0.98)	4520 (16 RCTs)	⊕⊕⊕⊖ Moderate[1]
	105 per 1000	80 per 1000 (62 to 103)			

Wound infection at last follow-up	Study population		RR 1.08 (0.91 to 1.28)	6557 (23 RCTs)	⊕⊕⊕⊖ Moderate[1]
	105 per 1000	114 per 1000 (96 to 135)			
Wound dehiscence at last follow-up	Study population		RR 1.24 (0.93 to 1.67)	6199 (22 RCTs)	⊕⊕⊕⊖ Moderate[1]
	27 per 1000	33 per 1000 (25 to 45)			
Sinus or fistula formation at last follow-up	Study population		RR 1.91 (0.77 to 4.73)	2285 (8 RCTs)	⊕⊖⊖⊖ Very low[1,2,3]
	25 per 1000	48 per 1000 (19 to 118)			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).
CI: confidence interval; **RCT**: randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
Very low quality: we have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1]Downgraded one level for serious risk of bias (includes at least one study with overall high risk of bias).
[2]Downgraded one level for inconsistency (I^2 = 77%).
[3]Downgraded one level for imprecision (overlapping no effect).

Summary of findings 5. Fast absorbable versus slow absorbable sutures for laparotomy incision

Fast absorbable versus slow absorbable sutures for laparotomy incisions

Patient or population: patients undergoing a laparotomy incision
Setting: community and hospital-based, outpatient and inpatient, worldwide
Intervention: slow absorbable sutures
Comparison: fast absorbable sutures

Outcomes	Anticipated absolute effects* (95% CI)	Relative effect (95% CI)	№ of participants (studies)	Quality of the evidence (GRADE)

	Risk with fast absorbable sutures	Risk with slow absorbable sutures			
Incisional hernia follow-up: 1 year	Study population		RR 0.81 (0.63 to 1.06)	3643 (10 RCTs)	⊕⊕⊕⊖ Moderate[1]
	113 per 1000	92 per 1000 (71 to 120)			
Wound infection at last follow-up	Study population		RR 1.16 (0.85 to 1.57)	4100 (11 RCTs)	⊕⊕⊕⊖ Moderate[1]
	75 per 1000	87 per 1000 (64 to 118)			
Wound dehiscence at last follow-up	Study population		RR 1.55 (0.92 to 2.61)	3440 (8 RCTs)	⊕⊕⊕⊖ Moderate[1]
	15 per 1000	24 per 1000 (14 to 40)			
Sinus or fistula formation at last follow-up	Study population		RR 0.88 (0.05 to 16.05)	911 (2 RCTs)	⊕⊖⊖⊖ Very low[1,2,3]
	15 per 1000	13 per 1000 (1 to 243)			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).
CI: confidence interval; **RCT**: randomised controlled trial; **RR:** risk ratio

GRADE Working Group grades of evidence
High quality: we are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
Very low quality: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect

[1]Downgraded one level for serious risk of bias (includes at least one study with overall high risk of bias).
[2] Downgraded one level for inconsistency (I^2 = 72%).
[3]Downgraded one level for imprecision (overlapping no effect).

BACKGROUND

Description of the condition

Laparotomy is a surgical incision used to gain access to the organs of the abdominal cavity and is one of the most common surgical procedures performed globally. Sutures, most commonly, provide mechanical support for the closed wound during its initial healing. They approximate the wound edges and help to maintain wound closure until the healing process provides sufficient strength for the wound to withstand stress and strain. Surgeons have several choices for closing the abdominal fascia, but there is currently scant consensus as to the best suture material or closure method. For the majority of surgeons, the choice of a suture material in a given instance has mostly been directed by training exposure and local opinion, with many surgeons reluctant to attempt different techniques once their personal preferences have been established (Anthimidis 2013; Chalya 2015; Hodgson 2001; Tully 2002).

Incisional hernia is a frequent complication of laparotomy. It is a late manifestation of failure to secure fascial closure. The incidence following major abdominal surgery is reported to range from 2% to 20% across studies, depending on patient and wound factors (incidence may go up to 40% in those with wound infections) (Le Huu Nho 2012; Sanders 2012; Santora 1993). Incisional hernias, as they enlarge over time, cause the patient discomfort, which in turn, result in patients restricting their work and other physical activities. Cosmetic concerns may also arise. Overall, patient quality of life can be greatly affected. Complications of incisional hernias include pain, bowel obstruction, incarceration and strangulation and the risk of need for repeat surgery. In 2011, the number of incisional hernia repairs in the USA alone was estimated to be between 190,000 to 200,000, with approximately 1% to 2% annual growth in volume (Smith 2012). In addition, this volume reflects the economic impact of the condition given the surgical manpower and expensive mesh materials employed in hernia repairs (Rutkow 2003). Incisional hernia repair is also associated with hernia recurrence, ranging from 10% to 50%, and considerable morbidity and mortality. The rate of hernia recurrence is largely unchanged over time as surgeons continue to face increasing formidable patient factors such as older, more comorbid and more obese patients undergoing primary surgery (Anthony 2000; Hawn 2010; Helgstrand 2012; Langer 1985; Leber 1998; Mudge 1985; Stey 2015).

A large, prospective study (Itatsu 2014), in which patients were examined for hernia every 3 months following surgery, assessed the time from index surgery to the diagnosis of hernia. The study authors found that there was no time point in which the diagnosis of incisional hernia plateaued over the first two years following surgery. Approximately 5.2% of incisional hernias were diagnosed within the first 12 months, while 10.2% of hernias were diagnosed within the first 24 months. An additional study (Goodenough 2015) found that of those who developed an incisional hernia within 5 years of surgery, more than half were diagnosed within the first 12 months.

Several comorbid conditions have also been shown to be associated with the development of incisional hernia and these are listed in the right half of Table 1 (Bucknall 1982; Connelly 2015; Goodenough 2015; Lamont 1988; Sugerman 1996).

Some studies have reported that the majority of incisional hernias occur within the first two years after surgery, suggesting that initial wound closure is an important factor in hernia prevention (Bucknall 1982; Lamont 1988). However, the limited follow-up in these studies may have underestimated late occurrence of incisional hernia, as suggested by long-term studies (Ellis 1983; George 1986; Mudge 1985; Pollock 1989; Spencer 2015).

The incidence of incisional hernia has been reported to vary with the type of incision, with a greater incidence reported with midline incisions compared to paramedian incisions (Brown 2005; Cox 1986; Guillou 1980; Kendall 1991). However, the midline incision remains the workhorse of open surgery due to its ideal properties in regards to optimal intraperitoneal access, exposure, speed and the simplicity of the incision and postoperative pain characteristics relative to the paramedian approach (Hughes 2009). One of the benefits of the modern uptake of laparoscopic surgery was thought to be a reduced rate of incisional hernias due to the use of smaller incisions. However, the modern evidence is variable in this regard and some studies demonstrate that laparoscopic surgery still results in notable rates of incisional hernia, in some cases, no different than when compared to the open approach (Benlice 2015; Ihedioha 2008; Llaguna 2010). In addition, many laparoscopic procedures (e.g. colectomy, splenectomy) require an incision to remove the specimen, and have an inherent hernia risk.

A number of factors influence the occurrence of postoperative wound infection and incisional hernia (Table 1). Some of these factors are considered to be under the control of the surgeon (such as the choice of incision), while others are only partly (e.g. the length of the incision or the duration of the operation), or not at all (e.g. most patient factors including diabetes and chronic lung disease) influenced by the surgeon. Risk factors for surgical wound infection should be considered additionally as incisional hernia risk factors, as infection disrupts wound healing, which in turn increases the risk of fascial dehiscence (Bucknall 1982). Fascial dehiscence that is not acutely diagnosed and repaired, or occurs in a delayed fashion, will ultimately become an incisional hernia.

This review explores how variations in the selection of closure techniques and suture materials in closing laparotomy (not laparoscopy) incisions affects the occurrence of post-operative wound complications, such as development of incisional hernia and wound infection.

Description of the intervention

Fascial closure following laparotomy involves several key decisions. The first decision is whether to close the layers of the abdominal wall in separate anatomic layers (peritoneum, posterior fascia, anterior fascia, subcutaneous tissues) or 'en masse' (incorporating all layers of the fascia, with or without the peritoneum, into one suture line). We have considered layered closure to be closure of the peritoneum and linea alba separately in midline incisions. For non-midline incisions, we defined layered closure as closure of the fascial layers (posterior fascia, anterior fascia) and peritoneum separately.

The second decision for surgeons is whether to close the fascia using an interrupted or a continuous method. We defined continuous closure as the use of a running suture on the fascia with knots only at either extreme of the wound, or the use of two running sutures with knots at the extremes of the wound, and

tied together in the middle of the wound. We defined interrupted closure as the use of multiple knotted sutures to close the fascia. We did not distinguish between the types of interrupted closures (e.g. Smead Jones, simple, figure of eights). Interrupted closure has the advantage of ensuring closure, even if one of the suture knots breaks, but requires a longer closure time. Continuous closure is advantageous in that it disperses the tension more evenly and is more quickly completed. The disadvantage is that if the suture breaks, the entire incision may fall apart (dehisce).

The third decision is the type of suture material. Surgeons may choose from absorbable (i.e. sutures which will lose their tensile strength over time as the body breaks down the material) or non-absorbable sutures (i.e. permanent). We further classified absorbable sutures into fast absorbable (those with loss of tensile strength within 30 days) and slow absorbable (loss of tensile strength greater than 30 days) in this review. A surgeon may also choose between monofilament or multifilament sutures.

How the intervention might work

Closing the abdominal wall allows for approximation of the cut edges from the laparotomy. Suturing the fascial layer closed protects the abdominal contents from critical dehydration, hypothermia, injury and infection, helps with pulmonary mechanics, and should reduce or eliminate the development of abdominal wall hernias postoperatively.

Why it is important to do this review

It is apparent that a multitude of factors play a role in the selection of an appropriate suture material in a given situation, including costs. The sequelae of a poorly closed wound can be considerable. Early wound failure (wound infection and dehiscence) can lead to a return to the operating room, and increased length and cost of stay. Late wound failures (incisional hernia, sinus and fistula formation) can lead to additional surgical procedures and can affect a patient's quality of life. Determining the optimal closure technique could help to reduce these issues. This review was concerned with suture materials and closure techniques in the closure of laparotomy incisions. Many randomised controlled trials have studied suture materials and closure techniques employed for fascial closure after laparotomy incisions. We have attempted to summarise the evidence and provide conclusive comments on the efficacy of different suture materials and closure techniques in prior meta-analyses and reviews (Hodgson 2000; Rucinski 2001; Van't Riet 2002; Weiland 1998). However, each of the reviews was limited either by methodology, lack of comprehensive literature searching, restricted inclusion criteria, or a combination of these issues.

OBJECTIVES

The objectives of this review were to identify the best available suture techniques and suture materials for closure of the fascia following laparotomy incisions by assessing the following comparisons:

- absorbable versus non-absorbable sutures;
- mass versus layered closure;
- continuous versus interrupted closure techniques;
- monofilament versus multifilament sutures; and
- slow absorbable versus fast absorbable sutures.

Our objective was not to determine the single best combination of suture material and techniques, but to compare the individual components of abdominal closure.

METHODS

Criteria for considering studies for this review

Types of studies

We included only randomised controlled trials (RCTs). Cluster-randomised trials were also considered for inclusion. We did not restrict the inclusion of studies by duration of follow-up (although we only included trials with a follow-up of more than one year for the primary outcome, incisional hernia). We included studies regardless of how hernia was diagnosed (clinical, radiological or combination of both).

Types of participants

We included trials that compared the interventions of interest in adults and children. We included trials that performed abdominal incisions in all types of operations including, but not limited to, gastrointestinal surgery, obstetric procedures, emergency procedures including those for perforating or penetrating abdominal injuries, and surgical intervention for obesity. We included trials that enrolled participants undergoing laparotomy through any type of abdominal incision and with any septic status of the incision including clean, clean-contaminated and septic or infected. We did not restrict inclusion based on the nutritional status or age of the participants. We excluded trials with participants undergoing laparoscopy and laparoscopic-assisted operations.

Types of interventions

We included trials that compared any of the following interventions separately or in combination with each other for fascial closure following abdominal incisions.

Suture technique

- Continuous suture
- Interrupted suture
- Mass closure either as a single mass layer or using the Smead-Jones technique (internal mass closure) with or without inclusion of the peritoneal layer
- Layered closure with or without inclusion of the peritoneal layer

Suture material

We classified the suture material as absorbable or non-absorbable. Absorbable suture materials included, but were not limited to, surgical catgut, polyglactin, polyglycolic acid, polydioxanone and polyglyconate. We further classified absorbable sutures into fast absorbable (those with loss of tensile strength within 30 days) and slow absorbable (loss of tensile strength greater than 30 days). Non-absorbable (i.e. permanent) suture materials included, and were not limited to, silk, polypropylene, stainless steel and nylon.

We also classified sutures as either monofilament or multifilament (i.e. braided). We did not exclude studies that compared monofilament versus multifilament sutures with different absorptive characteristics (e.g. we included studies that

compared non-absorbable monofilament sutures to absorbable multifilament sutures).

If multiple types of sutures were used, we categorised the trial based on what type of suture was used on the fascial layers (Table 2).

We excluded trials that compared materials or techniques, or both, for the closure of the skin or peritoneum only. The use of retention sutures (defined as sutures that encompassed the entire abdominal wall (including the skin), placed in addition to the primary method of fascial closure) was also not compared in this review. We also excluded trials that only assessed stitch bites (small versus large) and not one of our other techniques.

Types of outcome measures

Primary outcomes

The primary outcome for the review was:

- Proportion of participants who developed incisional hernia, as defined in the included studies, at one year or more of follow-up.

Secondary outcomes

The secondary outcomes for the review were:

- Wound infection, as defined and identified in the included studies.
- Wound dehiscence (i.e. fascial breakdown in the postoperative period), as defined and identified in the included studies.
- Wound sinus or fistula formation, as defined in included studies.

We focused on superficial surgical site infections, as these are most clinically relevant to the suture material and technique. If studies presented organ space, deep site and superficial site infections, we included only the superficial site infection in the outcome.

We did not incorporate the specific management of wound dehiscence into our review. We considered both dehiscence requiring reoperation and dehiscence managed non-operatively for inclusion in our review.

Search methods for identification of studies

Electronic searches

On 8 February 2017 we searched the following electronic databases with no language or date of publication limitations:

- Cochrane Central Register of Controlled Trials (CENTRAL; 2017, Issue 2) (Appendix 1);
- MEDLINE (OVID) 1950 to 8 February 2017 (Appendix 2);
- Embase (OVID) 1974 to 8 February 2017 (Appendix 3);
- ClinicalTrials.gov, 8 February 2017 (Appendix 4); and
- World Health Organization International Clinical Trials Registry Platform (ICTRP), 8 February 2017 (Appendix 5)

Searching other resources

We searched the reference lists of all included studies to identify RCTs that the electronic search may have failed to identify. We searched the Science Citation Index (8 February 2017) to identify additional trials that may have cited the included trials.

Data collection and analysis

Selection of studies

Review authors (SVP, DP, SS, SV, RN) independently assessed each title and abstract of all reports identified through the electronic and manual searches. We labelled each report as (a) definitely exclude, (b) unsure or (c) definitely include. We retrieved full texts for those classified as 'unsure' or 'definitely include'. Two review authors (from SVP, DP, SS, SV, RN) independently assessed these full-text articles for inclusion. We included all eligible studies irrespective of whether measured outcome data were reported on in a usable way. We resolved differences through discussion.

Data extraction and management

Two of the review authors (from SSV, SVP, DP) independently extracted data for the study characteristics, and primary and secondary outcomes onto data collection forms developed for this purpose. We resolved discrepancies through discussion. We attempted to contact authors of studies with missing data or unclear methods. One review author (either SVP, SSV or DP) entered all data into Review Manager 5 (RevMan 5.3) (RevMan 2014) and a second review author (either SVP or DP) verified the data entered.

Assessment of risk of bias in included studies

Two review authors (from SVP, DP, SS, SV, RN) independently assessed the included studies for sources of systematic bias according to the guidelines in Chapter 8, sections 1 to 16, of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011a). We evaluated the studies for the following criteria: randomisation, allocation concealment (selection bias and performance bias), blinding of outcome assessors, rates of follow-up and the use of an intention-to-treat analysis (attrition bias), selective reporting and other biases identified in the assessment process.

We assessed selective reporting for whether hernia outcomes were determined at a minimum of one year's follow-up, and whether wound infection and dehiscence were reported in the perioperative period. We classified each bias as (a) low risk of bias, (b) high risk of bias or (c) unclear risk of bias, as described in the Cochrane 'Risk of bias' tool (Higgins 2011a, Appendix 6). We resolved differences between the two review authors by discussion. We judged trials as overall high risk of bias if we identified one or more domains as being at high risk of bias. We attempted to contact authors in studies that we judged to have 'unclear risk of bias' in any domain.

Measures of treatment effect

We measured all outcomes as dichotomous variables (i.e. occurring or not occurring) over the study period, and therefore measured the treatment effect using risk ratios (RR) with corresponding 95% confidence intervals (CI). We included postoperative outcomes (dehiscence and wound infection) if the trial measured these outcomes within the postoperative period, defined as within 30 days of surgery. We included sinus or fistula tract occurrence if identified at any point. We included incisional hernia if at least one year of follow-up was completed for the study.

Unit of analysis issues

The unit of analysis in this review was the individual participant. We did not identify any cluster-RCTs in the search, but should we do so

in later updates, we will seek expert statistical advice to minimise potential unit-of-analysis issues.

Studies with more than two intervention groups

In studies with multiple comparison arms, we included pair-wise data in all applicable meta-analyses, as long as the groups were independent (i.e. did not share participants) and compared an intervention of interest. If two or more groups shared an intervention of interest and could be compared to a separate group (e.g. two groups using absorbable sutures, with a third using non-absorbable sutures), we combined the two comparable groups for analysis. The exception was if an intervention differed by more than one component between groups. In this case, we included the groups differing by only one intervention in the meta-analysis. For example, if there were three groups, group one using interrupted absorbable sutures, group two using continuous absorbable sutures and group three using non-absorbable continuous sutures, we would compare group one to group two for analysis of continuous versus interrupted sutures, and group two to group three for analysis of absorbable versus non-absorbable sutures.

Dealing with missing data

With regard to missing individuals from studies, we have based analyses on intention-to-treat analyses as far as permitted by published data for relevant outcome measures. For studies with dropout rates exceeding 10%, we performed best-case/worst-case sensitivity analyses for binary outcomes.

Assessment of heterogeneity

We assessed clinical and methodological heterogeneity using data collected to assess risk of bias and the table of Characteristics of included studies. We assessed statistical heterogeneity using the I^2 statistic (Higgins 2003), categorizing heterogeneity into low (I^2 less than 30%), moderate (I^2 30% to 60%) or substantial (I^2 more than 60%) as described in the *Cochrane Handbook for Systematic Reviews of Interventions* (Chapter 9.5 Deeks 2011). We anticipated that type of incision (midline, paramedian, subcostal), acuity of surgery (elective versus emergent) and wound contamination classification would be sources of heterogeneity.

We also considered studies that compared interventions differing by more than one component between groups to be a source of heterogeneity.

Assessment of reporting biases

We assessed reporting biases with the use of funnel plots. We created funnel plots for our primary outcome, incisional hernia, for each comparison where there were more than 10 included studies, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Sterne 2011).

Data synthesis

We performed the meta-analyses using RevMan 5 software provided by Cochrane (RevMan 2014).
We calculated a summary RR for the dichotomous outcomes included in the review following guidelines in the *Cochrane Handbook for Systematic Reviews of Interventions* (Deeks 2011).

We analysed five comparisons for closure material and technique:

- absorbable versus non-absorbable materials;
- continuous versus interrupted closure;
- mass versus layered closure;
- monofilament versus multifilament sutures; and
- slow versus fast absorbable sutures.

If trials compared a combination of different materials and techniques (e.g. absorbable, continuous closure versus non-absorbable, interrupted closure), we included the trial in all applicable analyses (i.e. absorbable versus non-absorbable and continuous versus interrupted). For trials in which there were more than two comparator groups, we attempted to include outcome data for analysis in which only one component differed between groups (e.g. suture material or technique). If a third group differed by more than one component, we did not include it in the analysis.

We used random-effects modelling exclusively throughout our analyses given the clinical heterogeneity of the included studies.

Subgroup analysis and investigation of heterogeneity

We undertook subgroup analyses for each outcome comparing the results for those trials that assessed interventions that differed only by the assessed comparison (e.g. absorbable sutures versus non-absorbable sutures, both with continuous closure) to those that assessed interventions that differed by more than just this comparison (e.g. absorbable suture and continuous closure versus non-absorbable sutures with interrupted closure).

We also conducted subgroup analysis to determine if the type of incision (the use of midline incision only - there was insufficient data to assess paramedian incisions) affected the incidence of incisional hernia (this subgroup analysis only included comparisons where the intervention differed in a single component across groups).

We also planned a subgroup analysis to determine the effect of acuity of surgery (emergent versus elective) and wound classification on the association between our interventions and the primary outcome, but there were insufficient data to conduct these analyses.

Sensitivity analysis

We conducted sensitivity analyses to determine the impact of excluding studies with at least one domain identified as being at a high risk of bias. We also conducted best case/worst case sensitivity analysis as explained above for missing data.

'Summary of findings' tables

We evaluated the quality of evidence using the GRADE approach (Schünemann 2011) for each outcome. We presented the quality of evidence in 'Summary of Findings' tables for the following comparisons.

- Absorbable versus non-absorbable sutures for laparotomy incisions
- Mass versus layered closure for laparotomy incisions
- Continuous versus interrupted closure for laparotomy incisions
- Monofilament versus multifilament sutures for laparotomy incisions
- Fast absorbable versus slow absorbable sutures for laparotomy incisions

The GRADE system classifies the quality of evidence in one of four grades.

- **High quality:** we are very confident that the true effect lies close to that of the estimate of the effect
- **Moderate quality:** we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
- **Low quality:** our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect
- **Very low quality:** we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

The quality of evidence could be downgraded by one (serious concern) or two (very serious concern) for the following reasons: risk of bias, inconsistency (unexplained heterogeneity, inconsistency of results), indirectness (indirect population, intervention, control, outcomes), imprecision (wide confidence intervals, overlapping no effect), and publication bias.

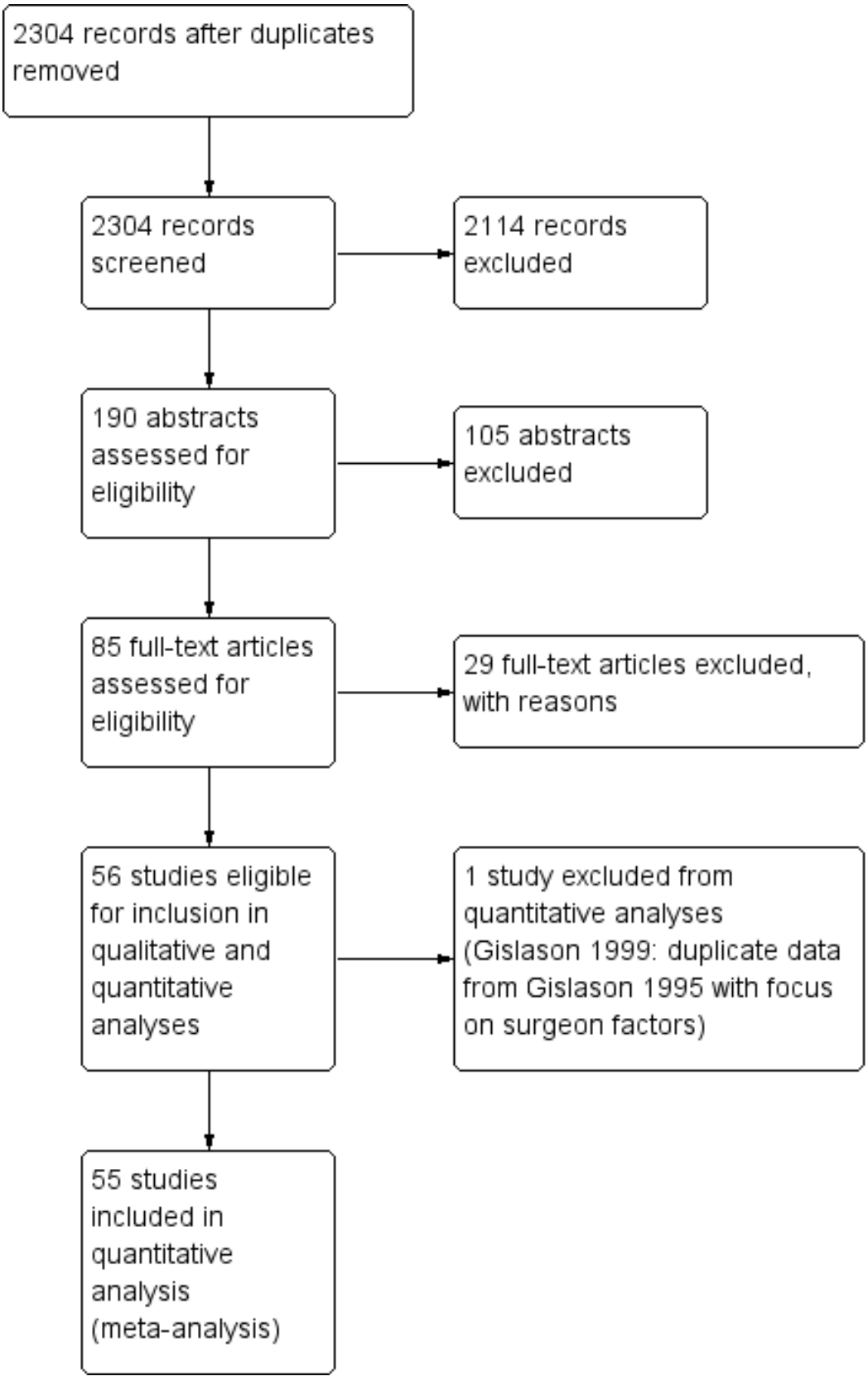
RESULTS

Description of studies

Results of the search

As seen in Figure 1, there were 2304 studies identified through the primary search. From these studies, we identified 85 for full-text review, 55 of which were included in the quantitative analyses.

Figure 1. Study flow diagram



We furthermore identified six ongoing studies (NCT01965249; NCT00544583; ISRCTN25616490; NCT00514566; TCTR20150318001; NCT02145052), from searches in ClinicalTrials.gov and World Health Organization International Clinical Trials Registry Platform.

Included studies

We included a total of 55 studies with 19,174 participants in this review. Studies were published between 1975 and 2015. A summary of each study can be found in the Characteristics of included studies table. There was a large degree of heterogeneity in the types of comparisons performed within these studies, and they investigated a variety of absorbable sutures (including polyglactin-910, polydioxanone, polyglycolic acid, polyglyconate and chromic catgut) and non-absorbable sutures (nylon, polyester, polypropylene, silk, steel). There was a large amount of variability in the combination of suture material, closure technique (continuous versus interrupted) and closure method (mass versus layered). Commonly, we found that more than one component varied in the pair-wise comparisons (i.e. absorbable, continuous, mass closure versus non-absorbable, interrupted, layered closure).

In addition, 15 studies investigated more than two groups for comparison. Of these, only Agrawal 2009 was a factorial study with 4 interventional groups. For the purpose of our meta-analyses, we included the individual group results in our analyses. Four studies included three or more groups, with only one component that differed between groups (Bresler 1995; Corman 1981; Donaldson 1982; Pollock 1979). Ten studies included three or more groups and had more than one component that differed between groups (Agrawal 2014; Berretta 2010; Gislason 1995; Goligher 1975; Irvin 1977; Larsen 1989; Leaper 1977; Savolainen 1988; Seiler 2009; Wissing 1987). The groups used for the outcome analyses are specified in the notes section of the Characteristics of included studies table.

There was a broad range of surgical indications for laparotomy (upper gastrointestinal, biliary tree, small bowel, colorectal, obesity surgery). Only one study looked only at emergency surgery patients (Agrawal 2009). In addition, the types of incision varied widely between studies (upper midline, lower midline, paramedian, subcostal, transverse) and even within studies. In total, 26 studies included participants undergoing only midline incisions (Agrawal 2009; Agrawal 2014; Berretta 2010; Bloemen 2011; Bresler 1995; Brolin 1996; Carlson 1995; Colombo 1997; Dan 2014; Deitel 1990; Efem 1980; Fagniez 1985; Israelsson 1994; Krukowski 1987; Lewis 1989; McNeill 1986; Ohira 2015; Orr 2003; Pandley 2013; Savolainen 1988; Seiler 2009; Siddique 2015; Taylor 1985; Trimbos 1992;Ullrich 1981 Wissing 1987), while two studies included participants undergoing paramedian incisions alone (Donaldson 1982; Goligher 1975). The remaining studies included a combination of incisions, or did not specify the type of incisions used.

Follow-up duration for the included studies included at least the perioperative period (allowing for assessment of wound infection and dehiscence). Follow-up duration for the detection of incisional hernia varied greatly. We had to exclude several studies from the hernia analysis due to insufficient follow-up duration (i.e. less than one year).

Excluded studies

After full-text review, we excluded 29 studies for a variety of reasons. The reasons for exclusion can be found in the Characteristics of excluded studies table.

Risk of bias in included studies

We assessed only one trial as having a low risk of bias across all assessed categories (Bloemen 2011). Twenty-six of the 55 trials had a high risk of bias in at least one category. The remainder had an unclear risk of bias. The large number of trials with an unclear risk of bias was due to poor reporting of their trial methods.

Allocation

The majority of the included trials suffered from poor reporting of their methods. Many trials did not specify the methods of randomisation and allocation concealment (Figure 2; Figure 3). Randomisation was adequate in 15 of 55 included studies, and allocation concealment was adequate in 16 of 55 studies. Of the 15 with adequate randomisation, nine studies had an unclear risk of bias for allocation concealment. Of the 16 studies with adequate allocation concealment, nine had either unclear or high risk of bias in randomisation.

Figure 2. 'Risk of bias' graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

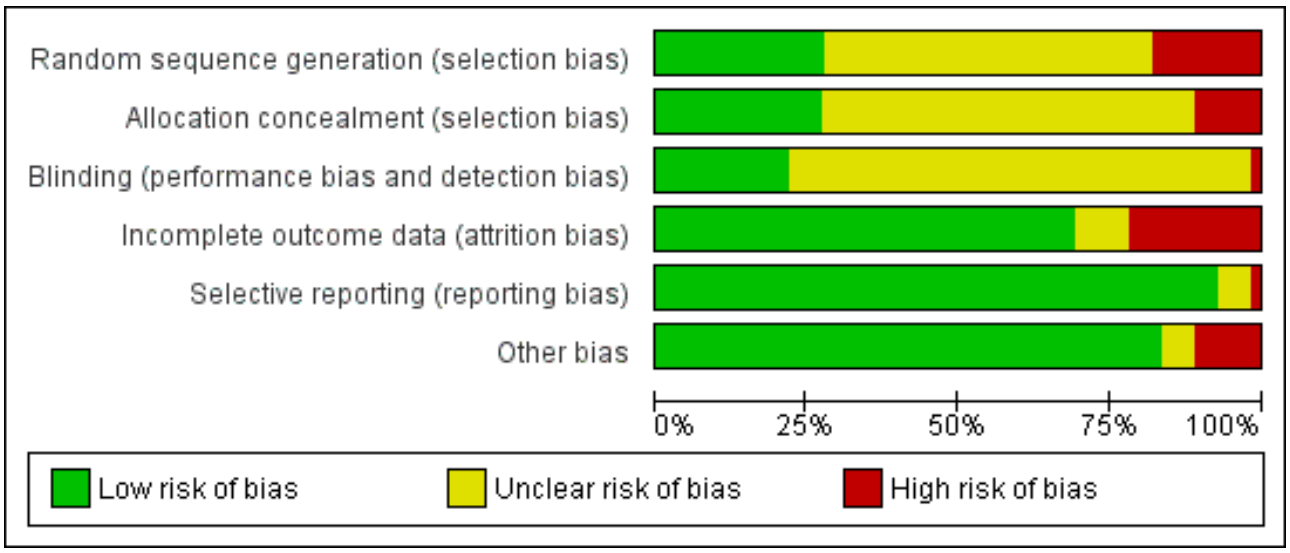


Figure 3. 'Risk of bias' summary: review authors' judgements about each risk of bias item for each included study

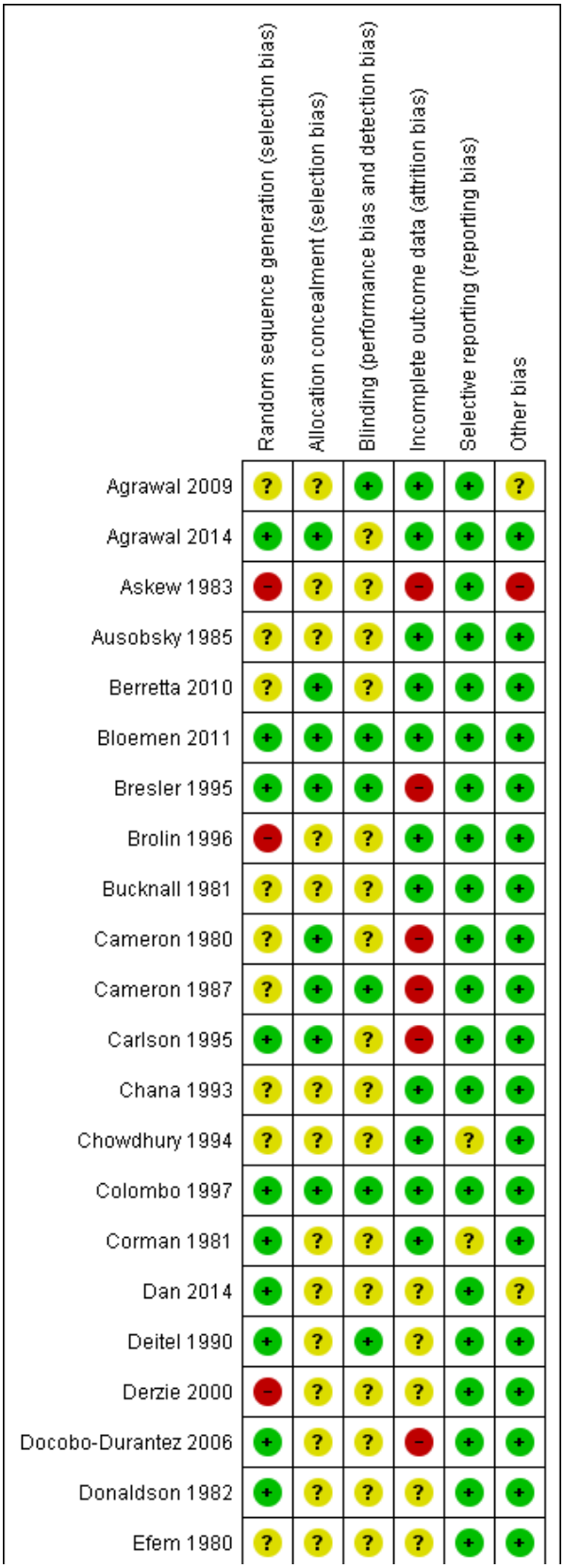


Figure 3. (Continued)

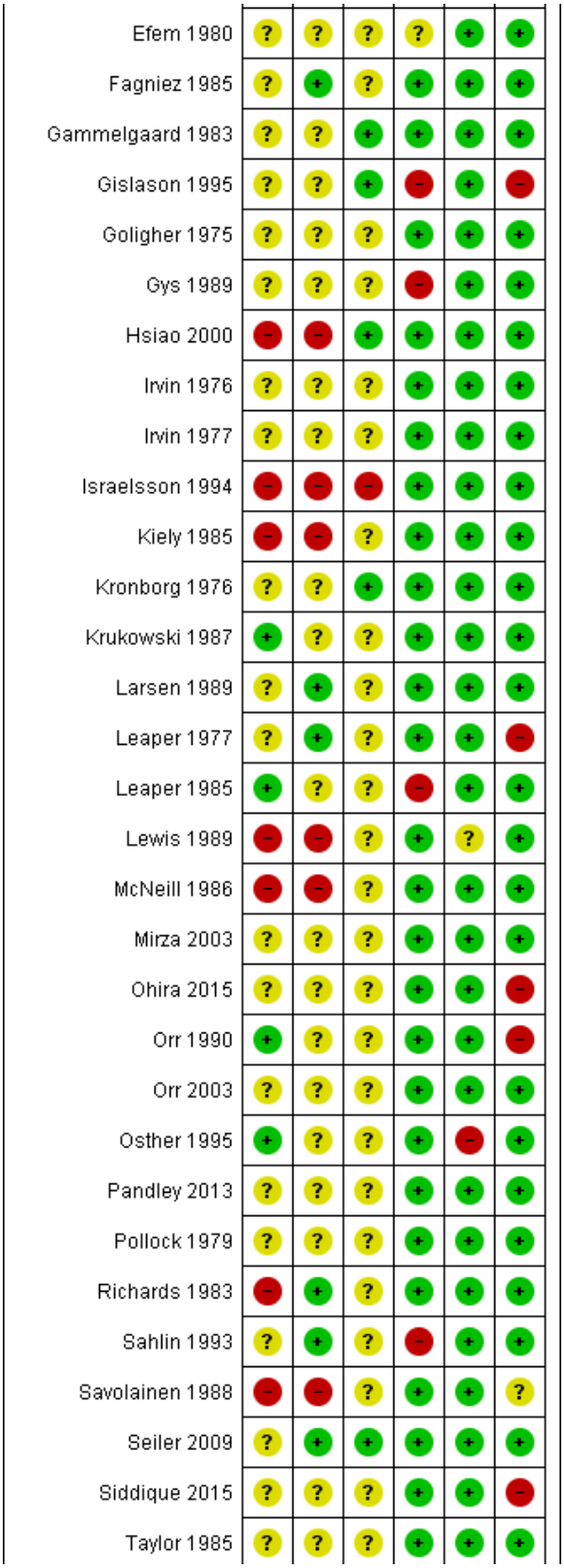
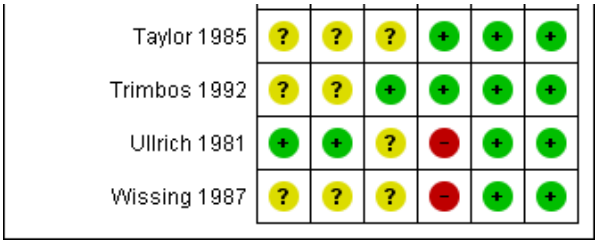


Figure 3. (Continued)



Blinding

Due to the nature of the intervention, blinding of the surgeon was not possible. The majority of studies did not explicitly discuss whether outcome assessors or participants were blinded to the intervention. Twelve of 55 studies reported avoiding detection bias by adequate outcome assessor blinding, while 43 studies were unclear about blinding or had high risk of bias of blinding (Figure 2; Figure 3).

Incomplete outcome data

Thirty-seven of 55 studies had adequate follow-up data, with few losses to follow-up. Twelve studies were at high risk of bias due to high loss to follow-up, without explanation as to the cause, or how this group differed from those who were followed up. The remainder of the studies did not adequately report the loss to follow-up, so the potential for attrition bias is unclear (Figure 2; Figure 3).

Of the 55 included studies, only one did not report an intention-to-treat analysis (Leaper 1985).

Selective reporting

None of the included trials had a registered trial protocol. Of the included trials, three were judged to have unclear risk of selective repoting (Chowdhury 1994; Corman 1981; Lewis 1989) due to unclear length of follow up. In addition, one trial was felt to be high risk of selective reporting, as dehiscence was a prespecified outcome, but was not reported (Osther 1995). All other trials reported their outcomes and were judged to be at low risk of selective reporting (reporting bias) (Figure 2; Figure 3).

Other potential sources of bias

Six of the 55 studies were clearly at high risk of other sources of bias. The sources of bias included: early termination of a trial without an a priori stopping rule (Askew 1983), follow-up through mailed surveys (Gislason 1995), surgeons refusing to randomise participants (Leaper 1977), participants not similar between groups (Ohira 2015), no available baseline characteristics (Orr 1990), or inappropriate exclusion criteria (Siddique 2015).

Effects of interventions

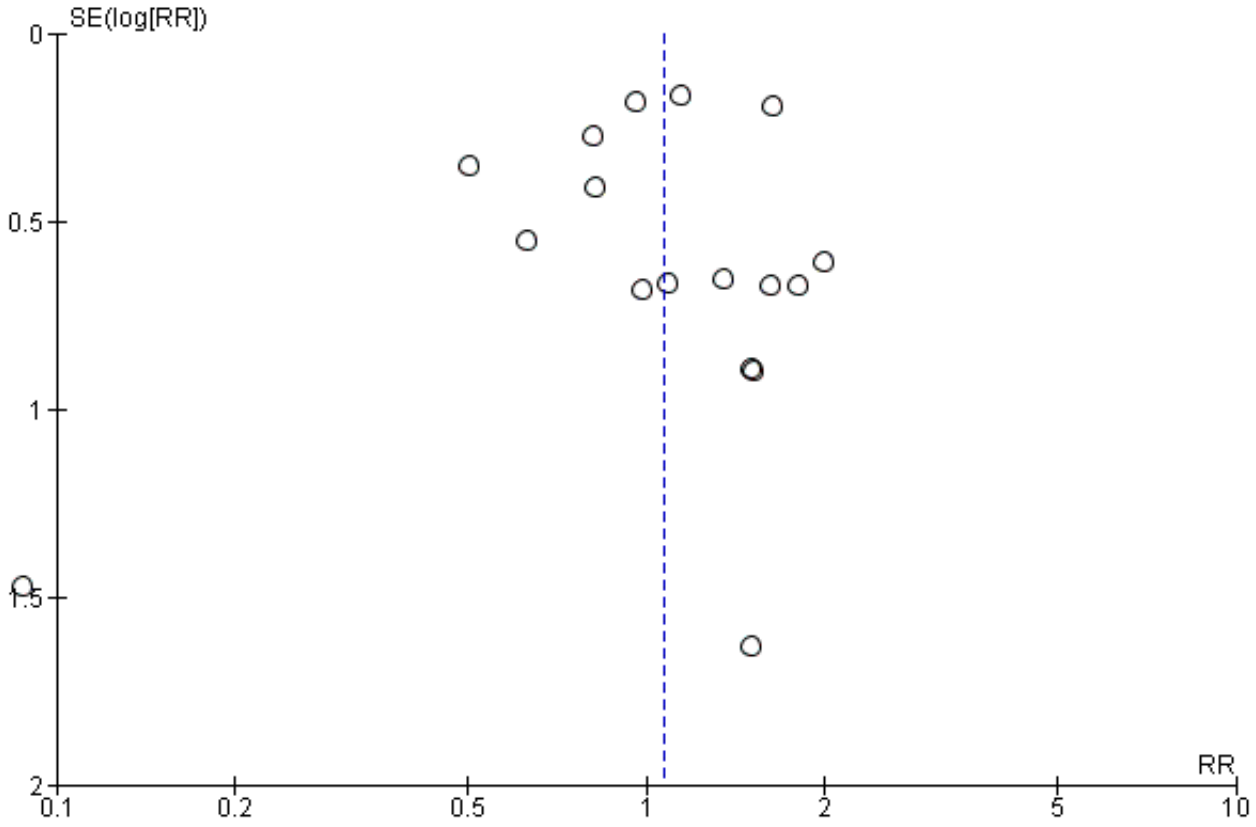
See: **Summary of findings for the main comparison** Absorbable versus non-absorbable sutures for laparotomy incisions; **Summary of findings 2** Mass versus layered closure for laparotomy incisions; **Summary of findings 3** Continuous versus interrupted closure for laparotomy incisions; **Summary of findings 4** Monofilament versus multifilament sutures for laparotomy incisions; **Summary of findings 5** Fast absorbable versus slow absorbable sutures for laparotomy incision

1. Primary outcome: incisional hernia at one year or more of follow-up

1.1 Absorbable versus non-absorbable sutures

We included a total of 17 studies, with 4720 participants, in the analysis of absorbable versus non-absorbable sutures for hernia formation. Overall, we found no evidence of a difference between absorbable and non-absorbable suture material and the risk of hernia (risk ratio (RR) 1.07, 95% confidence interval (CI) 0.86 to 1.32, P = 0.53, I^2 = 19%). A subgroup analysis, including only those studies that compared the same closure technique and method, found similar results (RR 1.13, 95% CI 0.95 to 1.34, P = 0.15, I^2 = 0%). There was no evidence of a subgroup effect (P = 0.73) (Analysis 1.1; Figure 4). Of note, there were four comparison groups from the study by Agrawal 2009. As such, we included two comparisons from this study, the first compared interrupted closures between the two suture materials, while the second compared continuous closures between the two suture materials. We implemented a similar approach in other applicable analyses in which the study was included.

Figure 4. Funnel plot of comparison 1. Absorbable suture versus non-absorbable sutures (any closure or technique), outcome 1.1: hernia



1.2 Mass versus layered closure

We included a total of five studies, with 1176 participants, in the analysis of mass versus layered closure for hernia formation. There was no evidence that mass versus layered closure resulted in an increased hernia risk (RR 1.92, 95% CI 0.58 to 6.35, P = 0.29, I^2 = 61%). Only one study assessed mass versus layered closure, using the same type of suture and closure technique (Ausobsky 1985). This study found that mass closure resulted in increased hernia risk (RR 3.86, 95% CI 1.34 to 11.07, P = 0.01), although there was no evidence of a subgroup effect within this analysis (P = 0.31) (Analysis 2.1).

1.3 Continuous versus interrupted closure

We included a total of 11 studies, with 3854 participants, in the analysis of continuous versus interrupted closure for hernia. The use of continuous or interrupted closure technique did not appear to affect the risk of hernia (RR 1.01, 95% CI 0.76 to 1.35, P = 0.94, I^2 = 42%). A subgroup analysis, including only those studies that compared the same type of suture, found similar results, and the difference between subgroups was not significant (test of subgroup effect, P = 0.22) (Analysis 3.1). Of note, there were four comparison groups from the study by Agrawal 2009. Results were grouped accordingly (as described above).

1.4 Monofilament versus multifilament sutures

We included a total of 16 studies, with 4520 participants, in the analysis of monofilament versus multifilament sutures for hernia. Of the 16 studies, nine compared groups with similar absorption of sutures (i.e. absorbable versus absorbable or non-absorbable versus non-absorbable) (Bresler 1995; Deitel 1990; Gislason 1995; Hsiao 2000; Ohira 2015; Osther 1995; Sahlin 1993; Seiler 2009; Trimbos 1992). Overall, there was evidence to suggest that monofilament sutures reduced the risk of hernia, relative to multifilament sutures (RR 0.76, 95% CI 0.59 to 0.98, P = 0.04, I^2 = 30%). There was no evidence of a subgroup effect when we assessed trials with the same closure method and technique separately (test of subgroup differences P = 0.73) (Analysis 4.1).

1.5 Slow absorbable versus fast absorbable sutures

We included a total of 10 studies, with 3643 participants, in the analysis of slow versus fast absorbable sutures for hernia formation. There was no evidence that the rate of absorption affected the risk of hernia (RR 0.81, 95% CI 0.63 to 1.06, P value = 0.12, I^2 = 33%). We found no subgroup effect when comparing trials with the same closure methods to those with differing closure methods (test of subgroup effect P value = 0.78) (Analysis 5.1).

2. Secondary outcome: wound infection

2.1 Absorbable versus non-absorbable sutures

We included a total of 29 studies, with 8457 participants, in the analysis of absorbable versus non-absorbable sutures for wound infection. Overall, we found no evidence of a difference in the risk of wound infection between absorbable and non-absorbable sutures (RR 0.99, 95% CI 0.84 to 1.17, P = 0.9, I^2 = 35%). Subgroup analysis, including only those studies that compared the same closure

technique and method, found similar results (test of subgroup effect P = 0.68) (Analysis 1.2).

2.2 Mass versus layered closure

We included a total of 11 studies, with 2926 participants, in the analysis of mass versus layered closure for wound infection. Overall, there was no evidence that mass versus layered closure resulted in a difference in wound infection (RR 0.93, 95% CI 0.67 to 1.30, P = 0.68, I^2 = 50%). Only one study assessed mass versus layered closure, using the same type of suture and closure technique (Ausobsky 1985). There was no evidence of a subgroup effect within this analysis (P = 0.33) (Analysis 2.2).

2.3 Continuous versus interrupted closure

We included a total of 23 studies, with 10,039 participants, in the analysis of continuous versus interrupted closure for wound infection. There was no statistically significant evidence to suggest that interrupted sutures may result in a lower risk of wound infection (RR 1.13, 95% CI 0.96 to 1.34, P value = 0.15, I^2 = 32%), We found similar results in the subgroup analysis of studies with the same closure methods and suture materials within each group (P value = 0.49) (Analysis 3.2).

2.4 Monofilament versus multifilament sutures

We included a total of 23 studies, with 6557 participants, in the analysis of monofilament versus multifilament sutures for wound infection. Overall, there was no evidence of a difference in risk of wound infection between monofilament and multifilament suture materials (RR 1.08, 95% CI 0.91 to 1.28, P = 0.38, I^2 = 21%). There was no evidence of a subgroup effect when we assessed trials with the same closure method and technique separately (test of subgroup differences P = 0.17) (Analysis 4.2).

2.5 Slow absorbable versus fast absorbable sutures

We included a total of 11 studies, with 4100 participants, in the analysis of slow versus fast absorbable sutures for wound infection. There was no evidence that the rate of absorption affected the risk of wound infection (RR 1.16, 95% CI 0.85 to 1.57, P = 0.35, I^2 = 36%). We found no subgroup effect when comparing trials with the same closure methods to those with differing closure methods (test of subgroup effect P value = 0.76) (Analysis 5.2).

3. Secondary outcome: wound dehiscence

3.1 Absorbable versus non-absorbable sutures

We included a total 34 studies, with 9004 participants, in the analysis of absorbable versus non-absorbable sutures for dehiscence. Overall, we found no evidence of a difference in the risk of wound dehiscence between absorbable and non-absorbable sutures (RR 0.78, 95% CI 0.55 to 1.10, P = 0.16, I^2 = 32%). There was no evidence of a subgroup effect when comparing trials with the same closure methods to those with differing closure methods (P = 0.29) (Analysis 1.3).

3.2 Mass versus layered closure

We included a total of 11 studies, with 2863 participants, in the analysis of mass versus layered closure for dehiscence. Overall, there was no conclusive evidence to suggest that layered closure may decrease wound dehiscence (RR 0.69, 95% CI 0.31 to 1.52, P = 0.35, I^2 = 25%). Only one study assessed mass versus layered closure, using the same type of suture and closure technique (Ausobsky 1985). There was no evidence of a subgroup effect within this analysis (P = 0.75) (Analysis 2.3).

3.3 Continuous versus interrupted closure

We included a total of 21 studies, with 9228 participants, in the analysis of continuous versus interrupted closure for dehiscence. The use of continuous or interrupted closure technique did not affect the risk of dehiscence (RR 1.21, 95% CI 0.90 to 1.64, P = 0.21, I^2 = 17%). There was no evidence of a subgroup effect, when analysing studies using a similar suture material and closure method (P = 0.76). (Analysis 3.3).

3.4 Monofilament versus multifilament sutures

We included a total of 22 studies, with 6199 participants, in the analysis of monofilament versus multifilament sutures for dehiscence. Overall, there was no evidence that monofilament sutures increased the risk of dehiscence, compared to multifilament sutures (RR 1.24, 95% CI 0.93 to 1.67, P = 0.15, I^2 = 0%). There was no evidence of a subgroup effect when we assessed trials with the same closure method and technique separately (test of subgroup differences P = 0.56) (Analysis 4.3).

3.5 Slow absorbable versus fast absorbable sutures

We included a total of eight studies, with 3440 participants, in the analysis of slow versus fast absorbable sutures for dehiscence. There was no evidence to suggest that slow absorbable sutures may increase the risk of dehiscence (RR 1.55, 95% CI 0.92 to 2.61, P = 0.10, I^2 = 0%). We found no subgroup effect when comparing trials with the same closure methods to those with differing closure methods (test of subgroup effect P value = 0.42) (Analysis 5.3).

4. Secondary outcome: wound sinus or fistula formation

4.1 Absorbable versus non-absorbable sutures

We included a total of 19 studies, with 5470 participants, in the analysis of absorbable versus non-absorbable sutures for wound sinus or fistula formation. Overall, we found evidence that absorbable sutures decreased the risk of sinus or fistula tract formation (RR 0.49, 95% CI 0.26 to 0.94, P = 0.03, I^2 = 52%). Subgroup analysis, including only those studies that compared the same closure technique and method, demonstrated similar results, with no evidence of a subgroup effect (P = 0.51) (Analysis 1.4).

4.2 Mass versus layered closure

We included a total of six studies, with 1076 participants, in the analysis of mass versus layered closure for sinus or fistula tract formation. Mass versus layered closure did not result in a difference in terms of fistula or sinus formation (RR 0.49, 95% CI 0.15 to 1.62, P = 0.24, I^2 = 38%). Only one study assessed mass versus layered closure, using the same type of suture and closure technique (Ausobsky 1985). There was no evidence of a subgroup effect within this analysis (P = 0.55) (Analysis 2.4).

4.3 Continuous versus interrupted closure

We included a total of 10 studies, with 5082 participants, in the analysis of continuous versus interrupted closure for sinus or fistula formation. The use of continuous or interrupted closure technique did not appear to affect the risk of sinus or fistula tract formation (RR 1.51, 95% CI 0.64 to 3.61, P = 0.35, I^2 = 57%). There was

evidence of a subgroup effect (P = 0.005), although the analysis of studies with the same suture material and closure method found no evidence of a difference in sinus or fistula tract formation (RR 0.76, 95% CI 0.51 to 1.12, P = 0.17, I^2 = 0%) (Analysis 3.4).

4.5 Monofilament versus multifilament sutures

We included a total of eight studies, with 2285 participants, in the analysis of monofilament versus multifilament sutures for sinus or fistula tract formation. There was no evidence that the risk of sinus or fistula formation was increased with the use of monofilament versus multifilament suture materials (RR 1.91, 95% CI 0.77 to 4.73, P = 0.16, I^2 = 51%). There was no evidence of a subgroup effect when we assessed trials with the same closure method and technique separately (P = 0.87) (Analysis 4.4).

4.6 Slow absorbable versus fast absorbable sutures

We included a total of two studies, with 911 participants, in the analysis of slow versus fast absorbable sutures for sinus or fistula formation. There was no evidence that the rate of absorption affected the risk of sinus or fistula formation (RR 0.88, 95% CI 0.05 to 16.05, P = 0.93, I^2 = 72%). There was no significant evidence of a subgroup effect between the two studies (P = 0.07), (Analysis 5.4).

5. Subgroup analyses

5.1 Effect of the type of incision

Of the included studies, 24 included participants who underwent a midline incision only (Agrawal 2009; Agrawal 2014; Berretta 2010; Bloemen 2011; Brolin 1996; Carlson 1995; Colombo 1997; Dan 2014; Deitel 1990; Efem 1980; Fagniez 1985; Israelsson 1994; Krukowski 1987; Lewis 1989; McNeill 1986; Ohira 2015; Orr 2003; Pandley 2013; Savolainen 1988; Seiler 2009; Siddique 2015; Taylor 1985; Trimbos 1992; Wissing 1987), and two included participants who underwent a paramedian incision only (Donaldson 1982; Goligher 1975). No other types of incisions were looked at in isolation by any of the included trials. Of the remaining studies, they either included a combination of the incision types, or did not specify the type of incision(s). Due to the small number of papers only studying paramedian incisions, we conducted a subgroup analysis for midline incisions only.

There were not enough studies reporting results for those having a midline incision within the fast absorbable versus slow absorbable comparison to complete the subgroup analysis for the outcomes in midline-only incisions. A comparison of mass versus layered closure for midline-only incisions seemed clinically implausible as all midline incisional closures should be mass by definition (with the exception of the peritoneum which was not of interest/excluded for the purposes of this review).

For trials that compared absorbable to non-absorbable sutures, with the same closure methods and techniques between groups, we found no evidence of a difference between absorbable and non-absorbable sutures in terms of hernia (RR 1.13, 95% CI 0.95 to 1.34, P = 0.15, I^2 = 0%) and no subgroup effect with midline incisions compared with all other types of incision (P = 0.91) (Analysis 1.5). Similarly, we found no evidence of a difference between continuous and interrupted sutures in terms of hernia in those who had a midline incision (RR 1.19, 95% CI 0.86 to 1.64, P = 0.29, I^2 = 0%) and no subgroup effect with midline incision compared to all other types of incision (P = 0.78) (Analysis 3.5).

There was no evidence of a subgroup effect between participants with a midline incision versus other incisions, when comparing monofilament and multifilament sutures (P value = 0.24). However, when we analysed participants undergoing midline incision alone in isolation, monofilament sutures decreased the risk of incisional hernia, compared with multifilament closure (RR 0.62, 95% CI 0.47 to 0.81, P = 0.0005) (Analysis 4.5).

5.2 Effect of acuity of surgery

There was only one study that assessed emergent participants only (Agrawal 2009). As such, we were unable to perform a subgroup analysis to determine the effect of emergent versus elective participants on the association between the interventions and our primary outcome. Other studies that included both elective and emergent surgeries did not discriminate between these acuities when presenting their results.

5.3 Effect of wound contamination classification

Of the 55 studies, only 20 provided information for contamination classification distribution within each experimental group. The proportion of clean, clean-contaminated, contaminated and dirty wounds varied greatly within these studies, and as such we could not perform any formal analysis to determine how this affected our analysis.

6. Sensitivity analysis

6.1 Excluding high risk of bias and multiple comparison studies

After excluding trials that had at least one category of 'high risk of bias' and trials that compared groups that differed by more than one component, we undertook a sensitivity analysis for our primary outcome, incisional hernia.

For the absorbable versus non-absorbable analysis (Analysis 6.1), across nine qualifying studies with 2949 participants, there was no significant effect seen (RR 1.21, 95% CI 0.98 to 1.49, P = 0.07, I^2 = 0%).

In the continuous versus interrupted analysis of three studies with 869 participants (Analysis 6.2), the sensitivity analysis was similar to the overall analysis, in showing no evidence of a difference in hernia, by technique (RR 1.20, 95% CI 0.87 to 1.64, P = 0.26, I^2 = 0%).

For the analysis of monofilament versus multifilament sutures (Analysis 6.3), the sensitivity analysis of five studies with 1336 participants resulted in the same direction of effect (favouring monofilament sutures) (RR 0.65, 95% CI 0.42 to 1.01, P = 0.05, I^2 = 9%).

We did not undertake a sensitivity analysis in the fast versus slow absorbable sutures comparison or in the mass versus layered analysis, as there was an insufficient number of trials with a low risk of bias to analyse (Table 3).

6.2 Accounting for missing data in studies with high losses to follow-up

Eight studies that had a high risk of bias due to incomplete outcome data (i.e. high losses to follow-up) assessed hernia as an outcome (Askew 1983; Cameron 1987; Carlson 1995; Docobo-Durantez 2006; Gislason 1995; Gys 1989; Sahlin 1993; Wissing 1987). Of these, two did not have group-wise data available for inclusion in this sensitivity analysis (Gys 1989; Sahlin 1993). To account for missing data, we undertook two series of sensitivity analyses. The first

(Analysis 7.1; Analysis 7.2; Analysis 7.3; Analysis 7.4; Analysis 7.5) assumed that all those lost to follow-up all developed an incisional hernia. The second (Analysis 8.1; Analysis 8.2; Analysis 8.3; Analysis 8.4; Analysis 8.5) assumed all those lost to follow-up did not develop an incisional hernia.

In the first series of analyses where hernia was assumed in those lost to follow-up, we found the following results: absorbable versus non-absorbable sutures, no difference (RR 1.10, 95% CI 0.93 to 1.30, P = 0.28, I^2 =54%); mass versus layered closure, no difference (RR 1.82, 95% CI 0.81 to 4.10, P = 0.15, I^2 = 59%); continuous versus interrupted closure, no difference (RR 0.92, 95% CI 0.67 to 1.26, P = 0.58, I^2 = 64% RR 0.89, 95% CI 0.61 to 1.30, P = 0.55, I^2 = 76%); monofilament versus multifilament sutures, significantly less hernia in the monofilament population (RR 0.77, 95% CI 0.63 to 0.95, P = 0.01, I^2 = 43%); and slow versus fast absorbable suture material, no difference (RR 0.89, 95% CI 0.74 to 1.07, P = 0.21, I^2 = 27%).

In the second series of analyses where no hernia was assumed in those lost to follow-up, we found the following results: absorbable versus non-absorbable sutures, no difference (RR 1.07, 95% CI 0.91 to 1.27, P = 0.40, I^2 = 0%); mass versus layered closure, no difference (RR 1.80, 95% CI 0.57 to 5.62, P = 0.31, I^2 = 57%); continuous versus interrupted closure, no difference (RR 1.01, 95% CI 0.76 to 1.34, P = 0.96, I^2 = 39%); monofilament versus multifilament sutures, significantly less hernia in the monofilament population (RR 0.76, 95% CI 0.60 to 0.97, P = 0.03, I^2 = 24%); and slow versus fast absorbable suture material, no difference (RR 0.82, 95% CI 0.62 to 1.08, P = 0.16, I^2 = 39%).

Furthermore four studies with high attrition bias are missing from the above list (Bresler 1995; Cameron 1980; Leaper 1985; Ullrich 1981). Data from Bresler 1995 is included in sensitivity analysis for monofilament versus multifilament and slow absorbable versus fast absorbable. Data from Cameron 1980 and Leaper 1985 was not included in hernia analysis due to inadequate duration of follow up, which is why the data are not included in the sensitivity analysis. Furthermore data from Ulrich 1981 did not assess hernia as an outcome.

7. Publication bias

We assessed publication bias for the incisional hernia outcome. We examined three analyses (absorbable versus non-absorbable sutures, continuous versus interrupted closure, and monofilament versus multifilament sutures), each including at least 10 trials (Figure 4; Figure 5; Figure 6).
In these funnel plots there appears to be adequate symmetry, suggesting no overt publication bias.

Figure 5. Funnel plot of comparison 3. Continuous versus interrupted closure, outcome 3.1: incisional hernia

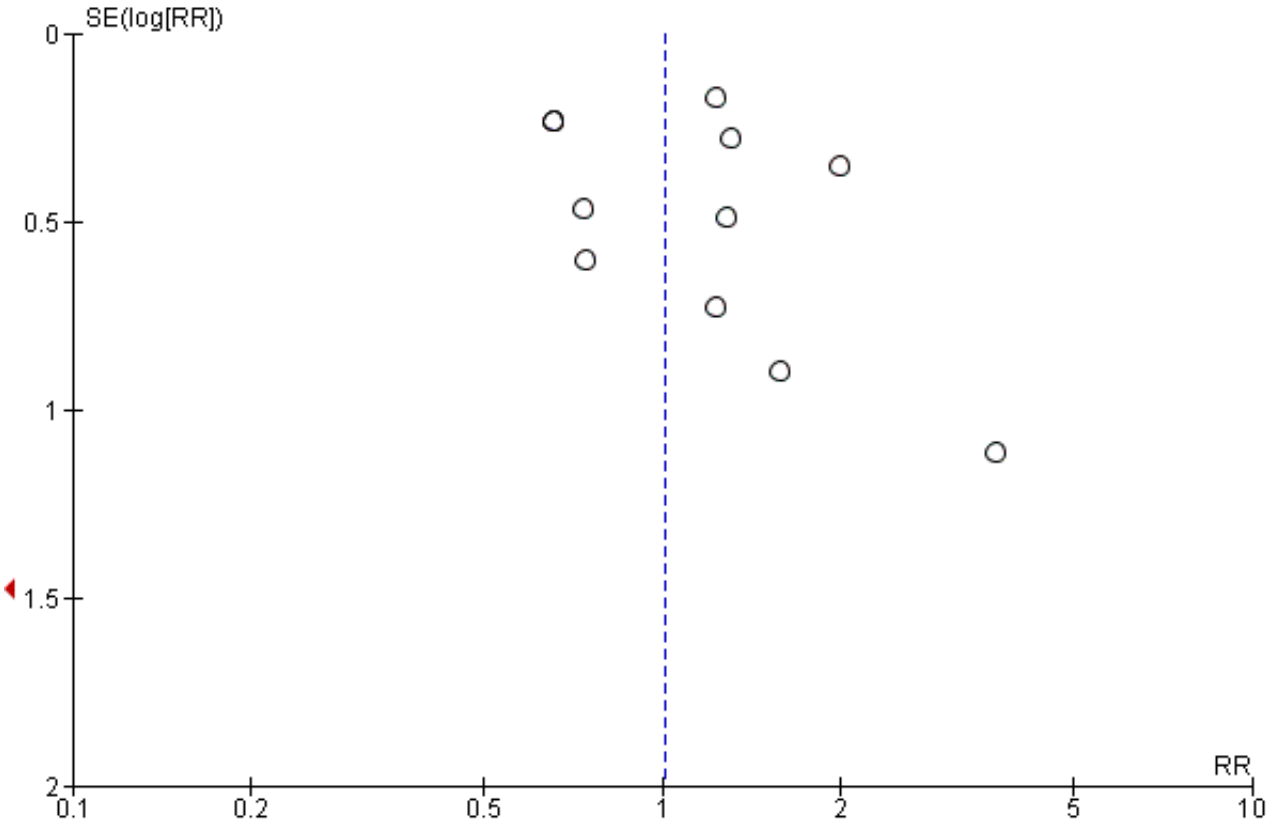
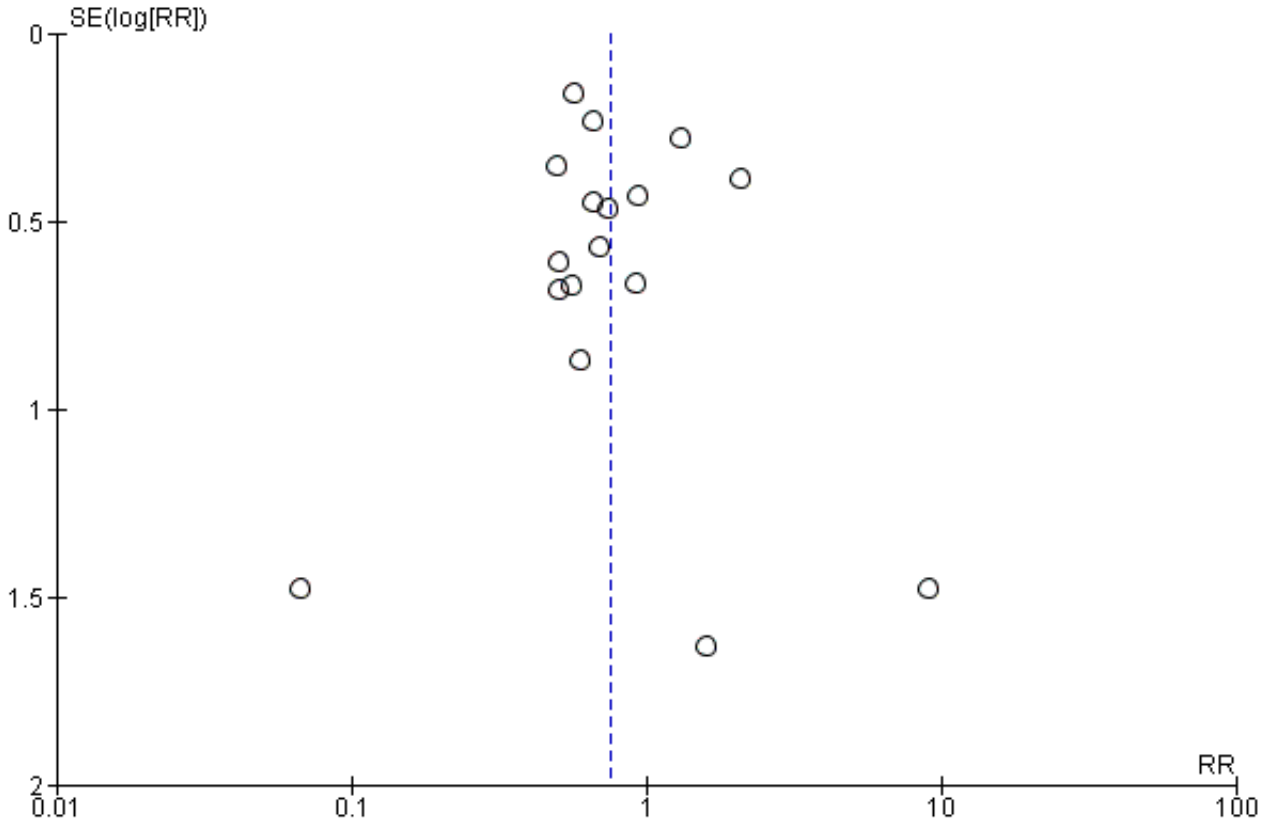


Figure 6. Funnel plot of comparison 4. Monofilament versus multifilament sutures, outcome 4.1: incisional hernia



DISCUSSION

Summary of main results

This review included 55 studies that assessed the effects of suture materials, and closure techniques and methods on the development of incisional hernia, wound infection, wound dehiscence, or sinus or fistula tract formation. The combination of suture material (absorbable or non-absorbable, monofilament or multifilament, fast or slow absorbable), suture technique (continuous or interrupted) and closure method (mass or layered) differed greatly between studies. As such, our focus was on determining the outcomes associated with each individual component.

Absorbable versus non-absorbable sutures

Despite the hypothesis that non-absorbable sutures would result in less incisional hernia formation, we did not find evidence of this effect when assessing and including all applicable trials. Even within the subgroup analysis, excluding those trials with differing technique and methods, there was no evidence that a treatment difference exists.

In terms of the other outcomes assessed, absorbable sutures decreased the risk of sinus or fistula tract formation (risk ratio (RR) 0.49, 95% confidence interval (CI) 0.26 to 0.94). There was high heterogeneity within this outcome (I^2 = 52%). Heterogeneity was reduced when we assessed studies comparing groups with the same closure technique and methods as a subgroup (I^2 = 22%). We did not find evidence that absorbable or non-absorbable sutures reduced the risk of dehiscence or wound infection.

Mass versus layered closure

Few studies assessed the effect of mass versus layered closure on the risk of hernia formation. Overall, there was no evidence that mass or layered closure resulted in a higher risk of hernia. Only one study compared mass versus layered closures, using the same suture material and closure technique in each group (Ausobsky 1985). This study found that mass closure increased the risk of hernia, but it suffered from methodological deficiencies (unclear method of randomisation, unclear allocation concealment and unclear blinding of wound assessors). As such, the confidence we can have in this conclusion is low.

For the secondary outcomes, it appeared that mass or layered closure had no effect on wound infections, wound dehiscence or sinus or fistula tract formation. These outcomes suffered from the fact that only one study had a common suture material and closure technique between groups (Ausobsky 1985).

Continuous versus interrupted closure

We found no benefit of continuous or interrupted closure in terms of hernia risk. Subgroup analysis and sensitivity analysis did not show any evidence that one technique or another resulted in a decrease in the risk of hernia. None of the secondary outcomes (wound infection, dehiscence or sinus or fistula formation) was associated with continuous or interrupted closure. Neither wound dehiscence

nor sinus or fistula tract formation seemed to be affected by the closure technique.

Monofilament versus multifilament sutures

The risk of hernia was reduced with monofilament sutures (RR 0.76, 95% CI 0.59 to 0.98). Despite the commonly held belief that multifilament sutures are associated with an increased risk of wound infection, we found no evidence of this within our analysis. The risk of dehiscence was not different between monofilament and multifilament sutures (RR 1.24, 95% CI 0.93 to 1.67). Sinus or fistula tract formation was not affected by monofilament or multifilament sutures (RR 1.91, 95% CI 0.77 to 4.73). This result had high heterogeneity (I^2 = 51%), which was not resolved with subgroup analysis. This heterogeneity may have been persistent, as only one study defined the outcome adequately (Wissing 1987). In addition, there was variable duration of follow-up to assess this outcome (from three months to two years).

Slow versus fast absorbable sutures

There did not appear to be a benefit for slow or fast absorbable sutures for hernia formation, wound infection or sinus formation. There was evidence to suggest a potential increase in dehiscence with slow absorbable sutures (RR 1.55, 95% CI 0.92 to 2.61). The finding that slow absorbable sutures may increase the risk of dehiscence is difficult to explain, as we expected that the longer duration of absorption would result in reinforcement of the wound edges for a longer period of time. One possible explanation for this may be the knot characteristics of polydioxanone versus Vicryl, etc. with the former, commonly-used slow absorbable suture material having much poorer handling and knotting profiles than the latter, common absorbable suture agent.

Midline incision

We undertook subgroup analyses to determine whether incidence of the primary outcome (hernia) was affected by the type of incision; sufficient data were available only for midline incision. We found no evidence of a subgroup effect in the absorbable versus non-absorbable sutures or continuous versus layered closure comparisons. For the monofilament versus multifilament comparison, we did find evidence of subgroup effect. The effect estimate favoured monofilament sutures in both the overall analysis as well as the midline incision subgroup.

Overall completeness and applicability of evidence

The primary objective of this review was to determine what a surgeon can do in terms of technique and material selection to prevent hernia, wound infection, wound dehiscence, and sinus or fistula formation following closure of a laparotomy incision. We assessed the surgeon-controlled risk factors (the choice of closure material and techniques), which have been implicated in closure failure in previous reviews. It is important to remember that patient factors (e.g. diabetes) and surgical pathology (e.g perforated diverticulitis with fecal peritonitis) also affect the risk of surgical wound complications, but the surgeon has no control over these.

The most discussed technique that was not included in this review was the short-stitch method described by Millbourn 2009 and others, as these trials had not been published at the time of acceptance of this study protocol. Although the early results appear promising, a limited number of trials are available for review.

The evidence presented in this review is applicable to any patient undergoing a laparotomy closure. We were able to identify over 19,000 participants from 55 studies for inclusion. This was a heterogeneous patient population and included patients undergoing emergency and elective procedures.

Quality of the evidence

Primary outcome, incisional hernia

We assessed the quality of evidence for each intervention using the methods described by Guyatt 2008. The quality of evidence can be found in Summary of findings for the main comparison; Summary of findings 2; Summary of findings 3; Summary of findings 4; and Summary of findings 5. For our primary outcome, incisional hernia, we found that there was moderate-quality evidence for absorbable versus non-absorbable sutures, continuous versus interrupted closure, monofilament versus multifilament sutures and slow versus fast absorbable sutures. We downgraded this outcome within these comparisons due to serious concerns regarding methodological quality and risk of bias. A rating of moderate quality (by definition) indicates that future research may have an important impact on our confidence in the estimate and may change the estimate (Guyatt 2008).

We graded the quality of evidence as very low for the mass versus layered closure outcomes. We downgraded this outcome for serious concerns about methodological quality, inconsistency and imprecision (few trials, with wide confidence intervals). A very low-quality grade indicates that we are very uncertain about the estimate and that future research is definitely required to better the estimate (Guyatt 2008).

Secondary outcomes

Comparing absorbable to non-absorbable sutures, we graded the quality of evidence for wound infections and dehiscence as moderate (downgraded for concerns about methodological quality), while we graded the quality of the evidence for sinus and fistula tract formation as low (downgraded for both poor methodological quality and inconsistency).

In the mass versus layered comparison, we graded the quality of the evidence for wound dehiscence as moderate (downgraded for concerns regarding risk of bias). We graded the quality of evidence for both sinus and fistula tract formation and wound infection as low (downgraded for methodological quality and inconsistency).

For the continuous versus interrupted outcomes, monofilament versus multifilament outcomes and slow versus fast absorbable sutures outcomes, we graded the quality of the evidence for wound infections and dehiscence as moderate (downgraded for concerns about methodological quality), while we graded the quality of the evidence for sinus or fistula tract formation as very low (downgraded for poor methodological quality, inconsistency and imprecision).

Potential biases in the review process

We minimised potential biases in the review process through duplication of study screening and data collection. We translated and included foreign language trials. We assessed all relevant

studies and included them if they met our inclusion criteria. We included a transparent search strategy and full details of why we excluded studies from analysis. Additional sources of potential bias include the decision to base analyses on intention-to-treat analyses, or the decision to only include trials with a follow-up of more than one year for the primary outcome, incisional hernia. Finally other potential sources of bias include the variability in the definition of individual studies of a hernia, wound infection and sinus.

Agreements and disagreements with other studies or reviews

There have been several previous meta-analyses assessing at least one of our comparisons (Hodgson 2000; Rucinski 2001; Sajid 2011; Van't Riet 2002; Weiland 1998).

Hodgson 2000 identified 13 trials for inclusion, and compared the effect of non-absorbable versus absorbable sutures and six trials comparing continuous versus interrupted sutures. They found a reduced odds of hernia with non-absorbable sutures (odds ratio (OR) 0.68, 95% CI 0.52 to0.87), with no evidence of a difference in wound infection or dehiscence between groups. Sinus formation was higher in the non-absorbable sutures groups (OR 2.18, 95% CI 1.48 to 3.22). Continuous closure was found to decrease the odds of hernia (OR 0.73, 95% CI 0.55 to 0.99), with no difference in the odds of wound infection or dehiscence.

Rucinski 2001 assessed non-absorbable versus absorbable braided sutures or absorbable monofilament sutures (the number of trials is unclear). They found that the use of absorbable braided sutures increased the risk of hernia, compared with non-absorbable sutures (RR 1.93, 95% CI 1.35 to 2.76), with no difference between monofilament absorbable and non-absorbable sutures.

Sajid 2011 compared slow absorbable sutures (polydioxanone) to non-absorbable sutures. Using eight trials, they found no difference in incisional hernia, wound infection, dehiscence or sinus formation.

Van't Riet 2002 compared continuous versus interrupted closure, as well fast absorbable versus slow absorbable, fast absorbable versus non-absorbable and slow absorbable versus non-absorbable sutures. They found non-absorbable sutures and slow absorbable sutures decreased the risk of hernia formation (one study for each analysis). They found no difference in hernia formation in the slow absorbable versus non-absorbable sutures comparison (five studies). Interrupted or continuous closure did not appear to affect incisional hernia risks. They did not find a difference in wound infections or wound dehiscence in any of the comparisons (slow versus fast absorbable, slow versus non-absorbable, fast versus non-absorbable, continuous versus interrupted closure).

Weiland 1998 compared continuous versus interrupted sutures, absorbable versus non-absorbable sutures and mass versus layered closures. They found that continuous sutures decreased hernia (seven studies) and wound infection (eight studies). They also found that non-absorbable sutures decreased hernia compared with absorbable sutures in continuous closures (seven studies) and interrupted closures (three studies). No difference was seen in wound infections. Dehiscence was less in the non-absorbable groups versus the absorbable group for both continuous closures (seven studies) and interrupted closures (four studies). Layered closures were found to decrease hernia over mass closure (nine studies). This meta-analysis included two non-randomised controlled trials.

None of the reviews specifically addressed monofilament versus multifilament sutures. Of these reviews, only the one by van't Riet specified a required follow-up duration for inclusion in analysis (Van't Riet 2002).

A summary of the findings from these meta-analyses for incisional hernia can be found in Table 3. We found no evidence of a difference between absorbable and non-absorbable sutures (16 trials), although the effect estimate favoured non-absorbable sutures. We found no difference between mass and layered closures (five trials), which differs from the study by Weiland 1998. The previous study did not have clear criteria for follow-up duration for hernia, and this likely explains the differences in our results. Our results showed no difference between continuous and interrupted sutures (11 trials), whereas two previous meta-analyses did find a reduction in hernia (Hodgson 2000; Weiland 1998). However, our analysis incorporated more studies and previous analyses did not define a required follow-up duration.

AUTHORS' CONCLUSIONS

Implications for practice

We investigated the effect of suture material, method and technique for laparotomy closure on hernia occurrence and other important outcomes. Due to limitations in the quality of included studies, we cannot draw firm conclusions on suture material, closure method and technique. We do not have evidence to determine the best type of suture material (absorbable versus non-absorbable; fast absorbable versus slow absorbable) or closure method (continuous versus interrupted, mass versus layered) to reduce hernia in patients undergoing a laparotomy. Monofilament sutures may reduce the risk of hernia in patients and can be considered (compared with multifilament sutures).

Implications for research

This review has assessed many trials that have attempted to compare the effects of suture materials, methods or techniques on several important outcomes. The main limitation of this review was the study design and reporting limitations of many of the included trials. We felt that only a small proportion of trials did not have at least one category of 'high risk of bias'. This review has not definitively resolved the question of which materials and methods are best for wound outcomes. As such, surgeons should demand the performance of further, higher-quality research on this topic.

The mass versus layered comparison was based on a small number of trials, with all but one comparing more than one intervention between groups. As such, there is a role for further work in this area.

With these factors in mind, further trials assessing laparotomy closure need to be more rigorously performed and reported. Adequate randomisation and allocation techniques, blinding of outcome assessors and adequate follow-up for long-term hernia outcomes are essential. In addition, it is important that future trials only compare one closure component between groups. Many of the included trials compared a combination of materials, methods or techniques, and thus it was difficult to determine the effect of each

component on the outcomes. At the very least, trials seeking to assess multiple components should employ factorial designs.

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REFERENCES

References to studies included in this review

Agrawal 2009 *{published data only}*

Agrawal V, Sharma N, Joshi MK, Minocha VR. Role of suture material and technique of closure in wound outcome following laparotomy for peritonitis. *Tropical Gastroenterology* 2009;**30**(4):237-40.

Agrawal 2014 *{published data only}*

Agrawal CS, Tiwari P, Mishra S, Rao A, Hadke NS, Adhikari S, et al. Interrupted abdominal closure prevents burst: randomized controlled trial comparing interrupted-X and conventional continuous closures in surgical and gynecological patients. *Indian Journal of Surgery* 2014;**76**(4):270-6.

Askew 1983 *{published data only}*

Askew AR. A comparison of upper abdominal wound closure with monofilament nylon and polyglycolic acid. *Australian & New Zealand Journal of Surgery* 1983;**53**(4):353-6.

Ausobsky 1985 *{published data only}*

Ausobsky JR, Evans M, Pollock AV. Does mass closure of midline laparotomies stand the test of time? A randomised controlled clinical trial. *Annals of the Royal College of Surgeons of England* 1985;**67**(3):159-61.

Berretta 2010 *{published data only}*

Berretta R, Rolla M, Patrelli TS, Piantelli G, Merisio C, Melpignano M, et al. Randomised prospective study of abdominal wall closure in patients with gynaecological cancer. *Australian and New Zealand Journal of Obstetrics and Gynecology* 2010;**50**(4):391-6.

Bloemen 2011 *{published data only}*

Bloemen A, Van Dooren P, Huizinga BF, Hoofwijk AGM. Randomized clinical trial comparing polypropylene or polydioxanone for midline abdominal wall closure. *British Journal of Surgery* 2011;**98**(5):633-9.

Bresler 1995 *{published data only}*

Bresler L, Courbey PJ, Feldman L, Bilweiss J, Tortuyaux JM, Rauch P, et al. Results of a controlled trial comparing 3 slowly absorbable suture materials for the closure of supra-umbilical midline laparotomies. *Annales de Chirurgie* 1995;**49**(6):544-8.

Brolin 1996 *{published data only}*

Brolin RE. Prospective, randomized evaluation of midline fascial closure in gastric bariatric operations. *American Journal of Surgery* 1996;**172**(4):328-31.

Bucknall 1981 *{published data only}*

Bucknall TE, Ellis H. Abdominal wound closure--a comparison of monofilament nylon and polyglycolic acid. *Surgery* 1981;**89**(6):672-7.

Cameron 1980 *{published data only}*

Cameron AEP, Gray RCF, Talbot RW, Wyatt AP. Abdominal wound closure: a trial of Prolene and Dexon. *British Journal of Surgery* 1980;**67**(7):487-8.

Cameron 1987 *{published data only}*

Cameron AE, Parker CJ, Field ES, Gray RC, Wyatt AP. A randomised comparison of polydioxanone (PDS) and polypropylene (Prolene) for abdominal wound closure. *Annals of the Royal College of Surgeons of England* 1987;**69**(3):113-5.

Carlson 1995 *{published data only}*

Carlson MA, Condon RE. Polyglyconate (Maxon registered trade mark) versus nylon suture in midline abdominal incision closure: a prospective randomized trial. *American Surgeon* 1995;**61**(11):980-3.

Chana 1993 *{published data only}*

Chana RS, Saxena VC, Agarwal A. A prospective study of closure techniques of abdominal incisions in infants and children. *Journal of the Indian Medical Association* 1993;**91**(3):59-61.

Chowdhury 1994 *{published data only}*

Chowdhury SK, Chowdhury SD. Mass closure versus layered closure of abdominal wound: a prospective clinical study. *Journal of the Indian Medical Association* 1994;**92**(7):229-32.

Colombo 1997 *{published data only}*

Colombo M, Maggioni A, Parma G, Scalambrino S, Milani R. A randomized comparison of continuous versus interrupted mass closure of midline incisions in patients with gynecologic cancer. *Obstetrics and Gynecology* 1997;**89**(5):684-9.

Corman 1981 *{published data only}*

Corman ML, Veidenheimer MC, Coller JA. Controlled clinical trial of three suture materials for abdominal wall closure after bowel operations. *American Journal of Surgery* 1981;**141**(4):510-3.

Dan 2014 *{published data only}*

Dan L, Jing Z, Yong-Gang L, Hao Z, Kai-Xuan C, Ke C, et al. Full fascia closure with interrupted absorbable suture and layered closure with interrupted silk suture in abdominal incision: comparison of curative effects and biocompatibility [可吸收缝线全筋膜与丝线间断缝合腹部切口:效果及生物相容性的比较]. *Chinese Journal Of Tissue Engineering* October 2014;**43**:6996-7000.

Deitel 1990 *{published data only}*

Deitel M, Alhindawi R, Yamen M, To TB, Burul CJ. Dexon Plus versus Maxon fascial closure in morbid obesity: a prospective randomized comparison. *Canadian Journal of Surgery* 1990;**33**(4):302-4.

Derzie 2000 *{published data only}*

Derzie AJ, Silvestri F, Liriano E, Benotti P. Wound closure technique and acute wound complications in gastric surgery for morbid obesity: a prospective randomized trial. *Journal of the American College of Surgeons* 2000;**191**(3):238-43.

Docobo-Durantez 2006 *{published and unpublished data}*

Docobo-Durantez F, Sacristán-Péreza C, Flor-Civerab B, Lledó-Matosesb S, Kreislercy E, Biondoc S. Randomized clinical study of polydioxanone and nylon sutures for laparotomy closure in high risk patients [Estudio clínico aleatorizado entre suturade

polidioxanona y de naylon en el cierrede laparotomía en pacientes de riesgo]. *Cirugía Española* 2006;**79**(5):305-9.

Donaldson 1982 *{published data only}*

Donaldson DR, Hall TJ, Zoltowski JA, Guillou PJ, Brennan TG. Does the type of suture material contribute to the strength of the lateral paramedian incision?. *British Journal of Surgery* 1982;**69**(3):163-5.

Efem 1980 *{published data only}*

Efem SEE, Aja A. Layered versus mass closure of vertical midline laparotomy wounds in Negro Africans. *Tropical Doctor* 1988;**18**(2):67-9.

Fagniez 1985 *{published data only}*

Fagniez PL, Hay JM, Lacaine, Thomsen C. Abdominal midline incision closure. A multicentric randomized prospective trial of 3,135 patients, comparing continuous vs interrupted polyglycolic acid sutures. *Archives of Surgery* 1985;**120**(12):1351-3.

Gammelgaard 1983 *{published data only}*

Gammelgaard N, Jensen J. Wound complications after closure of abdominal incisions with Dexon or Vicryl. A randomized double-blind study. *Acta Chirurgica Scandinavica* 1983;**149**(5):505-8.

Gislason 1995 *{published data only}*

Gislason H, Gronbech JE, Soreide O. Burst abdomen and incisional hernia after major gastrointestinal operations - comparison of three closure techniques. *Acta Chirurgica* 1995;**161**(5):349-54.

Goligher 1975 *{published data only}*

Goligher JC, Irvin, TT, Johnston D, De Dombal FT, Hill GL, Horrocks JC. A controlled clinical trial of three methods of closure of laparotomy wounds. *British Journal of Surgery* 1975;**62**(10):823-9.

Gys 1989 *{published data only}*

Gys T, Hubens A. A prospective comparative clinical study between monofilament absorbable and non-absorbable sutures for abdominal wall closure. *Acta Chirurgica Belgica* 1989;**89**(5):265-70.

Hsiao 2000 *{published data only}*

Hsiao WC, Young KC, Wang ST, Lin PW. Incisional hernia after laparotomy: prospective randomized comparison between early-absorbable and late-absorbable suture materials. *World Journal of Surgery* 2000;**24**(6):747-52.

Irvin 1976 *{published data only}*

Irvin TT, Koffman CG, Duthie HL. Layer closure of laparotomy wounds with absorbable and non-absorbable suture materials. *British Journal of Surgery* 1976;**63**(10):793-6.

Irvin 1977 *{published data only}*

Irvin TT, Stoddard CJ, Greaney MG, Duthie HL. Abdominal wound healing: a prospective clinical study. *British Medical Journal* 1977;**2**(6083):351-2.

Israelsson 1994 *{published data only}*

Israelsson LA, Jonsson T. Closure of midline laparotomy incisions with polydioxanone and nylon: the importance of suture technique. *British Journal of Surgery* 1994;**81**(11):1606-8.

Kiely 1985 *{published data only}*

Kiely EM, Spitz L. Layered versus mass closure of abdominal wounds in infants and children. *British Journal of Surgery* 1985;**72**(9):739-40.

Kronborg 1976 *{published data only}*

Kronborg O. Polyglycolic acid (Dexon) versus silk for fascial closure of abdominal incisions. *Acta Chirurgica Scandinavica* 1976;**142**(1):9-12.

Krukowski 1987 *{published data only}*

Krukowski ZH, Cusick EL, Engeset J, Matheson NA. Polydioxanone or polypropylene for closure of midline abdominal incisions: a prospective comparative clinical trial. *British Journal of Surgery* 1987;**74**(9):828-30.

Larsen 1989 *{published data only}*

Larsen PN, Nielsen K, Mejdahl S, Larsen T, Moesgaard F, Shultz A. Closure of the abdominal fascia after clean and clean-contaminated laparotomy. *Acta Chirurgica Scandinavica* 1989;**155**(9):461-4.

Leaper 1977 *{published data only}*

Leaper DJ, Pollock AV, Evans M. Abdominal wound closure: a trial of nylon, polyglycolic acid and steel sutures. *British Journal of Surgery* 1977;**64**(8):603-6.

Leaper 1985 *{published data only}*

Leaper DJ, Allan A, May RE, Corfield AP, Kennedy RH. Abdominal wound closure: a controlled trial of polyamide (nylon) and polydioxanone suture (PDS). *Annals of the Royal College of Surgeons of England* 1985;**67**(5):273-5.

Lewis 1989 *{published data only}*

Lewis RT, Wiegand FM. Natural history of vertical abdominal parietal closure: Prolene versus Dexon. *Canadian Journal of Surgery* 1989;**32**(3):196-200.

McNeill 1986 *{published data only}*

McNeil PM, Sugerman HJ. Continuous absorbable vs interrupted nonabsorbable fascial closure. A prospective, randomized comparison. *Archives of Surgery* 1986;**121**(7):821-3.

Mirza 2003 *{published data only}*

Mirza SM, Hanif F, Khalid K, Ali AA, Chaudry A. Abdominal wound closure - a prospective randomized trial of polypropylene and polydioxanone. *Emirates Medical Journal* 2003;**21**(1):45-8.

Ohira 2015 *{published data only}*

Ohira G, Kawahira H, Miyauchi H, Suzuki K, Nishimori T, Hanari N, et al. Synthetic polyglycomer short-term absorbable sutures vs. polydioxanone long-term absorbable sutures for preventing incisional hernia and wound dehiscence after abdominal wall closure: a comparative randomized study of patients treated for gastric or colon cancer. *Surgery Today* 2015;**45**(7):841-5.

Orr 1990 *{published data only}*

Orr JW, Orr PF, Barrett JM, Ellington JR, Jennings RH, Paredes KB, et al. Continuous or interrupted fascial closure: a prospective evaluation of No. 1 Maxon suture in 402 gynecologic procedures. *American Journal of Obstetrics and Gynecology* 1990;**163**(5 pt 1):1485-9.

Orr 2003 *{published data only}*

Orr JW, Montz FJ, Barter J, Schaitzberg SD, Delmore JE, Dodson MK, et al. Continuous abdominal fascial closure: a randomized controlled trial of poly (L-lactide/glycolide). *Gynecologic Oncology* 2003;**90**(2):342-7.

Osther 1995 *{published data only}*

Osther PJ, Gjøde P, Mortensen BB, Mortensen PB, Bartholin J, Gottrup F. Randomized comparison of polyglycolic acid and polyglyconate sutures for abdominal fascial closure after laparotomy in patients with suspected impaired wound healing. *British Journal of Surgery* 1995;**82**(8):1080-2.

Pandley 2013 *{published data only}*

Pandey S, Singh M, Singh K, Sandhu S. A prospective randomized study comparing non-absorbable polypropylene (Prolene®) and delayed absorbable polyglactin 910 (Vicryl®) suture material in mass closure of vertical laparotomy wounds. *Indian Journal of Surgery* 2013;**75**(4):306-10.

Pollock 1979 *{published data only}*

Pollock AV, Greenall MJ, Evans M. Single-layer mass closure of major laparotomies by continuous suturing. *Journal of the Royal Society of Medicine* 1979;**72**(12):889-93.

Richards 1983 *{published data only}*

Richards PC, Balch CM, Aldrete JS. Abdominal wound closure. A randomized prospective study of 571 patients comparing continuous vs. interrupted suture techniques. *Annals of Surgery* 1983;**197**(2):238-43.

Sahlin 1993 *{published data only}*

Sahlin S, Ahlberg J, Granstrom L, Ljungstrom KG. Monofilament versus multifilament absorbable sutures for abdominal closure. *British Journal of Surgery* 1993;**80**(3):322-4.

Savolainen 1988 *{published data only}*

Savolainen H, Ristkari S, Mokka R. Early laparotomy wound dehiscence: a randomized comparison of three suture materials and two methods of fascial closure. *Annales Chirurgiae et Gynaecologiae* 1988;**77**(3):111-3.

Seiler 2009 *{published data only}*

Seiler CM, Bruckner T, Diener MK, Papyan A, Golcher H, Seidlmayer C, et al. Interrupted or continuous slowly absorbable sutures for closure of primary elective midline abdominal incisions: a multicenter randomized trial. *Annals of Surgery* 2009;**249**(4):576-82.

Siddique 2015 *{published data only}*

Siddique A, Ahmed MA, Rehman Z. Polydioxanone vs. prolene closure for midline abdominal incisions: to compare postoperative wound dehiscence. *Medical Forum Monthly* 2015;**26**(6):40-3.

Taylor 1985 *{published data only}*

Taylor TV. The use of polydioxanone suture in midline incisions. *Journal of the Royal College of Surgeons of Edinburgh* 1985;**30**(3):191-2.

Trimbos 1992 *{published data only}*

Trimbos JB, Smit IB, Holm JP, Hermans J. A randomized clinical trial comparing two methods of fascia closure following midline laparotomy. *Archives of Surgery* 1992;**127**(10):1232-4.

Ullrich 1981 *{published data only}*

Ullrich F, Henningsen B, Böttcher W. Fascial closure of median laparotomies with a synthetic, resorbable suture material (polyglycolic acid). *Der Chirurg; Zeitschrift für alle Gebiete der operativen Medizen* 1981;**52**(12):777-9.

Wissing 1987 *{published data only}*

Wissing J, Van Vroonhoven TJ, Schattenkerk ME, Veen HF, Ponsen RJ, Jeekel J. Fascia closure after midline laparotomy: results of a randomized trial. *British Journal of Surgery* 1987;**74**(8):738-41.

References to studies excluded from this review

Agarwal 2011 *{published and unpublished data}*

Agarwal A, Hossain Z, Agarwal A, Das A, Chakraborty S, Mitra N, et al. Reinforced tension line suture closure after midline laparotomy in emergency surgery. *Tropical Doctor* 2011;**41**(4):193-6.

Atul Kumar 2005 *{published data only}*

Atul Kumar S. Single versus double layer closure of low transverse uterine incision at cesarean section. *Journal of Obstetrics and Gynecology of India* 2005;**55**(3):231-6.

Baracs 2011 *{published and unpublished data}*

Baracs J, Huszar O, Sajjadi SG, Horvath OP. Surgical site infections after abdominal closure in colorectal surgery using triclosan-coated absorbable suture (PDS Plus) vs. uncoated sutures (PDS II): a randomized multicenter study. *Surgical Infections* 2011;**12**(6):483-9.

Cengiz 2001 *{published data only}*

Cengiz Y, Blomquist P, Israelsson LA. Small tissue bites and wound strength: an experimental study. *Archives of Surgery* 2001;**136**(3):272-5.

Deerenberg 2015 *{published and unpublished data}*

Deerenberg EB, Harlaar JJ, Steyerberg EW, Lont HE, Van Doorn HC, Heisterkamp J, et al. Small bites versus large bites for closure of abdominal midline incisions (STITCH): a double blind, multicentre, randomised controlled trial. *Lancet* 2015;**386**(10000):1254-60.

Ellis 1977 *{published data only}*

Ellis H, Heddle R. Does the peritoneum need to be closed at laparotomy?. *British Journal of Surgery* 1977;**64**(10):733-6.

Gilbert 1987 *{published data only}*

Gilbert JM, Ellis H, Foweraker S. Peritoneal closure after lateral paramedian incision. *British Journal of Surgery* 1987;**74**(2):113-5.

Gislason 1999 *{published data only}*

Gislason H, Soreide O, Viste A. Wound complications after major gastrointestinal operations. The surgeon as a risk factor. *Digestive Surgery* 1999;**16**(6):512-4.

Gorozpe-Calvillo 1999 *{published data only}*

Gorozpe-Calvillo JI, Gonzalez-Villamil J, Santoyo-Hara S. Closure of skin with cyanoacrylate in cesarean section. *Ginecologia y Obstetricia de Mexico* 1999;**67**:491-6.

Harlaar 2011 *{published data only}*

Harlaar JJ, Deerenberg EB, Van Ramshorst GH, Lont HE, Van der Borst EC, Schouten WR, et al. A multicenter randomized controlled trial evaluating the effect of small stitches on the incidence of incisional hernia in midline incisions. *BMC Surgery* 2011;**11**:20.

Hugh 1990 *{published data only}*

Hugh TB, Nankivell C, Meagher AP, Li B. Is closure of the peritoneal layer necessary in the repair of midline surgical abdominal wounds?. *World Journal of Surgery* 1990;**14**(2):231-4.

Hull 1991 *{published and unpublished data}*

Hull DB, Varner MW. A randomized study of closure of the peritoneum at cesarean delivery. *Obstetrics and Gynecology* 1991;**77**(6):818-21.

Irion 1996 *{published and unpublished data}*

Irion O, Luzuy F, Beguin F. Nonclosure of the visceral and parietal peritoneum at caesarean section: a randomised controlled trial. *British Journal of Obstetrics and Gynecology* 1996;**103**(7):690-4.

Israelsson 1999 *{published data only}*

Israelsson LA. Bias in clinical trials: the importance of suture technique. *European Journal of Surgery* 1999;**165**(1):3-7.

Johnson 1982 *{published data only}*

Johnson CD, Bernhardt LW, Bentley PG. Incisional hernia after mass closure of abdominal incisions with Dexon and Prolene. *British Journal of Surgery* 1982;**69**:55-7.

Justinger 2013 *{published and unpublished data}*

Justinger C, Slotta JE, Ningel S, Graber S, Kollmar O, Schilling MK. Surgical-site infection after abdominal wall closure with triclosan-impregnated polydioxanone sutures: results of a randomized clinical pathway facilitated trial (NCT00998907). *Surgery* 2013;**154**(3):589-95.

Khachatryan 2011 *{published and unpublished data}*

Khachatryan N, Dibirov M, Omelyanovsky V, Chupalov M, Gasanova G. Prevention of postoperative infections in abdominal surgery using reabsorbable suture with antibacterial activity (Vicryl plus) versus reabsorbable standard sutures. 24th European Congress on Surgical Infections. 2011.

Marwah 2005 *{published data only}*

Marwah S, Marwah N, Singh M, Kapoor A, Karwasra RK. Addition of rectus sheath relaxation incisions to emergency midline laparotomy for peritonitis to prevent fascial dehiscence. *World Journal of Surgery* 2005;**29**(2):235-9.

Mattavelli 2011 *{published and unpublished data}*

Mattavelli I, Nespoli L, Alfieri S, Cantore F, Sebastian-Douglas S, Cobianchi L, et al. Triclosan-coated suture to reduce surgical site infection after colorectal surgery. 24th European Congress on Surgical Infections. 2011.

Mayer 1981 *{published data only}*

Mayer AD, Ausobsky JR, Evans M, Pollock AV. Compression suture of the abdominal wall: a controlled trial in 302 major laparotomies. *British Journal of Surgery* 1981;**68**(9):634-62.

Millbourn 2009 *{published data only}*

Millbourn D, Cengiz Y, Israelsson LA. Effect of stitch length on wound complications after closure of midline incisions: a randomized controlled trial. *Archives of Surgery* 2009;**144**(11):1056-9.

Millbourn 2011 *{published data only}*

Millbourn D, Cengiz Y, Israelsson LA. Risk factors for wound complications in midline abdominal incisions related to the size of stitches. *Hernia* 2011;**15**(3):261-6.

Nagele 1996 *{published data only}*

Nagele F, Karas H, Spitzer D, Staudach A, Karasegh S, Beck A, et al. Closure or nonclosure of the visceral peritoneum at cesarean delivery. *American Journal of Obstetrics and Gynecology* 1996;**174**(4):1366-70.

Niggebrugge 1999 *{published data only}*

Niggebrugge AH, Trimbos JB, Hermans J, Steup WH, Van De Velde CJ. Influence of abdominal-wound closure technique on complications after surgery: a randomised study. *Lancet* 1999;**353**(9164):1563-7.

Pietrantoni 1991 *{published data only}*

Pietrantoni M, Parsons MT, O'Brien WF, Collins E, Knuppel RA, Spellacy WN. Peritoneal closure or non-closure at cesarean. *Obstetrics & Gynecology* 1991;**77**:293-6.

Rasic 2011 *{published and unpublished data}*

Rasic Z, Schwarz D, Adam VN, Sever M, Lojo N, Rasic D, et al. Efficacy of antimicrobial triclosan-coated polyglactin 910 (Vicryl Plus) suture for closure of the abdominal wall after colorectal surgery. *Collegium Antropologicum* 2011;**35**(2):439-43.

Rink 2000 *{published data only}*

Rink AD, Goldschmidt D, Dietrich J, Nagelschmidt M, Vestweber KH. Negative side-effects of retention sutures for abdominal wound closure. A prospective randomised study. *European Journal of Surgery* 2000;**166**(12):932-7.

Rosenberg 1975 *{published data only}*

Rosenberg IL, Brennan TG, Giles GR. How tight should tension sutures be tied? A controlled clinical trial. *British Journal of Surgery* 1975;**62**(12):950-1.

Xiao-dong 2009 *{published and unpublished data}*

Xiao-dong W, Li J, Zhi F, Li L. Two-layer suturing versus four-layer suturing in abdominal median incision: a randomized controlled trial. *Chinese Journal of Evidence-Based Medicine* 2009;**9**(2):199-203.

References to ongoing studies

ISRCTN25616490 *{unpublished data only}*

ISRCTN25616490. Hughes Abdominal Repair Trial (HART) - abdominal wall closure techniques to reduce the incidence of incisional hernias: study protocol for a randomised controlled trial. www.isrctn.com/ISRCTN25616490 2016.

NCT00514566 *{unpublished data only}*

NCT00514566. PDS vs. polyamide for midline abdominal closure PPMAC. clinicaltrials.gov/ct2/show/NCT00514566.

NCT00544583 *{published and unpublished data}*

NCT00544583. Continuous versus interrupted abdominal wall closure after emergency midline laparotomy (CONTINT). clinicaltrials.gov/ct2/show/NCT00544583 2010.

NCT01965249 *{unpublished data only}*

NCT01965249. Short stitch versus long stitch suture technique using monomax for abdominal wall closure after primary median laparotomy. A randomized controlled, double blinded, multicenter international trial. clinicaltrials.gov/ct2/show/NCT01965249.

NCT02145052 *{unpublished data only}*

NCT02145052. Optimal method of fascial closure in high risk patients undergoing laparotomy: a prospective randomized trial. clinicaltrials.gov/ct2/show/NCT02145052.

TCTR20150318001 *{unpublished data only}*

TCTR20150318001. Randomized trial to compare dehiscence with continuous versus interrupted mass closure of transverse incisions in children with absorbable suture (CLOSE). www.clinicaltrials.in.th/index.php?tp=regtrials&menu=trialsearch&smenu=fulltext&task=search&task2=view1&id=1335.

Additional references

Anthimidis 2013

Anthimidis G, Gregoriou M, Stavrakis T, Vasiliadou K, Lyras I, Ioannidis K, et al. New-fangled slowly-absorbable versus non-absorbable sutures for abdominal fascial closure. Have the goals towards an advantageous suture been met?. *Surgical Science* 2013;**4**(6):32282.

Anthony 2000

Anthony T, Bergen PC, Kim LT. Factors affecting recurrence following incisional herniorrhaphy. *World Journal of Surgery* 2000;**24**:95-101.

Benlice 2015

Benlice C, Stocchi L, Costedio M, Gorgun E, Hull T, Kessler H, et al. Laparoscopic IPAA is not associated with decreased rates of incisional hernia and small-bowel obstruction when compared with open technique: long-term follow-up of a case-matched study. *Diseases of the Colon and Rectum* 2015;**58**(3):314-20.

Brown 2005

Brown SR, Tiernan J. Transverse verses midline incisions for abdominal surgery. *Cochrane Database of Systematic Reviews* 2005, Issue 4. [DOI: 10.1002/14651858.CD005199.pub2]

Bucknall 1982

Bucknall TE, Cox PJ, Ellis H. Burst abdomen and incisional hernia: a prospective study of 1129 major laparotomies. *British Medical Journal (Clinical Research edition)* 1984;**284**:931-3.

Chalya 2015

Chayla PL, Massinde AN, Kihunrwa A, Mabula JB. Abdominal fascia closure following elective midline laparotomy: a surgical experience at a tertiary care hospital in Tanzania. *BMC Research Notes* 2015;**8**:281.

Connelly 2015

Connelly TM, Tappouni R, Mathew P, Salgado J, Messaris E. Risk factors for the development of an incisional hernia after sigmoid resection for diverticulitis: an analysis of 33 patients, operative and disease-associated factors. *The American Surgeon* May 2015;**81**(5):492-7.

Cox 1986

Cox PJ, Ausobsky JR, Ellis H, Pollock AV. Towards no incisional hernias: lateral paramedian versus midline incisions. *Journal of the Royal Society of Medicine* 1986;**79**:711-3.

Deeks 2011

Deeks JJ, Higgins JPT, Altman DG (editors). Chapter 9: Analysing data and undertaking meta-analyses. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Ellis 1983

Ellis HG, George CD. Incisional hernias: when do they occur?. *British Journal of Surgery* 1983;**70**:290-1.

George 1986

George CD, Ellis H. The results of incisional hernia repair: a twelve year review. *Annals of the Royal College of Surgeons of England* 1986;**68**:185-7.

Goodenough 2015

Goodenough CJ, Ko TC, Kao LS, Nguyen MT, Holihan JL, Alawadi Z, et al. Development and validation of a risk stratification score for ventral incisional hernia after abdominal surgery: hernia expectation rates in intra-abdominal surgery (the HERNIA Project). *Journal of the American College of Surgeons* 2015;**220**(4):405-13.

Guillou 1980

Guillou PJ, Hall TJ, Donaldson DR, Broughton AC, Brennan TG. Vertical abdominal incisions - a choice?. *British Journal of Surgery* 1980;**67**:395-9.

Guyatt 2008

Guyatt GH, Oxman AD, Kunz R, Vist GE, Falck-Ytter Y, Schünemann HJ, GRADE Working Group. What is "quality of evidence" and why is it important to clinicians?. *BMJ* 2008;**336**(7651):995-8.

Hawn 2010

Hawn MT, Snyder CW, Graham LA, Gray SH, Finan KR, Vick CC. Long-term follow-up of technical outcomes for incisional hernia repair. *Journal of the American College of Surgeons* 2010;**5**:648-55.

Helgstrand 2012

Helgstrand F, Rosenberg J, Kehlet H, Strandfelt P, Bisgaard T. Reoperation versus clinical recurrence rate after ventral hernia repair. *Annals of Surgery* December 2012;**256**(6):955-8.

Higgins 2003

Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003;**327**:557-60.

Higgins 2011a

Higgins JPT, Altman DG, Sterne JAC (editors). Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Higgins 2011b

Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Hodgson 2000

Hodgson NC, Malthaner RA, Ostbye T. The search for an ideal method of abdominal fascial closure: a meta-analysis. *Annals of Surgery* 2000;**231**(3):436-42.

Hodgson 2001

Hodgson NC, Malthaner RA, Ostbye T. Current practice of abdominal fascial closure: a survey of Ontario general surgeons. *Canadian Journal of Surgery* 2001;**44**(5):366-70.

Hughes 2009

Hughes K, Selim NM. The lateral paramedian: revisiting a forgotten incision. *The American Surgeon* April 2009;**75**(4):321-3.

Ihedioha 2008

Ihedioha U, Mackay G, Leung E, Molloy RG, O'Dwyer PJ. Laparoscopic colorectal resection does not reduce incisional hernia rates when compared with open colorectal resection. *Surgical Endoscopy* March 2008;**22**(3):689-92.

Itatsu 2014

Itatsu K, Yokoyama Y, Sugawara G, Kubota H, Tojima Y, Kurumiya Y, et al. Incidence of and risk factors for incisional hernia after abdominal surgery. *British Journal of Surgery* 2014;**101**(11):1439-47.

Kendall 1991

Kendall WH, Brennan G, Guillou J. Suture length to wound length ratio and integrity of midline and lateral paramedian incisions. *British Journal of Surgery* 1991;**78**:705-7.

Lamont 1988

Lamont PM, Ellis H. Incisional hernia in re-opened abdominal incisions: an overlooked risk factor. *British Journal of Surgery* 1988;**75**:374-6.

Langer 1985

Langer S, Christiansen J. Long term results after incisional hernia repair. *Acta Chirurgica Scandinavica* 1985;**151**:217-9.

Le Huu Nho 2012

Le Huu Nho R, Mege D, Ouaïssi M, Sielezneff I, Sastre B. Incidence and prevention of ventral incisional hernia. *Journal of Visceral Surgery* October 2012;**149**(5 (supplement)):e3-14.

Leber 1998

Leber GE, Garb JL, Alexander AJ, Reed WP. Long-term complications associated with prosthetic repair of incisional hernias. *Archives of Surgery* 1998;**133**:378-82.

Llaguna 2010

Llaguna OH, Avgerinos DV, Lugo JZ, Matatov T, Abbadessa B, Martz JE, et al. Incidence and risk factors for the development of incisional hernia following elective laparoscopic versus opencolon resections. *The American Journal of Surgery* August 2010;**200**(2):265-9.

Mudge 1985

Mudge M, Hughes LE. Incisional hernia: a 10 year prospective study of incidence and attitudes. *British Journal of Surgery* 1985;**72**:70-1.

Nilsson 1983

Nilsson T. Abdominal wound repair: an experimental study of the wound healing mechanism in the rabbit. *Danish Medical Bulletin* 1983;**30**:394-407.

Pollock 1989

Pollock AV, Evans M. Early prediction of late incisional hernias. *British Journal of Surgery* 1989;**76**:953-4.

Postlethwait 1975

Postlethwait RW, Willigan DA, Ulin AW. Human tissue reaction to sutures. *Annals of Surgery* 1975;**181**:144-50.

RevMan 2014 [Computer program]

Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager 5 (RevMan 5). Version 5.3. Copenhagen: Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Rucinski 2001

Rucinski J, Margolis M, Panagopoulos G, Wise L. Closure of the abdominal midline fascia: meta-analysis delineates the optimal technique. *American Surgeon* 2001;**67**(5):421-6.

Rutkow 2003

Rutkow IM. Demographic and socioeconomic aspects of hernia repair in the United States in 2003. *Surgical Clinics of North America* 2003;**83**:1045-51.

Sajid 2011

Sajid MS, Parampalli U, Baig MK, McFall MR. A systematic review on the effectiveness of slowly-absorbable versus non-absorbable sutures for abdominal fascial closure following laparotomy. *International Journal of Surgery* 2011;**9**(8):615-25.

Sanders 2012

Sanders DL, Kingsnorth AN. The modern management of incisional hernias. *BMJ* 2012;**344**:e2843.

Santora 1993

Santora TA, Roslyn JJ. Incisional hernia. *Surgical Clinics of North America* 1993;**73**:557-70.

Schünemann 2011

Schünemann HJ, Oxman AD, Vist GE, Higgins JPT, Deeks JJ, Glasziou P, et al. on behalf of the Cochrane Applicability and Recommendations Methods Group. Chapter 12: Interpreting results and drawing conclusions. In: Higgins JPT, Green S (editors), Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Smith 2012

Smith M. Surgeons face more complex hernias in more complex reimbursement world. *General Surgery News* January 2012;**39**(1):1.

Spencer 2015

Spencer RJ, Hayes KD, Rose S, Zhao Q, Rathouz PJ, Rice LW, et al. Risk factors for early-occurring and late-occurring incisional hernias after primary laparotomy for ovarian cancer. *Obstetrics and Gynecology* February 2015;**125**(2):407-13.

Sterne 2011

Sterne JAC, Egger M, Moher D (editors). Chapter 10: Addressing reporting biases. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Intervention. Version 5.1.0 (updated March 2011). The Cochrane Collaboration, 2011. Available from handbook.cochrane.org.

Stey 2015

Stey AM, Russell MM, Sugar CA, Hall BL, Zingmond DS, Lawson EH, et al. Extending the value of the National Surgical Quality Improvement Program claims dataset to study long-term outcomes: rate of repeat ventral hernia repair. *Surgery* 2015;**157**(6):1157-65.

Sugerman 1996

Sugerman HJ, Kellum JM, Reines HD, DeMaria EJ, Newsome HH, Lowry JW. Greater risk of incisional hernia with morbidly obese than steroid-dependent patients and low recurrence with prefascial polypropylene mesh. *American Journal of Surgery* 1996;**171**:80-4.

Tully 2002

Tully L, Gates S, Brocklehurst P, McKenzie-McHarg K, Ayers S. Surgical techniques used during caesarean section operations: results of a national survey of practice in the UK. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 2002;**102**:120-6.

Van't Riet 2002

Van't Riet M, Steyerberg EW, Nellensteyn J, Bonjer HJ, Jeekel J. Meta-analysis of techniques for closure of midline abdominal incisions. *British Journal of Surgery* 2002;**89**(11):1350-6.

Weiland 1998

Weiland DE, Bay RC, Del Sordi S. Choosing the best abdominal closure by meta-analysis. *American Journal of Surgery* 1998;**176**(6):666-70.

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Agrawal 2009

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: not described **Gender**: not described **Types of incisions**: all participants received a vertical midline incision **Types of surgery**: emergency surgery for peritonitis **Contamination classification of included participants**: not described **Pre-operative antibiotic use**: all participants received ceftriaxone and metronidazole **Prognostic patient factors**: not described

Agrawal 2009 *(Continued)*

	Inclusion criteria: all patients with peritonitis at a single centre
	Exclusion criteria: none described
Interventions	**Comparisons reported**:
	Group 1:
	Suture: polygalactin-910 (multifilament, fast absorbable)
	Suturing technique: continuous
	Closure method: mass
	Group 2:
	Suture: polygalactin-910 (multifilament, fast absorbable)
	Suturing technique: interrupted
	Closure method: mass
	Group 3:
	Suture: polypropylene (monofilament, non-absorbable)
	Suturing technique: continuous
	Closure method: mass
	Group 4:
	Suture: polypropylene (monofilament, non-absorbable)
	Suturing technique: interrupted
	Closure method: mass
	Surgeon characteristics: "Trained surgeon with a minimum of three years of surgical residency"
Outcomes	**Incisional hernia**: clinical exam, confirmed with ultrasound
	Follow-up duration: 3 months and 4 years
	Wound infection: not defined
	Dehiscence: not defined
	Sinus or fistula: not defined
Notes	Hernia outcome data used from the 4-year follow-up period
	As this was a factorial design, the outcomes for each group were input separately against their comparison group

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Draw of lots" by nurse
Allocation concealment (selection bias)	Unclear risk	Not stated

Agrawal 2009 *(Continued)*

Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessor blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Unclear risk	Exclusion criteria, postoperative care, etc. not described

Agrawal 2014

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 37 years Group 2 (mean): 36.5 years Group 3 (mean): 34.7 years **Gender**: Group 1 (%): 76.9% Female Group 2 (%): 81.0% Female Group 3 (%): 71.8% Female **Types of incisions**: all participants received a vertical midline incision **Types of surgery**: Group 1 (% emergent): 68.6% Group 2 (% emergent): 65.4% Group 3 (% emergent): 67.5% **Contamination classification of included participants**: Group 1 (% contaminated): 27.3% Group 2 (% contaminated): 25.5% Group 3 (% contaminated): 33.3% **Prognostic patient factors**: Average BMI: Group 1 22.5; Group 2 22.8; Group 3 21.6 Malignancy (%): Group 1 5%; Group 2 3.6%; Group 3 6% **Inclusion criteria**: elective or emergent gynaecology cases or emergency general surgery cases

Agrawal 2014 *(Continued)*

	Exclusion criteria: patients with previous "Burst" Abdomen
Interventions	**Comparisons reported**: Group 1: Suture: Prolene (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass Group 2: Sutures: Prolene (monofilament, non-absorbable) Suturing technique: "X Technique" (interrupted) Closure method: mass *Group 3*: Sutures: Prolene (monofilament, non-absorbable) Suturing technique: modified Smead Jones (interrupted) Closure method: mass **Surgeon characteristics**: not stated
Outcomes	**Dehiscence:** Intra-abdominal components in the wound (30-day follow-up)
Notes	Groups 2 & 3 combined into "Interrupted" closure for analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Codes from randomization.com using permuted block design
Allocation concealment (selection bias)	Low risk	Sealed, opaque envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not specifically addressed
Incomplete outcome data (attrition bias) All outcomes	Low risk	No dropouts over study period
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Askew 1983

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**:

Askew 1983 *(Continued)*

	Group 1 (mean): 54 years (male), 41 years (female) Group 2 (mean): 50 years (male), 47 years (female) **Gender**: Group 1: 52% female Group 2: 74% female **Type of incision**: Group 1: midline 19.4%, rectus split 56.5%, transverse 24.1%, other 0% Group 2: midline 26.2%, rectus split 61.9%, transverse 6.9%, other 5.0% **Type of surgery**: Group 1: biliary 67.7%, gastric 19.4%, liver/spleen/pancreas 12.9%; emergent 1.6% Group 2: biliary 61.9%, gastric 28.6%, liver/spleen/pancreas 9.5%; emergent 4.8% **Contamination classification of included participants**: not reported **Pre-operative antibiotic use**: not reported **Prognostic patient factors**: Group 1: malignancy 12.0%, jaundice 8.1% Group 2: malignancy 2.4%, jaundice 2.4% **Inclusion criteria**: not clearly stated; consecutive participants undergoing upper abdominal laparotomy **Exclusion criteria**: none stated
Interventions	**Comparisons reported**: Group 1: Suture: nylon (monofilament, non-absorbable) Suturing technique: continuous Closure method: layered Group 2: Sutures: PGA (multifilament, fast absorbable) Suturing technique: Smead-Jones (interrupted) Closure method: mass **Surgeon characteristics**: a single staff surgeon operated on all participants
Outcomes	**Incisional hernia**: not defined **Follow-up duration**: 12 months **Dehiscence**: not defined **Wound infection**: discharge of pus from the wound; at 6 months
Notes	-

Risk of bias

Bias	Authors' judgement	Support for judgement

Askew 1983 *(Continued)*

Random sequence generation (selection bias)	High risk	"Randomization was according to the date of operation, nylon closure on even dates and Dexon closure on odd dates."
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	Only 60% followed up in clinic, while 21% followed up by telephone. No follow-up available on 19% of participants
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	High risk	"The trial was designed to have at least 100 patients in each limb, but the trial was closed when analysis of the first 104 patients showed a significant difference in wound infection and incisional hernia between the two groups." No a priori stopping rules were described

Ausobsky 1985

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: not reported **Gender**: not reported **Type of incision**: Group 1: midline 60.5%, paramedian 10.2%, transverse/oblique 29.2% Group 2: midline 5.2%, paramedian 74.8%, transverse/oblique 20.0% **Type of surgery**: not reported **Contamination classification of included participants**: 37.4% in Group 1 and 28.9% in Group 2 classified as 'contaminated' (culture swabs collected before skin closure) **Pre-operative antibiotic use**: cefuroxime or cephaloridine administered to all participants **Prognostic patient factors**: not reported **Inclusion criteria**: all emergency and elective major laparotomy procedures **Exclusion criteria**: grid-iron incisions, Pfannenstiel incisions for exposure of bladder, incisions for exposure of kidneys and hernia repairs
Interventions	**Comparisons reported**: Group 1: Suture: nylon suture (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass Group 2:

Ausobsky 1985 *(Continued)*

	Sutures: posterior rectus sheath with PGA (multifilament, fast absorbable), and anterior rectus sheath with nylon (monofilament, non-absorbable) Suturing technique: continuous Closure method: layered **Surgeon characteristics**: no information provided
Outcomes	**Incisional hernia**: visible bulge when coughing in standing position, together with a palpable sharp-margined defect in the abdominal wall at the site of a scar **Follow-up duration**: 1 to 4-year follow-up **Wound infection**: presence of pus in the wound **Wound dehiscence**: protrusion of abdominal viscera through the wound **Suture sinus**: no definition provided
Notes	Variable follow-up duration; between 1 and 4 years

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Between January 1980 and May 1981, 282 consecutive patients who were admitted under the care of one consultant surgeon and who accepted elective or emergency major laparotomy were randomised to one or other of the closure regimens detailed below."
Allocation concealment (selection bias)	Unclear risk	No information provided
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information provided
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participants who died within 6 months without developing an event were excluded from analysis
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Berretta 2010

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 59 years Group 2 (mean): 59 years Group 3 (mean): 56 years **Gender**: all participants were female

Berretta 2010 *(Continued)*

	Type of incision: all participants received a vertical midline incision **Type of surgery**: elective laparotomy for gynaecologic malignancy **Contamination classification of included participants**: not described **Pre-operative antibiotic use**: all participants received ampicillin and sulbactam or clindamycin **Prognostic patient factors**: Group 1: diabetes 11%; obesity 32% Group 2: diabetes 13%; obesity 28% Group 3: diabetes 15%; obesity 32% **Inclusion criteria**: participants with ovarian, endometrial or cervical cancer and a life expectancy of > 1 year **Exclusion criteria**: pre-existing ventral hernia, chemotherapy within 2 weeks of surgery, > 8 weeks of neoadjuvant radiation therapy, current immunosuppression, pre-operative coagulopathy or collagen disorder
Interventions	Group 1: Suture: polypropylene 1-0 (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass closure Group 2: Suture: PDS 1-0 (monofilament, slow absorbable) Suturing technique: continuous Closure method: mass Group 3: Sutures: polyester (multifilament, non-absorbable) for fascia, polyglactin (absorbable) for peritoneum Suturing technique: interrupted Closure method: mass **Surgeon characteristics**: no information provided
Outcomes	**Incisional hernia**: palpable defect in the fascia or a protrusion beyond the level of the fascia with the participant supine lifting both legs, and coughing or straining in an erect position; confirmed by ultrasound (in obese participants, ultrasound was performed routinely due to a lack of physical exam sensitivity) **Follow-up duration:** 1 year **Wound infection**: defined as "dehiscence with secretion either of putrid or caliginous, smelly fluid or requiring antibiotic treatment or surgical intervention" **Dehiscence**: superficial (intact fascia), deep (complete disruption)
Notes	Groups 1 compared with Group 2 only for 'absorbable versus non-absorbable' outcomes, as they had a common closure technique and method Groups 1 and 2 combined for 'continuous versus interrupted' outcomes Groups 1 and 2 combined for 'monofilament versus multifilament' outcomes

Risk of bias

Bias	Authors' judgement	Support for judgement

Berretta 2010 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Block randomisation by centre. Specific randomisation technique was not described
Allocation concealment (selection bias)	Low risk	Opaque envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not specified
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants included in analysis
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Bloemen 2011

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 63.1 years Group 2 (mean): 63.8 years **Gender**: Group 1: 40.6% female Group 2: 44.9% female **Type of incision**: all participants received midline incisions **Type of surgery**: Group 1: elective 80.1%; colorectal cancer 47.7%, aortic aneurysm 11.3%, benign colorectal 13.3%, gastric cancer 3.5%, cholelithiasis 5.5%, bowel perforation 3.9%, hiatal hernia 3.9%, appendicitis 2.0%, other 9.0% Group 2: elective 85.4%; colorectal cancer 53.2%, aortic aneurysm 10.9%, benign colorectal 12.3%, gastric cancer 4.9%, cholelithiasis 2.6%, bowel perforation 3.4%, hiatal hernia 2.6%, appendicitis 3.0%, other 7.1% **Contamination classification of included participants**: not described **Pre-operative antibiotic use**: not described **Prognostic patient factors**: Group 1: DM 9.8%; mean BMI 25.6; steroids 6.3%; chronic pulmonary conditions 3.9% Group 2: DM 6.4%; mean BMI 25.8; steroids 7.9%; chronic pulmonary conditions 10.1% **Inclusion criteria**: elective or emergent laparotomy with midline incision

Bloemen 2011 *(Continued)*

	Exclusion criteria: pregnancy, presence of an abdominal hernia, lack of informed consent, age < 18 years or life expectancy of < 1 year
Interventions	Group 1: Suture: 1-0 polypropylene (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: 1-0 PDS (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: consultant or resident surgeons
Outcomes	**Incisional hernia**: defined as "any abdominal wall gap with or without a bulge in the area of a postoperative scar, perceptible or palpable by clinical examination or imaging" *Follow-up duration*: up to 54 months **Dehiscence**: "Early post-operative fascial dehiscence was distinguished from later incisional hernia, defined by a clinically palpable gap in the abdominal fascia with, or without wound dehiscence during the first 30 days after surgery..." **Wound infection**: not defined **Sinus or fistula**: not defined
Notes	Occurrence of incisional hernia at 1 year used in analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Low risk	Sealed, opaque envelopes
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and included in analysis
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Bresler 1995

Methods	**RCT** **Methods to control for contributory patient factors**: none described

Bresler 1995 *(Continued)*

Participants	**Age**: Group 1: < 40 years 3.6%; 40-60 years 40.3%; > 60 years 29%** Group 2: < 40 years 25.7%; 40-60 years 40.0%; > 60 years 34.2% Group 3: < 40 years 16.9%; 40 to 60 years 43.6%; > 60 years 39.4% **Gender**: Group 1: 61.2% female Group 2: 60% female Group 3: 67% female **Type of incision**: all participants received midline incisions **Type of surgery**: Cholecystectomy, digestive tract surgery, splenectomy, hiatal hernia repair, gastrectomy, hepato-pancreatic (group-wise data not given) **Contamination classification of included participants**: Group 1: clean 66.1%; clean-contaminated 33.8% Group 2: clean 72.8%; clean-contaminated 27.1% Group 3: clean 81.6%; clean-contaminated 18.2% **Pre-operative antibiotic use**: not described **Prognostic patient factors**: not described **Inclusion criteria**: laparotomy via midline incision **Exclusion criteria**: emergency surgery, presence of ascites, presence of carcinomatosis ** % do not add up to 100*
Interventions	Group 1: Suture: polyglactin-910 (multifilament, fast-absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: PDS I (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: PDS II (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: Group 1: attending surgeon 19.3%; assistant 59,6%; intern 20.9% Group 2: attending surgeon 25.7%; assistant 50%; intern 24.2% Group 3: attending surgeon 22.5%; assistant 56.3%; intern 21.1%
Outcomes	**Incisional hernia**: not defined

Bresler 1995 *(Continued)*

	Follow-up duration: 1 year
Notes	Group 1 and group 2 pooled as monofilament, slowly absorbable

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table
Allocation concealment (selection bias)	Low risk	Allocation at time of closure by random number table
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessor blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	No outcome data on 15 participants in group 1, 8 participants group 2, 9 participants group 3
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Brolin 1996

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 39 years Group 2 (mean): 38 years **Gender**: Group 1: 81.6% female Group 2: 80.0% female **Type of incision**: all participants had midline incisions **Type of surgery**: all were elective bariatric procedures Group 1: vertical banded gastroplasty: 9.2%; Roux-en-Y gastric bypass 90.8% Group 2: vertical banded gastroplasty: 11.7%; Roux-en-Y gastric bypass 88.3% **Contamination classification of included participants**: no information provided **Pre-operative antibiotic use**: all participants received either a cephalosporin or vancomycin **Prognostic patient factors**: all participants were morbidly obese

Brolin 1996 *(Continued)*

	Inclusion criteria: participants who had gastric-restrictive bariatric procedures performed by one surgeon, for treatment of morbid obesity **Exclusion criteria**: no exclusion criteria were explicitly reported
Interventions	**Comparisons reported**: Group 1: Suture: polyester (multifilament, non-absorbable) Suturing technique: continuous Closure method: layered (polyester on fascia, other layers closed by same methods in both groups) Group 2: Suture: PDS (monofilament, slowly absorbable) Suturing technique: interrupted, 'figure-of-eight' Closure method: layered (PDS on fascia) **Characteristics of surgeons**: all procedures were performed by a chief resident
Outcomes	**Incisional hernia**: participant-reported symptoms of discomfort or lumps in their incision **Follow-up duration**: mean follow-up was 29.4 months, 65% followed for > 2 years **Wound infection**: not defined **Wound dehiscence**: acute dehiscence on the first postoperative day
Notes	Minimum follow-up period not described; hernias at 1 year not specifically addressed

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"Randomization was carried out in the operating room according to the last digit of the patient's hospital identification number. Patients with an even number (n = 109) had closure with [Polyester]; patients with an odd digit (n = 120) had closure using [Polydioxanone]."
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and included in the analysis
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Bucknall 1981

Methods	**RCT** **Methods to control for contributory patient factors**: none described

Bucknall 1981 *(Continued)*

Participants	**Age**: Group 1 (mean): 53.3 years Group 2 (mean): 50.5 years **Gender**: Group 1: 53.8% female Group 2: 61.5% female **Type of incision**: Group 1: midline 37.7%, paramedian 62.3% Group 2: midline 41.3%, paramedian 58.6% **Type of surgery**: Group 1: emergent 18.8%; "bowel surgery" 43.4%; malignancy 26.4% Group 2: emergent 17.3%; "bowel surgery" 39.4%; malignancy 20.2% **Contamination classification of included participants**: information not provided **Pre-operative antibiotic use**: information not provided **Prognostic patient factors**: information not provided **Inclusion criteria**: all adult patients admitted to 1 hospital who underwent laparotomy through vertical incisions in the year 1979 **Exclusion criteria**: none described
Interventions	**Comparisons reported**: Group 1 Suture: nylon (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: PGA (multifilament, fast absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: Group 1: consultant 32.1%; senior resident 44.3%; other resident 23.6% Group 2: consultant 26.0%; senior resident 49.0%; other resident 25.0%
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: 8.3 months in nylon group, 8.5 months in PGA group **Wound infection**: no definition provided **Wound dehiscence**: "total wound disruption" **Suture sinus or fistula**: no definition provided
Notes	Hernia data not included in analysis due to inadequate follow-up duration; other outcomes included

Risk of bias

Bias	Authors' judgement	Support for judgement

Bucknall 1981 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	"In 1979, all adult patients in the Professorial Surgical Unit at Westminster Hospital who underwent laparotomy through vertical incisions were randomised, by means of random number cards, into two groups."
Allocation concealment (selection bias)	Unclear risk	No information provided
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information provided
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% loss to follow-up (4/110 in group 1, 2/106 in group 2)
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Cameron 1980

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: not reported **Gender**: Group 1: 54.5% female Group 2: 51.1% female **Type of incision**: Group 1: midline 34.1%, paramedian 65.9% Group 2: midline 34.4%, paramedian 65.6% **Type of surgery**: Group 1: emergency 17.4% Group 2: emergency 22.2% **Contamination classification of included participants**: Group 1: contaminated 7.2% Group 2: contaminated 10.5% **Pre-operative antibiotic use**: no information provided **Prognostic patient factors**: Group 1: corticosteroid use 1.8%, jaundice 1.2% Group 2: corticosteroid use 1.6%, jaundice 7.2% **Inclusion criteria**: age > 15 years, with vertical abdominal incisions **Exclusion criteria**: patients being re-operated on via an incision made < 1 month previously

Cameron 1980 *(Continued)*

Interventions	**Comparisons reported**: Group 1 Suture: polypropylene (monofilament, non-absorbable) Suturing technique: interrupted ("figure-of-eight, near and far") Closure method: mass Group 2: Sutures: PGA (multifilament, fast absorbable) Suturing technique: interrupted ("figure-of-eight, near and far") Closure method: mass **Surgeon characteristics**: Group 1: consultant/senior resident 56.9%, registrar/senior health officer 43.1% Group 2: consultant/senior resident 56.7%, registrar/senior health officer 43.3%
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: 6 months **Wound infection**: no definition provided **Wound dehiscence**: complete disruption
Notes	Hernia data not included in analysis due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method to generate allocation sequence not described ("...randomly allocated...")
Allocation concealment (selection bias)	Low risk	"Patients were randomly allocated to a suture material by the opening of a sealed envelope during the procedure."
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information provided
Incomplete outcome data (attrition bias) All outcomes	High risk	High loss to follow-up (33/167 in group 1, 49/180 in group 2)
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Cameron 1987

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 60.2 years

Cameron 1987 *(Continued)*

	Group 2 (mean): 61.6 years **Gender**: Group 1: 56.0% female Group 2: 54.5% female **Type of incision**: Group 1: midline 66.7%; paramedian 33.3% Group 2: midline 56.0%; paramedian 44.0% **Type of surgery**: Group 1: emergent 19.6%; biliary 29.8%, gastric 17.7%, colon 29.1%, other 23.4% Group 2: emergent 19.9%; biliary 32.9%, gastric 23.1%, colon 21.0%, other 23.1% **Contamination classification of included participants**: Group 1: clean 77.3%, clean-contaminated 9.2%, contaminated 13.5% Group 2: clean 79.7%, clean-contaminated 6.3%, contaminated 14.0% **Pre-operative antibiotic use**: "antibiotic prophylaxis was given according to the surgeon's usual routine" **Prognostic patient factors**: Group 1: obesity 26%, corticosteroid use 1.4%, jaundice 3.5% Group 2: obesity 24%, corticosteroid use 2.1%, jaundice 3.5% **Inclusion criteria**: patients undergoing laparotomy by vertical abdominal incision **Exclusion criteria**: patients who were being re-operated on via the original incision were excluded
Interventions	**Comparisons reported**: Group 1 Suture: polypropylene (monofilament, non-absorbable) Suturing technique: interrupted, "figure-of-eight" Closure method: mass Group 2: Suture: PDS (monofilament, slowly absorbable) Suturing technique: interrupted, "figure-of-eight" Closure method: mass **Surgeon characteristics**: Group 1: senior resident 56.0%, junior resident 40.4% Group 2: senior resident 52.4%, junior resident 46.8%
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: minimum 12 months (mean 14.7 months) **Wound infection**: "discharge of pus, up to one month of follow-up" **Wound dehiscence**: "burst abdomen" **Suture sinus or fistula**: no definition provided
Notes	

Cameron 1987 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No information provided
Allocation concealment (selection bias)	Low risk	"At the end of the operation, the circulating nurse drew a sealed envelope and informed the surgeon of the suture to be used."
Blinding (performance bias and detection bias) All outcomes	Low risk	"This assessment was 'double-blind', as neither the examiner nor the participant knew which suture had been used."
Incomplete outcome data (attrition bias) All outcomes	High risk	High loss to follow-up (51/141 in group 1, 43/143 in group 2)
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Carlson 1995

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: not reported **Gender**: not reported **Types of incisions**: all incisions were in the vertical midline **Type of surgery**: Group 1: elective 75.8%; colon 26.4% Group 2: elective 76.2%; colon 18.7% **Contamination classification of included participants**: Group 1: clean 29.7%, clean-contaminated 70.3% Group 2: clean 31.2%, clean-contaminated 68.2% **Pre-operative antibiotic use**: intravenous antibiotics were administered 30 min prior to surgery for clean-contaminated wounds and oral antibiotics were given following lavage with PEG for participants undergoing colonic procedures, in both groups **Prognostic patient factors**: no information provided **Inclusion criteria**: patients undergoing laparotomy via a midline incision **Exclusion criteria**: life expectancy < 2 years, established peritonitis or pre-existing ventral hernia
Interventions	**Comparisons reported**: Group 1 Suture: nylon (monofilament, non-absorbable)

Carlson 1995 *(Continued)*

	Suturing technique: continuous Closure method: mass Group 2: Suture: polyglyconate (multifilament, slowly absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: all closures, in both groups, were performed by a senior or chief resident
Outcomes	**Incisional hernia definition**: no definition provided **Follow-up duration**: 2 years **Wound infection**: no definition provided **Wound dehiscence**: no definition provided **Suture sinus or fistula**: no definition provided
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...using a random number sequence..."
Allocation concealment (selection bias)	Low risk	"...using a random number sequence kept in serial sealed envelopes that were opened by the circulating nurse in the operating room."
Blinding (performance bias and detection bias) All outcomes	Unclear risk	"Follow-up evaluation for the presence or absence of a ventral hernia was performed by the surgeon or an investigator through physical examination and communication with the patient's physician."
Incomplete outcome data (attrition bias) All outcomes	High risk	High loss to follow-up (21/112 in group 1, 33/113 in group 2)
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Chana 1993

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: not reported **Gender**: not reported **Type of incision**: no group-wise data were reported; overall: transverse 58.8%, vertical 20.6%, oblique 20.6% **Type of surgery**: emergent 55.9% (overall) **Contamination classification of included participants**: contaminated: 64.7% (overall)

Chana 1993 *(Continued)*

	Pre-operative antibiotic use: no information provided **Prognostic patient factors**: Group 1: malnutrition 53.0% Group 2: malnutrition 58.8% **Inclusion criteria**: infants and children < 12 years who underwent laparotomy **Exclusion criteria**: none explicitly mentioned
Interventions	**Comparisons reported**: Group 1 Suture: polyglactin-910 (multifilament, fast absorbable) Suturing technique: interrupted, 'figure-of-eight' Closure method: mass Group 2: Sutures: polyglactin-910 (multifilament, fast absorbable) Suturing technique: continuous Closure method: layered **Surgeon characteristics**: no information provided
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: unclear duration **Wound infection**: no definition provided **Wound dehiscence**: no definition provided **Suture sinus or fistula**: no definition provided
Notes	Incisions in group 1 included upper transverse and midline. Incisions in group 2 included transverse, subcostal and paramedian Hernia data excluded from analysis due to unclear follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"...randomly allocated..."
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	No losses to follow-up were reported
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Chowdhury 1994

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (range): 12-78 years Group 2 (range): 10-75 years **Gender**: Group 1: 35.0% female Group 2: 42.5% female **Type of incision**: Group 1: median 37.5%, paramedian 60.0%; transverse 2.5% Group 2: median 15.0%; paramedian 85.0%; transverse 0% **Type of surgery**: Group 1: emergent 42.5%; biliary 22.5%, gastric 27.5%, intestinal 27.5%, other 22.5% Group 2: emergent 20.0%; biliary 30.0%; gastric 32.5%, intestinal 15%, other 22.5% **Contamination classification of included participants**: no information provided **Pre-operative antibiotic use**: no information provided **Prognostic patient factors**: Group 1: diabetes 5.0%, malignancy 15%, chronic pulmonary conditions 2.5%, anaemia 65%, malnutrition 30%, jaundice 20% Group 2: diabetes 2.5%, malignancy 15%, chronic pulmonary conditions 12.5%, anaemia 57.5%, malnutrition 20%, jaundice 12.5% **Inclusion criteria**: patients who had either a median, paramedian or transverse laparotomy incision **Exclusion criteria**: grid-iron or Pfannenstiel incisions for kidney exposure and hernia operations
Interventions	**Comparisons reported**: Group 1 Suture: nylon (monofilament, non-absorbable) Suturing technique: interrupted, Smead-Jones Closure method: mass Group 2: Sutures: chromic catgut (monofilament, fast absorbable) Suturing technique: continuous Closure method: layered (peritoneum and muscle/fascial layers closed separately) **Surgeon characteristics**: Group 1: consultant 30.0%, registrar 70.0% Group 2: consultant 52.5%, registrar 47.5%
Outcomes	**Incisional hernia**: not reported **Wound infection**: discharge of pus from the wound **Wound dehiscence**: separation of all abdominal layers allowing visualisation or palpation of abdominal viscera

Chowdhury 1994 *(Continued)*

	Suture sinus or fistula: no definition provided
Notes	**Follow-up duration**: 1-15 months, no group-wise data available. No specific follow-up time described for primary analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Out of these 160 patients, 80 patients were randomised to have the abdominal wall closed in mass closure and 80 in the layer closure."
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not reported
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants included in analysis
Selective reporting (reporting bias)	Unclear risk	Unclear length of follow-up for incisional hernia outcomes
Other bias	Low risk	The study appears to be free of other sources of bias

Colombo 1997

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 51.1 years Group 2 (mean): 52.7 years **Gender**: all participants were female **Type of incision**: Group 1: lower midline 75%, complete midline 25% Group 2: lower midline 79%, complete midline 21% **Type of surgery**: Group 1: exploratory laparotomy 51.0%, exploratory laparotomy with bowel resection and anastomosis 13.3%, radical hysterectomy with pelvic lymphadenectomy 23.4%, total hysterectomy 10.1%, pelvic exenteration 2.3% Group 2: exploratory laparotomy 52.6%; exploratory laparotomy with bowel resection and anastomosis 11.1%; radical hysterectomy with pelvic lymphadenectomy 20.3%; total hysterectomy 15.0%; pelvic exenteration 1.0% **Contamination classification of included participants**: no information provided

Colombo 1997 *(Continued)*

	Pre-operative antibiotic use: all participants in both groups received pre-operative antibiotics: 1-2 doses of intravenous cefazolin for procedures with no bowel resection and cefoxitin, gentamicin and metronidazole for procedures involving bowel resection **Prognostic patient factors**: all participants in both groups had malignancy Group 1: diabetes 2%, obesity (BMI ≥ 25 kg/m^2) 30%, prior chemotherapy 38%, prior radiotherapy 5% Group 2: diabetes 3%, obesity (BMI ≥ 25 kg/m^2) 32%, prior chemotherapy 32%, prior radiotherapy 6% **Inclusion criteria**: all women admitted for surgical treatment of gynaecological cancer using a vertical midline incision **Exclusion criteria**: none described
Interventions	**Comparisons reported**: Group 1 Suture: polyglyconate (multifilament, slowly absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: PGA (multifilament, fast absorbable) Suturing technique: interrupted Closure method: mass **Surgeon characteristics**: "Most wounds were closed by house officers under the direct supervision of a senior staff gynaecologist..."
Outcomes	**Incisional hernia**: any palpable defect in the fascia, even if an increase in intra-abdominal pressure did not result in a swelling in the abdominal scar **Follow-up duration**: 12, 24 and 36 months **Wound infection**: purulent discharge with or without a positive culture **Wound dehiscence**: no definition provided **Suture sinus or fistula**: no definition provided
Notes	Hernia data at 12 months used in analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...according to a table of computer-generated random numbers..."
Allocation concealment (selection bias)	Low risk	"At the moment of abdominal-wall suturing, a nurse assigned the patients to one of two closure techniques according to a table of computer-generated random numbers and informed the surgeons of the type of closure to be used."
Blinding (performance bias and detection bias) All outcomes	Low risk	"Incisions were evaluated using careful palpation by physicians who were unaware of the type of suturing technique."
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants included in analysis. Excluded participants discussed (met exclusion criteria)

Colombo 1997 *(Continued)*

Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Corman 1981

Methods	**RCT** **Methods to control for contributory patient factors**: "Patients were further classified according to septic or contaminated status and whether or not steroids were required."
Participants	**Age**: no information provided **Gender**: no information provided **Type of incision**: no information provided **Type of surgery**: overall: sigmoid colectomy 25%, right colectomy 20%, proctocolectomy 11%, low anterior resection 4%, Hartmann resection 3%, transverse colectomy 3%, other 11% **Contamination classification of included participants**: no information provided **Pre-operative antibiotic use**: no information provided **Prognostic patient factors**: a total of 86 participants (53%) were operated for malignancy Sepsis: 8.9% in group 1, 9.4% in group 2 and 6.8% in group 3 **Inclusion criteria**: consecutive patients having a bowel operation employing a midline incision **Exclusion criteria**: none described
Interventions	**Comparisons reported**: Group 1 Suture: nylon (multifilament, non-absorbable) Suturing technique: interrupted, simple Closure method: mass Group 2: Suture: polypropylene (monofilament, non-absorbable) Suturing technique: interrupted, simple Closure method: mass Group 3: Suture: polyglactin-910 (multifilament, fast absorbable). Suturing technique: interrupted, simple Closure method: mass **Surgeon characteristics**: no clear information; "All procedures were performed by or under the direction of one of the three authors"
Outcomes	**Wound infection**: no definition provided **Follow-up duration**: mean follow-up was 19 months overall; no group-wise data available **Incisional hernia**: no definition provided **Wound dehiscence**: no definition provided **Suture sinus or fistula**: no definition provided
Notes	Hernia data excluded from analysis due to unclear follow-up duration

Corman 1981 *(Continued)*

	Groups 1 and 2 combined for analysis of absorbable versus non-absorbable sutures
	Groups 1 and 3 combined for analysis of monofilament versus multifilament sutures

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"...the suture material to be used was randomly selected using a computer."
Allocation concealment (selection bias)	Unclear risk	"...the suture material to be used was randomly selected using a computer."
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information provided
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants analysed in the group they were assigned
Selective reporting (reporting bias)	Unclear risk	Unclear length of follow-up for incisional hernia outcomes
Other bias	Low risk	The study appears to be free of other sources of bias

Dan 2014

Methods	**RCT** **Methods to control for contributory patient factors**: unknown
Participants	**Age**: groupwise data not available. Ages 30-82 years **Gender**: groupwise data not available. Overall, Male = 59.5% **Types of incisions**: all midline **Types of surgery**: all elective surgery **Contamination classification of included participants**: not described **Preoperative antibiotic use**: not described **Prognostic patient factors**: not described **Inclusion criteria**: elective midline laparotomy **Exclusion criteria**:
Interventions	**Comparisons reported**: Group 1: Sutures: polyglactin (multifilament, fast absorbable) Suture technique: interrupted Closure method: mass closure Group 2:

Dan 2014 *(Continued)*

	Sutures: silk (multifilament, non-absorbable) Suture technique: interrupted Closure method: mass closure
Outcomes	**Wound infection**: not defined **Dehiscence**: not defined **Sinus or fistula**: "Suture rejection"
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Loss to follow-up and patient accountability not explicitly addressed
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Unclear risk	Follow-up duration not described

Deitel 1990

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 34 years Group 2 (mean): 36 years **Gender**: Group 1: 36.6% female Group 2: 39.3% female **Type of incision**: all participants had an upper midline incision ending above the umbilicus **Type of surgery**: all participants underwent vertical banded gastroplasty **Contamination classification of included participants**: all wounds were classified as clean-contaminated

Deitel 1990 *(Continued)*

	Pre-operative antibiotic use: all participants received antibiotic prophylaxis with 2 g of cefazolin **Prognostic patient factors**: all participants were diagnosed with morbid obesity **Inclusion criteria**: consecutive participants who underwent vertical banded gastroplasty for morbid obesity **Exclusion criteria**: none described
Interventions	**Comparisons reported**: Group 1 Suture: PGA (multifilament, fast absorbable) Suturing technique: continuous, reinforced with "a few" interrupted sutures Closure method: mass Group 2: Suture: polyglyconate (monofilament, slowly absorbable) Suturing technique: continuous sutures, reinforced with "a few" interrupted sutures Closure method: mass **Surgeon characteristics**: all procedures were performed by a senior resident under supervision
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: no group-wise data provided; all participants were followed up for > 2 years **Wound infection**: discharge of pus, associated with fever and increased leukocyte count **Wound dehiscence**: no definition provided
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The patients were allocated for closure with No.1 Dexon Plus or with No.1 Maxon by drawing a randomised card."
Allocation concealment (selection bias)	Unclear risk	Not clearly described
Blinding (performance bias and detection bias) All outcomes	Low risk	"All patients were followed up for more than 2 years by two surgeons who were blinded to the closure material used..."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not clearly reported
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Derzie 2000

Methods	**RCT**

Derzie 2000 *(Continued)*

	Methods to control for contributory patient factors: none described
Participants	**Age**: no information provided **Gender**: no information provided **Types of incisions**: no information provided **Type of surgery**: Group 1: Roux-en-Y gastric bypass 83.1%, vertical banded gastroplasty 2.3%, revision procedures 14.5%, additional cholecystectomy 14.0% Group 2: Roux-en-Y gastric bypass 84.3%, vertical banded gastroplasty 6.9%, revision procedures 8.8%, additional cholecystectomy 13.8% **Contamination classification of included participants**: no information provided **Preoperative antibiotic use**: all participants received either cefazolin or gentamicin and vancomycin (if allergic to penicillins) **Prognostic patient factors**: all participants were morbidly obese **Inclusion criteria**: none described **Exclusion criteria**: none described
Interventions	**Comparisons reported**: *Group 1*: Sutures: nylon (in first 196 participants randomised), PDS (in the last 135 participants randomised) Suturing technique: continuous Closure method: mass *Group 2*: Sutures: nylon (in first 196 participants), PDS (in the last 135 participants) Suturing technique: interrupted, "figure-of-8" Closure method: mass **Surgeon characteristics**: no information provided
Outcomes	**Incisional hernia**: not measured **Wound infection**: local or systemic inflammation and collection of purulent subcutaneous fluid from wound **Deep wound complications**: included deep surgical site infections and fascial dehiscence
Notes	**Follow-up duration**: "All wounds were monitored for 30 postoperative days." Dehiscence (n = 2) were not separated from "wound complications". All "wound complications" analysed as wound infection

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	"All patients were randomised by odd or even medical record number at the time of fascial closure to either continuous or interrupted fascial closure."
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described

Derzie 2000 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not clearly reported
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Docobo-Durantez 2006

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1: > 65 years 47.9% Group 2: > 65 years 49.2% **Gender**: Group 1: 47.2% female Group 2: 44.2% female **Type of incision**: overall, 78.1% were midline **Type of surgery**: Group 1: emergency 27.5% Group 2: emergency 28.2% **Contamination classification of included participants**: information not provided **Pre-operative antibiotic use**: not described **Prognostic patient factors**: Group 1: malignancy 54.3%. obesity 17.1%, diabetes 18.4%, corticosteroids 4.4%, jaundice 4.2%, hypoproteinaemia 16.6%, renal failure 4.0%, ascites 1.3% Group 2: malignancy 52.7%, obesity 22.3%, diabetes 15.4%, corticosteroids 6.9%, jaundice 5.3%, hypoproteinaemia 13.8%, renal failure 5.0%, ascites 4.1% **Inclusion criteria**: laparotomies performed for gastrointestinal diseases and hepato-biliopancreatic procedures (including transplant) in patients with at least 1 risk factor for wound complications: male, age > 65 years, pulmonary disease, haemodynamic instability, emergency surgery, hypoproteinaemia, clinical infection, obesity, renal failure, malignancy, ascites, steroids, hypertension, anaemia, jaundice or diabetes **Exclusion criteria**: hernia repair surgery, bariatric surgery, need for reinforcement sutures, uncommon incisions (including paramedian and McBurney incisions), life expectancy of < 1.5 years and deaths unrelated to wounds
Interventions	**Comparisons reported**: Group 1 Suture: PDS (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass

Docobo-Durantez 2006 *(Continued)*

	Group 2: Suture: nylon (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: information not provided
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: 3, 6, 12 and 18 months **Wound infection**: "as per the Center for Disease Control (CDC) definition for surgical site infection" **Dehiscence**: no definition provided
Notes	Extremely high loss to follow-up. Hernia data at 1 year used in analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation tables created
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	Only 104/451 in PDS group and 72/319 in nylon group followed up at 1 year
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Donaldson 1982

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: Group 1 (mean): 54.9 years Group 2 (mean): 53.4 years Group 3 (mean): 60.1 years **Gender**: Group 1: 55% female Group 2: 59% female

Donaldson 1982 *(Continued)*

	Group 3: 53% female **Type of incision**: all participants underwent laparotomy through a lateral paramedian incision Group 1: upper abdominal 59%, mid-abdominal 19%, lower abdominal 22% Group 2: upper abdominal 66%, mid-abdominal 15%, lower abdominal 19% Group 3: upper abdominal 75%, mid-abdominal 10%, lower abdominal 15% **Type of surgery**: Group 1: elective 68%; biliary 28%, pancreatic 1%, peptic ulcer 20%, colorectal cancer 15%, small bowel obstruction 3%, inflammatory bowel disease 9%, gastric cancer 5%, appendicitis 3%, other 13% Group 2: elective 72%; biliary 31%, pancreatic 0%, peptic ulcer 22%, colorectal cancer 14%, small bowel obstruction 3%, inflammatory bowel disease 5%, gastric cancer 5%, appendicitis 0%, other 15% Group 3: elective 75%; biliary 38%, pancreatic 1%, peptic ulcer 23%, colorectal cancer 13%, small bowel obstruction 5%, inflammatory bowel disease 4%, gastric cancer 9%, appendicitis 1%, other 3% **Contamination classification of included participants**: Group 1: clean 11%, clean-contaminated 54%, contaminated 35% Group 2: clean 9%, clean-contaminated 51%, contaminated 40% Group 3: clean 5%, clean-contaminated 58%, contaminated 37% **Preoperative antibiotic use**: no prophylactic antibiotics were used **Prognostic patient factors**: Group 1: hypoalbuminaemia 33%, steroids 4%, diabetes 2.5%, uraemia 0%, jaundice 9%, respiratory disease 10% Group 2: hypoalbuminaemia 28%, steroids 0%, diabetes 0%, uraemia 3%, jaundice 8%, respiratory disease 9% Group 3: hypoalbuminaemia 34%, steroids 4%, diabetes 1%, uraemia 5%, jaundice 6%, respiratory disease 6% **Inclusion criteria**: all patients admitted between August 1978 and August 1979 for a laparotomy procedure under the care of the senior study author **Exclusion criteria**: patients with life-threatening intra-abdominal haemorrhage or who had a previous abdominal incision
Interventions	**Comparisons reported**: Group 1 Suture: PGA (multifilament, fast absorbable) Suturing technique: continuous Closure method: layered Group 2: Sutures: chromic catgut (monofilament, fast absorbable) Suturing technique: continuous Closure method: layered Group 3: Sutures: polypropylene (monofilament, non-absorbable) Suturing technique: continuous Closure method: layered

Donaldson 1982 *(Continued)*

	Surgeon characteristics: no information provided
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: "All wounds were further examined at 1, 3, 6, and 12 months after operation." **Wound infection**: wound discharge eliciting a positive bacterial culture **Wound dehiscence**: no definition provided **Suture sinus**: no definition provided
Notes	Groups 1 and 2 analysed together as "absorbable sutures" in the primary analysis Group 1 compared against Groups 2 and 3 (combined) in the monofilament versus multifilament analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"However, closure of the anterior rectus sheath was randomly allocated (using a blind card system selected prior to the laparotomy)..."
Allocation concealment (selection bias)	Unclear risk	No clear description of the allocation procedure
Blinding (performance bias and detection bias) All outcomes	Unclear risk	None described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Losses to follow-up not clearly described
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Efem 1980

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: not reported **Gender**: not reported **Types of incisions**: all participants underwent a vertical midline incision **Types of surgery**: Group 1: emergent 45% Group 2: emergent 45% **Contamination classification of included participants**: not reported **Pre-operative antibiotic use**: not reported

Efem 1980 *(Continued)*

	Prognostic patient factors: not reported **Inclusion criteria**: patients who underwent procedures through a vertical midline laparotomy **Exclusion criteria**: paramedian, transverse, oblique, gridiron, Pfannenstiel and Rutherford-Morrison incisions were excluded
Interventions	**Comparisons reported**: *Group 1* Suture: nylon (monofilament, non-absorbable) Suturing technique: interrupted, "Figure-of-8" Closure method: mass *Group 2* Sutures: chromic catgut (monofilament, fast absorbable) and nylon (monofilament, non-absorbable) Suturing technique: unclear Closure method: layered (#1 chromic for peritoneum, nylon for rectus sheath, 2-0 chromic for fat) **Surgeon characteristics**: not reported
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: 6-18 months (80% for 8 months, 10% for 18 months) **Wound infection**: "Wound sepsis delaying discharge from hospital" **Dehiscence**: no definition provided **Sinus or fistula**: no definition provided
Notes	Hernia data excluded from analysis due to inadequate follow-up duration at 1 year

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Unlcear how losses to follow-up were accounted for
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Fagniez 1985

Methods	**RCT**

Fagniez 1985 *(Continued)*

	Methods to control for contributory patient factors:
Participants	**Age**: Group 1 (mean): 54 years Group 2 (mean): 53 years **Gender**: Group 1: 55.0% female Group 2: 58.7% female **Type of incision**: Group 1: upper midline 55.1%; lower midline 32.7%; central midline 6.9%; complete midline 5.3% Group 2: upper midline 54.9%; lower midline 32.7%; central midline 6.8%; complete midline 5.6% **Type of surgery**: not reported **Contamination classification of included participants**: Group 1: clean 32.6%; clean-contaminated 42.6%; contaminated 25.0% Group 2: clean 32.6%; clean-contaminated 42.3%; contaminated 24.7% **Pre-operative antibiotic use**: Group 1: 16.7% Group 2: 17.1% **Prognostic patient factors**: Group 1: obesity 11.9% Group 2: obesity 12.5% **Inclusion criteria**: all patients operated on who received a midline abdominal incision for any indication **Exclusion criteria**: patients operated on with incisions other than midline abdominal were excluded
Interventions	**Comparisons reported**: *Group 1*: Sutures: PGA (multifilament, fast absorbable) Suture technique: interrupted Closure method: mass Group 2: Sutures: PGA (multifilament, fast absorbable) Suture technique: continuous Closure method: mass **Surgeon characteristics**: not reported
Outcomes	**Incisional hernia**: not defined **Follow-up duration**: unclear, but suggests 30 days **Wound infection**: "Wound abscess" **Dehiscence**: not defined

Fagniez 1985 *(Continued)*

	Sinus or fistula: not defined
Notes	Hernia data excluded from analysis due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Low risk	Sealed form opened by nurse at time of surgery
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Gammelgaard 1983

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (median): 34 Group 2 (median): 38 **Gender**: Group 1: 63% female Group 2: 60% female **Type of incision**: Group 1: angular 13.9%, longitudinal 43.0%, transverse/oblique 43.0% Group 2: angular 10.1%, longitudinal 46.5%, transverse/oblique 40.9% **Type of surgery**: Group 1: emergency 29.0%; biliary 22.5%, gastric/duodenal 20.5%, intestinal 11.3%, appendectomy 24.5%, internal genitalia 21.2% Group 2: emergency 34.2%; biliary 20.1%, gastric/duodenal 19.5%, intestinal 10.1%, appendectomy 25.8%, internal genitalia 22.0% **Contamination classification of included participants**: not described

Gammelgaard 1983 *(Continued)*

	Pre-operative antibiotic use: not reported **Prognostic patient factors**: Group 1: obesity 34.4%, malignancy 15.2% Group 2: obesity 28.4%, malignancy 12.2% **Inclusion criteria**: consecutive abdominal incisions, either emergency or elective, for operations of the gastrointestinal tract or internal genital organs **Exclusion criteria**: hernioplasties, McBurney incisions, re-operations within the follow-up period, incisions in preparation for stoma operations, patients receiving steroids and non-Danish patients
Interventions	**Comparisons reported**: Group 1 Suture: polyglactin-910 (multifilament, fast absorbable) Suturing technique: peritoneum - continuous, fascia - interrupted Closure method: layered Group 2: Sutures: PGA (multifilament, fast absorbable) Suturing technique: peritoneum - continuous, fascia - interrupted Closure method: layered **Characteristics of surgeons**: not reported
Outcomes	**Incisional hernia**: no definition provided **Follow-up duration**: 6 months **Wound infection**: defined as "wound abscess" **Wound dehiscence**: not defined **Sinus or fistula tract**: not defined
Notes	Hernia data excluded from analysis due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcomes assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Gislason 1995

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 62 years Group 2 (mean): 60 years Group 3 (mean): 60 years **Gender**: Group 1: 1:1 (male:female) Group 2: 0.87:1 (male:female) Group 3: 1:1 (male:female) **Type of incision**: Group 1: midline 84%, transverse 16% Group 2: midline 83%, transverse 17% Group 3: midline 86%, transverse 14% **Type of surgery**: Group 1: emergency 36%; gastric/oesophageal 25.1%, hepato-pancreaticobiliary 14.8%, small intestine 14.3%, colorectal 40.9%, other 4.9% Group 2: emergency 29%; gastric/oesophageal 19.1%, hepato-pancreaticobiliary 19.1%, small intestine 15.6%, colorectal 42.7%, other 3.5% Group 3: emergency 32%; gastric/oesophageal 24.9%; hepato-pancreaticobiliary 15.7%; small intestine 14.2%; colorectal 41.1%; other 4.1% **Contamination classification of included participants**: Group 1: clean 22%, clean-contaminated/contaminated 66%, dirty 12% Group 2: clean 32%, clean-contaminated/contaminated 59%, dirty 9% Group 3: clean 23%, clean-contaminated/contaminated 66%, dirty 11% **Pre-operative antibiotic use**: all received doxycycline or cefuroxime and metronidazole **Prognostic patient factors**: Group 1: mean weight 66 kg, malignancy 49.2% Group 2: mean weight 66 kg, malignancy 50.2% Group 3: mean weight 67 kg, malignancy 53.3% **Inclusion criteria**: "major GI surgery" (via laparotomy) **Exclusion criteria**: urological or gynaecological surgeries, "minor surgical procedures"; laparotomy within last 3 months
Interventions	**Comparisons reported**:

Gislason 1995 *(Continued)*

	Group 1 Suture: polyglyconate (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: polyglactin-910 (multifilament, fast absorbable) Suturing technique: continuous Closure method: mass Group 3: Suture: polyglactin-910 (multifilament, fast absorbable) Suturing technique: interrupted Closure method: mass **Surgeon characteristics**: not reported
Outcomes	**Incisional hernia**: visible/palpable bulge with patient standing **Follow-up duration**: 1 year **Wound infection**: inflammation of the wound with discharge, fever, increased leukocyte count or serum C-reactive protein and a positive wound culture **Wound dehiscence**: ascites or abdominal viscera escaping from wound
Notes	Groups 2 compared with Group 3 in 'continuous versus interrupted' analysis Group 1 compared with Group 2 in 'monofilament versus multifilament' analysis Group 1 compared with Group 2 in 'slow versus fast absorbable' analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	High rates of loss to follow-up (39/203 in group 1, 36/199 in group 2)
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	High risk	Not all participants followed up within clinical setting. Some followed up by mailed survey only

Goligher 1975

Methods	**RCT**

Goligher 1975 *(Continued)*

	Methods to control for contributory patient factors: none
Participants	**Age**: Group 1: < 60 years 66.4%, 60-80 years 31.8%, > 80 years 1.9% Group 2: < 60 years 64.5%, 60-80 years 33.6%, > 80 years 1.9% Group 3: < 60 years 61.8%, 60-80 years 35.5%, > 80 years 2.7% **Gender**: Group 1: 45.8% female Group 2: 32.7% female Group 3: 46.3% female **Type of incision**: all paramedian incisions **Type of surgery**: all elective procedures Group 1: peptic ulcer disease 37.3%, colorectal cancer 18.7%, palliative 8.4%, inflammatory bowel disease 22.4%, other 13.1% Group 2: peptic ulcer disease 32.7%, colorectal cancer 23.3%, palliative 6.5%, inflammatory bowel disease 23.3%, other 14.0% Group 3: peptic ulcer disease 36.4%, colorectal cancer 17.2%, palliative 10.0%, inflammatory bowel disease 21.8%, other 14.5% **Contamination classification of included participants**: Group 1: contaminated 21.5% Group 2: contaminated 30.8% Group 3: contaminated 18.2% **Pre-operative antibiotic use**: not described **Prognostic patient factors**: Group 1: obesity 30.8%, malignancy 27.1%, corticosteroids 8.4% Group 2: obesity 35.5%, malignancy 30.0%, corticosteroids 12.1% Group 3: obesity 40.0%, malignancy 27.3%, corticosteroids 10.0% **Inclusion criteria**: patients undergoing elective laparotomy through rectus-displacing paramedian incisions **Exclusion criteria**: none described
Interventions	**Comparisons reported**: Group 1 Suture: chromic catgut (monofilament, fast absorbable) Suturing technique: continuous, plus reinforcing interrupted sutures on the anterior rectus Closure method: layered Group 2: Sutures: chromic catgut (monofilament, fast absorbable) plus nylon retention sutures Suture technique: continuous, plus reinforcing interrupted nylon sutures on the anterior rectus Closure method: layered Group 3:

Goligher 1975 *(Continued)*

	Suture: stainless steel (monofilament, non-absorbable) Suturing technique: interrupted, "figure-of-8" sutures Closure method: mass **Surgeon characteristics**: Group 1: consultant 30.0%, registrar 70.0% Group 2: consultant 30.8%, registrar 66.3%, unknown 2.8% Group 3: consultant 38.2%, registrar 60.0%, unknown 1.8%
Outcomes	**Incisional hernia**: not defined **Follow-up duration**: 6 months **Wound infection**: not defined **Dehiscence**: not defined **Sinus or fistula**: "Persistent wound infection and sinus formation"
Notes	Hernia data excluded, due to < 1 year's follow-up Group 2 excluded from analysis (combined absorbable and non-absorbable sutures)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participants followed up for < 1 year for incisional hernia outcomes
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Gys 1989

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 64 years

Gys 1989 *(Continued)*

	Group 2 (mean): 61 years **Gender**: Group 1: 48% female Group 2: 49% female **Type of incision**: Group 1: upper midline 30%, lower midline 39%, full midline 9%, subcostal 25%, other 7% Group 2: upper midline 30%, lower midline 34%, full midline 9%, subcostal 27%, other 0% **Type of surgery**: Group 1: emergency 24%; colorectal 34%, pancreaticobiliary 28%, oesophagogastric 22%, vascular 6%, other 10% Group 2: emergency 26%; colorectal 32%, pancreaticobiliary 34%, oesophagogastric 20%, vascular 3%, other 11% **Contamination classification of included participants**: Group 1: contaminated 9.0% Group 2: contaminated 4.6% **Pre-operative antibiotic use**: not described **Prognostic patient factors**: Group 1: diabetes 9.0%, obesity 40.3%, malignancy 56.7%, respiratory failure 9.0%, jaundice 4.5% Group 2: diabetes 7.7%, obesity 30.8%, malignancy 44.6%, respiratory failure 9.2%, jaundice 7.7% **Inclusion criteria**: consecutive patients undergoing elective or emergency laparotomy **Exclusion criteria**: none described
Interventions	**Comparisons reported**: Group 1 Suture: nylon (monofilament, non-absorbable) Suturing technique: continuous Closure method: layered ('0' for peritoneum, '1' for musculo-aponeurotic layer) Group 2: Suture: polyglyconate (monofilament, slowly absorbable) Suturing technique: continuous Closure method: layered ('0' for peritoneum, '1' for musculo-aponeurotic layer) **Surgeon characteristics**: not described
Outcomes	**Incisional hernia**: assessed by palpation with patient lying supine and with elevation of extended legs **Follow-up duration**: 1 year **Wound infection**: postoperative purulent discharge with proven growth of a micro-organism **Dehiscence**: "burst abdomen" **Sinus or fistula**: no definition provided
Notes	—

Gys 1989 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	Of the total of 132 participants, 13 (9.8%) died within 1 year and 22 (17.0%) were lost to follow-up
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Hsiao 2000

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 60.9 years Group 2 (mean): 58.5 years **Gender**: Group 1: 44% female Group 2: 48% female **Type of incision**: Group 1: midline 50.5%, paramedian 4.3%, subcostal 26.1%, subcostal plus midline 4.9%, bilateral subcostal plus midline 14.1% Group 2: midline 45.5%, paramedian 5.1%, subcostal 26.3%, subcostal plus midline 5.1%, bilateral subcostal plus midline 17.9% **Type of surgery**: all surgeries were elective Group 1: upper GI 17.4%, hepato-pancreaticobiliary 63.6%, lower GI 15.2%, vascular 3.3%, other 0.5% Group 2: upper GI 15.4%, hepato-pancreaticobiliary 65.4%, lower GI 13.5%, vascular 1.2%, other 4.5% **Contamination classification of included participants**: not described **Pre-operative antibiotic use**: all participants received cefmetazole and metronidazole **Prognostic patient factors**:

Hsiao 2000 *(Continued)*

	Group 1: mean BMI 23.0, malignancy 58.1% Group 2: mean BMI 22.8, malignancy 54.4% **Inclusion criteria**: patients undergoing elective laparotomy **Exclusion criteria**: emergency laparotomies, history of laparotomy within 3 months, previous incisional hernia
Interventions	**Comparisons reported**: Group 1 Suture: polyglactin-910 (multifilament, fast absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: PDS (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: same surgeon for all procedures
Outcomes	**Incisional hernia**: visible and palpable defect in the fascia or a protrusion in the wound when the participant was carefully examined in both horizontal and vertical positions **Follow-up duration**: 24 months **Wound infection**: purulent discharge from the wound, confirmed by standard signs including fever and an elevated leukocyte count **Dehiscence**: no definition provided **Sinus or fistula**: no definition provided
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised based on last digit of hospital patient number
Allocation concealment (selection bias)	High risk	Randomised based on last digit of hospital patient number
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessor blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Irvin 1976

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 51 years Group 2 (mean): 48 years Group 3 (mean): 50 years **Gender**: Group 1: 48.0% female Group 2: 38.5% female Group 3: 42.0% female **Type of incision**: Group 1: median 46.2%, paramedian 53.8% Group 2: median 48.0%, paramedian 52.0% Group 3: median 45.6%, paramedian 53.4% **Type of surgery**: all elective Group 1: biliary 36.5%, peptic ulcer 32.7%, intestinal 15.4%, other 15.4% Group 2: biliary 28.8%, peptic ulcer 42.3%, intestinal 15.4%, other 13.5% Group 3: biliary 28.1%, peptic ulcer 31.6%, intestinal 19.3%, other 21.0% **Contamination classification of included participants**: not specified **Pre-operative antibiotic use**: not specified **Prognostic patient factors**: Group 1: obesity 38.5%, malignancy 9.6% Group 2: obesity 26.9%, malignancy 11.5% Group 3: obesity 26.3%, malignancy 14.0% **Inclusion criteria**: patients undergoing laparotomy through median or paramedian incisions **Exclusion criteria**: patients with prior median or paramedian scars
Interventions	**Comparisons reported**: Group 1 Suture: PGA (multifilament, fast absorbable, absorbable) Suturing technique: continuous closure of peritoneum and posterior rectus sheath, interrupted closure of the anterior rectus sheath Closure method: layered Group 2: Suture: polyglactin XLG (multifilament, fast absorbable) Suturing technique: continuous closure of peritoneum and posterior rectus sheath, interrupted closure of the anterior rectus sheath Closure method: layered

Irvin 1976 *(Continued)*

	Group 3: Suture: polypropylene (monofilament, non-absorbable) Suturing technique: continuous closure of peritoneum and both rectus sheaths Closure method: layered **Surgeon characteristics**: Group 1: consultant 67.3%, registrar 32.7% Group 2: consultant 53.9%, registrar 46.1% Group 3: consultant 52.6%, registrar 47.4%
Outcomes	**Incisional hernia**: not defined **Follow-up duration**: 6 months **Wound infection**: pus discharged from wound **Dehiscence**: not defined **Sinus formation**: not defined
Notes	Hernia data excluded from analysis due to inadequate follow-up duration Groups 1 and 2 analysed together as 'absorbable sutures', as well as multifilament sutures

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Random allocation by drawing "trial cards"
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants discussed, with explanation of those not included in analysis
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Irvin 1977

Methods	**RCT** **Methods to control for contributory patient factors**: "The method of randomisation took into account the type of surgery performed..."
Participants	**Age**: unknown

Irvin 1977 *(Continued)*

	Gender: unknown **Type of incision**: Group 1: median 43.2%, paramedian 56.8% Group 2: median 40.6%, paramedian 59.4% **Type of surgery**: Group 1: emergent 16.8%, palliative 12.6%; biliary 27.4%, peptic ulcer 30.5%, intestinal 25.3%, other 16.8% Group 2: emergent 14.6%, palliative 10.4%; biliary 35.4%, peptic ulcer 25.0%, intestinal 20.8%, other 18.8% **Contamination classification of included participants**: 163 "clean" wounds, 28 "infected" wounds, not broken down by group **Pre-operative antibiotic use**: not described **Prognostic patient factors**: not reported **Inclusion criteria**: patients going through exploratory laparotomy through median or paramedian incisions **Exclusion criteria**: not described
Interventions	**Comparisons reported**: Group 1 Sutures: polypropylene (monofilament, non-absorbable), polyester retention sutures Suturing technique: continuous (with interrupted retention sutures) Closure method: layered Group 2: Sutures: stainless steel (monofilament, non-absorbable) Suturing technique: interrupted, 'figure-of-8' Closure method: mass **Surgeon characteristics**: Group 1: consultant 40.0%, registrar 60.0% Group 2: consultant 43.4%, registrar 56.6%
Outcomes	**Incisional hernia**: palpable defect in abdominal fascia with straining **Follow-up duration**: 6 months **Wound dehiscence**: no definition provided **Wound infection**: discharge of pus from wound
Notes	Hernia data excluded from analysis due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"randomly allocated by drawing a trial card at the end of the abdominal procedure, and the method of randomisation took account of the type of surgery performed…"

Irvin 1977 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	"randomly allocated by drawing a trial card at the end of the abdominal procedure, and the method of randomisation took account of the type of surgery performed…"
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and dropouts adequately explained
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Israelsson 1994

Methods	**RCT** **Methods to control for contributory patient factors**: not described
Participants	**Age**: Group 1 (mean): 62 years Group 2 (mean): 62 years **Gender**: Group 1: 45.7% female Group 2: 48.0% female **Type of incision**: all incisions were midline **Type of surgery**: Group 1: emergency 30% Group 2: emergency 33% **Contamination classification of included participants**: Group 1: clean 34%, clean-contaminated 55%, contaminated 11% Group 2: clean 34%, clean-contaminated 56%, contaminated 10% **Pre-operative antibiotic use**: not described **Prognostic patient factors**: not described **Inclusion criteria**: patients undergoing abdominal surgery through a midline incision **Exclusion criteria**: patients with an incisional hernia from previous abdominal surgery
Interventions	**Comparisons reported**: Group 1: Suture: PDS (monofilament, slowly absorbable)

Israelsson 1994 *(Continued)*

	Suturing technique: continuous Closure method: mass Group 2: Suture: nylon (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: group-wise not described
Outcomes	**Incisional hernia**: palpable defect in the fascia or a protrusion beyond the level of the fascia with the patient supine lifting both legs, and coughing or straining in an erect position **Follow-up duration**: 12 months **Wound infection**: purulent discharge from the wound with or without generalised symptoms **Dehiscence**: no definition provided **Sinus or fistula tract**: no definition provided
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised based on alternating weeks
Allocation concealment (selection bias)	High risk	See above
Blinding (performance bias and detection bias) All outcomes	High risk	See above
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Kiely 1985

Methods	**RCT**
Participants	**Age**: infants and children **Gender**: Group 1: female 38.6% Group 2: female 36.4% **Types of incisions**

Kiely 1985 *(Continued)*

	Group 1: transverse 70%; vertical 30% Group 2: transverse 66.8%; vertical 33.2% **Types of surgery**: not specified **Contamination** Group 1: contaminated 38.2% Group 2: contaminated 37.1% **Preoperative antibiotics**: not described **Inclusion criteria**: all patients < 16 years undergoing laparotomy between 1980 and 1982 **Exclusion criteria**: none specified
Interventions	**Comparison reported**: Group 1: Suture: PGA (fast absorbable, multifilament) Suture technique: interrupted Closure method: mass Group 2: Suture: PGA (fast absorbable, multifilament) Suture technique: continuous for each layer Closure method: layer
Outcomes	**Hernia**: not defined **Follow-up duration**: not defined **Wound infection**: not defined **Dehiscence**: not defined
Notes	Data excluded from hernia outcome, due to unclear follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Alternate case allocation
Allocation concealment (selection bias)	High risk	Alternate case allocation
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed

Kiely 1985 *(Continued)*

Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Kronborg 1976

Methods	**RCT** **Methods to control for contributory patient factors**: none described
Participants	**Age**: not described **Gender**: Group 1: female 59% Group 2: female 45% **Types of incisions**: Group 1: longitudinal 44%, transverse 45%, angular 11% Group 2: longitudinal 46.7%, transverse 41.1%, angular 12.2% **Types of surgery**: elective Group 1: colorectal 53.3%, gastric 28.8%, common bile duct 17.9% Group 2: colorectal 60.1%, gastric 27%, common bile duct 12.9% **Contamination classification of included participants**: not described **Pre-operative antibiotic use**: not described **Prognostic patient factors**: Group 1: obesity 17.8% Group 2: obesity 16.0% **Inclusion criteria**: patients undergoing elective, major surgery of the GI tract **Exclusion criteria**: patients undergoing simple cholecystectomies, proximal gastric vagotomies, findings of inoperable cancers and with previous laparotomies
Interventions	**Comparisons reported**: Group 1: Suture: PGA (multifilament, fast absorbable) for fascia Suturing technique: interrupted fascial closure; peritoneum closed with continuous catgut, subcutaneous tissues closed with interrupted catgut, skin closed with interrupted silk Closure method: layered Group 2: Suture: silk (multifilament, non-absorbable) for fascia Suturing technique: interrupted fascial closure; peritoneum closed with continuous catgut, subcutaneous tissue closed with interrupted catgut, skin closed with interrupted silk Closure method: layered **Surgeon characteristics**: not described

Kronborg 1976 *(Continued)*

Outcomes	**Incisional hernia**: not defined **Follow-up duration**: 3 months **Wound infection**: not defined **Dehiscence**: "wound rupture" with fascial dehiscence **Sinus tract formation**: "suture granuloma"
Notes	Incisional hernia data excluded due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Blind paired sample principle" prior to fascial closure
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessors blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for, analysed in group allocation
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Krukowski 1987

Methods	**RCT** **Methods to control for contributory patient factors**: stratified by age (>/< 60 years), sex, emergent versus elective and degree of contamination
Participants	**Age**: Group 1: 48.6% < 60 years Group 2: 49.1% < 60 years **Gender**: Group 1: 48.4% female Group 2: 46.2% female **Type of incision**: vertical midline incision for all participants **Type of surgery**: both emergent and elective **Contamination classification of included participants**:

Krukowski 1987 *(Continued)*

	Group 1: clean 24.6%, clean-contaminated 51.8%, contaminated 7.2%, dirty 16.3% Group 2: clean 26.6%, clean-contaminated 49.6%, contaminated 8.0%, dirty 15.7% **Pre-operative antibiotic use**: not described **Prognostic patient factors**: not described **Inclusion criteria**: patients undergoing laparotomy through a vertical midline incision **Exclusion criteria**: patients undergoing repair of an incisional hernia
Interventions	**Comparisons reported**: Group 1: Suture: PDS (monofilament, slowly absorbable) Suturing technique: continuous Closure method: mass Group 2: Suture: polypropylene (monofilament, non-absorbable) Suturing technique: continuous Closure method: mass **Surgeon characteristics**: all cases performed by 2 consultants
Outcomes	**Hernia**: palpable gap without herniation or a diffuse bulge or obvious herniation **Follow-up duration**: 12 months **Wound infection**: discharge of pus from the wound or growth of a pathogenic organism from serous or sanguineous discharge **Dehiscence**: evisceration **Sinus or fistula**: not defined
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation tables
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intention-to-treat, all participants accounted for
Selective reporting (reporting bias)	Low risk	Hernia (at least 1 year); dehiscence and wound infection outcomes all reported
Other bias	Low risk	The study appears to be free of other sources of bias

Larsen 1989

Methods	**RCT** **Methods to control for contributory patient factors**:
Participants	**Age**: Group 1 (median): 36 years Group 2 (median): 37 years Group 3 (median): 40 years **Gender**: Group 1: 84.0% female Group 2: 85.5% female Group 3: 86.8% female **Type of incision**: Group 1: transverse/oblique 76.0%, median/paramedian 24.0% Group 2: transverse/oblique 83.9%, median/paramedian 16.1% Group 3: transverse/oblique 71.1%, median/paramedian 28.9% **Type of surgery**: Group 1: emergent 28.0%, elective 72.0%; gastric 9.3%, biliary 30.7%, other non-gynaecological 8.0%, caesarean section 28.0%, hysterectomy 17.3%, others 6.7% Group 2: emergent 29.9%, elective 70.1%; gastric 6.9%, biliary 28.7%, other non-gynaecological 9.2%, caesarean 20.7%, hysterectomy 19.5%, others 15% Group 3: emergent 28.9%, elective 71.1%; gastric 9.2%, biliary 23.7%, non-gynaecological 11.8%, caesarean 19.7%, hysterectomy 18.4%, others 17.1% **Contamination classification of included participants**: **Preoperative antibiotic use**: **Prognostic patient factors**: **Inclusion criteria**: patients undergoing clean and clean-contaminated laparotomy **Exclusion criteria**: patients with ascites, appendectomy through an oblique muscle-split incision, surgery through an old laparotomy scar, IDDM, thromboembolic prophylaxis with vitamin K-antagonist
Interventions	**Comparisons reported**: Group 1: Sutures: PGA (multifilament, fast absorbable) Suture technique: continuous Closure method: layered Group 2: Sutures: nylon (multifilament, non-absorbable) Suture technique: continuous Closure method: layered Group 3: Sutures: PGA (multifilament, fast absorbable)

Larsen 1989 *(Continued)*

	Suture technique: interrupted Closure method: layered **Characteristics of surgeons**: not described
Outcomes	**Hernia**: not defined **Follow-up duration**: at 3 months then 14 to 52 months (median = 41 months) **Wound infection**: not defined **Dehiscence**: not defined **Sinus/fistula**: not defined
Notes	Hernia data from late follow-up (median 41 months) Group 1 and 3 analysed together as 'absorbable' suture for absorbable versus non-absorbable analysis, Group 1 and 2 analysed together as 'continuous' in the continuous versus interrupted analysis. Group 1 compared to Group 2 in subgroup analysis of absorbable versus non-absorbable. Group 1 compared to group 3 in subgroup analysis of interrupted versus layered

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Type of randomisation not specified
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not stated
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intention-to-treat, all participants accounted for
Selective reporting (reporting bias)	Low risk	Reported on wound infections, dehiscence and had adequate follow-up for hernia
Other bias	Low risk	The study appears to be free of other sources of bias

Leaper 1977

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: not stated **Gender**: Group 1 female 54.3% Group 2 female 53%

Leaper 1977 *(Continued)*

	Group 3 female 46.7% **Types of incisions**: Group 1 paramedian 11.2%, midline 56.9%, transverse 31.9% Group 2 paramedian 10.7%, midline 53.7%, transverse 35.5% Group 3 paramedian 10%, midline 54.1%, transverse 35.8% **Types of surgery**: Group 1 colorectal 26.7%, biliary 20.7%, gastric 28.4%, miscellaneous 24.1% Group 2 colorectal 26.4%, biliary 28.9%, gastric 22.3%, miscellaneous 22.3% Group 3 colorectal 27.5%, biliary 25.8%, gastric 34.2%, miscellaneous 12.5% **Contamination classification of included participants**: **Preoperative antibiotic use**: **Prognostic patient factors**: Malignancy: Group 1 25.8%, Group 2 34.7%, Group 3 36.7% COPD: Group 1 44%, Group 2 52%, Group 3 42% Hypoproteinaemia: Group 1 11%, Group 2 10%, Group 3 5% **Inclusion criteria**: major laparotomies **Exclusion criteria**: appendectomy through muscle-splitting incision, lumbar sympathectomy, renal bladder and prostatic surgery, incisions through previous scars
Interventions	**Comparisons reported**: Group 1: Sutures: nylon (monofilament, non-absorbable) Suture technique: continuous Closure method: layered (peritoneum and posterior sheath closed with chromic catgut, anterior sheath by nylon) Group 2: Sutures: PGA (multifilament, fast absorbable) Suture technique: interrupted (Smead Jones) Closure method: mass closure Group 3: Sutures: steel (monofilament, non-absorbable) Suture technique: interrupted (Smead Jones) Closure method: mass closure **Characteristics of surgeons**: Consultant: Group 1 25.8%, Group 2 28.9%, Group 3 30%
Outcomes	**Hernia**: bulge noticeable by patient and assessor upon standing **Follow-up duration**: 6 months **Wound infection**: primary sepsis is discharge of pus from a previously dry wound, secondary sepsis is acquisition of infection by a discharging wound. Major sepsis involves the deep layers of the wound and is accompanied by constitutional symptoms

Leaper 1977 *(Continued)*

	Dehiscence: separation of deep layers, heralded by discharge of ascites **Sinus or fistula**: not defined
Notes	Hernia data excluded from analysis due to inadequate follow-up duration Group 2 compared with group 3 for 'absorbable versus non-absorbable' and 'monofilament versus multifilament' as they share a common closure technique and method Group 2 and 3 analysed together as 'interrupted', 'mass'

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation was by "means of instructions in a sealed envelope"
Allocation concealment (selection bias)	Low risk	Sealed envelope
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	High risk	Surgeons refused randomisation in 17 cases

Leaper 1985

Methods	**RCT** **Methods to control for contributory patient factors**:
Participants	**Age (SD)**: Group 1 mean 57.4 years (1.8), Group 2 mean 57.9 years (1.7) **Gender**: Group 1 female 64%, Group 2 female 60% **Types of incisions**: Group 1: midline 77.3%, transverse 22.7% Group 2: midline 72%, transverse 28% **Types of surgery**: Group 1: oesophageal 14.4%, pancreaticobiliary 49.5%, small bowel 4.1%, colon 23.7%, unopened viscus 8.2% Group 2: oesophageal 17.7%, pancreaticobiliary 41.1%, small bowel 4.7%, colon 27.1%, unopened viscus 9.3% **Contamination classification of included participants**:

Leaper 1985 *(Continued)*

	Preoperative antibiotic use: single intravenous dose of third generation cephalosporin at induction for oesophago-duodeno-gastric, biliary and pancreatic operations; either the same or a combination with metronidazole at induction and at 6 and 12 h postoperatively for small bowel and colorectal operations **Prognostic patient factors**: Malignancy: Group 1 25.8%, Group 2 29% Jaundice: Group 1 25.8%, Group 2 16.3% **Inclusion criteria**: midline and transverse incisions **Exclusion criteria**: incisions through scar
Interventions	**Comparisons reported**: Group 1: Sutures: nylon (monofilament, non-absorbable) Suture technique: continuous Closure method: mass Group 2: Sutures: PDS (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: Group 1 consultants 33%, Group 2 consultants 37.4%
Outcomes	**Hernia**: not defined **Follow-up duration**: 6 months **Wound infection**: not defined **Dehiscence**: not defined
Notes	Hernia data excluded due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated
Allocation concealment (selection bias)	Unclear risk	Not explicitly described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly described
Incomplete outcome data (attrition bias) All outcomes	High risk	Not an intention-to-treat analysis
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting

Leaper 1985 *(Continued)*

Other bias	Low risk	The study appears to be free of other sources of bias

Lewis 1989

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 mean 56.8 (17), Group 2 mean 55.8 (18) **Gender**: Group 1 female 57.3%, Group 2 female 48.4% **Types of incisions**: vertical laparotomy 100% **Types of surgery**: Group 1 biliary 46.6%, upper GI 22.3%, colorectal 29.1%, vascular 6.8%, miscellaneous 5.8% Group 1 biliary 37.6%, upper GI 40.8%, colorectal 25.8%, vascular 7.5%, miscellaneous 8.6% **Contamination classification of included participants**: Clean: Group 1 30%, Group 2 28% Clean-contaminated: Group 1 51.5%, Group 2 54.8% Contaminated: Group 1 18.4%, Group 2 17.2% **Preoperative antibiotic use**: Group 1 65%, Group 2 68.8% **Prognostic patient factors**: Malignancy: Group 1 28.1%, Group 2 22.6% Corticosteroids: Group 1 5.8%, Group 2 4.3% Elevated bilirubin: Group 1 5.8%, Group 2 6.4% **Inclusion criteria**: vertical laparotomy > 10 cm **Exclusion criteria**: emergency procedures
Interventions	**Comparisons reported**: Group 1: Sutures: PGA (multifilament, fast absorbable) Suture technique: interrupted (Smead Jones) Closure method: mass Group 2: Sutures: polypropylene (monofilament, non-absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**:
Outcomes	**Hernia**: defect with sharp fascial margins and presenting as a bulge when patient strained while standing **Follow-up duration**: unknown **Wound infection**: pus from wound

Lewis 1989 *(Continued)*

	Dehiscence: evisceration
Notes	Hernia data excluded from analysis due to unclear follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised based on birth year (even versus odd)
Allocation concealment (selection bias)	High risk	Even versus odd birth year
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for, dropouts explained
Selective reporting (reporting bias)	Unclear risk	Follow-up duration unclear, wound infection and dehiscence reported
Other bias	Low risk	The study appears to be free of other sources of bias

McNeill 1986

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 mean 35 (12), Group 2 mean 38 (11) **Gender**: Group 1 female 81.2%, Group 2 female 84.3% **Types of incisions**: vertical midline incision in all participants **Types of surgery**: Group 1: gastric bypass 33.3%, gastroplasty 66.7% Group 2: gastric bypass 27.5%, gastroplasty 72.5% **Contamination classification of included participants**: not described **Preoperative antibiotic use**: not described **Prognostic patient factors**: all participants undergoing surgery for morbid obesity **Inclusion criteria**: none clearly specified although patients were undergoing Roux-en-Y gastric bypass or gastroplasty for morbid obesity **Exclusion criteria**: none clearly specified
Interventions	**Comparisons reported**: Group 1:

McNeill 1986 *(Continued)*

	Sutures: steel (monofilament, non-absorbable) Suture technique: interrupted Smead Jones Closure method: mass Group 2: Sutures: PGA (multifilament, fast absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: all closure by residents under supervision of consultant
Outcomes	**Hernia**: not defined **Follow-up duration**: 8-35 months **Wound infection**: not defined **Dehiscence**: not defined
Notes	Hernia data excluded from analysis as not all participants followed up for at least 1 year

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomisation by hospital number – odd numbers to steel, even numbers to Dexon Plus
Allocation concealment (selection bias)	High risk	Randomisation by hospital number – odd numbers to steel, even numbers to Dexon Plus
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not stated
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for; clear explanation of dropouts
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Mirza 2003

Methods	**RCT** **Methods to control for contributory patient factors**: unknown
Participants	**Age**: Group 1 (mean): 40.6 Group 2 (mean): 41.8 **Gender**: Group 1: female 45.6%

Mirza 2003 *(Continued)*

	Group 2: female 44.7% **Types of incisions**: Group 1: midline 51.9%, paramedian 13.9%, subcostal 27.8%, transverse 6.4% Group 1: midline 50.6%, paramedian 15.3%, subcostal 27.1%, transverse 7.0% **Types of surgery**: Emergency surgery: Group 1 23%; Group 2 33% Group 1: upper GI 8.9%; small bowel 34.2%; biliary tract 26.6%; large bowel 24.0%; solid organs 6.3% Group 2: upper GI 9.4%; small bowel 34.1%; biliary tract 27.1%; large bowel 23.5%; solid organs 5.9% **Contamination classification of included participants**: Group 1: clean 24.1%; clean-contaminated 46.8%, contaminated 29.1% Group 2: clean 24.7%; clean-contaminated 48.2%, contaminated 27.1% **Preoperative antibiotic use**: all participants received 3 doses of 2nd-generation cephalosporin, participants with opening of bowel received metronidazole as well **Prognostic patient factors**: Group 1: malignancy 26.6%, diabetes 16.4%, jaundice 15.2%, obesity 7.6%, pulmonary disease 6.3%, steroids 5.1% Group 2: malignancy 25.9%, diabetes 17.6%, jaundice 15.3%, obesity 4.7%, pulmonary disease 5.9%, steroids 3.5% **Inclusion criteria**: elective and emergency patients **Exclusion criteria**: previous surgery through same incision within last 6 months, heavily contaminated operations
Interventions	**Comparisons reported**: Group 1: Sutures: PDS (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass closure of midline incision, layered closure of other incisions Group 2: Sutures: polypropylene (monofilament, non-absorbable) Suture technique: continuous Closure method: mass closure of midline incision, layered closure of other incisions
Outcomes	**Hernia**: visible swelling with positive cough impulse and palpable fascial defect **Follow-up duration**: 12 months **Wound infection**: discharge of pus or growth of pathogenic microbes from wound discharge **Dehiscence**: operative closure of fascial wound necessitated **Sinus or fistula**: micro-abscess or a chronic discharging sinus healed only after removal of suture
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement

Mirza 2003 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; wound infection and dehiscence reported
Other bias	Low risk	The study appears to be free of other sources of bias

Ohira 2015

Methods	**RCT** **Methods to control for contributory patient factors**: unknown
Participants	**Age**: not reported **Gender**: Group 1: female 7.1% Group 2: female 44.4% **Types of incisions**: all incisions were midline **Types of surgery**: all elective surgery Group 1: gastric 53.5%; colon 46.5% Group 2: gastric 55.6%; colon 44.4% **Contamination classification of included participants**: not reported **Preoperative antibiotic use**: not reported **Prognostic patient factors**: Group 1: diabetes 10.7%; average BMI 21.7 Group 2: diabetes 25.9%; average BMI 22.0 **Inclusion criteria**: gastric or colon cancer patients operated on with curative intent, aged 20-80 years **Exclusion criteria**: non curative surgery, previous midline incision, laparoscopic surgery; immunosuppression (as defined by long-term corticosteroid use, uncontrolled diabetes, or cirrhosis of the liver); and the surgeon's judgment that the patient was unsuitable for the trial.
Interventions	**Comparisons reported**:

Ohira 2015 *(Continued)*

	Group 1: Sutures: polyglactin (multifilament, fast absorbable) Suture technique: interrupted Closure method: mass closure Group 2: Sutures: PDS (monofilament, slowly absorbable) Suture technique: interrupted Closure method: mass closure
Outcomes	**Hernia:** physical exam, CT scan every 6 months; follow-up: up to 36 months (minimum 12 months) **Wound Infection:** not defined **Dehiscence:** not defined
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation sequence not clearly described
Allocation concealment (selection bias)	Unclear risk	Allocation concealment not clearly described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Blinding of outcome assessors not clearly stated
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	High risk	Participants not similar at baseline (higher proportion of women in group 2, 2 vs 12); curative intent of surgery not determined until after randomisation

Orr 1990

Methods	**Methods to control for contributory patient factors**: none
Participants	**Age**: not described **Gender**: not described **Types of incisions**: not described **Types of surgery**: not described **Contamination classification of included participants**: not described **Preoperative antibiotic use**: not described **Prognostic patient factors**: not described

Orr 1990 *(Continued)*

	Inclusion criteria: patients included with risk criteria < 7 using prespecified criteria **Exclusion criteria:** none specifically described
Interventions	**Comparisons reported**: Group 1: Sutures: polyglyconate (monofilament, slowly absorbable) Suture technique: continuous, non-locking, 2 suture technique Closure method: mass Group 2: Sutures: polyglyconate (monofilament, slowly absorbable) Suture technique: interrupted, Smead Jones Closure method: mass **Characteristics of surgeons**: not described
Outcomes	**Hernia**: no definition **Follow-up duration**: 6 months **Wound infection**: no definition given
Notes	Hernia data excluded due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for/dropouts described
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	High risk	Baseline characteristics of groups not described

Orr 2003

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1: mean 55.1 (SD 15.4)

Orr 2003 *(Continued)*

	Group 2: mean 55.3 (SD 14.3) **Gender**: all female **Types of incisions**: Group 1: upper 19.2%, lower 33.7%, extended 47.1% Group 2: upper 21.6%, lower 30.9%, extended 47.4% **Types of surgery**: Group 1: gynaecological cancer 72%; GI cancer 3.8%; sarcoma 0.96%; lymphoma 0.96%; obesity 15.4%; GI disease 1.9%; pelvic mass 4.8% Group 2: gynaecological cancer 68%; GI cancer 5.1%; sarcoma 1%; lymphoma 0%; obesity 12.3%; GI disease 6.2%; pelvic mass 7.2% **Contamination classification of included participants**: All participants with clean or clean-contaminated wounds. Group breakdown not given **Preoperative antibiotic use**: participants receive by protocol ≤ 3 doses of prophylactic antibiotics. Type of antibiotic and compliance not described **Prognostic patient factors**: Group 1: diabetes mellitus 15%, malignancy 22.9%, corticosteroids 9.5%, chronic pulmonary conditions 13.3% Group 2: diabetes mellitus 14%, malignancy 21.4%, corticosteroids 8.2%, chronic pulmonary conditions 12.2% **Inclusion criteria**: age ≥ 18 years, with at least one of: > 70 years of age; obesity; confirmed cancer; diabetes (requiring pharmacotherapy); COPD (FEV < 60% mL; resting PO_2 < 70 mmHg, PCO_2 > 45 mmHg); chronic steroid use (≥ 5 mg prednisone equivalent/day); altered nutritional status (albumin < 3.5 mg/dL or involuntary weight loss > 10% of body weight over the last 3 months); Ascites; chronic renal insufficiency (creatinine > 2.0 mg/dL); jaundice (total serum bilirubin > 2.5 mg/dL and clinical jaundice); prior radiation to surgical site; prior transverse incision that crosses the study vertical incision **Exclusion criteria**: not specifically described
Interventions	**Comparisons reported**: Group 1: Sutures: 1 Poly (L-lactide/glycolide) (multifilament, slowly absorbable); suture length: wound length > 4:1 Suture technique: continuous Closure method: mass closure Group 2: Sutures: polypropylene (monofilament, non-absorbable); suture length: wound length > 4:1 Suture technique: continuous Closure method: mass closure **Characteristics of surgeons**: 9 institutions
Outcomes	**Hernia**: no definition provided **Follow-up duration**: 6 months **Wound infection**: no definition provided **Dehiscence**: no definition provided

Orr 2003 *(Continued)*

Notes	Hernia data excluded due to inadequate follow-up duration

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	203 participants enrolled, results of 201 participants presented
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Osther 1995

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1: median 75 Group 2: median 77 **Gender**: Group 1 female 53%; Group 2 56.7% **Types of incisions**: Group 1: median 9%; paramedian 59%; oblique 13%; transverse 19% Group 2: median 10.6%; paramedian 53.8%; oblique 11.5%; transverse 23.1% **Types of surgery**: not described **Contamination classification of included participants**: not described **Preoperative antibiotic use**: not described **Prognostic patient factors**: Group 1: malignancy 42% Group 2: malignancy 47.1%

Osther 1995 *(Continued)*

	Inclusion criteria: undergoing laparotomy with ≥ 1 criteria for impaired wound healing including age > 70 years, COPD for at least 10 years, intra-abdominal malignancy or diffuse peritonitis **Exclusion criteria**: appendectomy through an oblique muscle-splitting incision, laparotomy through a previous scar
Interventions	**Comparisons reported**: Group 1: Sutures: PGA (multifilament, fast absorbable) Suture technique: interrupted Closure method: mass Group 2: Sutures: polyglyconate (monofilament, slowly absorbable) Suture technique: interrupted Closure method: mass **Characteristics of surgeons**: not described
Outcomes	**Hernia**: palpable protruding swelling and fascial defect **Follow-up duration**: 10 days, 3 months and 12 months **Wound infection**: purulent discharge leading to surgical drainage **Dehiscence**: fascial disruption with operative closure necessary **Sinus/fistula**: no definition provided
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random numbers using Geigy scientific tables
Allocation concealment (selection bias)	Unclear risk	Not explicitly described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for. Loss to follow-up described by group
Selective reporting (reporting bias)	High risk	Dehiscence not reported despite pre-specified
Other bias	Low risk	The study appears to be free of other sources of bias

Pandley 2013

Methods	**RCT**

Pandley 2013 *(Continued)*

	Methods to control for contributory patient factors: none
Participants	**Age**: Group 1 (mean): 54 Group 2 (mean): 56 **Gender**: Group 1: female 26.0% Group 2: female 22.0% **Types of incisions**: all participants had a midline incision **Types of surgery**: Emergency surgery: Group 1 73.5%; Group 2 77.1% Group 1: bowel obstruction 15.1%, hemoperitoneum 9.4%; blunt trauma 10.4%; abdominal mass 9.4%; gut gangrene 1.9%; umbilical hernia 2.8% Group 2: bowel obstruction 17.1%, hemoperitoneum 11.4%; blunt trauma 8.6%; abdominal mass 13.3%; gut gangrene 2.9%; umbilical hernia 1.9% **Contamination classification of included participants**: not specifically reported. Reported "perforation" as Group 1 45.3%; Group 2 40.0% **Preoperative antibiotic use**: not described **Prognostic patient factors**: Group 1: BMI (mean) 28.4; diabetes 6.6%; smoker 24.5% Group 2: BMI (mean) 27.6; diabetes 8.6%; smoker 22.9% **Inclusion criteria**: all participants undergoing an elective or emergency midline laparotomy for various indications **Exclusion criteria**: pregnancy, presence of an abdominal hernia, lack of informed consent, age < 18 years, and previous laparotomy
Interventions	**Comparisons reported**: Group 2: Sutures: polypropylene (monofilament, non-absorbable) Suture technique: continuous Closure method: mass Group 2: Sutures: polyglactin-910 (multifilament, fast absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: not reported
Outcomes	**Dehiscence**: not defined
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement

Pandley 2013 *(Continued)*

Random sequence generation (selection bias)	Unclear risk	Not clearly described
Allocation concealment (selection bias)	Unclear risk	Not clearly described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not clearly described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for with no losses to follow-up
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Pollock 1979

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1: 60.4% ≥ 60 Group 2: 61.6% ≥ 60 Group 3: 62.6% ≥ 60 **Gender**: Group 1: female 57.3% Group 2: female 58.6% Group 3: female 59.6% **Types of incisions**: Group 1: midline 56.3%; transverse 43.7% Group 1: midline 58.6%; transverse 41.4% Group 1: midline 55.6%; transverse 44.4% **Types of surgery**: Group 1: emergency 12.5% Group 2: emergency 21.2% Group 3: emergency 22.2% **Contamination classification of included participants**: not specified **Preoperative antibiotic use**: not specified

Pollock 1979 *(Continued)*

	Prognostic patient factors: Group 1: obesity 32.3%; jaundice 8.3% Group 2: obesity 41.4%; jaundice 6.1% Group 1: obesity 34.3%; jaundice 5.1% **Inclusion criteria**: consecutive patients undergoing emergency or elective major laparotomy **Exclusion criteria**: gridiron muscle-splitting incision, Pfannenstiel for prostatectomy, lumbar and incisions through pre-existing incisional hernias were excluded
Interventions	**Comparisons reported**: Group 1: Sutures: steel (monofilament, non-absorbable) Suture technique: continuous Closure method: mass Group 2: Sutures: PGA (multifilament, fast absorbable) Suture technique: continuous Closure method: mass Group 3: Sutures: nylon (monofilament, non-absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: consultant (50.8%) and registrar closures (49.2%)
Outcomes	**Hernia**: visible bulge deep to the scar on straining, plus palpable defect in musculo-aponeurosis **Follow-up duration**: "Not less than 6 months" **Wound infection**: any discharge from wound within 1 month of surgery **Sinus/fistula**: no definition provided
Notes	Hernia data excluded from analysis due to inadequate follow-up duration Group 1 and 3 analysed together as 'non-absorbable' and 'monofilament'

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not specified
Allocation concealment (selection bias)	Unclear risk	Not specified
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not specified
Incomplete outcome data (attrition bias) All outcomes	Low risk	Participants accounted for; loss to follow-up described by group

Pollock 1979 *(Continued)*

Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Richards 1983

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: unknown **Gender**: unknown **Types of incisions**: Group 1: midline 85.3%; oblique 13.6%; paramedian 1.1% Group 2: midline 80.3%; oblique 17.5%; paramedian 2.1% **Types of surgery**: unknown **Contamination classification of included participants**: Group 1: clean 38.8%; clean-contaminated 53.8%; contaminated 7.3% Group 2: clean 31.9%; clean-contaminated 59.3%; contaminated 8.8% **Preoperative antibiotic use**: unknown **Prognostic patient factors**: not described **Inclusion criteria**: abdominal incision > 5 cm, excluding major trauma and heavily contaminated wounds
Interventions	**Comparisons reported**: Group 1: Sutures: polypropylene (monofilament, non-absorbable) Suture technique: continuous Closure method: mass Group 2: Sutures: PGA (multifilament, fast absorbable) for anterior sheath, polypropylene (monofilament, non-absorbable) for posterior sheath Suture technique: interrupted Smead Jones for anterior, continuous for posterior/transverse/oblique Closure method: layered **Characteristics of surgeons**: unknown
Outcomes	**Hernia**: no definition **Follow-up duration**: 12 months **Wound infection**: no definition **Dehiscence**: no definition **Sinus/fistula**: no definition

Richards 1983 *(Continued)*

Notes	Not included in absorbable versus non-absorbable analysis as polypropylene was used on the fascia for both groups

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Method of closure determined by drawing a sealed card from 1 of 3 boxes
Allocation concealment (selection bias)	Low risk	Sealed card
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not stated
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and dropouts explained
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; dehiscence and wound infection reported
Other bias	Low risk	The study appears to be free of other sources of bias

Sahlin 1993

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 mean age 58 (SD 17); Group 2 mean age 58 (SD 17) **Gender**: Group 1 female 65.8%; Group 2 female 60.2% **Types of incisions**: Group 1: midline 42.9%; paramedian 11.3%; subcostal/transverse 44.9%; other 0.1% Group 2: midline 45.7%; paramedian 9.4%; subcostal/transverse 43.6%; other 0.1% **Types of surgery**: Group 1: upper GI 15.6%; HPB 41.4%; lower GI 35.6%; vascular 3.2%; other 4.1% Group 2: upper GI 17.4%; HPB 41.6%; lower GI 35.9%; vascular 3.2%; other 1.8% **Contamination classification of included participants**: unknown **Preoperative antibiotic use**: unknown **Prognostic patient factors**: malignancy: Group 1 18.8%, Group 2 17.7% **Inclusion criteria**: consecutive patients undergoing abdominal surgery

Sahlin 1993 *(Continued)*

Interventions	**Comparisons reported**: Group 1: Sutures: polyglyconate (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass Group 2: Sutures: polyglactin (multifilament, fast absorbable) Suture technique: interrupted (Smead Jones) Closure method: mass **Characteristics of surgeons**: unknown
Outcomes	**Hernia**: protrusion in the wound when patient lifted legs in supine position **Follow-up duration**: 12 months **Wound infection**: no definition **Dehiscence**: no definition
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Random sequence generation not described
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information
Incomplete outcome data (attrition bias) All outcomes	High risk	All participants accounted for/dropouts explained. High loss to follow-up: 308 of 988 participants lost to follow-up (31%)
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; wound infection and dehiscence reported
Other bias	Low risk	The study appears to be free of other sources of bias

Savolainen 1988

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: no information given **Gender**: no information given **Types of incisions**: upper midline incision only

Savolainen 1988 *(Continued)*

	Types of surgery: no information **Contamination classification of included participants**: no information **Preoperative antibiotic use**: no information **Prognostic patient factors**: no information **Inclusion criteria**: all upper midline incisions within 1 year
Interventions	**Comparisons reported**: Group 1: Sutures: PGA (multifilament, fast absorbable) Suture technique: interrupted, simple Closure method: mass Group 2: Sutures: polyglyconate (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass Group 3: Sutures: polypropylene (monofilament, non-absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: not described
Outcomes	**Wound infection**: no definition **Dehiscence**: no definition
Notes	Hernia not an outcome of this study Group 1 compared with Group 2 in 'interrupted versus continuous' analysis and 'slow versus fast absorbable' analysis, Group 2 compared with Group 3 in 'absorbable versus non-absorbable' analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Randomised according to birthday
Allocation concealment (selection bias)	High risk	Randomised according to birthday
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for/dropouts explained
Selective reporting (reporting bias)	Low risk	Dehiscence and wound infection reported
Other bias	Unclear risk	Duration of follow-up not specified (in hospital only)

Seiler 2009

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 65.5 Group 2 (mean): 63.8 Group 3 (mean): 64.7 **Gender**: Group 1: female 37.3% Group 2: female 39.7% Group 3: female 36.6% **Types of incisions**: all participants had a midline incision **Types of surgery**: all participants had elective surgery Group 1: colon 43%, rectum 25%, upper GI 15%, aortic aneurysm repair 4%, pancreas 7%, small bowel 1.5%, other 4.4% Group 2: colon 48%, rectum 23%, upper GI 10%, aortic aneurysm repair 3%, pancreas 6%, small bowel 1.5%, other 7.5% Group 3: colon 45%, rectum 24%, upper GI 15%, aortic aneurysm repair 3.4%, pancreas 10%, small bowel 1%, other 2.4% **Contamination classification of included participants**: not described **Preoperative antibiotic use**: not described **Prognostic patient factors**: Group 1: BMI (mean) 26.1 Group 2: BMI (mean) 25.6 Group 3: BMI (mean) 26.0 **Inclusion criteria**: elective primary midline laparotomy with an expected length of incision of at least 15 cm, informed consent, age ≥ 18 years and life expectancy > 1 year **Exclusion criteria**: patients requiring an emergency procedure, or undergoing current immunosuppressive therapy, or chemotherapy within 2 weeks or radiotherapy > 8 weeks before surgery; patients with coagulopathy or peritonitis or disorders that would preclude study participation (dementia, language problems) and patients participating in another trial
Interventions	**Comparisons reported**: Group 1: Sutures: polyglactin-910 (multifilament, fast absorbable) Suture technique: interrupted Closure method: mass Group 2: Sutures: PDS (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass

Seiler 2009 *(Continued)*

	Group 3: Sutures: PDS - MonoPlus (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: all performed by 1 surgeon
Outcomes	**Hernia**: fascial dehiscence after completed superficial wound healing with or without a prolapse of abdominal organs, confirmed by abdominal ultrasound **Follow-up duration**: 12 months **Wound infection**: redness, wound dehiscence with secretion either of putrid or caliginous smelly fluid or requiring antibiotic treatment or surgical intervention **Dehiscence**: missing continuity of abdominal fascia in combination with wound dehiscence with consecutive relapse operation
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not described
Allocation concealment (selection bias)	Low risk	Opaque, sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessors and participants blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; wound infection and dehiscence reported
Other bias	Low risk	The study appears to be free of other sources of bias

Siddique 2015

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 36 Group 2 (mean): 36 **Gender**: not reported **Types of incisions**: all participants had a midline incision

Siddique 2015 *(Continued)*

	Types of surgery: both elective and emergent (proportions not reported) **Contamination classification of included participants**: not described **Preoperative antibiotic use**: "all patients received antibiotics against gram negative and anaerobic organisms" **Prognostic patient factors**: not reported in detail **Inclusion criteria**: patients undergoing a midline laparotomy, age > 15, ASA 1 & 2 **Exclusion criteria**: patients who developed a wound infection
Interventions	**Comparisons reported**: Group 1: Sutures: PDS (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass Group 2: Sutures: polypropylene (monofilament, non-absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: not reported
Outcomes	**Dehiscence**: not defined, diagnosed within 7 days of surgery
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for, no losses to follow-up
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	High risk	Participants were excluded if they developed a wound infection

Taylor 1985

Methods	**RCT** **Methods to control for contributory patient factors**: none

Taylor 1985 *(Continued)*

Participants	**Age**: Group 1 (mean): 45.9 years Group 2 (mean): 48.6 years **Gender**: Group 1: female 38% Group 2: female 36% **Types of incisions**: upper midline only **Types of surgery**: unknown **Contamination classification of included participants**: unknown **Preoperative antibiotic use**: at surgeon's discretion **Prognostic patient factors**: unknown **Inclusion criteria**: consecutive patients undergoing upper midline incision
Interventions	**Comparisons reported**: Group 1: Sutures: PDS (monofilament, slowly absorbable) Suture technique: continuous Closure method: layered Group 2: Sutures: nylon (monofilament, non-absorbable) Suture technique: continuous Closure method: layered **Characteristics of surgeons**: all performed by 1 surgeon
Outcomes	**Hernia**: no definition **Follow-up duration**: 12 months **Wound infection**: no definition **Dehiscence**: no definition **Sinus or fistula**: no definition
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	No information
Allocation concealment (selection bias)	Unclear risk	No information
Blinding (performance bias and detection bias) All outcomes	Unclear risk	No information

Taylor 1985 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for/dropouts explained
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; wound infection and dehiscence reported
Other bias	Low risk	The study appears to be free of other sources of bias

Trimbos 1992

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1 (mean): 50 Group 2 (mean): 51 **Gender**: all participants female **Types of incisions**: all participants with midline incision **Types of surgery**: not described **Contamination classification of included participants**: Group 1: clean 40%, clean-contaminated 58%, contaminated 2% Group 2: clean 34%, clean-contaminated 64%, contaminated 2% **Preoperative antibiotic use**: not described **Prognostic patient factors**: Group 1: diabetes 7%, obesity 50%, malignancy 45%, corticosteroids 5%, other immunosuppression 14%, chronic pulmonary conditions 5% Group 2: diabetes 6%, obesity 45%, malignancy 51%, corticosteroids 5%, other immunosuppression 14%, chronic pulmonary conditions 3% **Inclusion criteria**: women undergoing midline laparotomy **Exclusion criteria**: none specified
Interventions	**Comparisons reported**: Group 1: Sutures: polyglyconate (monofilament, slowly absorbable) Suture technique: continuous Closure method: layered Group 2: Sutures: polyglactin-910 (multifilament, fast absorbable) Suture technique: interrupted Closure method: layered **Characteristics of surgeons**: not described
Outcomes	**Hernia**: swelling in the scar with increased intra-abdominal pressure

Trimbos 1992 *(Continued)*

	Follow-up duration: 12 months
	Wound infection: purulent discharge from wound or wound fluid containing pathogenic microbes on culture
	Dehiscence: not defined
	Sinus or fistula: not defined
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not explicitly described
Allocation concealment (selection bias)	Unclear risk	Not explicitly described
Blinding (performance bias and detection bias) All outcomes	Low risk	Outcome assessor blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	All participants accounted for and analysed
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; wound infection and dehiscence reported
Other bias	Low risk	The study appears to be free of other sources of bias

Ullrich 1981

Methods	**RCT**
	Methods to control for contributory patient factors: none
Participants	**Age**: not described
	Gender: 50.9% of participants were female
	Types of incisions: all participants with midline incision
	Types of surgery: not described, no exclusions
	Contamination classification of included participants:
	Group 1: clean 19%%, clean-contaminated 56%%, contaminated 9%; dirty 16%
	Group 2: clean 17%%, clean-contaminated 57%, contaminated 11%; dirty 15%
	Preoperative antibiotic use: not described
	Prognostic patient factors: not described
	Inclusion criteria: women undergoing midline laparotomy

Ullrich 1981 *(Continued)*

	Exclusion criteria: none specified
Interventions	**Comparisons reported**: Group 1: Sutures: PGA (multifilament, fast absorbable) Suture technique: continuous Closure method: layered Group 2: Sutures: polyester (multifilament, non-absorbable) Suture technique: continuous Closure method: layered **Characteristics of surgeons**: not described
Outcomes	**Dehiscence**: not defined **Sinus or fistula**: not defined
Notes	—

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table
Allocation concealment (selection bias)	Low risk	Opaque envelopes opened at start of case
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	Not all participants accounted for (11/78, 14% lost to follow-up)
Selective reporting (reporting bias)	Low risk	There was no evidence of selective reporting
Other bias	Low risk	The study appears to be free of other sources of bias

Wissing 1987

Methods	**RCT** **Methods to control for contributory patient factors**: none
Participants	**Age**: Group 1: < 45 years 26.8%, 45-59 years 26.0%, 60-69 years 19.4%, > 70 27.9% Group 2: < 45 years 27.9%, 45-59 years 22.4%, 60-69 years 23.4%, > 70 26.3% Group 3: < 45 years 22.8%, 45-59 years 23.9%, 60-69 years 24.9%, > 70 28.4%

Wissing 1987 *(Continued)*

	Group 4: < 45 years 28.2%, 45-59 years 26.9%, 60-69 years 23.2%, > 70 21.7% **Gender**: Group 1 (female): 40.2% Group 2 (female): 43.3% Group 3 (female): 41.0% Group 4 (female): 42.6% **Types of incisions**: all incisions midline **Types of surgery**: Group 1: large intestine 21.8%, small intestine 4.5%, biliary tract 14.6%, stomach 19.7%, vascular 9.8%, other 29.5% Group 2: large intestine 22.3%, small intestine 5.5%, biliary tract 16.8%, stomach 12.1%, vascular 14.7%, other 28.6% Group 3: large intestine 19.7, small intestine 5.4, biliary tract 19.7, stomach 13.8, vascular 12.7%, other 28.6% Group 4: large intestine 19.6%, small intestine 5.0%, biliary tract 19.6%, stomach 15.6%, vascular 12.4%, other 27.8% **Contamination classification of included participants**: Group 1: clean 48.1%, clean-contaminated 39.2%, contaminated 5.6%, dirty 7.1% Group 2: clean 47.5%, clean-contaminated 39.4%, contaminated 7.8%, dirty 5.2% Group 3: clean 46.3%, clean-contaminated 38.6%, contaminated 8.8%, dirty 6.4% Group 4: clean 49.3%, clean-contaminated 36.7%, contaminated 7.9%, dirty 6.0% **Preoperative antibiotic use**: Group 1: 60.1% Group 2: 67.2% Group 3: 57.3% Group 4: 60.8% **Prognostic patient factors**: Group 1: diabetes 6.1%, obesity 28.3%, malignancy 35.4%, corticosteroids 2.9% Group 2: diabetes 6.8%, obesity 28.1%, malignancy 26.8%, corticosteroids 1.8% Group 3: diabetes 6.1%, obesity 30.4%, malignancy 26.1%, corticosteroids 1.3% Group 4: diabetes 5.8%, obesity 28.2%, malignancy 25.3%, corticosteroids 1.8% **Inclusion criteria**: all patients with midline laparotomy **Exclusion criteria:** those whose skin was not closed primarily and in whom abdominal cavity was irrigated with antimicrobial agents or local antibiotics used in the wound
Interventions	**Comparisons reported**: Group 1: Sutures: polyglactin-910 (multifilament, fast absorbable)

Wissing 1987 *(Continued)*

	Suture technique: interrupted Closure method: mass Group 2: Sutures: polyglactin-910 (multifilament, fast absorbable) Suture technique: continuous Closure method: mass Group 3: Sutures: PDS (monofilament, slowly absorbable) Suture technique: continuous Closure method: mass Group 4: Sutures: nylon (monofilament, non-absorbable) Suture technique: continuous Closure method: mass **Characteristics of surgeons**: not described
Outcomes	**Hernia**: protruding swelling observed and fascial defect palpable in supine position with both legs lifted or when coughing **Follow-up duration**: 12 months **Wound infection**: purulent discharge from wound spontaneously or after surgical drainage and isolation of pathogenic microbes **Dehiscence**: when new operative closure of fascia necessitated **Sinus or fistula**: sinus when a micro-abscess or a chronic granulomatous inflammation resulted in a fistulous tract cured when the suture or knot was removed
Notes	Groups 2 and 3 combined in the 'absorbable versus non-absorbable' analysis (same technique), Group 1 compared with Group 2 in 'continuous versus interrupted closure' analysis (same suture and method) Group 1 and 2 analysed as 'fast absorbable' Group 2 compared with Group 3 and 4 in 'monofilament versus multifilament' analysis Group 2 compared with Group 3 in 'fast versus slow absorbable' analysis

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomized by opening an envelope"
Allocation concealment (selection bias)	Unclear risk	"Randomized by opening an envelope"
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described
Incomplete outcome data (attrition bias) All outcomes	High risk	All participants accounted for. Loss to follow-up was 21%, but similar in each group
Selective reporting (reporting bias)	Low risk	Hernia follow-up at least 1 year; wound infection and dehiscence reported

Wissing 1987 *(Continued)*

Other bias	Low risk	The study appears to be free of other sources of bias

BMI: body mass index
COPD: chronic obstructive pulmonary disease
DM: diabetes mellitis
FEV: forced expiratory volume
GI: gastrointestinal

PDS: polydioxanone
PGA: polyglycolic acid
RCT: randomised controlled trial
SD: standard deviation

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Agarwal 2011	Compared retention sutures versus no retention sutures. Primary outcome was dehiscence (not hernia)
Atul Kumar 2005	Compared closure of uterine incision
Baracs 2011	Compared PDS Plus versus PDS
Cengiz 2001	Non-human subjects
Deerenberg 2015	Compared small bites to large bites. Did not compare suture material, or technique as we classified it
Ellis 1977	Compared peritoneal versus non-peritoneal closure
Gilbert 1987	Compared peritoneal versus non-peritoneal closure
Gislason 1999	Duplicate of data from the Gislason 1995 article, with a focus on surgeon factors
Gorozpe-Calvillo 1999	Compared methods of skin closure
Harlaar 2011	Suture length outside of the protocol
Hugh 1990	Compared peritoneal versus non-peritoneal closure
Hull 1991	Compared peritoneal versus non-peritoneal closure
Irion 1996	Our primary and secondary outcomes were not assessed
Israelsson 1999	Did not specify suture material
Johnson 1982	Comment on Donaldson 1982
Justinger 2013	Compared the same suture material and technique in both arms. One arm contained antibiotic-impregnated sutures
Khachatryan 2011	Compared Vicryl with antimicrobial coating to Vicryl plain
Marwah 2005	Compared "rectus sheath relaxation incision" versus no relaxation incision

Study	Reason for exclusion
Mattavelli 2011	Compared Vicryl coated with antimicrobial coating to Vicryl plain
Mayer 1981	Compared compression to normal closure (i.e. tightening suture to 5 kg of pressure versus not)
Millbourn 2009	Suture length outside of the protocol
Millbourn 2011	Suture length outside of the protocol
Nagele 1996	Compared peritoneal versus non-peritoneal closure
Niggebrugge 1999	Compared 2 methods of closure with running PDS (continuous versus double double-looped)
Pietrantoni 1991	Compared peritoneal versus non-peritoneal closure
Rasic 2011	Compared antimicrobial suture to non-coated suture
Rink 2000	Compared the use of retention sutures to no retention sutures
Rosenberg 1975	Compared the tension on retention sutures
Xiao-dong 2009	Compared 2 types of layered closures

PDS: polydioxanone

Characteristics of ongoing studies *[ordered by study ID]*

ISRCTN25616490

Trial name or title	Hughes abdominal repair trial - abdominal wall closure techniques to reduce incidence of incisional hernia
Methods	RCT
Participants	Midline laparotomy incision after colorectal surgery
Interventions	Hughes repair vs mass closure
Outcomes	Incisional hernia at 12 months
Starting date	January 2013
Contact information	B Rees, HART@wales.nhs.uk
Notes	

NCT00514566

Trial name or title	PDS vs. polyamide for midline abdominal closure (PPMAC)
Methods	RCT
Participants	Patients with midline laparotomy

NCT00514566 *(Continued)*

Interventions	Polyamide vs PDS
Outcomes	Wound complications
Starting date	October 2004
Contact information	
Notes	Trial terminated early due to high wound dehiscence in the PDS group

NCT00544583

Trial name or title	CONTINT Trial
Methods	RCT
Participants	Patients undergoing emergency midline laparotomy
Interventions	Continuous, absorbable monofilament closure vs interrupted, absorbable, multifilament closure
Outcomes	Incisional hernia at 12 months
Starting date	October 2007
Contact information	NN Rahbari
Notes	No updates since January 2010

NCT01965249

Trial name or title	Effect of stitch technique on the occurence of incisional hernia after abdominal wall closure (ESTOIH)
Methods	RCT
Participants	Patients with median laparotomy
Interventions	Short stitch vs long stitch technique
Outcomes	Incisional hernia at 12 months
Starting date	February 2014
Contact information	P. Baumann
Notes	Currently enrolling

NCT02145052	
Trial name or title	Optimal method of fascial closure in high risk patients undergoing laparotomy
Methods	RCT
Participants	High-risk patients with a laparotomy
Interventions	Continuous vs interrupted closure
Outcomes	Dehiscence, wound infection, incisional hernia at 6, 12, 60 months
Starting date	20 May 2014
Contact information	MA Moya, Massachusetts General Hospital
Notes	Completed recruiting, no published results

TCTR20150318001	
Trial name or title	Randomized trial to compare dehiscence with continuous versus interrupted mass closure of transverse incisions in children with absorbable suture
Methods	RCT
Participants	Transverse incisions
Interventions	Continuous vs interrupted closures
Outcomes	Dehiscence
Starting date	Unknown
Contact information	Unknown
Notes	

PDS: polydioxanone
RCT: randomised controlled trial

DATA AND ANALYSES

Comparison 1. Absorbable sutures versus non-absorbable sutures (any closure or technique)

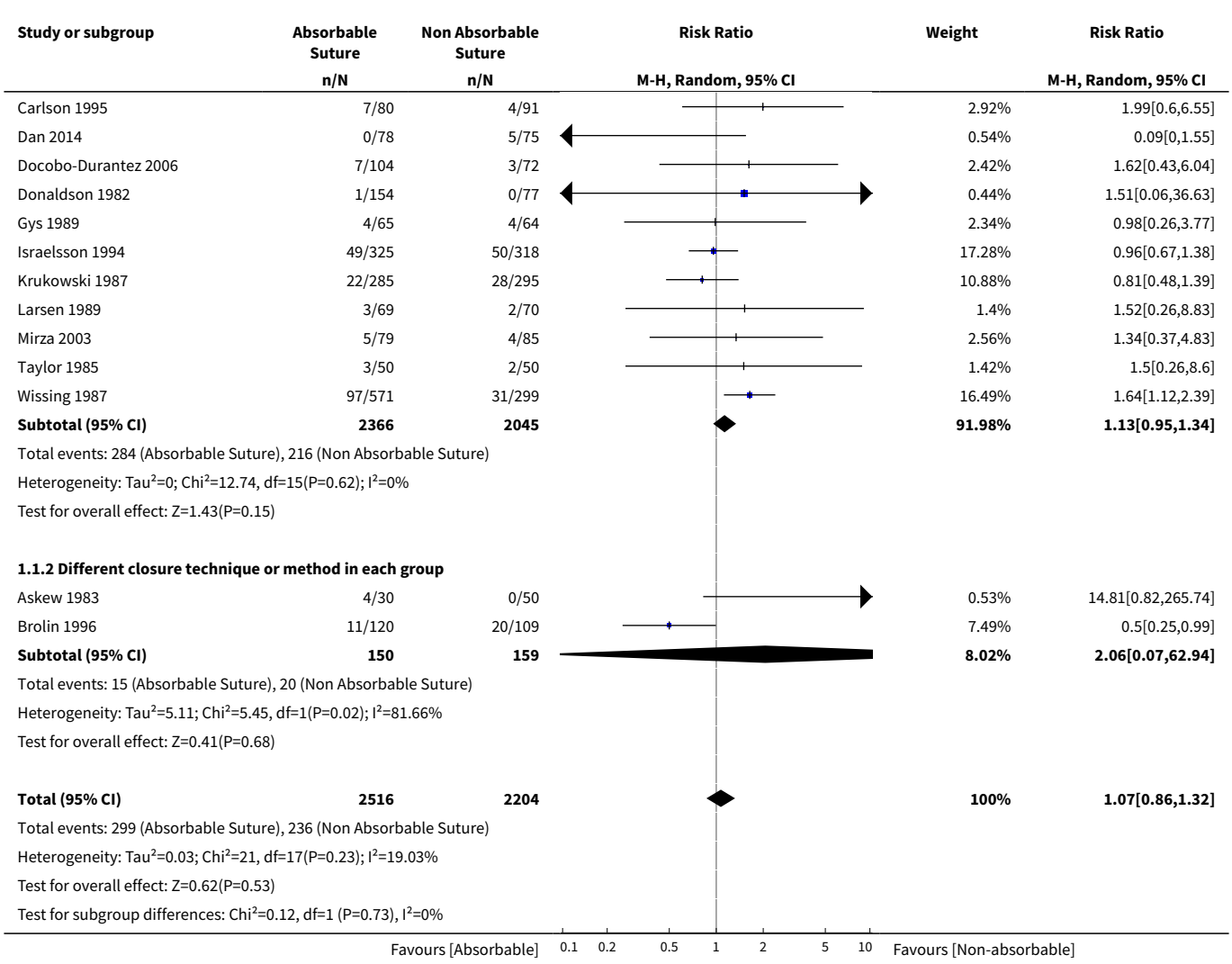
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incisional hernia	17	4720	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.86, 1.32]
1.1 Same closure technique and method in each group	15	4411	Risk Ratio (M-H, Random, 95% CI)	1.13 [0.95, 1.34]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.2 Different closure technique or method in each group	2	309	Risk Ratio (M-H, Random, 95% CI)	2.06 [0.07, 62.94]
2 Wound infection	28	8304	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.86, 1.19]
2.1 Same closure technique and method in each group	22	7363	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.87, 1.15]
2.2 Different closure technique or method in each group	6	941	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.56, 2.36]
3 Wound dehiscence	33	8851	Risk Ratio (M-H, Random, 95% CI)	0.82 [0.58, 1.17]
3.1 Same closure technique and method In each group	25	7647	Risk Ratio (M-H, Random, 95% CI)	0.77 [0.54, 1.10]
3.2 Different closure technique or method in each group	8	1204	Risk Ratio (M-H, Random, 95% CI)	1.46 [0.42, 5.14]
4 Sinus or fistula formation	19	5470	Risk Ratio (M-H, Random, 95% CI)	0.49 [0.26, 0.94]
4.1 Same closure technique and method in each group	16	4934	Risk Ratio (M-H, Random, 95% CI)	0.43 [0.26, 0.73]
4.2 Different closure technique or method in each group	3	536	Risk Ratio (M-H, Random, 95% CI)	1.16 [0.06, 21.09]
5 Hernia and type of incision	14	4258	Risk Ratio (M-H, Random, 95% CI)	1.14 [0.96, 1.36]
5.1 Midline incision only (same technique)	8	3229	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.95, 1.39]
5.2 Other incisions, combination of incision (same technique)	6	1029	Risk Ratio (M-H, Random, 95% CI)	1.09 [0.65, 1.83]

Analysis 1.1. Comparison 1 Absorbable sutures versus non-absorbable sutures (any closure or technique), Outcome 1 Incisional hernia.

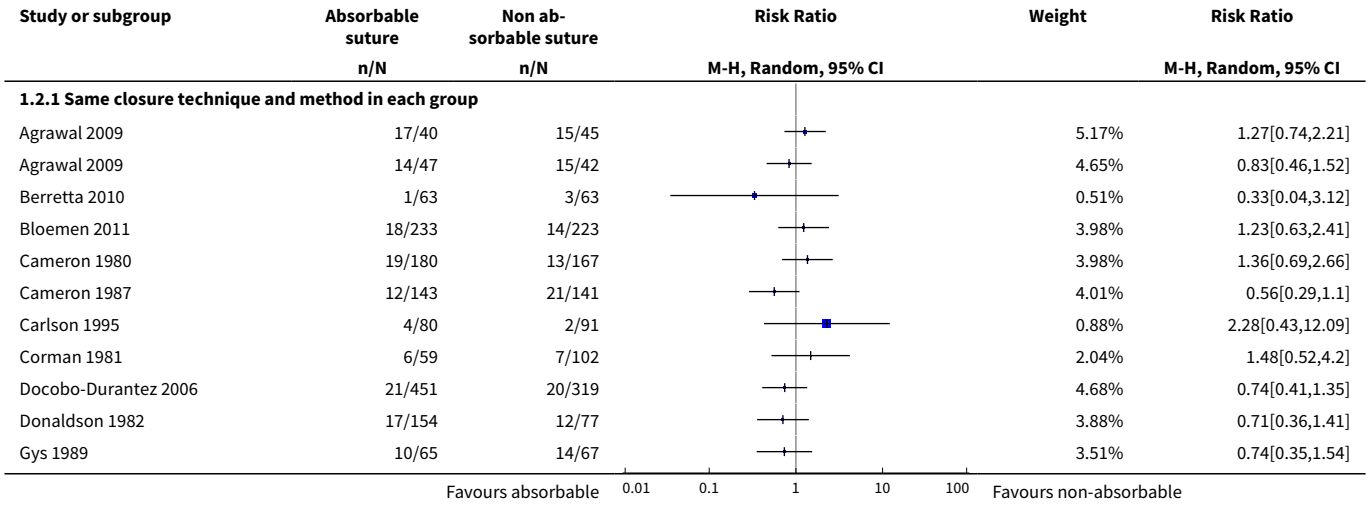
Study or subgroup	Absorbable Suture n/N	Non Absorbable Suture n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
1.1.1 Same closure technique and method in each group					
Agrawal 2009	4/36	4/39		2.45%	1.08[0.29,4.01]
Agrawal 2009	6/40	3/36		2.45%	1.8[0.49,6.68]
Berretta 2010	4/63	13/128		3.49%	0.63[0.21,1.84]
Bloemen 2011	62/267	52/256		19.1%	1.14[0.82,1.58]
Cameron 1987	10/100	11/90		5.78%	0.82[0.36,1.83]

Favours [Absorbable] Favours [Non-absorbable]

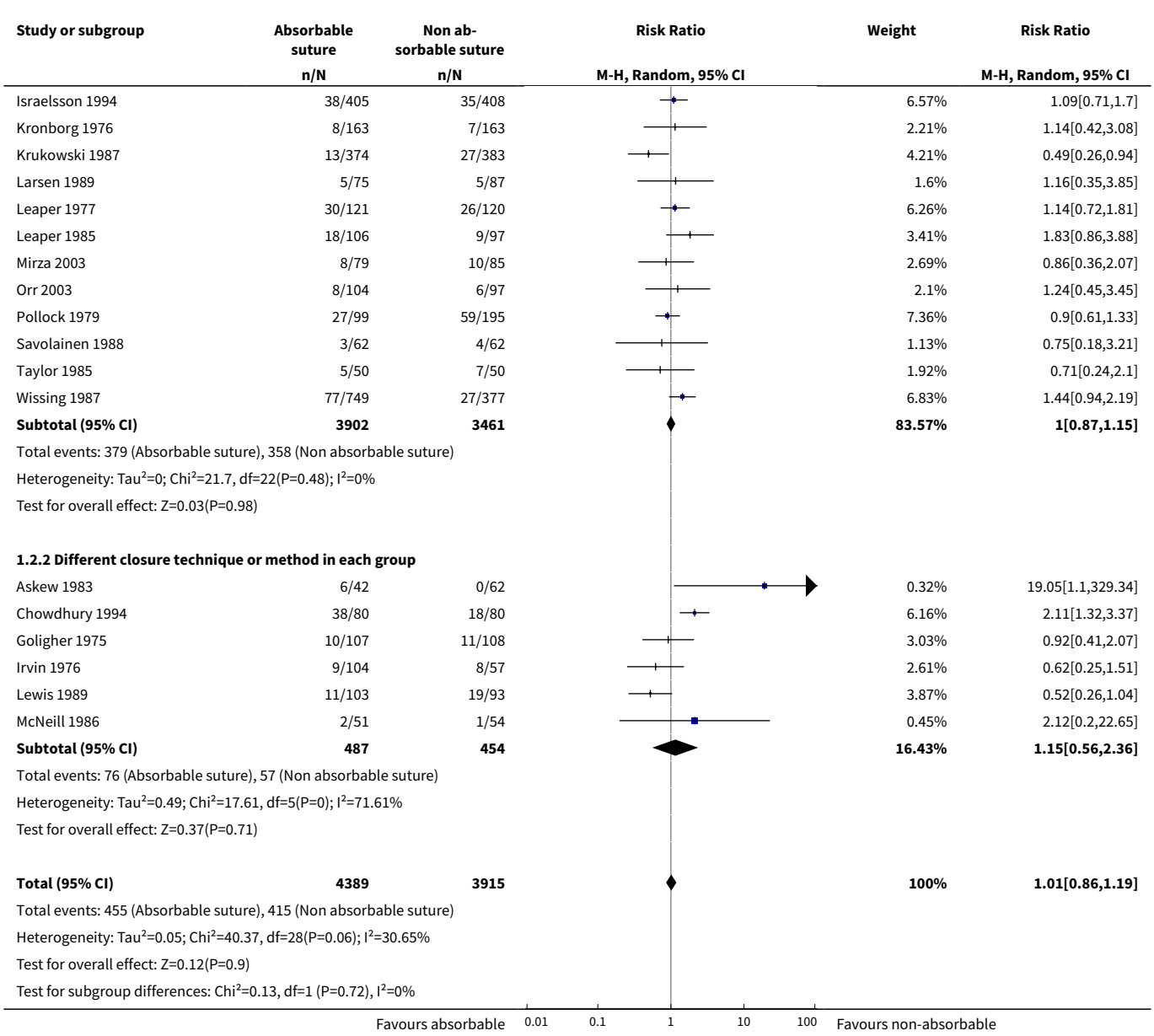


Study or subgroup	Absorbable Suture n/N	Non Absorbable Suture n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Carlson 1995	7/80	4/91		2.92%	1.99[0.6,6.55]
Dan 2014	0/78	5/75		0.54%	0.09[0,1.55]
Docobo-Durantez 2006	7/104	3/72		2.42%	1.62[0.43,6.04]
Donaldson 1982	1/154	0/77		0.44%	1.51[0.06,36.63]
Gys 1989	4/65	4/64		2.34%	0.98[0.26,3.77]
Israelsson 1994	49/325	50/318		17.28%	0.96[0.67,1.38]
Krukowski 1987	22/285	28/295		10.88%	0.81[0.48,1.39]
Larsen 1989	3/69	2/70		1.4%	1.52[0.26,8.83]
Mirza 2003	5/79	4/85		2.56%	1.34[0.37,4.83]
Taylor 1985	3/50	2/50		1.42%	1.5[0.26,8.6]
Wissing 1987	97/571	31/299		16.49%	1.64[1.12,2.39]
Subtotal (95% CI)	**2366**	**2045**		**91.98%**	**1.13[0.95,1.34]**
Total events: 284 (Absorbable Suture), 216 (Non Absorbable Suture)					
Heterogeneity: Tau^2=0; Chi^2=12.74, df=15(P=0.62); I^2=0%					
Test for overall effect: Z=1.43(P=0.15)					
1.1.2 Different closure technique or method in each group					
Askew 1983	4/30	0/50		0.53%	14.81[0.82,265.74]
Brolin 1996	11/120	20/109		7.49%	0.5[0.25,0.99]
Subtotal (95% CI)	**150**	**159**		**8.02%**	**2.06[0.07,62.94]**
Total events: 15 (Absorbable Suture), 20 (Non Absorbable Suture)					
Heterogeneity: Tau^2=5.11; Chi^2=5.45, df=1(P=0.02); I^2=81.66%					
Test for overall effect: Z=0.41(P=0.68)					
Total (95% CI)	**2516**	**2204**		**100%**	**1.07[0.86,1.32]**
Total events: 299 (Absorbable Suture), 236 (Non Absorbable Suture)					
Heterogeneity: Tau^2=0.03; Chi^2=21, df=17(P=0.23); I^2=19.03%					
Test for overall effect: Z=0.62(P=0.53)					
Test for subgroup differences: Chi^2=0.12, df=1 (P=0.73), I^2=0%					

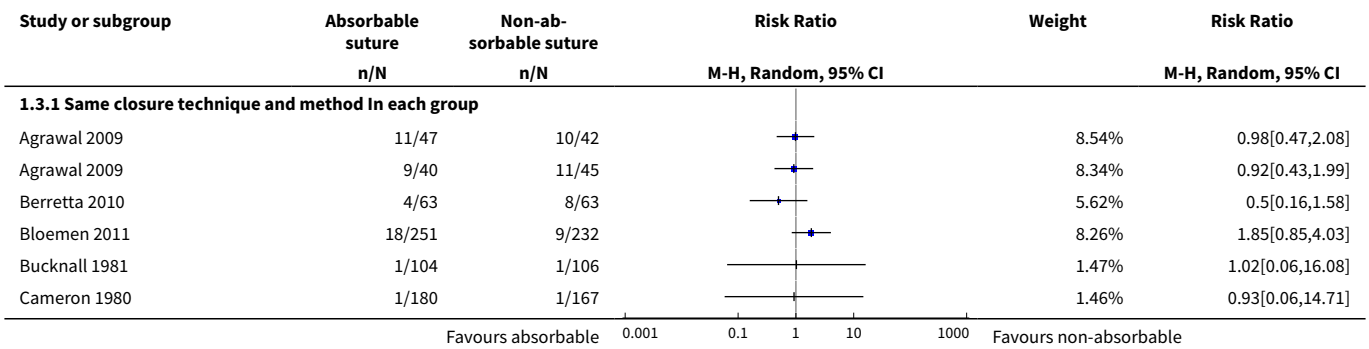
Analysis 1.2. Comparison 1 Absorbable sutures versus non-absorbable sutures (any closure or technique), Outcome 2 Wound infection.

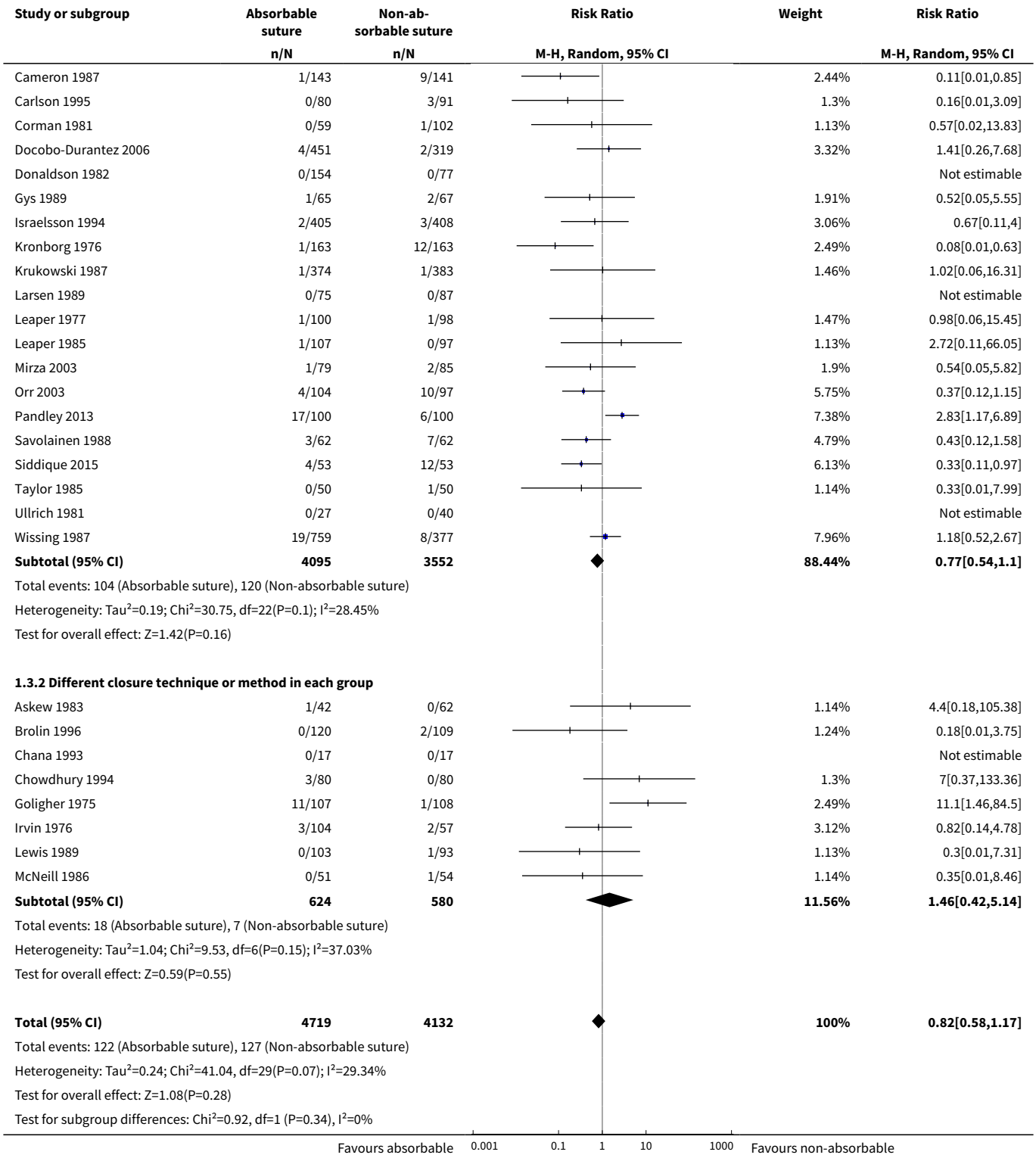


Study or subgroup	Absorbable suture n/N	Non absorbable suture n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
1.2.1 Same closure technique and method in each group					
Agrawal 2009	17/40	15/45		5.17%	1.27[0.74,2.21]
Agrawal 2009	14/47	15/42		4.65%	0.83[0.46,1.52]
Berretta 2010	1/63	3/63		0.51%	0.33[0.04,3.12]
Bloemen 2011	18/233	14/223		3.98%	1.23[0.63,2.41]
Cameron 1980	19/180	13/167		3.98%	1.36[0.69,2.66]
Cameron 1987	12/143	21/141		4.01%	0.56[0.29,1.1]
Carlson 1995	4/80	2/91		0.88%	2.28[0.43,12.09]
Corman 1981	6/59	7/102		2.04%	1.48[0.52,4.2]
Docobo-Durantez 2006	21/451	20/319		4.68%	0.74[0.41,1.35]
Donaldson 1982	17/154	12/77		3.88%	0.71[0.36,1.41]
Gys 1989	10/65	14/67		3.51%	0.74[0.35,1.54]



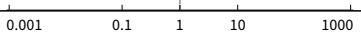
Analysis 1.3. Comparison 1 Absorbable sutures versus non-absorbable sutures (any closure or technique), Outcome 3 Wound dehiscence.





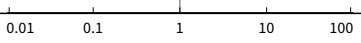
Analysis 1.4. Comparison 1 Absorbable sutures versus non-absorbable sutures (any closure or technique), Outcome 4 Sinus or fistula formation.

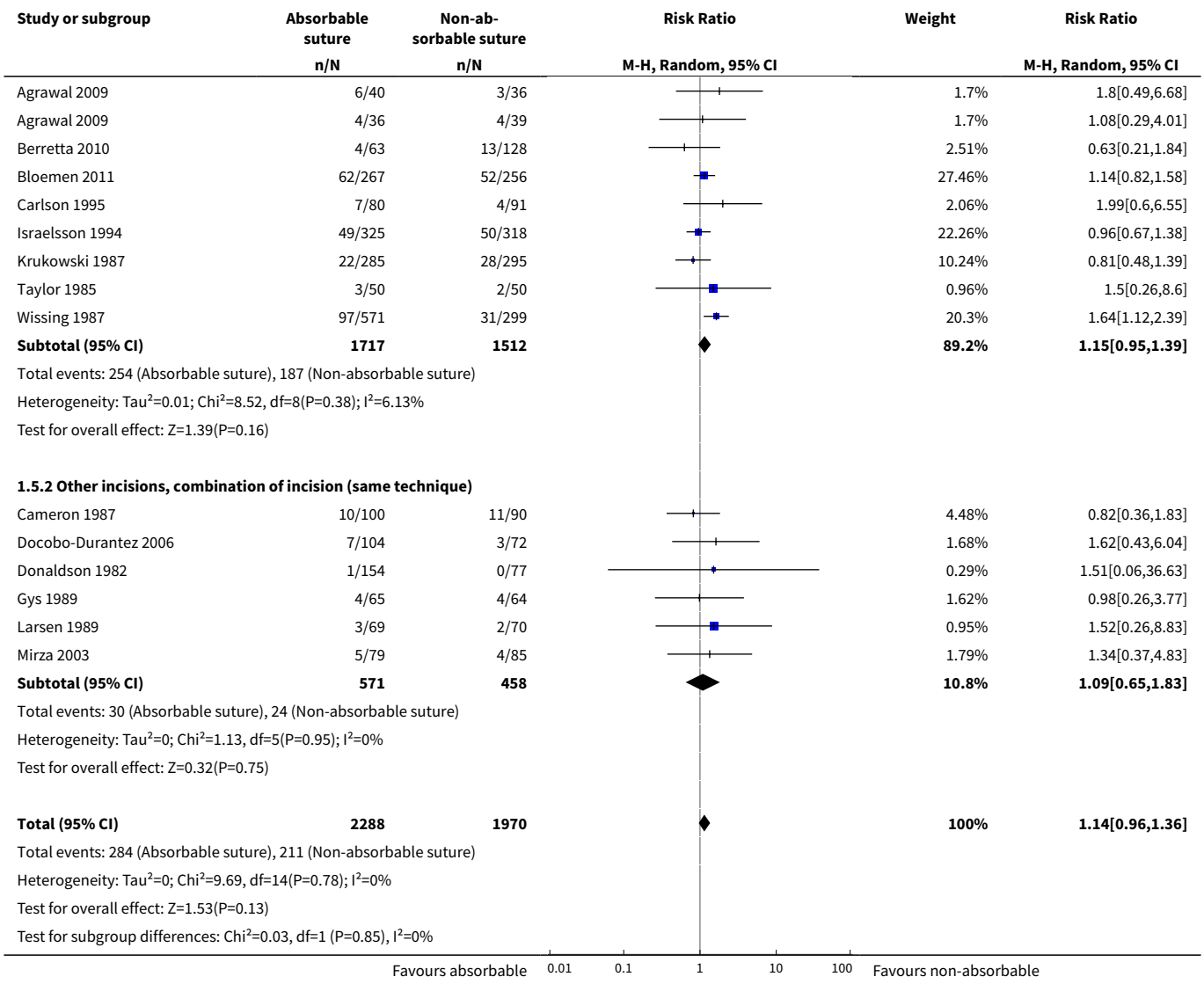
Study or subgroup	Absorbable suture n/N	Non-absorbable suture n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
1.4.1 Same closure technique and method in each group					
Agrawal 2009	0/40	2/45		3.45%	0.22[0.01,4.54]
Agrawal 2009	0/47	6/42		3.74%	0.07[0,1.19]
Bloemen 2011	5/233	3/223		8.1%	1.6[0.39,6.6]
Bucknall 1981	12/104	10/106		11.02%	1.22[0.55,2.71]
Cameron 1987	0/100	1/90		3.16%	0.3[0.01,7.28]
Carlson 1995	1/80	0/91		3.17%	3.41[0.14,82.48]
Corman 1981	0/59	9/102		3.78%	0.09[0.01,1.52]
Gys 1989	0/65	2/67		3.44%	0.21[0.01,4.21]
Israelsson 1994	1/405	1/408		3.89%	1.01[0.06,16.05]
Kronborg 1976	1/163	7/163		5.6%	0.14[0.02,1.15]
Krukowski 1987	0/374	1/383		3.15%	0.34[0.01,8.35]
Larsen 1989	0/69	0/76			Not estimable
Leaper 1977	0/100	3/98		3.55%	0.14[0.01,2.68]
Mirza 2003	2/79	11/85		7.86%	0.2[0.04,0.86]
Taylor 1985	0/50	3/50		3.57%	0.14[0.01,2.7]
Ullrich 1981	1/27	3/40		5.23%	0.49[0.05,4.5]
Wissing 1987	15/571	23/299		11.72%	0.34[0.18,0.64]
Subtotal (95% CI)	**2566**	**2368**		**84.43%**	**0.43[0.26,0.73]**
Total events: 38 (Absorbable suture), 85 (Non-absorbable suture)					
Heterogeneity: Tau^2=0.21; Chi^2=19.2, df=15(P=0.2); I^2=21.88%					
Test for overall effect: Z=3.11(P=0)					
1.4.2 Different closure technique or method in each group					
Chowdhury 1994	20/80	2/80		8.1%	10[2.42,41.38]
Goligher 1975	1/107	1/108		3.91%	1.01[0.06,15.93]
Irvin 1976	0/104	3/57		3.56%	0.08[0,1.5]
Subtotal (95% CI)	**291**	**245**		**15.57%**	**1.16[0.06,21.09]**
Total events: 21 (Absorbable suture), 6 (Non-absorbable suture)					
Heterogeneity: Tau^2=5.09; Chi^2=9.24, df=2(P=0.01); I^2=78.36%					
Test for overall effect: Z=0.1(P=0.92)					
Total (95% CI)	**2857**	**2613**		**100%**	**0.49[0.26,0.94]**
Total events: 59 (Absorbable suture), 91 (Non-absorbable suture)					
Heterogeneity: Tau^2=0.83; Chi^2=37.26, df=18(P=0); I^2=51.7%					
Test for overall effect: Z=2.15(P=0.03)					
Test for subgroup differences: Chi^2=0.43, df=1 (P=0.51), I^2=0%					



Analysis 1.5. Comparison 1 Absorbable sutures versus non-absorbable sutures (any closure or technique), Outcome 5 Hernia and type of incision.

Study or subgroup	Absorbable suture n/N	Non-absorbable suture n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
1.5.1 Midline incision only (same technique)					



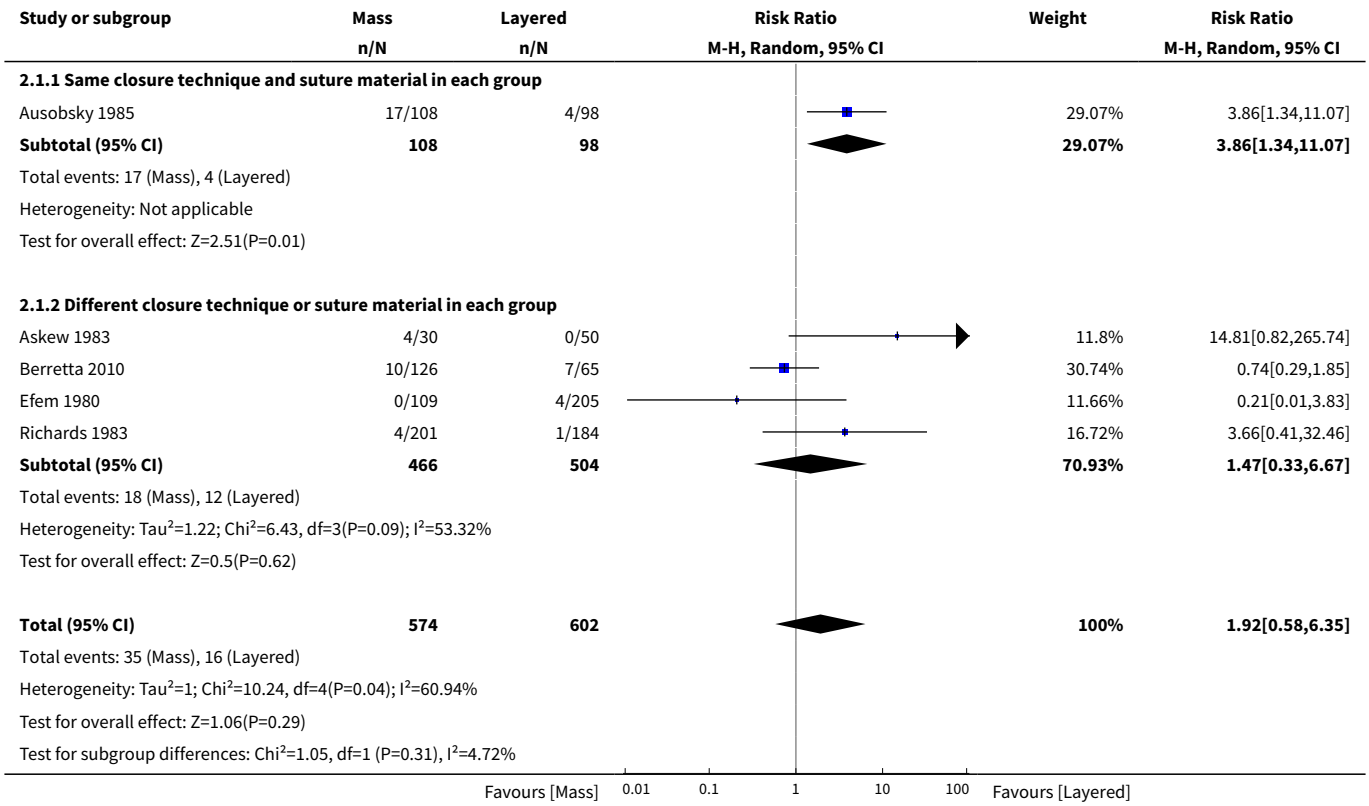


Comparison 2. Mass versus layered closure

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incisional hernia	5	1176	Risk Ratio (M-H, Random, 95% CI)	1.92 [0.58, 6.35]
1.1 Same closure technique and suture material in each group	1	206	Risk Ratio (M-H, Random, 95% CI)	3.86 [1.34, 11.07]
1.2 Different closure technique or suture material in each group	4	970	Risk Ratio (M-H, Random, 95% CI)	1.47 [0.33, 6.67]
2 Wound infection	11	2926	Risk Ratio (M-H, Random, 95% CI)	0.93 [0.67, 1.30]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Same closure technique and suture material in each group	1	282	Risk Ratio (M-H, Random, 95% CI)	1.26 [0.79, 2.02]
2.2 Different closure technique or suture material in each group	10	2644	Risk Ratio (M-H, Random, 95% CI)	0.89 [0.62, 1.28]
3 Wound dehiscence	11	2863	Risk Ratio (M-H, Random, 95% CI)	0.69 [0.31, 1.52]
3.1 Same closure technique and suture material in each group	1	282	Risk Ratio (M-H, Random, 95% CI)	0.46 [0.04, 5.01]
3.2 Different closure technique or suture material in each group	10	2581	Risk Ratio (M-H, Random, 95% CI)	0.69 [0.28, 1.68]
4 Sinus or fistula formation	6	1076	Risk Ratio (M-H, Random, 95% CI)	0.49 [0.15, 1.62]
4.1 Same closure technique and suture material in each group	1	282	Risk Ratio (M-H, Random, 95% CI)	0.92 [0.13, 6.43]
4.2 Different closure technique or suture material in each group	5	794	Risk Ratio (M-H, Random, 95% CI)	0.44 [0.10, 1.83]

Analysis 2.1. Comparison 2 Mass versus layered closure, Outcome 1 Incisional hernia.

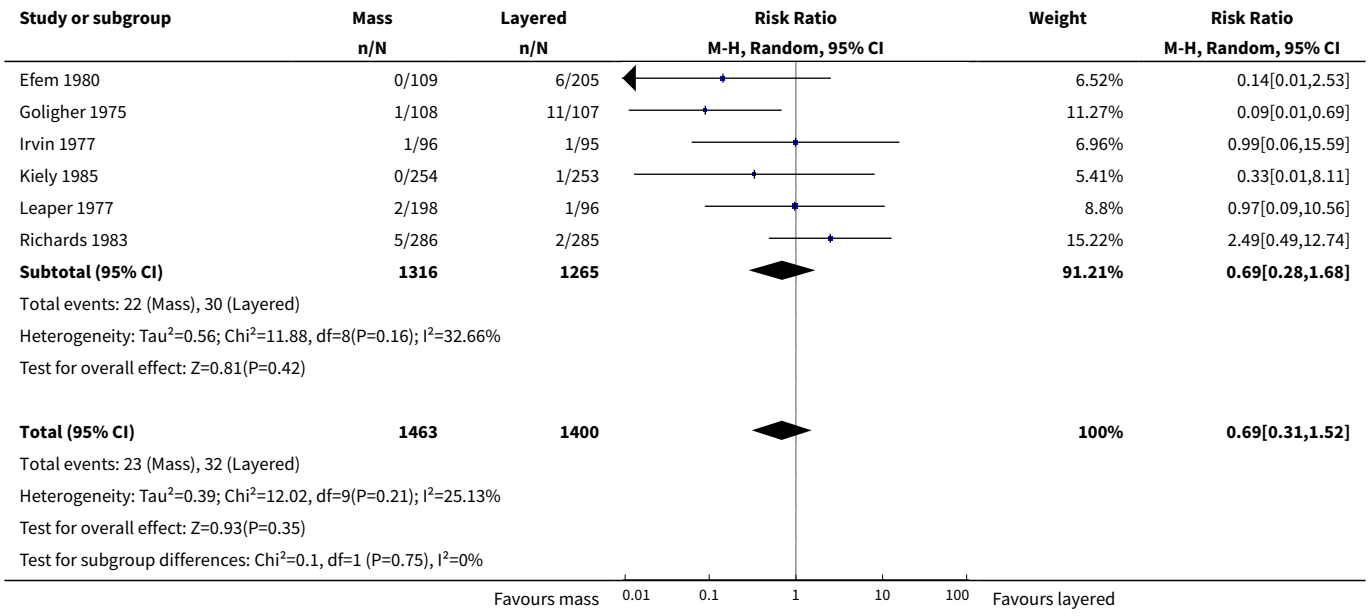


Analysis 2.2. Comparison 2 Mass versus layered closure, Outcome 2 Wound infection.

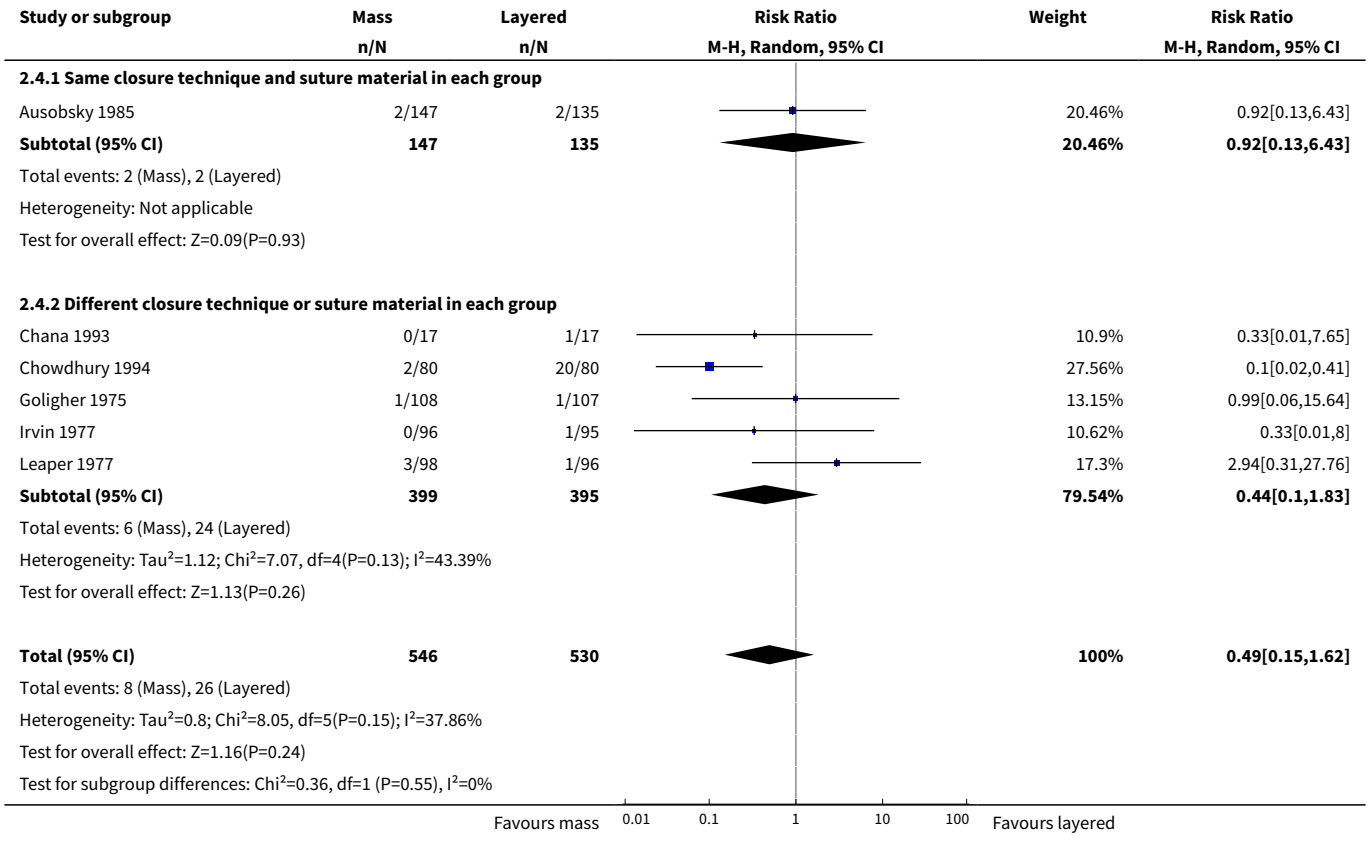
Study or subgroup	Mass n/N	Layered n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
2.2.1 Same closure technique and suture material in each group					
Ausobsky 1985	33/147	24/135		14.68%	1.26[0.79,2.02]
Subtotal (95% CI)	**147**	**135**		**14.68%**	**1.26[0.79,2.02]**
Total events: 33 (Mass), 24 (Layered)					
Heterogeneity: Not applicable					
Test for overall effect: Z=0.97(P=0.33)					
2.2.2 Different closure technique or suture material in each group					
Askew 1983	6/42	0/62		1.25%	19.05[1.1,329.34]
Berretta 2010	4/126	1/65		2.06%	2.06[0.24,18.09]
Chana 1993	5/17	3/17		5.11%	1.67[0.47,5.9]
Chowdhury 1994	18/80	38/80		14.75%	0.47[0.3,0.76]
Efem 1980	4/109	21/205		6.73%	0.36[0.13,1.02]
Goligher 1975	11/108	10/107		9.17%	1.09[0.48,2.46]
Irvin 1977	13/96	15/95		10.96%	0.86[0.43,1.7]
Kiely 1985	15/254	14/253		10.64%	1.07[0.53,2.16]
Leaper 1977	56/241	23/116		15.42%	1.17[0.76,1.81]
Richards 1983	10/286	13/285		9.25%	0.77[0.34,1.72]
Subtotal (95% CI)	**1359**	**1285**		**85.32%**	**0.89[0.62,1.28]**
Total events: 142 (Mass), 138 (Layered)					
Heterogeneity: Tau^2=0.15; Chi^2=18.01, df=9(P=0.04); I^2=50.02%					
Test for overall effect: Z=0.63(P=0.53)					
Total (95% CI)	**1506**	**1420**		**100%**	**0.93[0.67,1.3]**
Total events: 175 (Mass), 162 (Layered)					
Heterogeneity: Tau^2=0.13; Chi^2=20.18, df=10(P=0.03); I^2=50.46%					
Test for overall effect: Z=0.41(P=0.68)					
Test for subgroup differences: Chi^2=1.32, df=1 (P=0.25), I^2=24.39%					

Analysis 2.3. Comparison 2 Mass versus layered closure, Outcome 3 Wound dehiscence.

Study or subgroup	Mass n/N	Layered n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
2.3.1 Same closure technique and suture material in each group					
Ausobsky 1985	1/147	2/135		8.79%	0.46[0.04,5.01]
Subtotal (95% CI)	**147**	**135**		**8.79%**	**0.46[0.04,5.01]**
Total events: 1 (Mass), 2 (Layered)					
Heterogeneity: Not applicable					
Test for overall effect: Z=0.64(P=0.52)					
2.3.2 Different closure technique or suture material in each group					
Askew 1983	1/42	0/62		5.47%	4.4[0.18,105.38]
Berretta 2010	12/126	5/65		25.34%	1.24[0.46,3.36]
Chana 1993	0/17	0/17			Not estimable
Chowdhury 1994	0/80	3/80		6.22%	0.14[0.01,2.72]



Analysis 2.4. Comparison 2 Mass versus layered closure, Outcome 4 Sinus or fistula formation.

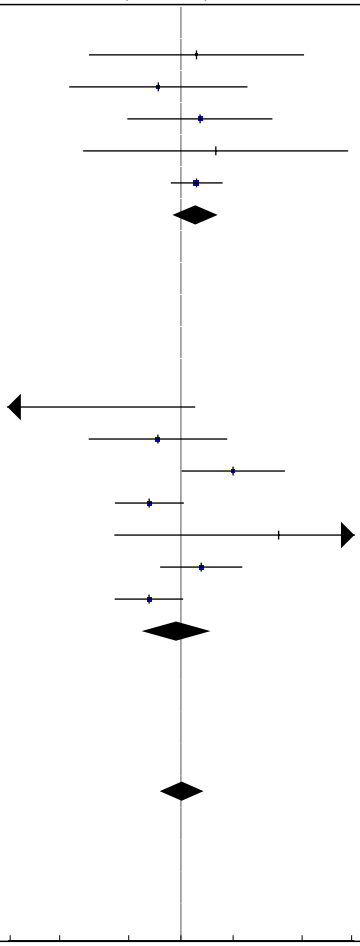


Comparison 3. Continuous versus interrupted closure

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incisional hernia	11	3854	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.76, 1.35]
1.1 Same closure method and suture material in each group	4	1195	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.89, 1.63]
1.2 Different closure method or suture material in each group	7	2659	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.59, 1.48]
2 Wound infection	23	10039	Risk Ratio (M-H, Random, 95% CI)	1.13 [0.96, 1.34]
2.1 Same closure method and suture material in each group	6	4933	Risk Ratio (M-H, Random, 95% CI)	1.20 [0.99, 1.45]
2.2 Different closure method or suture material in each group	17	5106	Risk Ratio (M-H, Random, 95% CI)	1.07 [0.83, 1.38]
3 Wound dehiscence	21	9228	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.90, 1.64]
3.1 Same closure method and suture material in each group	6	4928	Risk Ratio (M-H, Random, 95% CI)	1.15 [0.70, 1.88]
3.2 Different closure method or suture material in each group	15	4300	Risk Ratio (M-H, Random, 95% CI)	1.27 [0.84, 1.92]
4 Sinus or fistula formation	10	5082	Risk Ratio (M-H, Random, 95% CI)	1.51 [0.64, 3.61]
4.1 Same closure method and suture material in each group	4	4027	Risk Ratio (M-H, Random, 95% CI)	0.76 [0.51, 1.12]
4.2 Different closure method or suture material in each group	6	1055	Risk Ratio (M-H, Random, 95% CI)	3.71 [1.32, 10.45]
5 Hernia and type of incision	4	1195	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.89, 1.63]
5.1 Midline incision only (same suture material)	2	727	Risk Ratio (M-H, Random, 95% CI)	1.19 [0.86, 1.64]
5.2 Other incisions, combination of incisions (same suture material)	2	468	Risk Ratio (M-H, Random, 95% CI)	1.35 [0.58, 3.14]

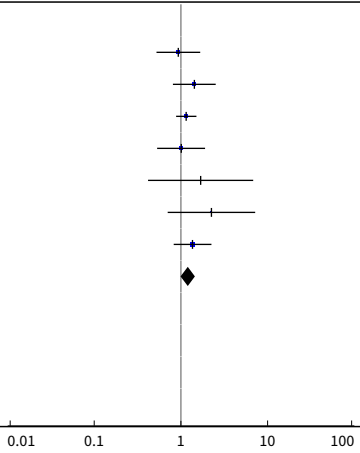
Analysis 3.1. Comparison 3 Continuous versus interrupted closure, Outcome 1 Incisional hernia.

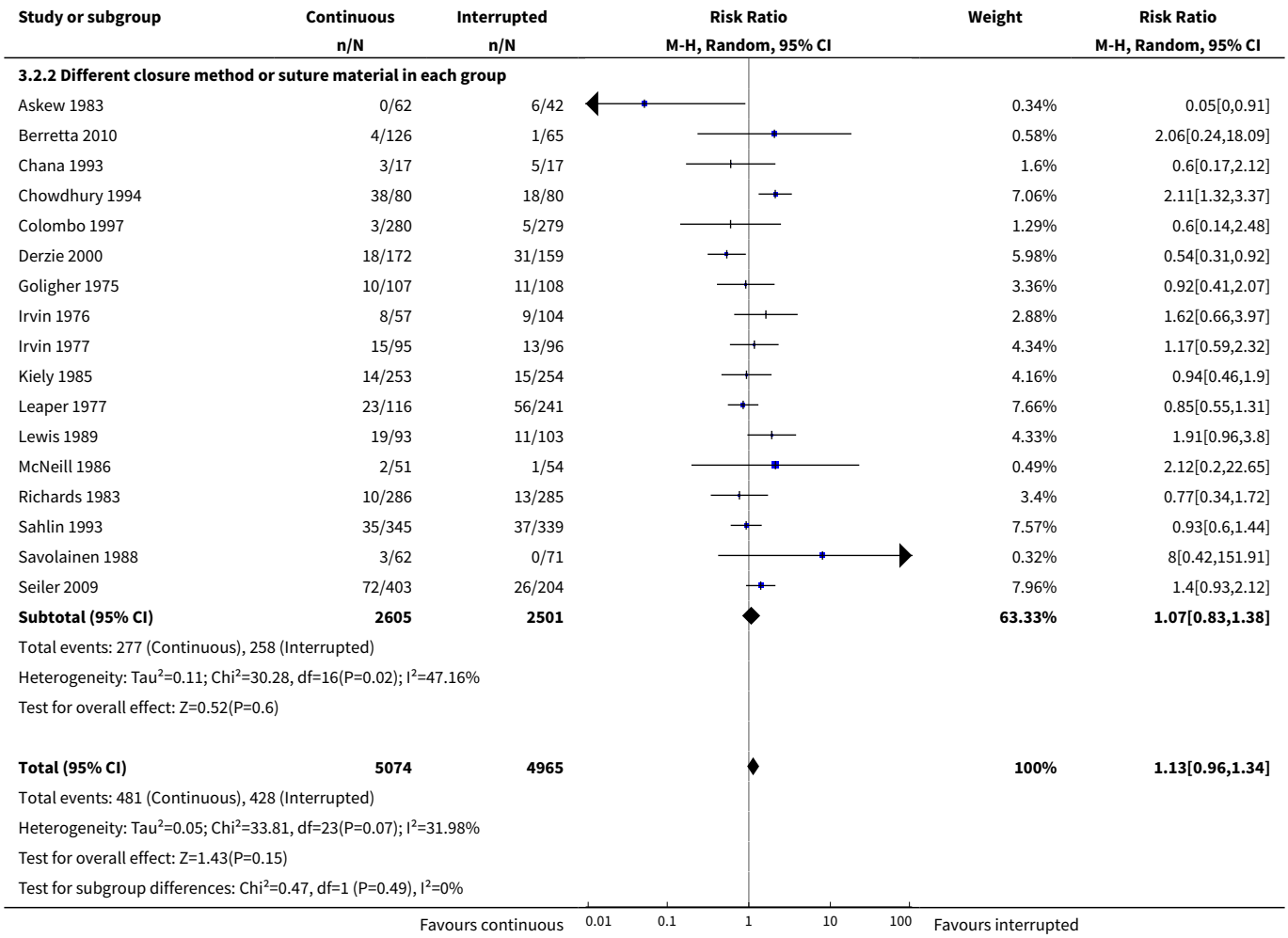
Study or subgroup	Continuous n/N	Interrupted n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
3.1.1 Same closure method and suture material in each group					
Agrawal 2009	4/39	3/36		3.57%	1.23[0.3,5.13]
Agrawal 2009	4/36	6/40		4.87%	0.74[0.23,2.42]
Gislason 1995	9/163	7/163		6.67%	1.29[0.49,3.37]
Larsen 1989	3/69	2/73		2.47%	1.59[0.27,9.21]
Wissing 1987	60/290	48/286		18.37%	1.23[0.88,1.74]
Subtotal (95% CI)	**597**	**598**		**35.94%**	**1.21[0.89,1.63]**
Total events: 80 (Continuous), 66 (Interrupted)					
Heterogeneity: Tau^2=0; Chi^2=0.78, df=4(P=0.94); I^2=0%					
Test for overall effect: Z=1.23(P=0.22)					
3.1.2 Different closure method or suture material in each group					
Askew 1983	0/50	4/30		0.98%	0.07[0,1.21]
Berretta 2010	10/126	7/65		7.14%	0.74[0.29,1.85]
Brolin 1996	20/109	11/120		10.37%	2[1.01,3.98]
Colombo 1997	27/280	41/279		15.34%	0.66[0.42,1.04]
Richards 1983	4/201	1/184		1.66%	3.66[0.41,32.46]
Sahlin 1993	28/345	21/339		13.21%	1.31[0.76,2.26]
Seiler 2009	37/355	28/176		15.35%	0.66[0.42,1.03]
Subtotal (95% CI)	**1466**	**1193**		**64.06%**	**0.94[0.59,1.48]**
Total events: 126 (Continuous), 113 (Interrupted)					
Heterogeneity: Tau^2=0.19; Chi^2=15.53, df=6(P=0.02); I^2=61.36%					
Test for overall effect: Z=0.28(P=0.78)					
Total (95% CI)	**2063**	**1791**		**100%**	**1.01[0.76,1.35]**
Total events: 206 (Continuous), 179 (Interrupted)					
Heterogeneity: Tau^2=0.09; Chi^2=18.83, df=11(P=0.06); I^2=41.6%					
Test for overall effect: Z=0.07(P=0.94)					
Test for subgroup differences: Chi^2=0.82, df=1 (P=0.37), I^2=0%					



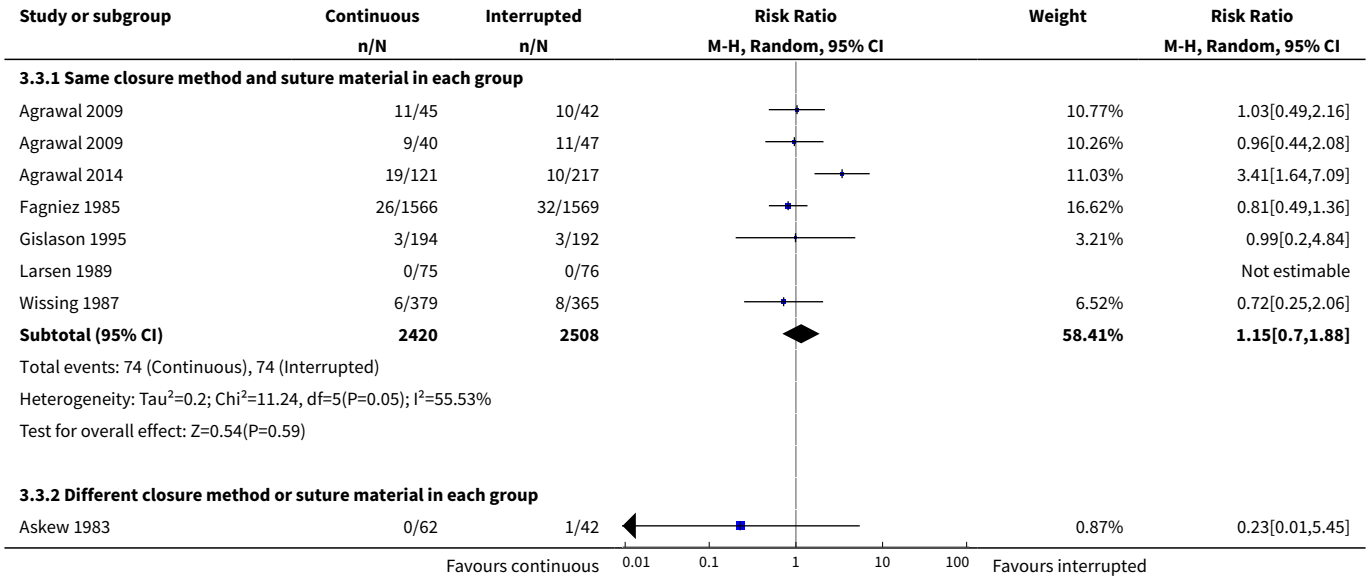
Analysis 3.2. Comparison 3 Continuous versus interrupted closure, Outcome 2 Wound infection.

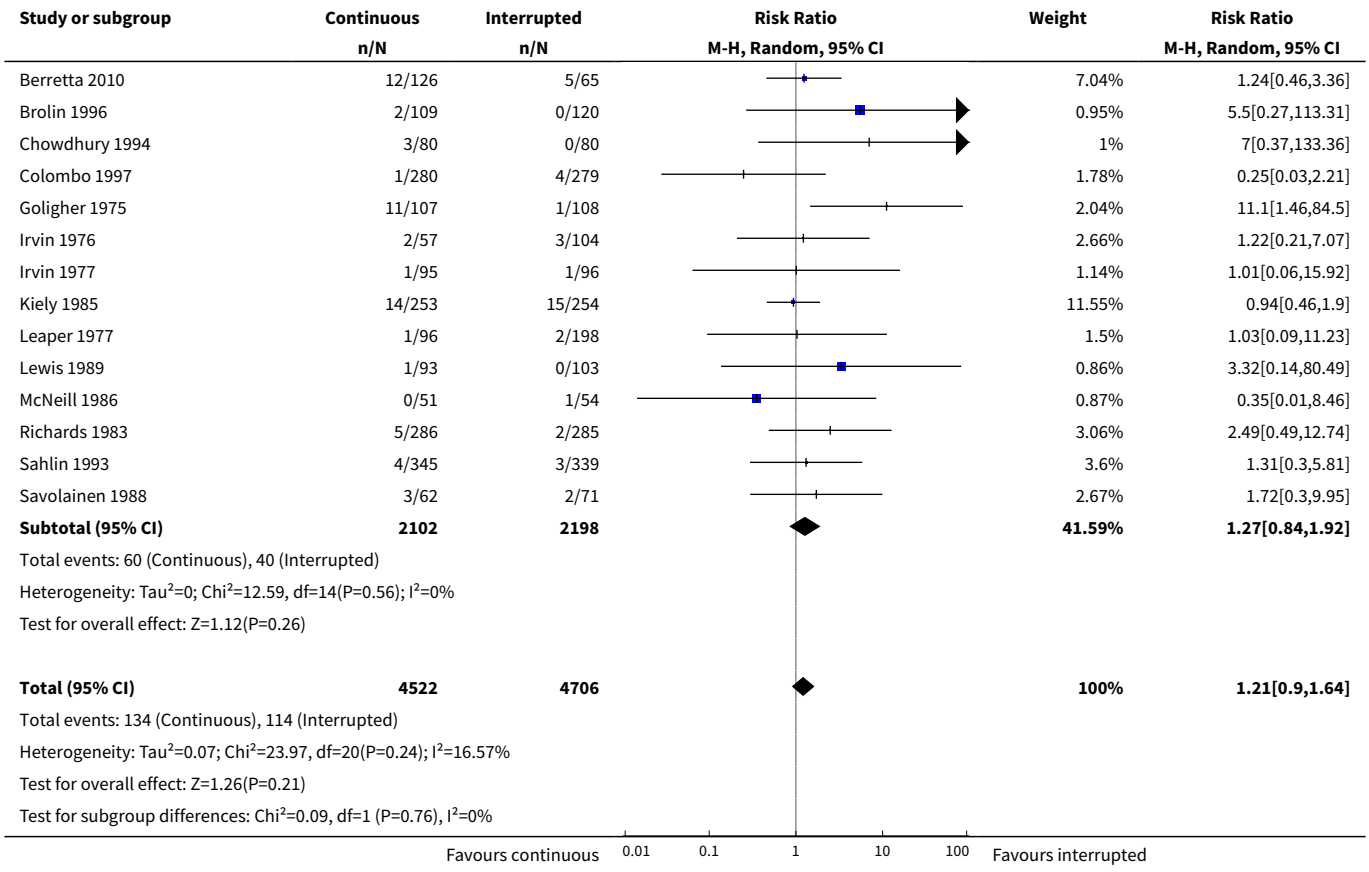
Study or subgroup	Continuous n/N	Interrupted n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
3.2.1 Same closure method and suture material in each group					
Agrawal 2009	15/45	15/42		5.47%	0.93[0.52,1.67]
Agrawal 2009	17/40	14/47		5.61%	1.43[0.81,2.52]
Fagniez 1985	107/1566	93/1569		11.06%	1.15[0.88,1.51]
Gislason 1995	17/163	17/164		4.83%	1.01[0.53,1.9]
Larsen 1989	5/75	3/76		1.34%	1.69[0.42,6.82]
Orr 1990	9/201	4/201		1.86%	2.25[0.7,7.19]
Wissing 1987	34/379	24/365		6.51%	1.36[0.83,2.25]
Subtotal (95% CI)	**2469**	**2464**		**36.67%**	**1.2[0.99,1.45]**
Total events: 204 (Continuous), 170 (Interrupted)					
Heterogeneity: Tau^2=0; Chi^2=3.07, df=6(P=0.8); I^2=0%					
Test for overall effect: Z=1.86(P=0.06)					



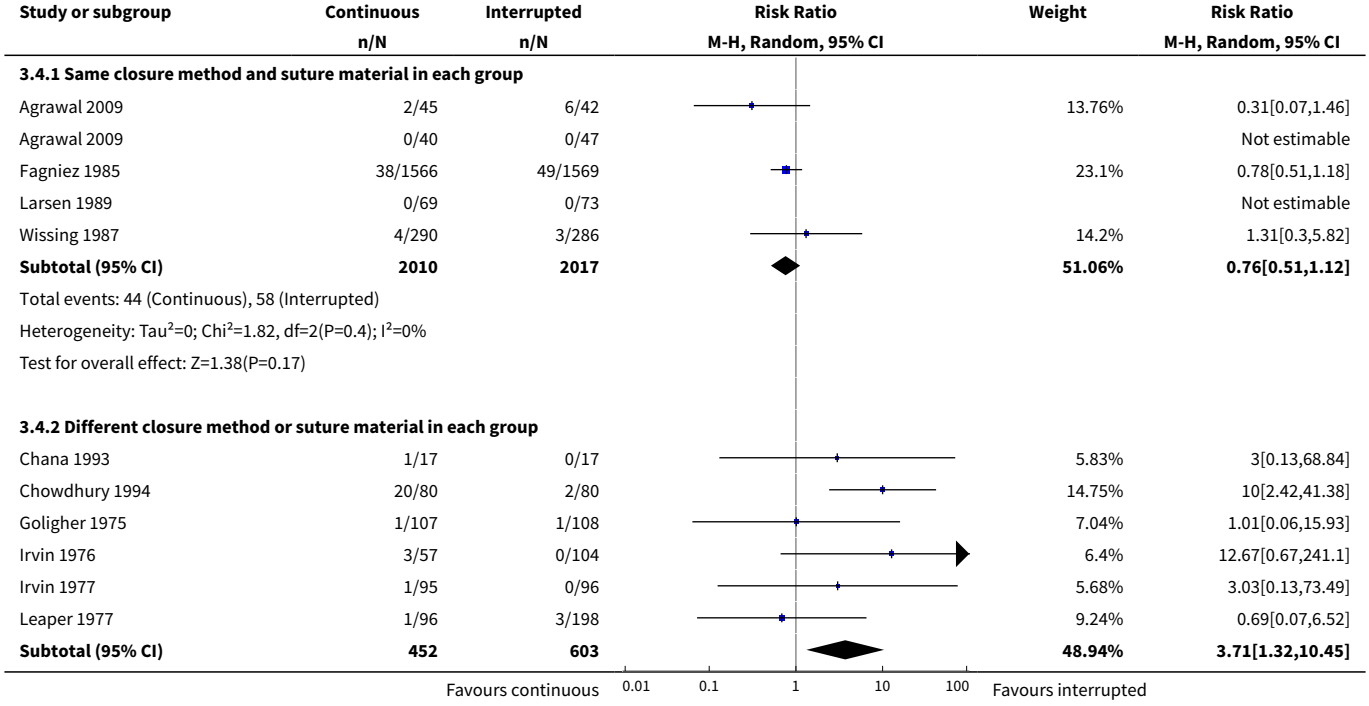


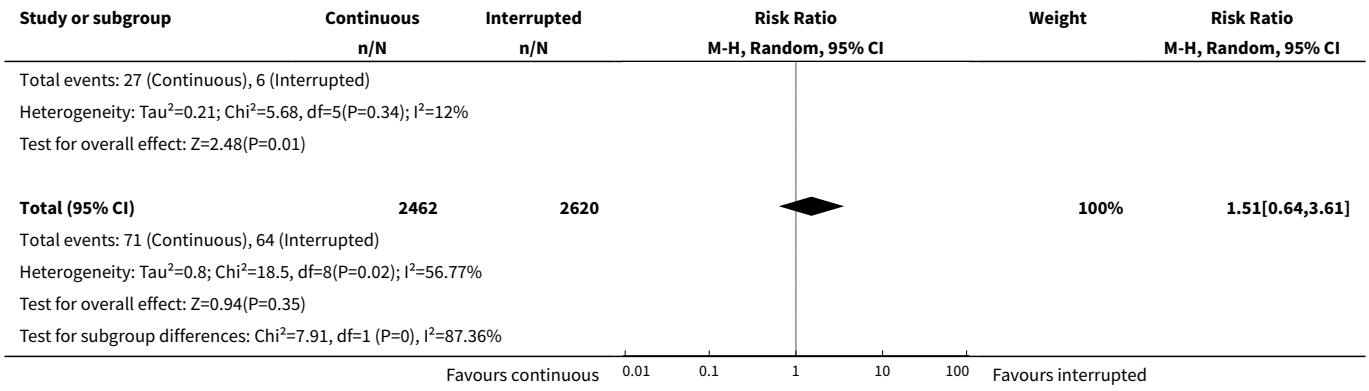
Analysis 3.3. Comparison 3 Continuous versus interrupted closure, Outcome 3 Wound dehiscence.



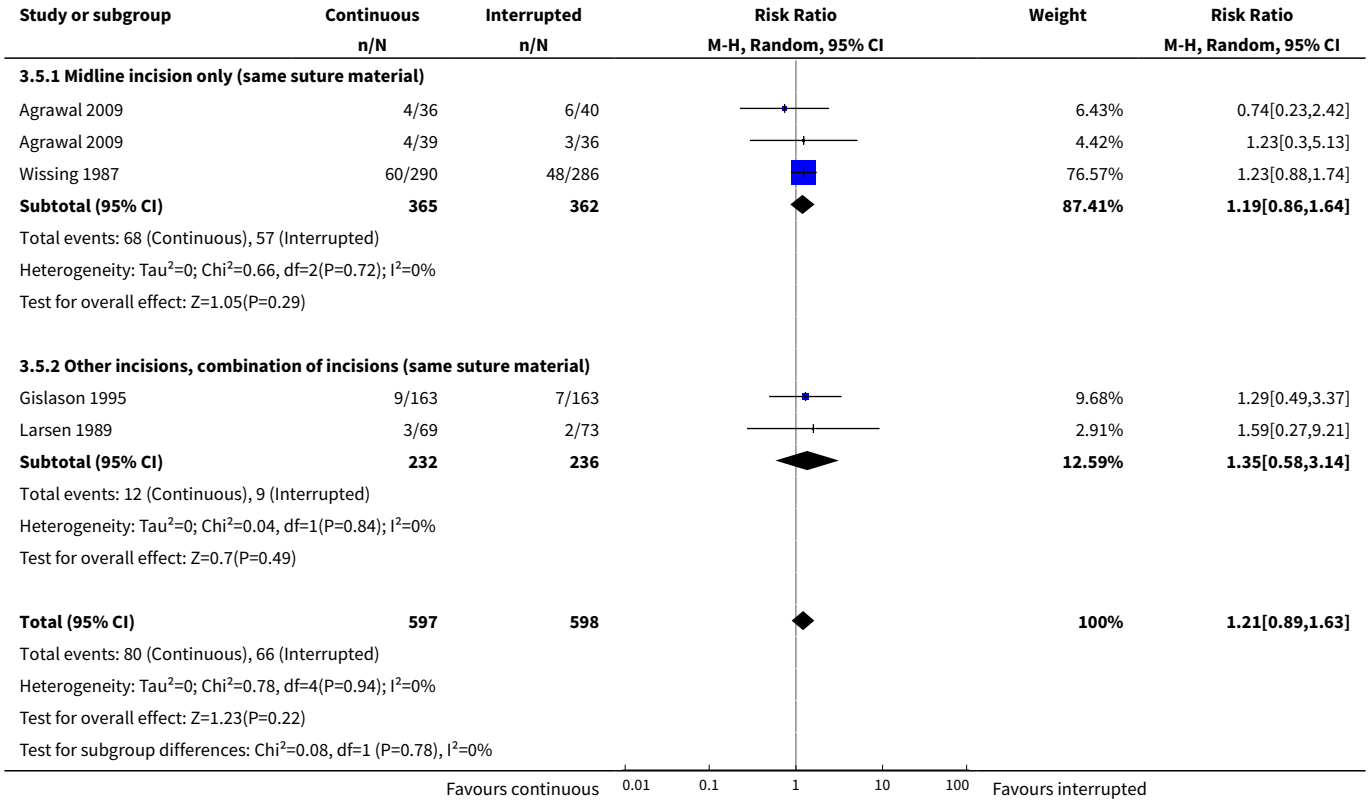


Analysis 3.4. Comparison 3 Continuous versus interrupted closure, Outcome 4 Sinus or fistula formation.





Analysis 3.5. Comparison 3 Continuous versus interrupted closure, Outcome 5 Hernia and type of incision.



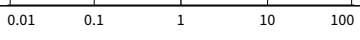
Comparison 4. Monofilament versus multifilament sutures

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incisional hernia	16	4520	Risk Ratio (M-H, Random, 95% CI)	0.76 [0.59, 0.98]

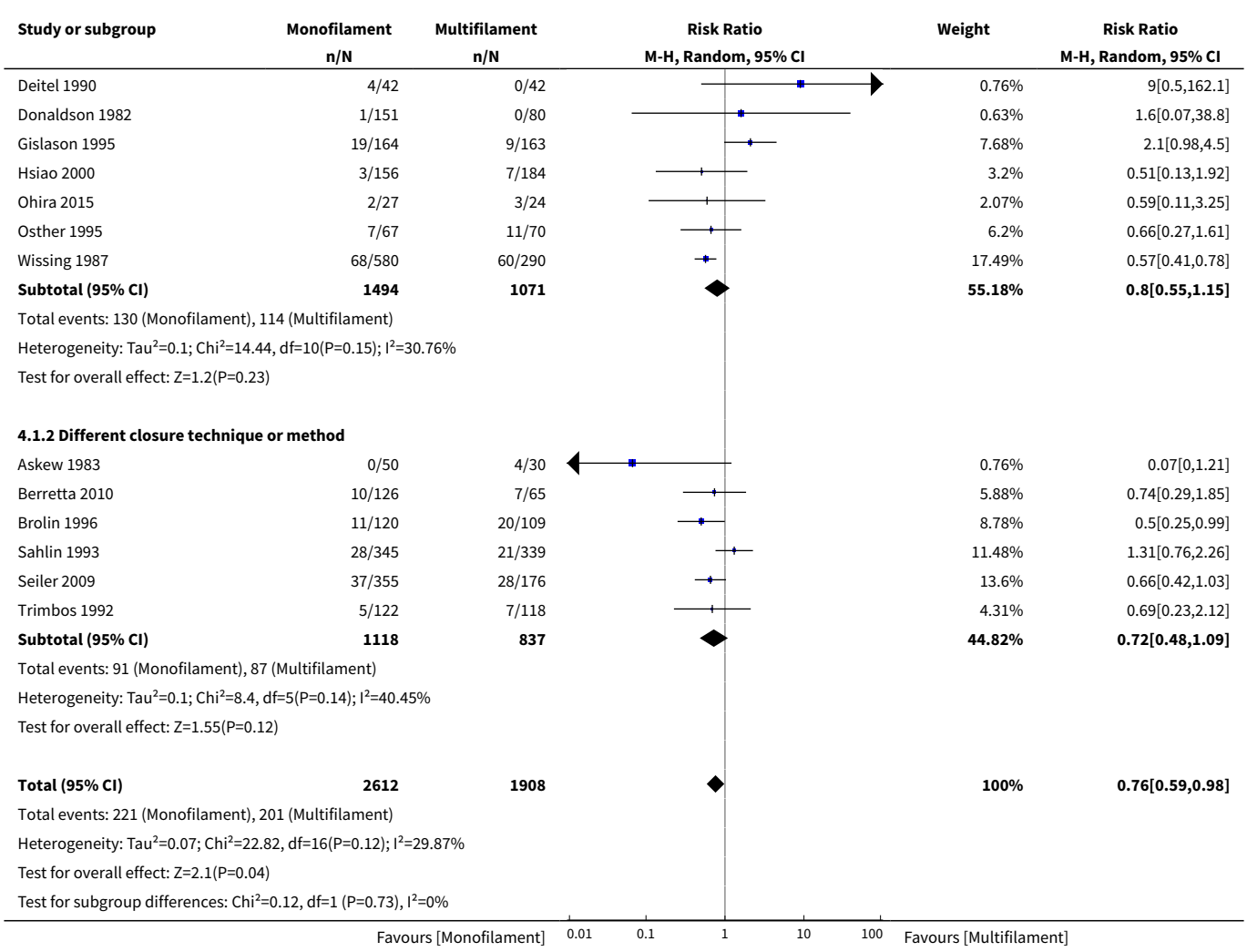
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Same closure technique and method	10	2565	Risk Ratio (M-H, Random, 95% CI)	0.80 [0.55, 1.15]
1.2 Different closure technique or method	6	1955	Risk Ratio (M-H, Random, 95% CI)	0.72 [0.48, 1.09]
2 Wound infection	23	6557	Risk Ratio (M-H, Random, 95% CI)	1.08 [0.91, 1.28]
2.1 Same closure technique and method	14	3956	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.85, 1.18]
2.2 Different closure technique or method	9	2601	Risk Ratio (M-H, Random, 95% CI)	1.35 [0.91, 2.01]
3 Wound dehiscence	22	6199	Risk Ratio (M-H, Random, 95% CI)	1.24 [0.93, 1.67]
3.1 Same closure technique and method	12	3465	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.76, 1.91]
3.2 Different closure technique or method	10	2734	Risk Ratio (M-H, Random, 95% CI)	1.49 [0.88, 2.53]
4 Sinus or fistula formation	8	2285	Risk Ratio (M-H, Random, 95% CI)	1.91 [0.77, 4.73]
4.1 Same closure technique and method	6	1784	Risk Ratio (M-H, Random, 95% CI)	1.98 [0.79, 4.99]
4.2 Different closure technique or method	2	501	Risk Ratio (M-H, Random, 95% CI)	1.36 [0.02, 108.15]
5 Hernia and type of incision	10	2565	Risk Ratio (M-H, Random, 95% CI)	0.80 [0.55, 1.15]
5.1 Midline incision only (same technique)	6	1530	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.47, 0.81]
5.2 Other incisions, combination of incisions (same technique)	4	1035	Risk Ratio (M-H, Random, 95% CI)	1.02 [0.47, 2.24]

Analysis 4.1. Comparison 4 Monofilament versus multifilament sutures, Outcome 1 Incisional hernia.

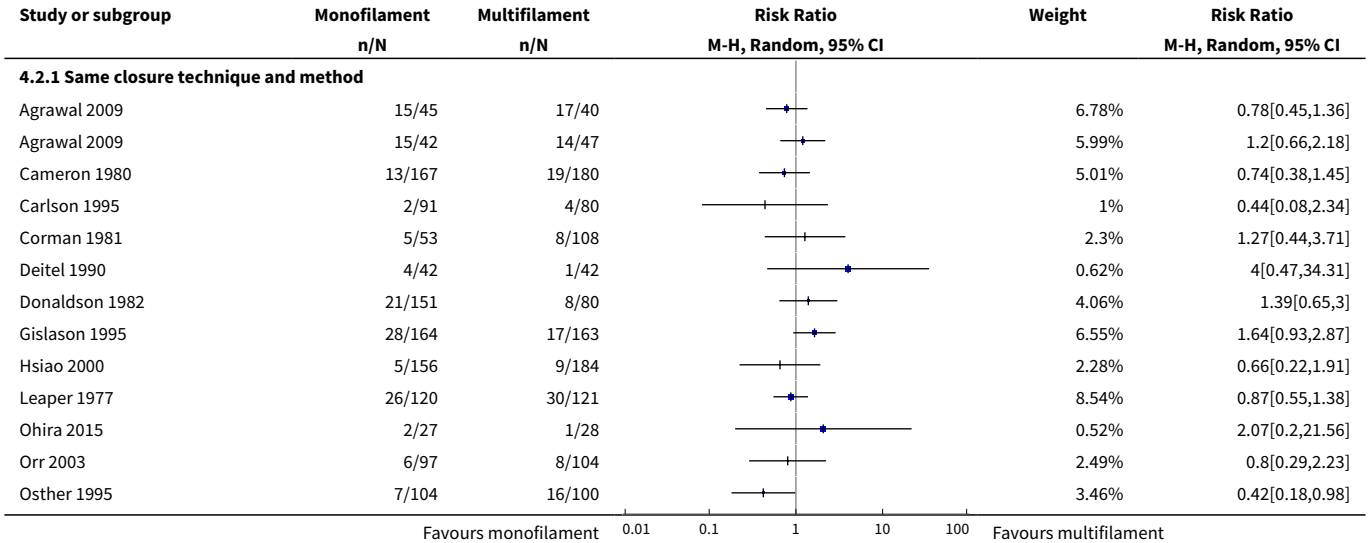
Study or subgroup	Monofilament n/N	Multifilament n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
4.1.1 Same closure technique and method					
Agrawal 2009	4/39	4/36		3.31%	0.92[0.25,3.42]
Agrawal 2009	3/36	6/40		3.3%	0.56[0.15,2.06]
Bresler 1995	15/141	7/62		6.64%	0.94[0.4,2.2]
Carlson 1995	4/91	7/80		3.89%	0.5[0.15,1.65]

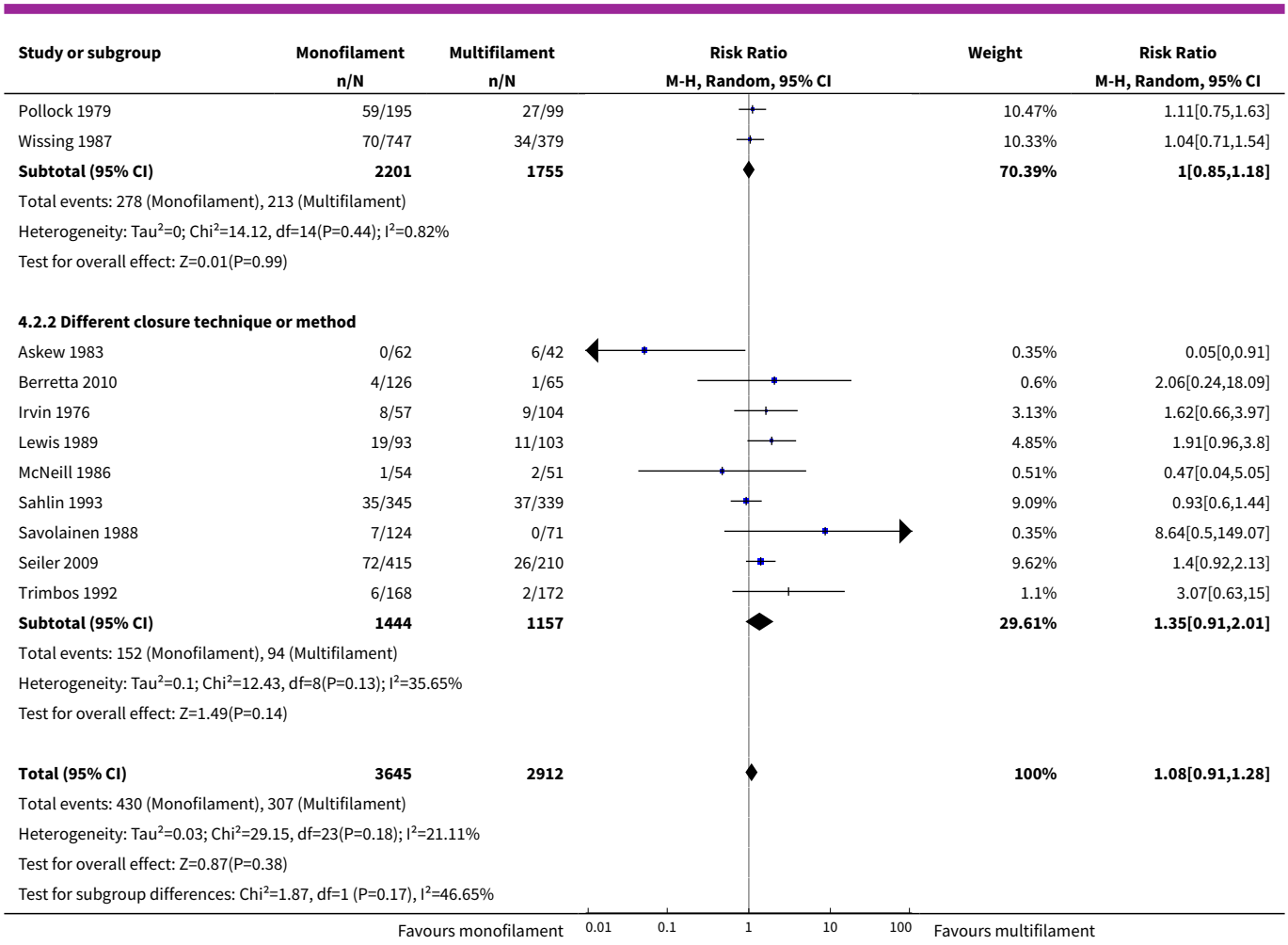


Favours [Monofilament] Favours [Multifilament]



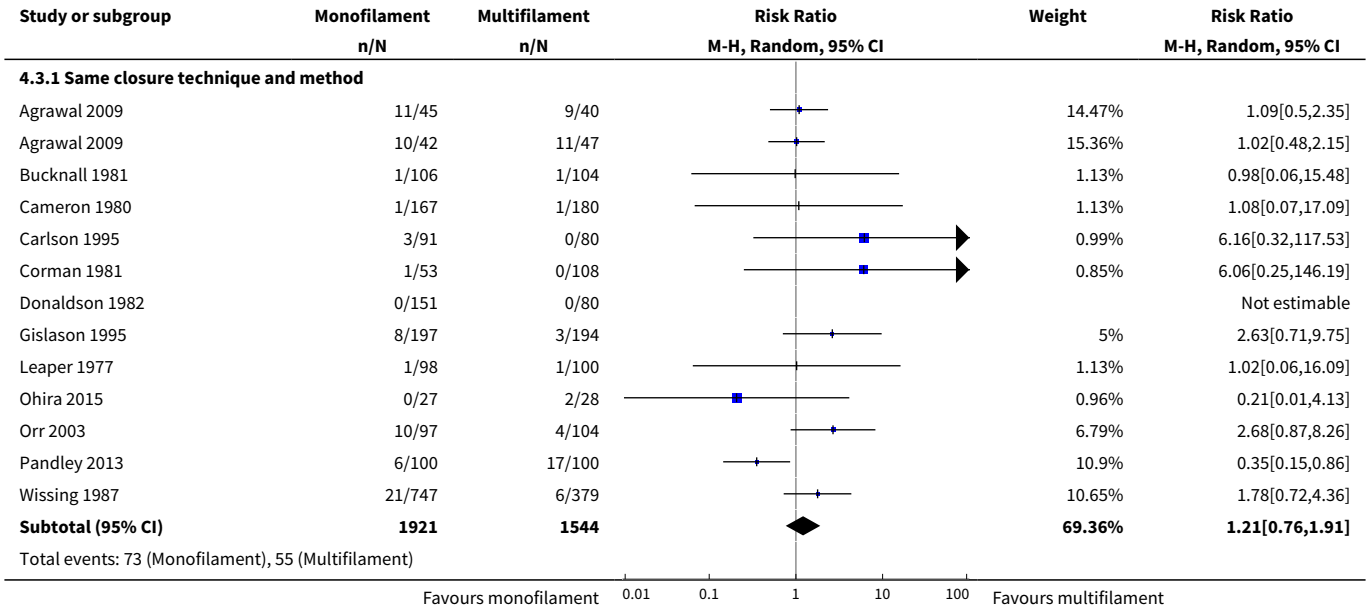
Analysis 4.2. Comparison 4 Monofilament versus multifilament sutures, Outcome 2 Wound infection.



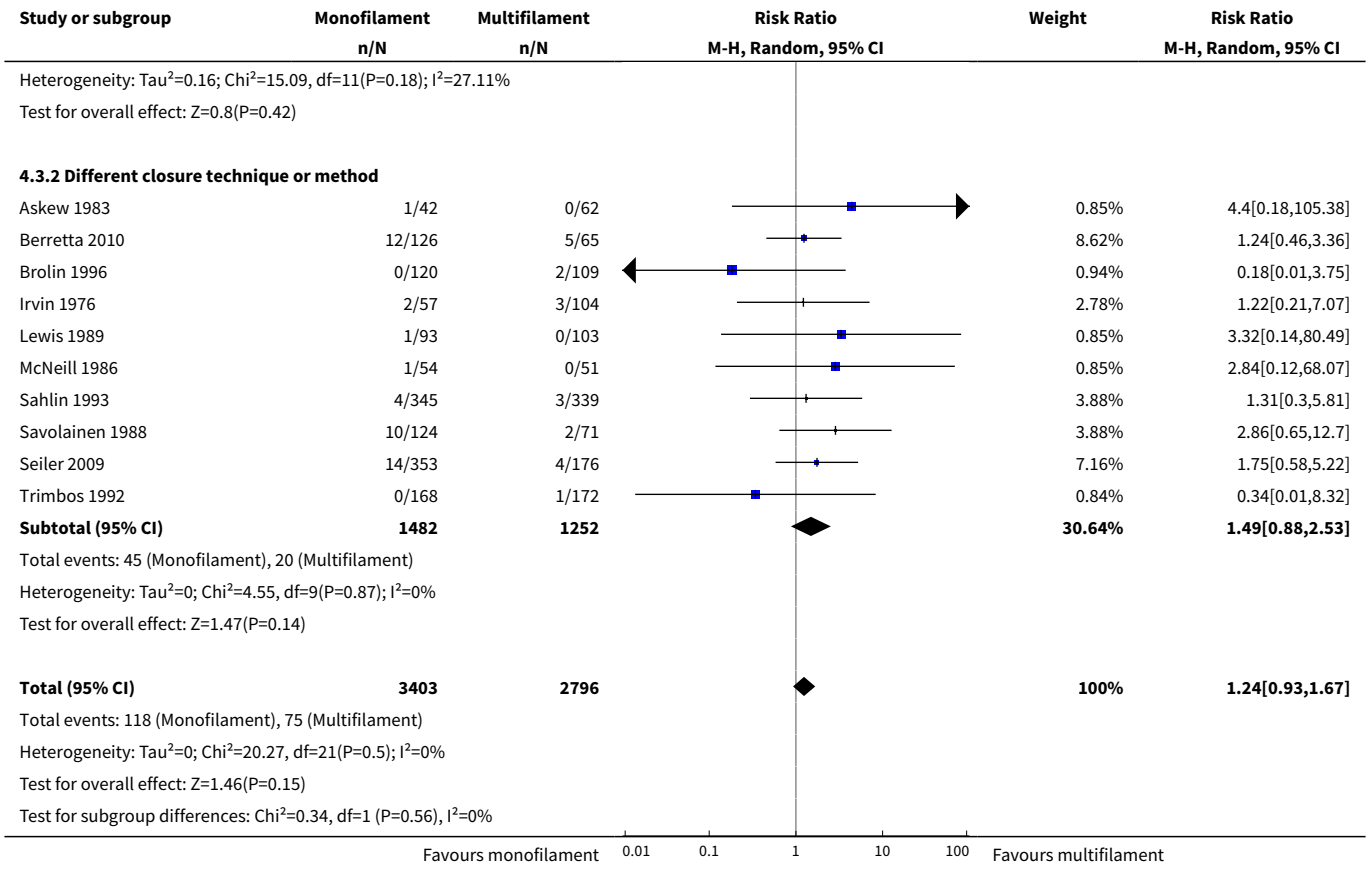


Study or subgroup	Monofilament n/N	Multifilament n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Pollock 1979	59/195	27/99		10.47%	1.11[0.75,1.63]
Wissing 1987	70/747	34/379		10.33%	1.04[0.71,1.54]
Subtotal (95% CI)	**2201**	**1755**		**70.39%**	**1[0.85,1.18]**
Total events: 278 (Monofilament), 213 (Multifilament)					
Heterogeneity: Tau^2=0; Chi^2=14.12, df=14(P=0.44); I^2=0.82%					
Test for overall effect: Z=0.01(P=0.99)					
4.2.2 Different closure technique or method					
Askew 1983	0/62	6/42		0.35%	0.05[0,0.91]
Berretta 2010	4/126	1/65		0.6%	2.06[0.24,18.09]
Irvin 1976	8/57	9/104		3.13%	1.62[0.66,3.97]
Lewis 1989	19/93	11/103		4.85%	1.91[0.96,3.8]
McNeill 1986	1/54	2/51		0.51%	0.47[0.04,5.05]
Sahlin 1993	35/345	37/339		9.09%	0.93[0.6,1.44]
Savolainen 1988	7/124	0/71		0.35%	8.64[0.5,149.07]
Seiler 2009	72/415	26/210		9.62%	1.4[0.92,2.13]
Trimbos 1992	6/168	2/172		1.1%	3.07[0.63,15]
Subtotal (95% CI)	**1444**	**1157**		**29.61%**	**1.35[0.91,2.01]**
Total events: 152 (Monofilament), 94 (Multifilament)					
Heterogeneity: Tau^2=0.1; Chi^2=12.43, df=8(P=0.13); I^2=35.65%					
Test for overall effect: Z=1.49(P=0.14)					
Total (95% CI)	**3645**	**2912**		**100%**	**1.08[0.91,1.28]**
Total events: 430 (Monofilament), 307 (Multifilament)					
Heterogeneity: Tau^2=0.03; Chi^2=29.15, df=23(P=0.18); I^2=21.11%					
Test for overall effect: Z=0.87(P=0.38)					
Test for subgroup differences: Chi^2=1.87, df=1 (P=0.17), I^2=46.65%					

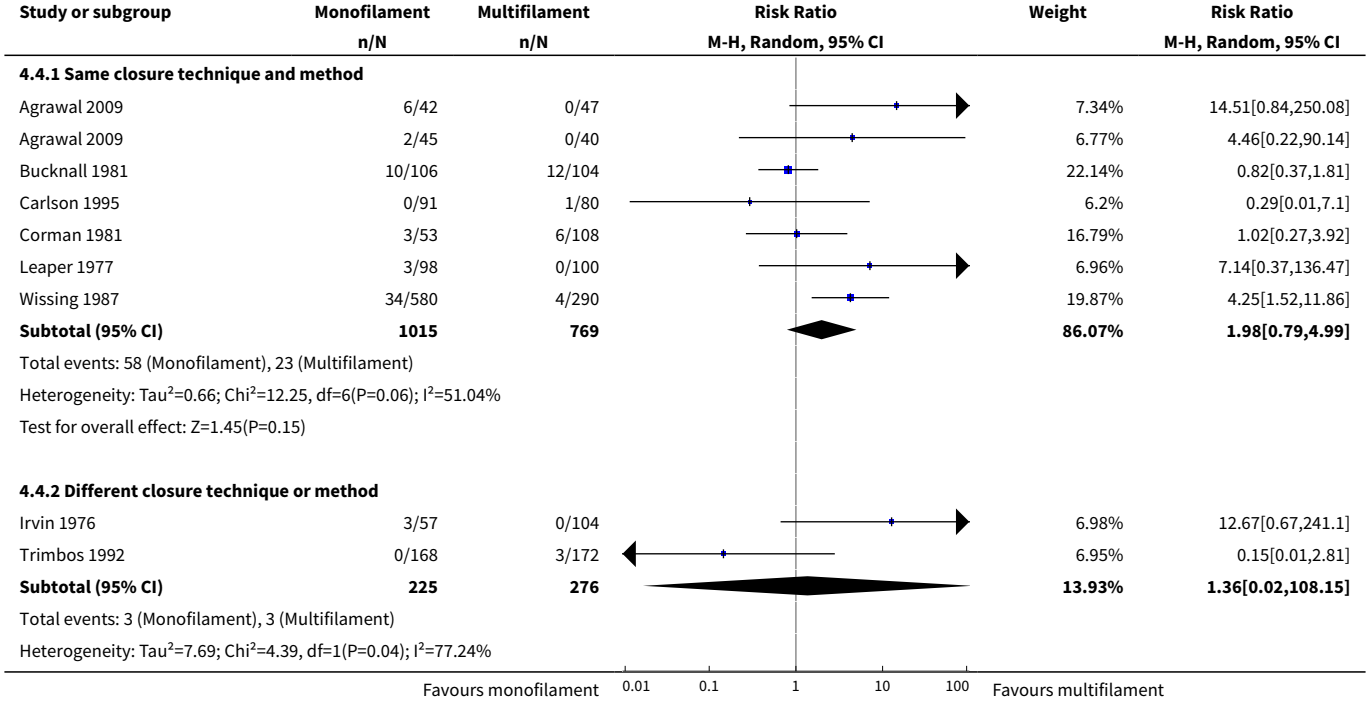
Analysis 4.3. Comparison 4 Monofilament versus multifilament sutures, Outcome 3 Wound dehiscence.

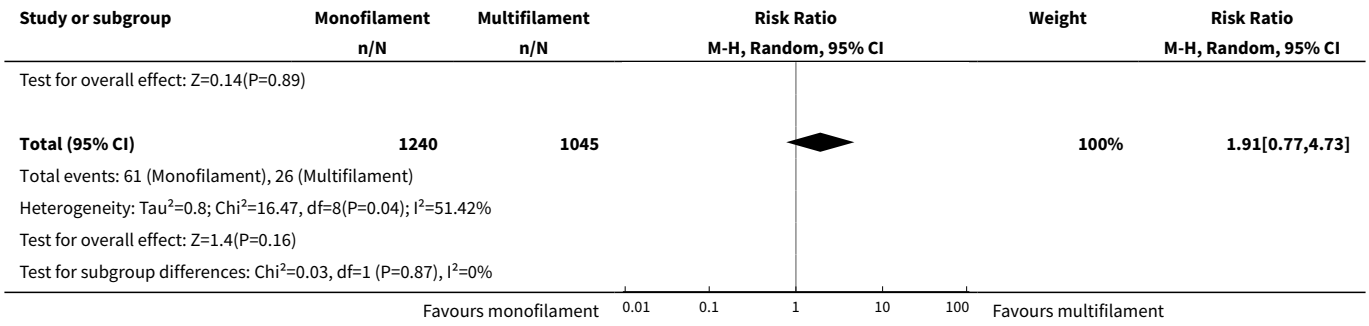


Study or subgroup	Monofilament n/N	Multifilament n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
4.3.1 Same closure technique and method					
Agrawal 2009	11/45	9/40		14.47%	1.09[0.5,2.35]
Agrawal 2009	10/42	11/47		15.36%	1.02[0.48,2.15]
Bucknall 1981	1/106	1/104		1.13%	0.98[0.06,15.48]
Cameron 1980	1/167	1/180		1.13%	1.08[0.07,17.09]
Carlson 1995	3/91	0/80		0.99%	6.16[0.32,117.53]
Corman 1981	1/53	0/108		0.85%	6.06[0.25,146.19]
Donaldson 1982	0/151	0/80			Not estimable
Gislason 1995	8/197	3/194		5%	2.63[0.71,9.75]
Leaper 1977	1/98	1/100		1.13%	1.02[0.06,16.09]
Ohira 2015	0/27	2/28		0.96%	0.21[0.01,4.13]
Orr 2003	10/97	4/104		6.79%	2.68[0.87,8.26]
Pandley 2013	6/100	17/100		10.9%	0.35[0.15,0.86]
Wissing 1987	21/747	6/379		10.65%	1.78[0.72,4.36]
Subtotal (95% CI)	**1921**	**1544**		**69.36%**	**1.21[0.76,1.91]**
Total events: 73 (Monofilament), 55 (Multifilament)					

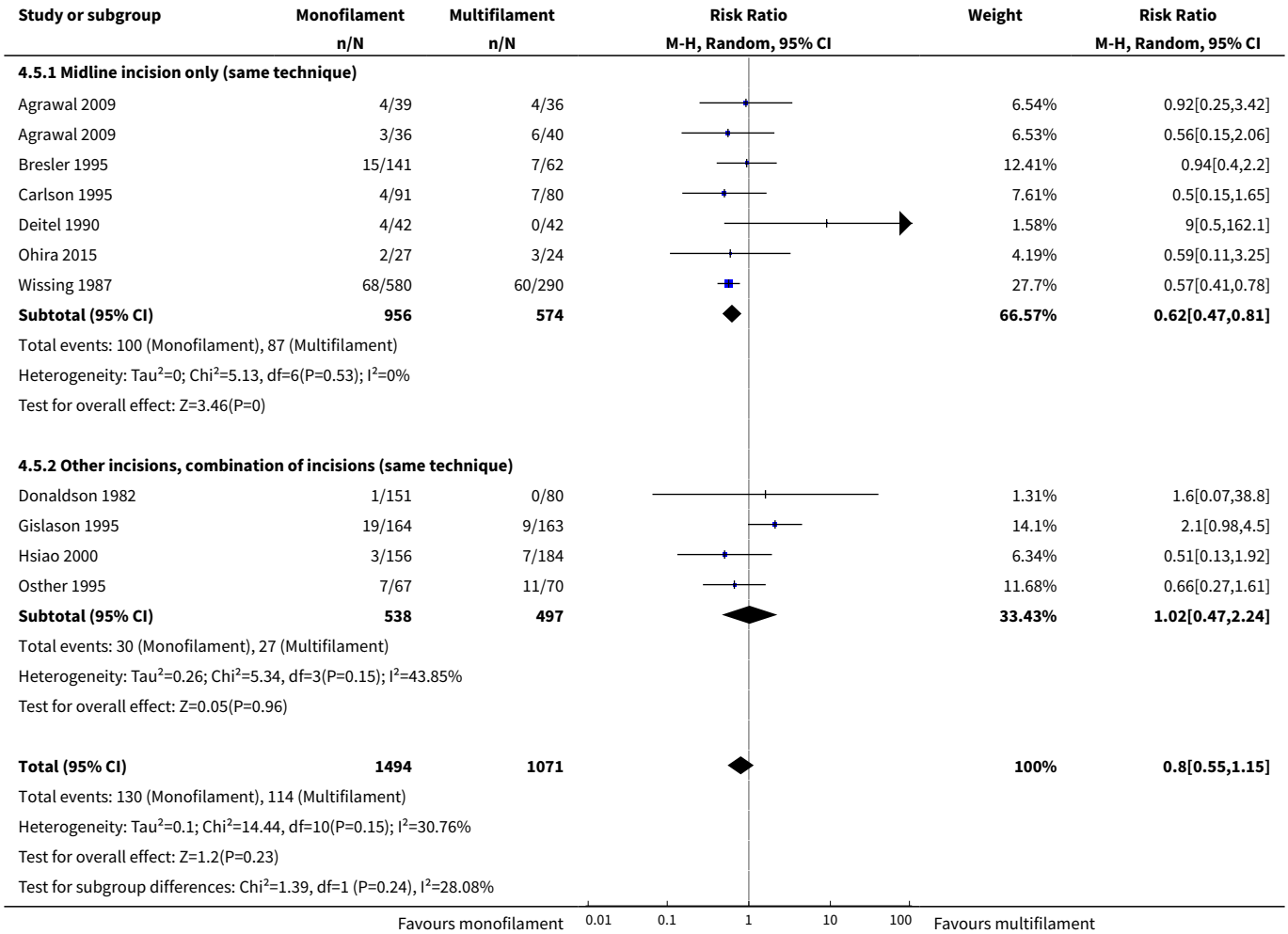


Analysis 4.4. Comparison 4 Monofilament versus multifilament sutures, Outcome 4 Sinus or fistula formation.





Analysis 4.5. Comparison 4 Monofilament versus multifilament sutures, Outcome 5 Hernia and type of incision.

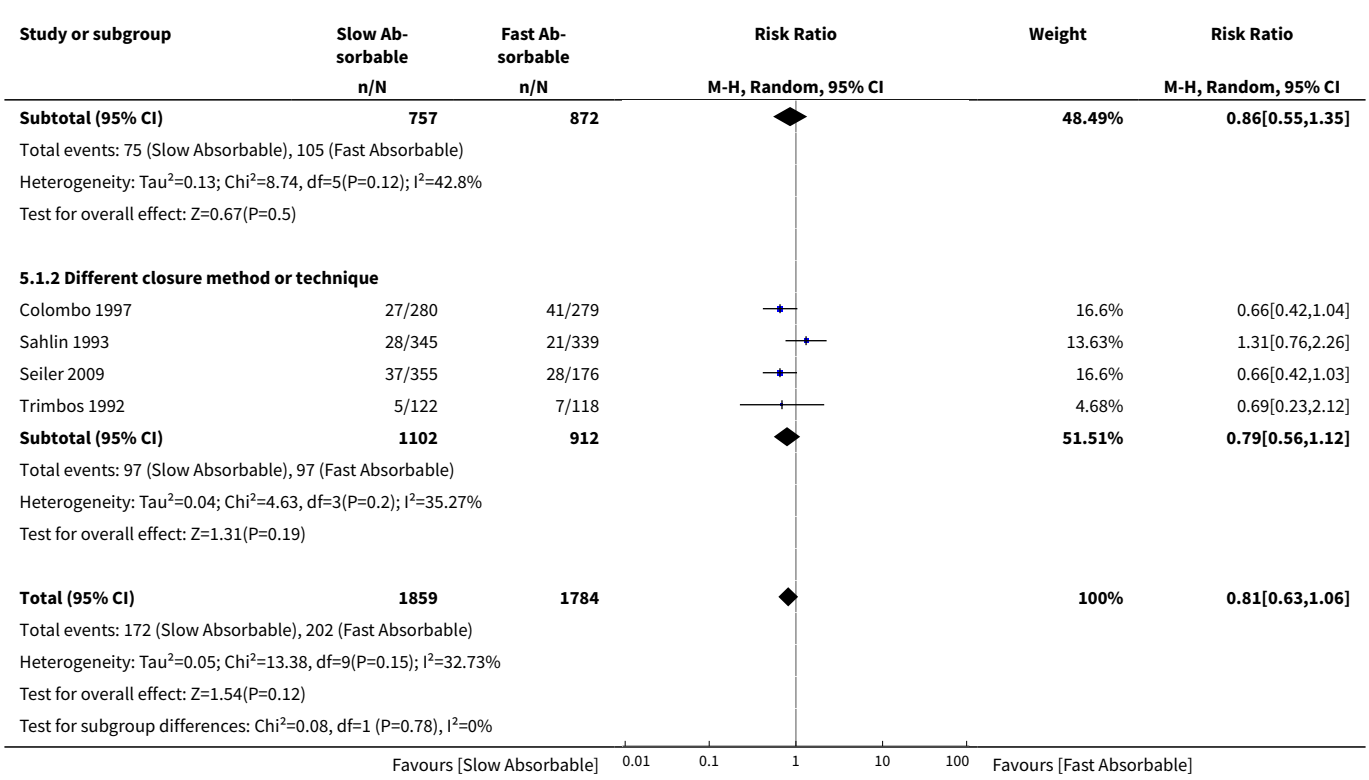


Comparison 5. Slow absorbable versus fast absorbable sutures (any technique)

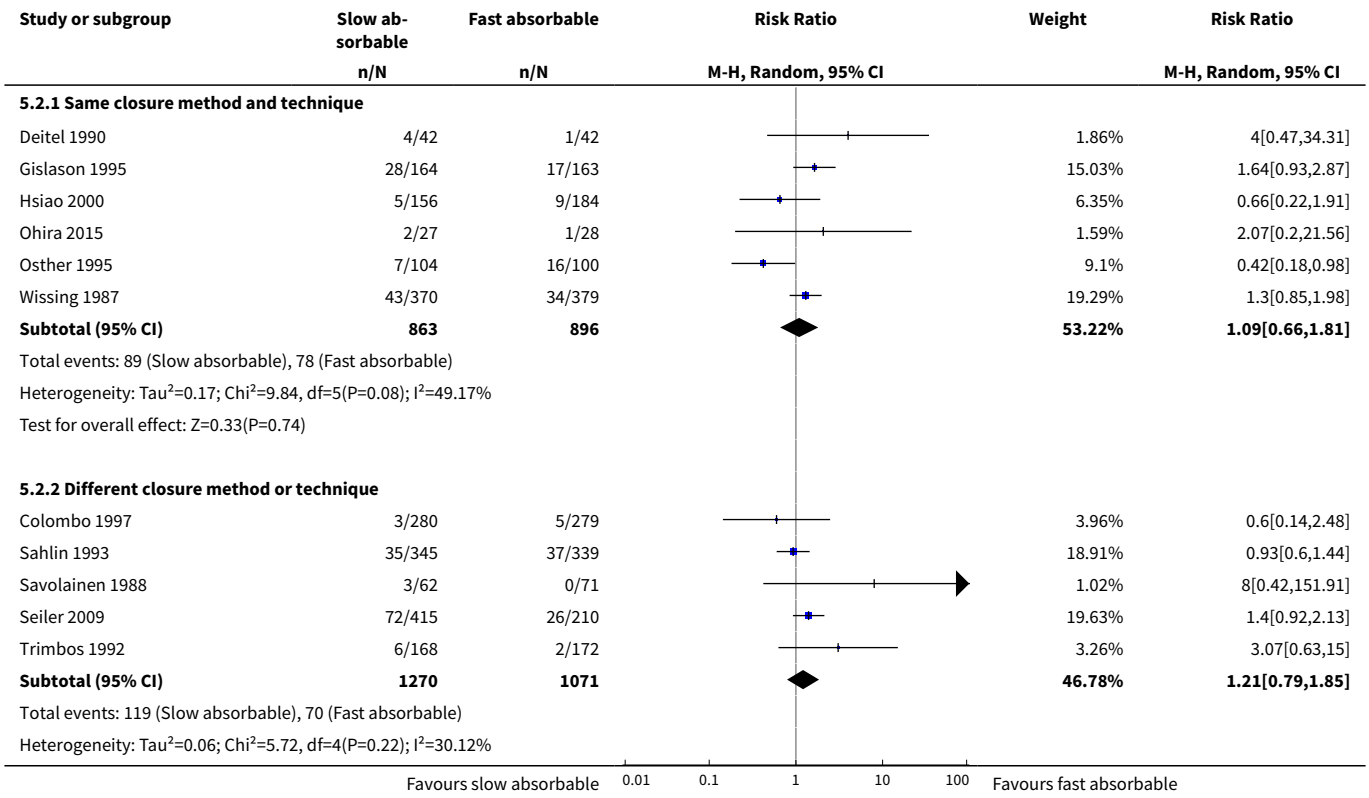
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incisional hernia	10	3643	Risk Ratio (M-H, Random, 95% CI)	0.81 [0.63, 1.06]
1.1 Same closure method and technique	6	1629	Risk Ratio (M-H, Random, 95% CI)	0.86 [0.55, 1.35]
1.2 Different closure method or technique	4	2014	Risk Ratio (M-H, Random, 95% CI)	0.79 [0.56, 1.12]
2 Wound infection	11	4100	Risk Ratio (M-H, Random, 95% CI)	1.16 [0.85, 1.57]
2.1 Same closure method and technique	6	1759	Risk Ratio (M-H, Random, 95% CI)	1.09 [0.66, 1.81]
2.2 Different closure method or technique	5	2341	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.79, 1.85]
3 Wound dehiscence	8	3440	Risk Ratio (M-H, Random, 95% CI)	1.55 [0.92, 2.61]
3.1 Same closure method and technique	3	1195	Risk Ratio (M-H, Random, 95% CI)	1.93 [0.80, 4.69]
3.2 Different closure method or technique	5	2245	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.59, 2.49]
4 Sinus or fistula formation	2	911	Risk Ratio (M-H, Random, 95% CI)	0.88 [0.05, 16.05]
4.1 Same closure method and technique	1	571	Risk Ratio (M-H, Random, 95% CI)	2.84 [0.91, 8.81]
4.2 Different closure method or technique	1	340	Risk Ratio (M-H, Random, 95% CI)	0.15 [0.01, 2.81]

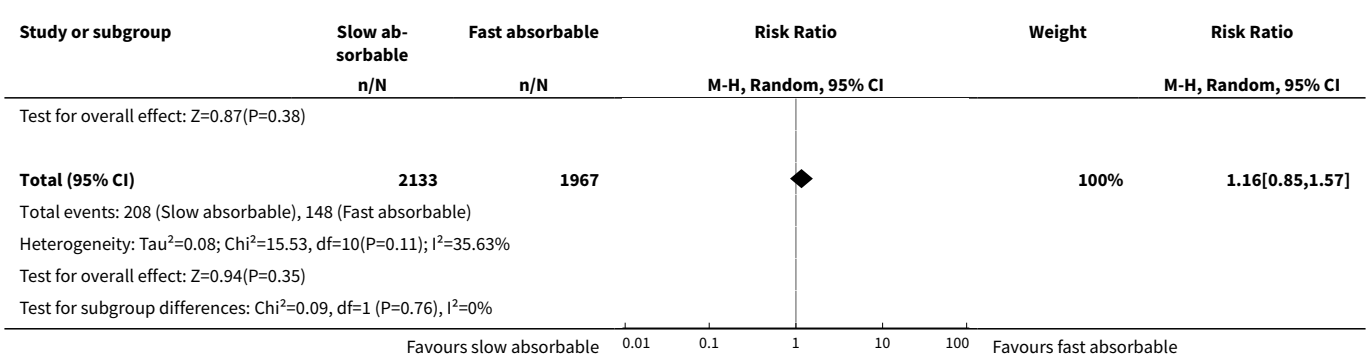
Analysis 5.1. Comparison 5 Slow absorbable versus fast absorbable sutures (any technique), Outcome 1 Incisional hernia.

Study or subgroup	Slow Absorbable n/N	Fast Absorbable n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
5.1.1 Same closure method and technique					
Bresler 1995	7/62	15/141		7.42%	1.06[0.46,2.47]
Gislason 1995	19/164	9/163		8.68%	2.1[0.98,4.5]
Hsiao 2000	3/156	7/184		3.43%	0.51[0.13,1.92]
Ohira 2015	2/27	3/24		2.19%	0.59[0.11,3.25]
Osther 1995	7/67	11/70		6.89%	0.66[0.27,1.61]
Wissing 1987	37/281	60/290		19.87%	0.64[0.44,0.93]
	Favours [Slow Absorbable]		0.01 0.1 1 10 100		Favours [Fast Absorbable]

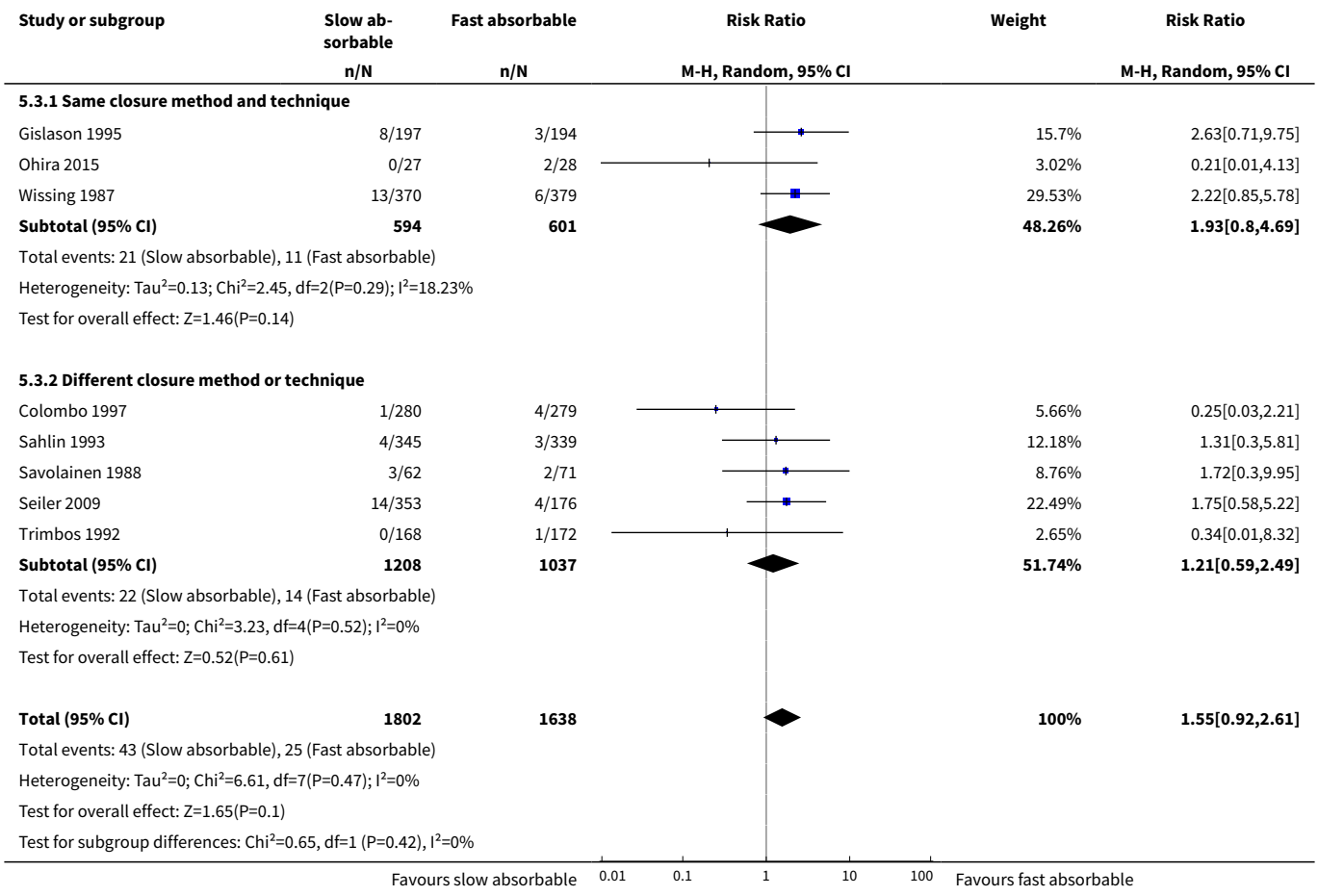


Analysis 5.2. Comparison 5 Slow absorbable versus fast absorbable sutures (any technique), Outcome 2 Wound infection.

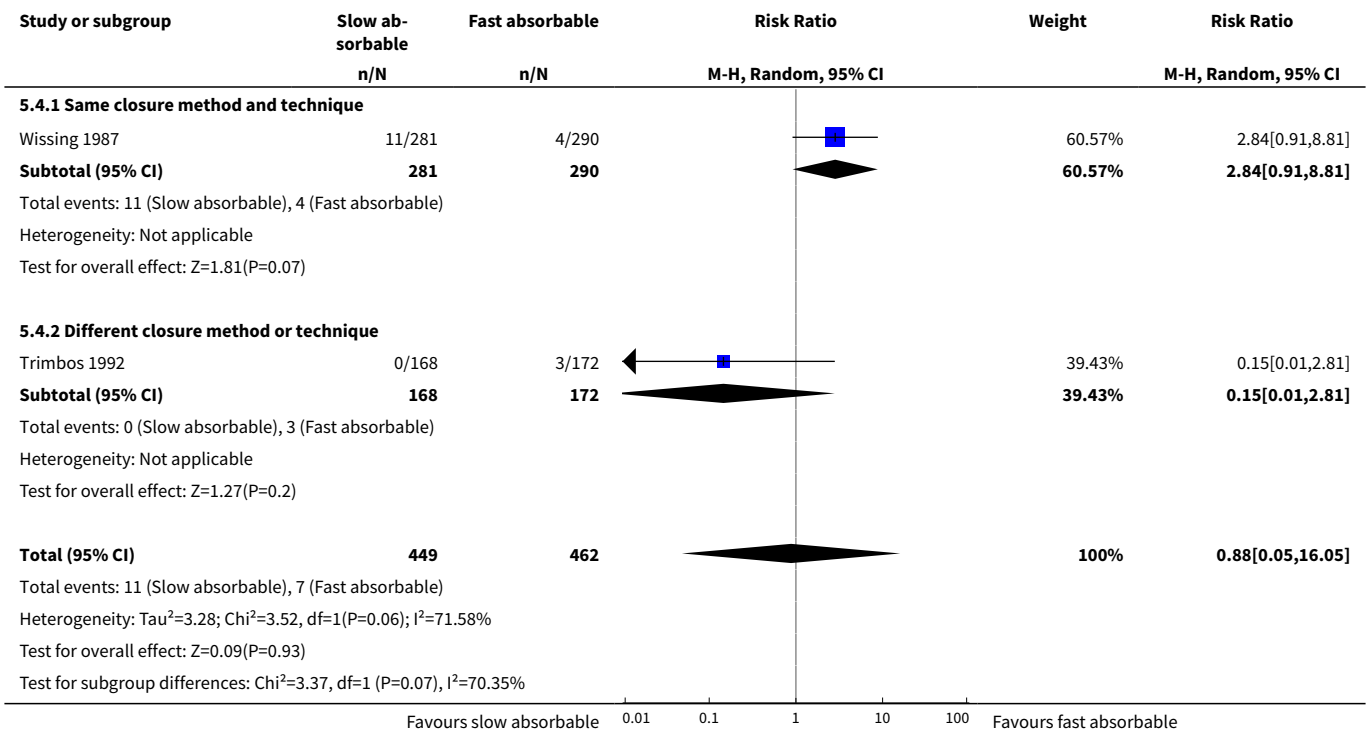




Analysis 5.3. Comparison 5 Slow absorbable versus fast absorbable sutures (any technique), Outcome 3 Wound dehiscence.



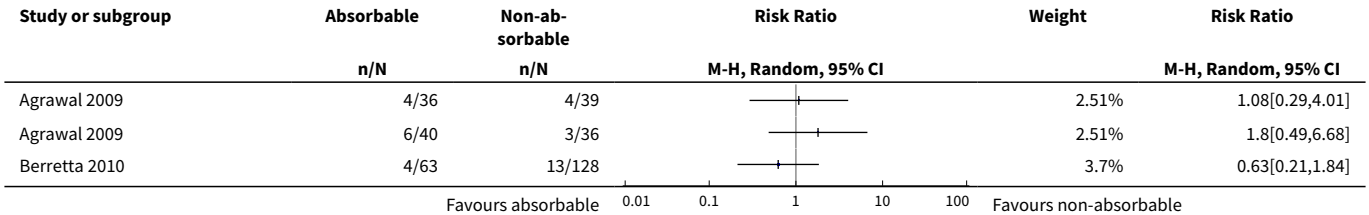
Analysis 5.4. Comparison 5 Slow absorbable versus fast absorbable sutures (any technique), Outcome 4 Sinus or fistula formation.

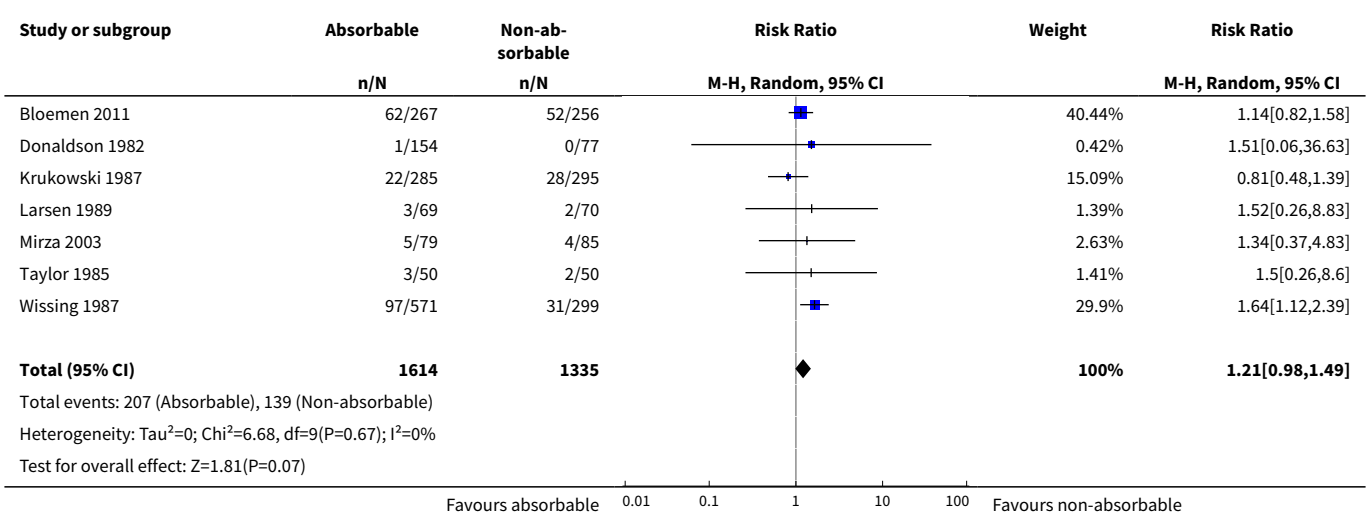


Comparison 6. Sensitivity analysis: excluding high-risk studies

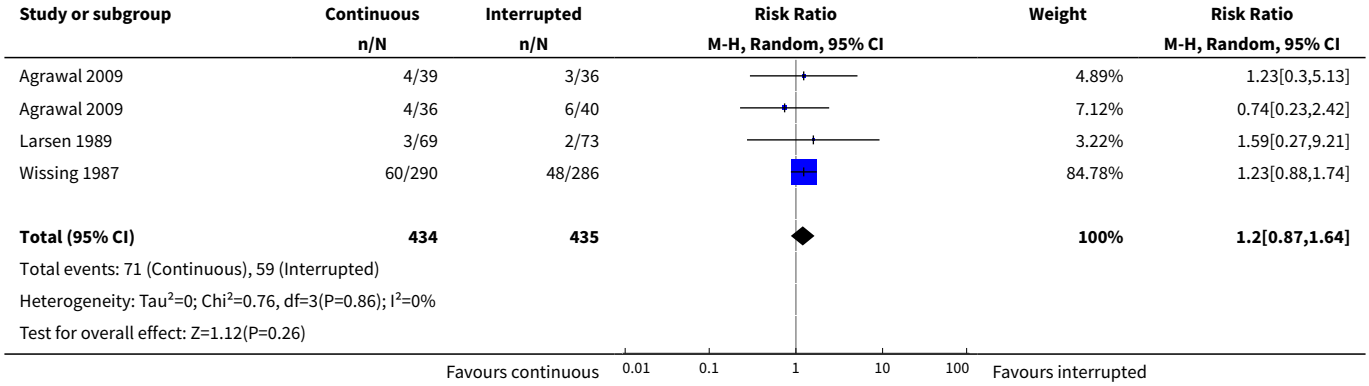
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Incisional hernia (absorbable versus non-absorbable suture, same technique)	9	2949	Risk Ratio (M-H, Random, 95% CI)	1.21 [0.98, 1.49]
2 Incisional hernia (continuous versus interrupted, same material and method)	3	869	Risk Ratio (M-H, Random, 95% CI)	1.20 [0.87, 1.64]
3 Incisional hernia (monofilament versus multifilament, same technique)	4	1336	Risk Ratio (M-H, Random, 95% CI)	0.65 [0.42, 1.01]

Analysis 6.1. Comparison 6 Sensitivity analysis: excluding high-risk studies, Outcome 1 Incisional hernia (absorbable versus non-absorbable suture, same technique).

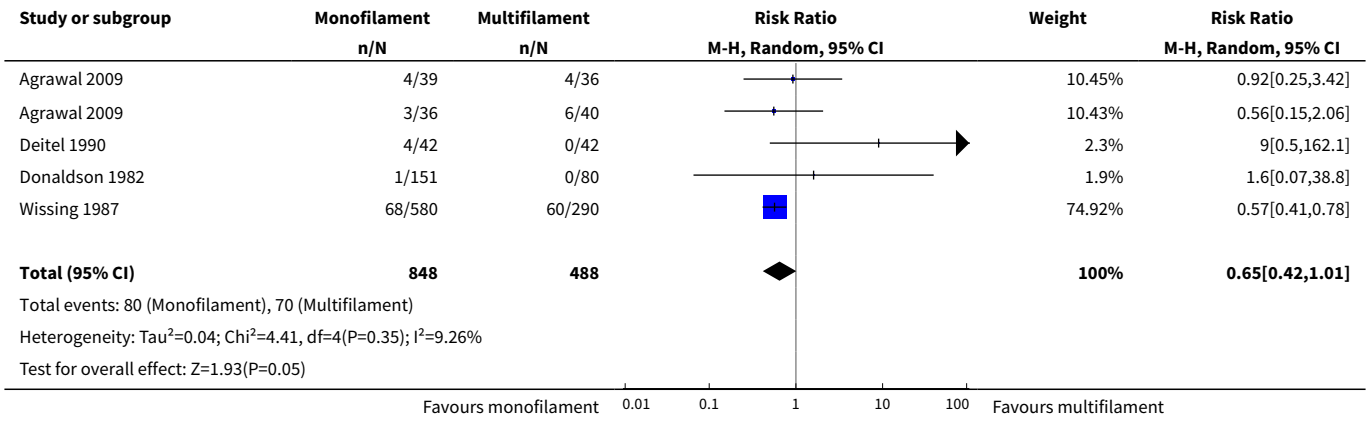




Analysis 6.2. Comparison 6 Sensitivity analysis: excluding high-risk studies, Outcome 2 Incisional hernia (continuous versus interrupted, same material and method).



Analysis 6.3. Comparison 6 Sensitivity analysis: excluding high-risk studies, Outcome 3 Incisional hernia (monofilament versus multifilament, same technique).

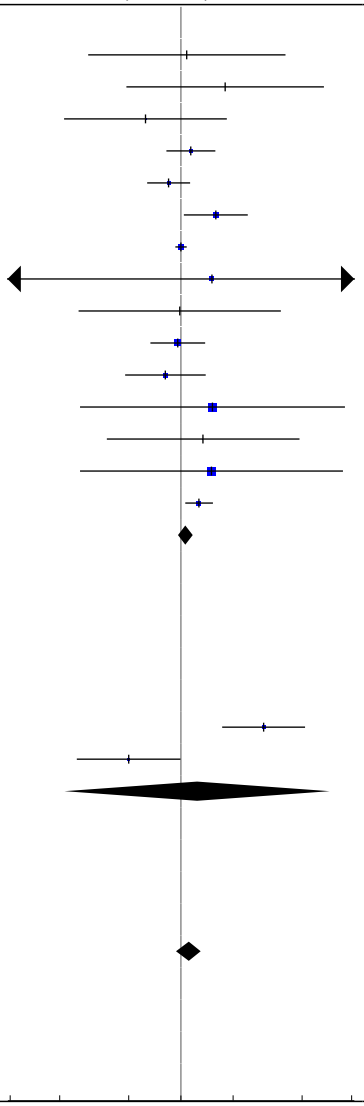


Comparison 7. Sensitivity analysis: inclusion of missing data, assuming loss to follow-up developed incisional hernia

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Absorbable versus non-absorbable (hernia)	16	5610	Risk Ratio (M-H, Random, 95% CI)	1.11 [0.94, 1.30]
1.1 Same closure technique and method in each group	14	5257	Risk Ratio (M-H, Random, 95% CI)	1.06 [0.96, 1.17]
1.2 Different closure technique or method in each group	2	353	Risk Ratio (M-H, Random, 95% CI)	1.24 [0.21, 7.21]
2 Mass versus layered closure (hernia)	5	1220	Risk Ratio (M-H, Random, 95% CI)	1.82 [0.81, 4.10]
2.1 Same closure technique and suture material in each group	1	206	Risk Ratio (M-H, Random, 95% CI)	3.86 [1.34, 11.07]
2.2 Different closure technique or suture material in each group	4	1014	Risk Ratio (M-H, Random, 95% CI)	1.40 [0.50, 3.94]
3 Continuous versus interrupted	11	4046	Risk Ratio (M-H, Random, 95% CI)	0.89 [0.61, 1.30]
3.1 Same closure method and suture material in each group	4	1363	Risk Ratio (M-H, Random, 95% CI)	1.13 [0.94, 1.35]
3.2 Different closure method or suture material in each group	7	2683	Risk Ratio (M-H, Random, 95% CI)	0.81 [0.45, 1.44]
4 Monofilament versus multifilament (hernia)	16	4981	Risk Ratio (M-H, Random, 95% CI)	0.77 [0.63, 0.95]
4.1 Same closure technique and method	10	2982	Risk Ratio (M-H, Random, 95% CI)	0.87 [0.72, 1.05]
4.2 Different closure technique or method	6	1999	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.42, 0.98]
5 Slow absorbable versus fast absorbable (hernia)	9	3877	Risk Ratio (M-H, Random, 95% CI)	0.89 [0.74, 1.07]
5.1 Same closure method and technique	5	1863	Risk Ratio (M-H, Random, 95% CI)	0.95 [0.77, 1.17]
5.2 Different closure method or technique	4	2014	Risk Ratio (M-H, Random, 95% CI)	0.79 [0.56, 1.12]

Analysis 7.1. Comparison 7 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up developed incisional hernia, Outcome 1 Absorbable versus non-absorbable (hernia).

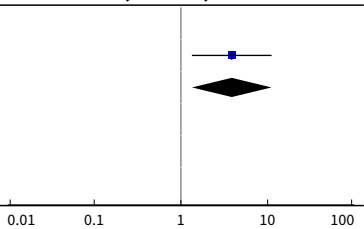
Study or subgroup	Absorbable n/N	Non Absorbable n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
7.1.1 Same closure technique and method in each group					
Agrawal 2009	4/36	4/39		1.47%	1.08[0.29,4.01]
Agrawal 2009	6/40	3/36		1.47%	1.8[0.49,6.68]
Berretta 2010	4/63	13/128		2.09%	0.63[0.21,1.84]
Bloemen 2011	62/267	52/256		10.71%	1.14[0.82,1.58]
Cameron 1987	53/143	62/142		11.92%	0.85[0.64,1.13]
Carlson 1995	40/113	25/112		8.29%	1.59[1.04,2.43]
Docobo-Durantez 2006	354/451	250/319		17.67%	1[0.93,1.08]
Donaldson 1982	1/154	0/77		0.27%	1.51[0.06,36.63]
Gys 1989	4/65	4/64		1.4%	0.98[0.26,3.77]
Israelsson 1994	49/325	50/318		9.76%	0.96[0.67,1.38]
Krukowski 1987	22/285	28/295		6.3%	0.81[0.48,1.39]
Larsen 1989	3/69	2/70		0.85%	1.52[0.26,8.83]
Mirza 2003	5/79	4/85		1.54%	1.34[0.37,4.83]
Taylor 1985	3/50	2/50		0.86%	1.5[0.26,8.6]
Wissing 1987	275/749	109/377		14.95%	1.27[1.06,1.53]
Subtotal (95% CI)	**2889**	**2368**		**89.54%**	**1.06[0.96,1.17]**
Total events: 885 (Absorbable), 608 (Non Absorbable)					
Heterogeneity: Tau^2=0; Chi^2=15.75, df=14(P=0.33); I^2=11.08%					
Test for overall effect: Z=1.17(P=0.24)					
7.1.2 Different closure technique or method in each group					
Askew 1983	36/62	12/62		6.06%	3[1.73,5.2]
Brolin 1996	11/120	20/109		4.4%	0.5[0.25,0.99]
Subtotal (95% CI)	**182**	**171**		**10.46%**	**1.24[0.21,7.21]**
Total events: 47 (Absorbable), 32 (Non Absorbable)					
Heterogeneity: Tau^2=1.51; Chi^2=15.95, df=1(P<0.0001); I^2=93.73%					
Test for overall effect: Z=0.24(P=0.81)					
Total (95% CI)	**3071**	**2539**		**100%**	**1.11[0.94,1.3]**
Total events: 932 (Absorbable), 640 (Non Absorbable)					
Heterogeneity: Tau^2=0.04; Chi^2=34.86, df=16(P=0); I^2=54.11%					
Test for overall effect: Z=1.19(P=0.23)					
Test for subgroup differences: Chi^2=0.03, df=1 (P=0.86), I^2=0%					



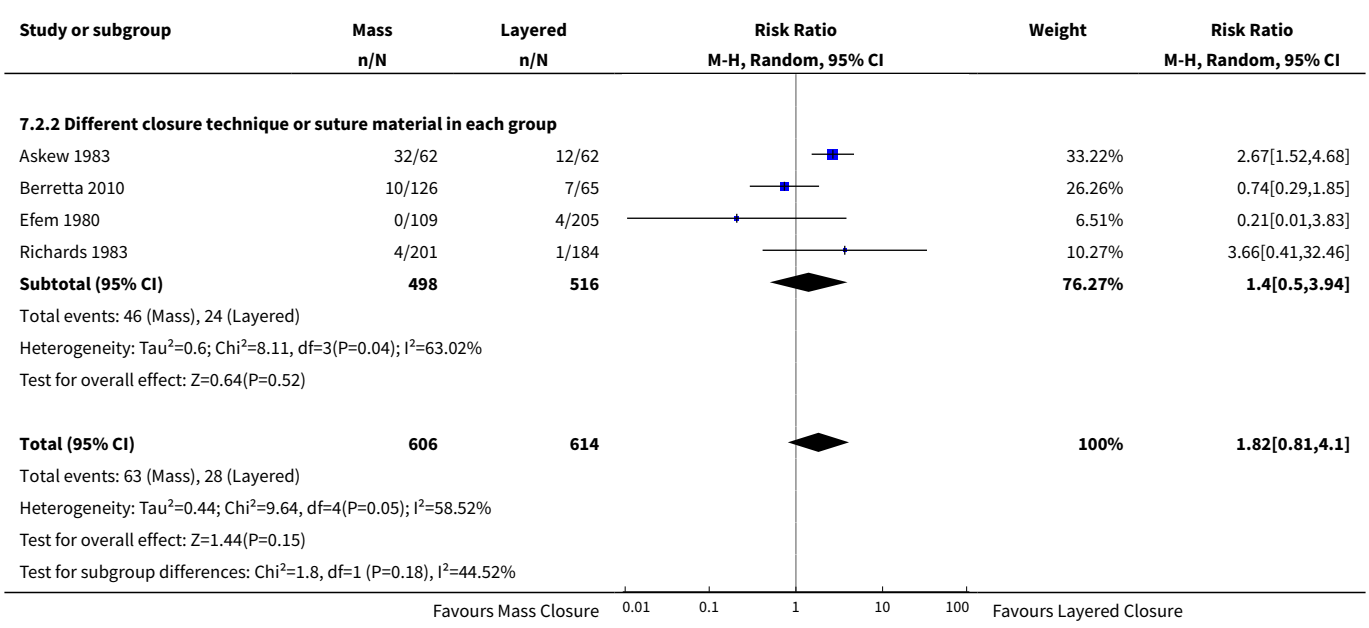
Favours Absorbable — Favours Non Absorbable

Analysis 7.2. Comparison 7 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up developed incisional hernia, Outcome 2 Mass versus layered closure (hernia).

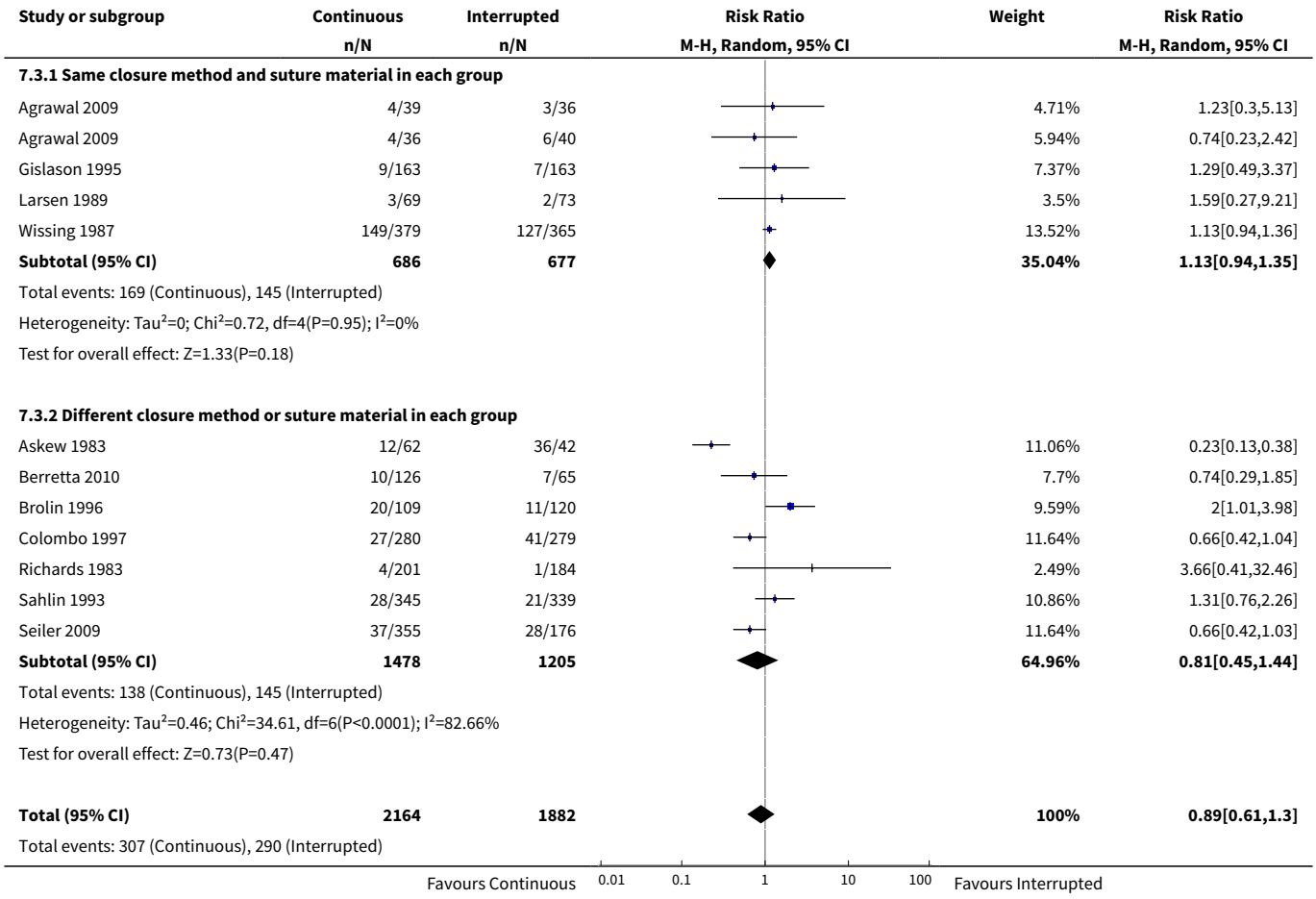
Study or subgroup	Mass n/N	Layered n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
7.2.1 Same closure technique and suture material in each group					
Ausobsky 1985	17/108	4/98		23.73%	3.86[1.34,11.07]
Subtotal (95% CI)	**108**	**98**		**23.73%**	**3.86[1.34,11.07]**
Total events: 17 (Mass), 4 (Layered)					
Heterogeneity: Not applicable					
Test for overall effect: Z=2.51(P=0.01)					



Favours Mass Closure — Favours Layered Closure



Analysis 7.3. Comparison 7 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up developed incisional hernia, Outcome 3 Continuous versus interrupted.



Study or subgroup	Continuous n/N	Interrupted n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Heterogeneity: Tau²=0.27; Chi²=45.91, df=11(P<0.0001); I²=76.04%					
Test for overall effect: Z=0.59(P=0.55)					
Test for subgroup differences: Chi²=1.18, df=1 (P=0.28), I²=15.25%					

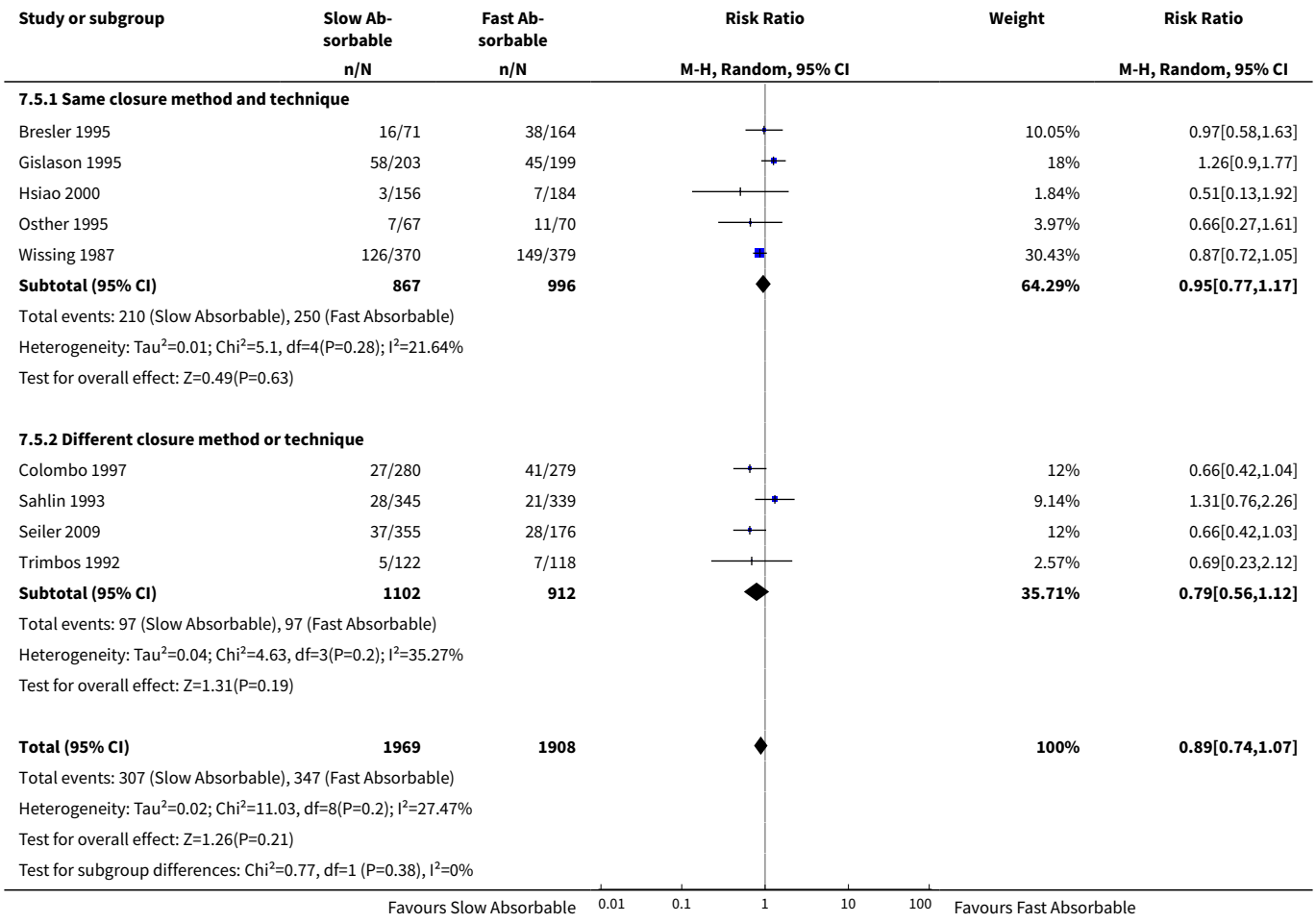
Favours Continuous 0.01 0.1 1 10 100 Favours Interrupted

Analysis 7.4. Comparison 7 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up developed incisional hernia, Outcome 4 Monofilament versus multifilament (hernia).

Study or subgroup	Monofilament n/N	Multifilament n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
7.4.1 Same closure technique and method					
Agrawal 2009	4/39	4/36		2.19%	0.92[0.25,3.42]
Agrawal 2009	3/36	6/40		2.19%	0.56[0.15,2.06]
Bresler 1995	38/164	16/71		8.65%	1.03[0.62,1.72]
Carlson 1995	26/113	39/112		10.48%	0.66[0.43,1.01]
Deitel 1990	4/42	0/42		0.5%	9[0.5,162.1]
Donaldson 1982	1/151	0/80		0.41%	1.6[0.07,38.8]
Gislason 1995	58/203	45/199		12.46%	1.26[0.9,1.77]
Hsiao 2000	3/156	7/184		2.12%	0.51[0.13,1.92]
Ohira 2015	2/27	3/24		1.36%	0.59[0.11,3.25]
Osther 1995	7/67	11/70		4.2%	0.66[0.27,1.61]
Wissing 1987	235/747	149/379		16.69%	0.8[0.68,0.94]
Subtotal (95% CI)	**1745**	**1237**		**61.24%**	**0.87[0.72,1.05]**
Total events: 381 (Monofilament), 280 (Multifilament)					
Heterogeneity: Tau²=0.02; Chi²=11.96, df=10(P=0.29); I²=16.4%					
Test for overall effect: Z=1.48(P=0.14)					
7.4.2 Different closure technique or method					
Askew 1983	12/62	36/62		8.01%	0.33[0.19,0.58]
Berretta 2010	10/126	7/65		3.97%	0.74[0.29,1.85]
Brolin 1996	11/120	20/109		6.06%	0.5[0.25,0.99]
Sahlin 1993	28/345	21/339		8.09%	1.31[0.76,2.26]
Seiler 2009	37/355	28/176		9.75%	0.66[0.42,1.03]
Trimbos 1992	5/122	7/118		2.87%	0.69[0.23,2.12]
Subtotal (95% CI)	**1130**	**869**		**38.76%**	**0.64[0.42,0.98]**
Total events: 103 (Monofilament), 119 (Multifilament)					
Heterogeneity: Tau²=0.16; Chi²=12.66, df=5(P=0.03); I²=60.5%					
Test for overall effect: Z=2.04(P=0.04)					
Total (95% CI)	**2875**	**2106**		**100%**	**0.77[0.63,0.95]**
Total events: 484 (Monofilament), 399 (Multifilament)					
Heterogeneity: Tau²=0.06; Chi²=28.23, df=16(P=0.03); I²=43.32%					
Test for overall effect: Z=2.49(P=0.01)					
Test for subgroup differences: Chi²=1.61, df=1 (P=0.2), I²=37.75%					

Favours Monofilament 0.01 0.1 1 10 100 Favours Multifilament

Analysis 7.5. Comparison 7 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up developed incisional hernia, Outcome 5 Slow absorbable versus fast absorbable (hernia).



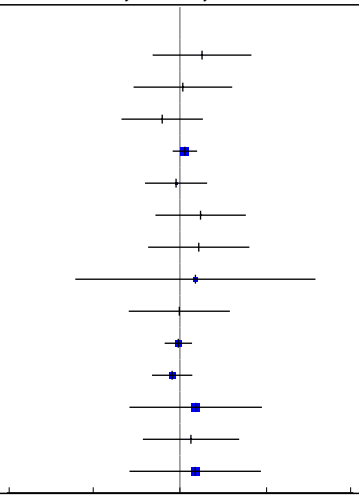
Comparison 8. Sensitivity analysis: inclusion of missing data, assuming loss to follow-up did not have developed incisional hernia

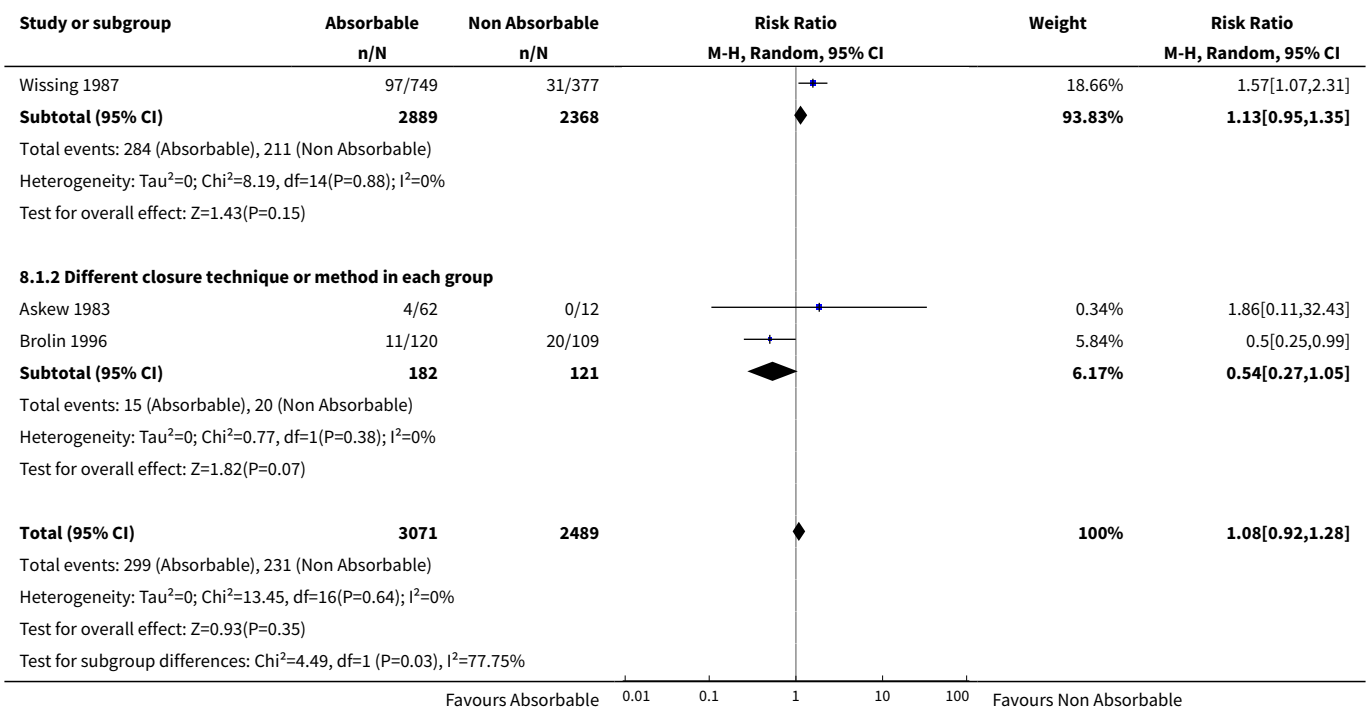
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Absorbable versus non-absorbable (hernia)	16	5560	Risk Ratio (M-H, Random, 95% CI)	1.08 [0.92, 1.28]
1.1 Same closure technique and method in each group	14	5257	Risk Ratio (M-H, Random, 95% CI)	1.13 [0.95, 1.35]
1.2 Different closure technique or method in each group	2	303	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.27, 1.05]
2 Mass versus layered closure (hernia)	5	1220	Risk Ratio (M-H, Random, 95% CI)	1.80 [0.57, 5.62]
2.1 Same closure technique and suture material in each group	1	206	Risk Ratio (M-H, Random, 95% CI)	3.86 [1.34, 11.07]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.2 Different closure technique or suture material in each group	4	1014	Risk Ratio (M-H, Random, 95% CI)	1.29 [0.34, 4.92]
3 Continuous versus interrupted	11	4046	Risk Ratio (M-H, Random, 95% CI)	1.01 [0.76, 1.34]
3.1 Same closure method and suture material in each group	4	1363	Risk Ratio (M-H, Random, 95% CI)	1.18 [0.87, 1.61]
3.2 Different closure method or suture material in each group	7	2683	Risk Ratio (M-H, Random, 95% CI)	0.94 [0.60, 1.48]
4 Monofilament versus multifilament (hernia)	16	4981	Risk Ratio (M-H, Random, 95% CI)	0.76 [0.60, 0.97]
4.1 Same closure technique and method	10	2982	Risk Ratio (M-H, Random, 95% CI)	0.80 [0.56, 1.14]
4.2 Different closure technique or method	6	1999	Risk Ratio (M-H, Random, 95% CI)	0.74 [0.50, 1.08]
5 Slow absorbable versus fast absorbable (hernia)	9	3877	Risk Ratio (M-H, Random, 95% CI)	0.82 [0.62, 1.08]
5.1 Same closure method and technique	5	1863	Risk Ratio (M-H, Random, 95% CI)	0.88 [0.53, 1.45]
5.2 Different closure method or technique	4	2014	Risk Ratio (M-H, Random, 95% CI)	0.79 [0.56, 1.12]

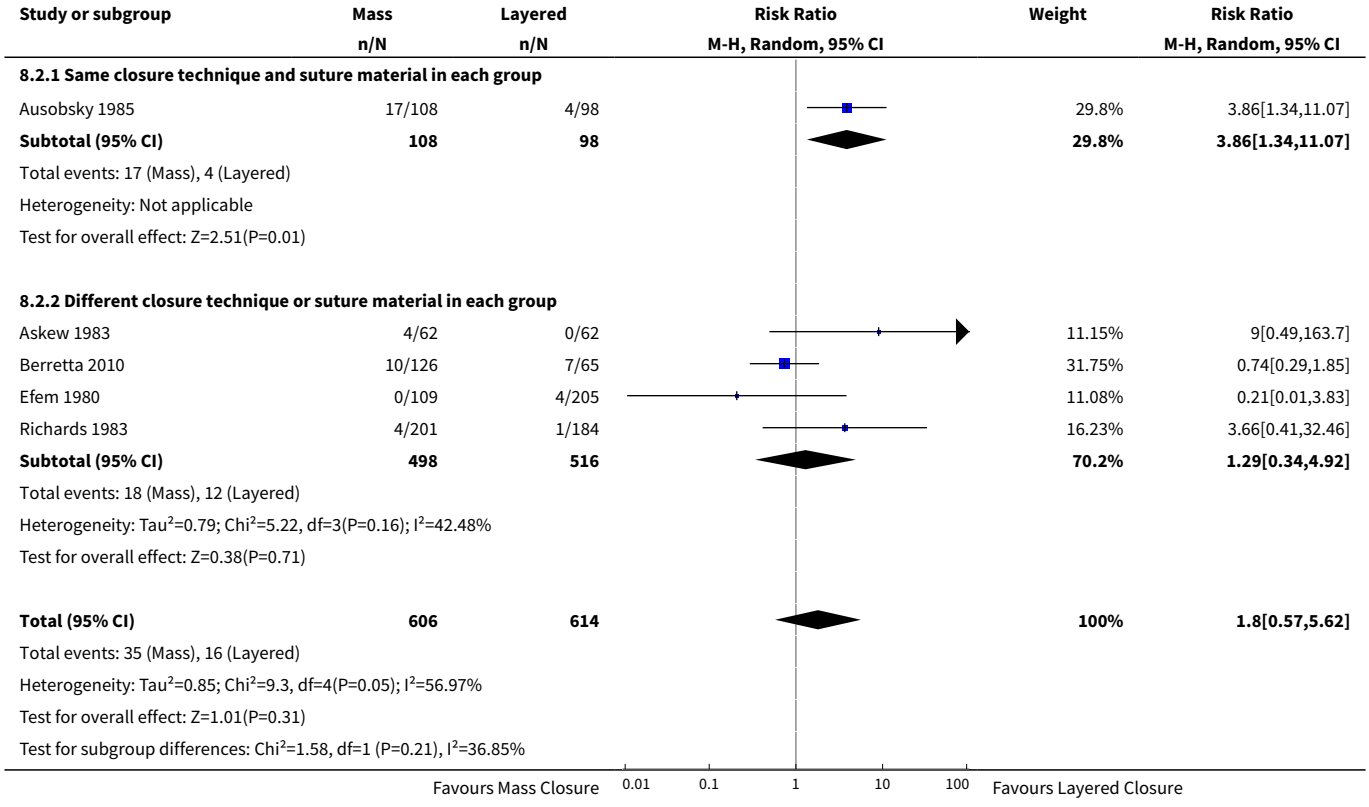
Analysis 8.1. Comparison 8 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up did not have developed incisional hernia, Outcome 1 Absorbable versus non-absorbable (hernia).

Study or subgroup	Absorbable n/N	Non Absorbable n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
8.1.1 Same closure technique and method in each group					
Agrawal 2009	6/40	3/36		1.61%	1.8[0.49,6.68]
Agrawal 2009	4/36	4/39		1.61%	1.08[0.29,4.01]
Berretta 2010	4/63	13/128		2.37%	0.63[0.21,1.84]
Bloemen 2011	62/267	52/256		25.99%	1.14[0.82,1.58]
Cameron 1987	10/143	11/142		4.07%	0.9[0.4,2.06]
Carlson 1995	7/113	4/112		1.92%	1.73[0.52,5.76]
Docobo-Durantez 2006	7/451	3/319		1.53%	1.65[0.43,6.33]
Donaldson 1982	1/154	0/77		0.27%	1.51[0.06,36.63]
Gys 1989	4/65	4/64		1.54%	0.98[0.26,3.77]
Israelsson 1994	49/325	50/318		21.06%	0.96[0.67,1.38]
Krukowski 1987	22/285	28/295		9.69%	0.81[0.48,1.39]
Larsen 1989	3/69	2/70		0.89%	1.52[0.26,8.83]
Mirza 2003	5/79	4/85		1.69%	1.34[0.37,4.83]
Taylor 1985	3/50	2/50		0.91%	1.5[0.26,8.6]



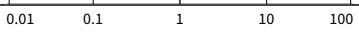


Analysis 8.2. Comparison 8 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up did not have developed incisional hernia, Outcome 2 Mass versus layered closure (hernia).



Analysis 8.3. Comparison 8 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up did not have developed incisional hernia, Outcome 3 Continuous versus interrupted.

Study or subgroup	Continuous n/N	Interrupted n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
8.3.1 Same closure method and suture material in each group					
Agrawal 2009	4/39	3/36		3.48%	1.23[0.3,5.13]
Agrawal 2009	4/36	6/40		4.77%	0.74[0.23,2.42]
Gislason 1995	9/163	7/163		6.56%	1.29[0.49,3.37]
Larsen 1989	3/69	2/73		2.4%	1.59[0.27,9.21]
Wissing 1987	60/379	48/365		18.52%	1.2[0.85,1.71]
Subtotal (95% CI)	**686**	**677**		**35.73%**	**1.18[0.87,1.61]**
Total events: 80 (Continuous), 66 (Interrupted)					
Heterogeneity: Tau^2=0; Chi^2=0.75, df=4(P=0.94); I^2=0%					
Test for overall effect: Z=1.08(P=0.28)					
8.3.2 Different closure method or suture material in each group					
Askew 1983	0/62	4/42		0.94%	0.08[0,1.37]
Berretta 2010	10/126	7/65		7.04%	0.74[0.29,1.85]
Brolin 1996	20/109	11/120		10.33%	2[1.01,3.98]
Colombo 1997	27/280	41/279		15.53%	0.66[0.42,1.04]
Richards 1983	4/201	1/184		1.61%	3.66[0.41,32.46]
Sahlin 1993	28/345	21/339		13.28%	1.31[0.76,2.26]
Seiler 2009	37/355	28/176		15.54%	0.66[0.42,1.03]
Subtotal (95% CI)	**1478**	**1205**		**64.27%**	**0.94[0.6,1.48]**
Total events: 126 (Continuous), 113 (Interrupted)					
Heterogeneity: Tau^2=0.19; Chi^2=15.24, df=6(P=0.02); I^2=60.64%					
Test for overall effect: Z=0.27(P=0.79)					
Total (95% CI)	**2164**	**1882**		**100%**	**1.01[0.76,1.34]**
Total events: 206 (Continuous), 179 (Interrupted)					
Heterogeneity: Tau^2=0.08; Chi^2=18.16, df=11(P=0.08); I^2=39.43%					
Test for overall effect: Z=0.04(P=0.96)					
Test for subgroup differences: Chi^2=0.69, df=1 (P=0.41), I^2=0%					

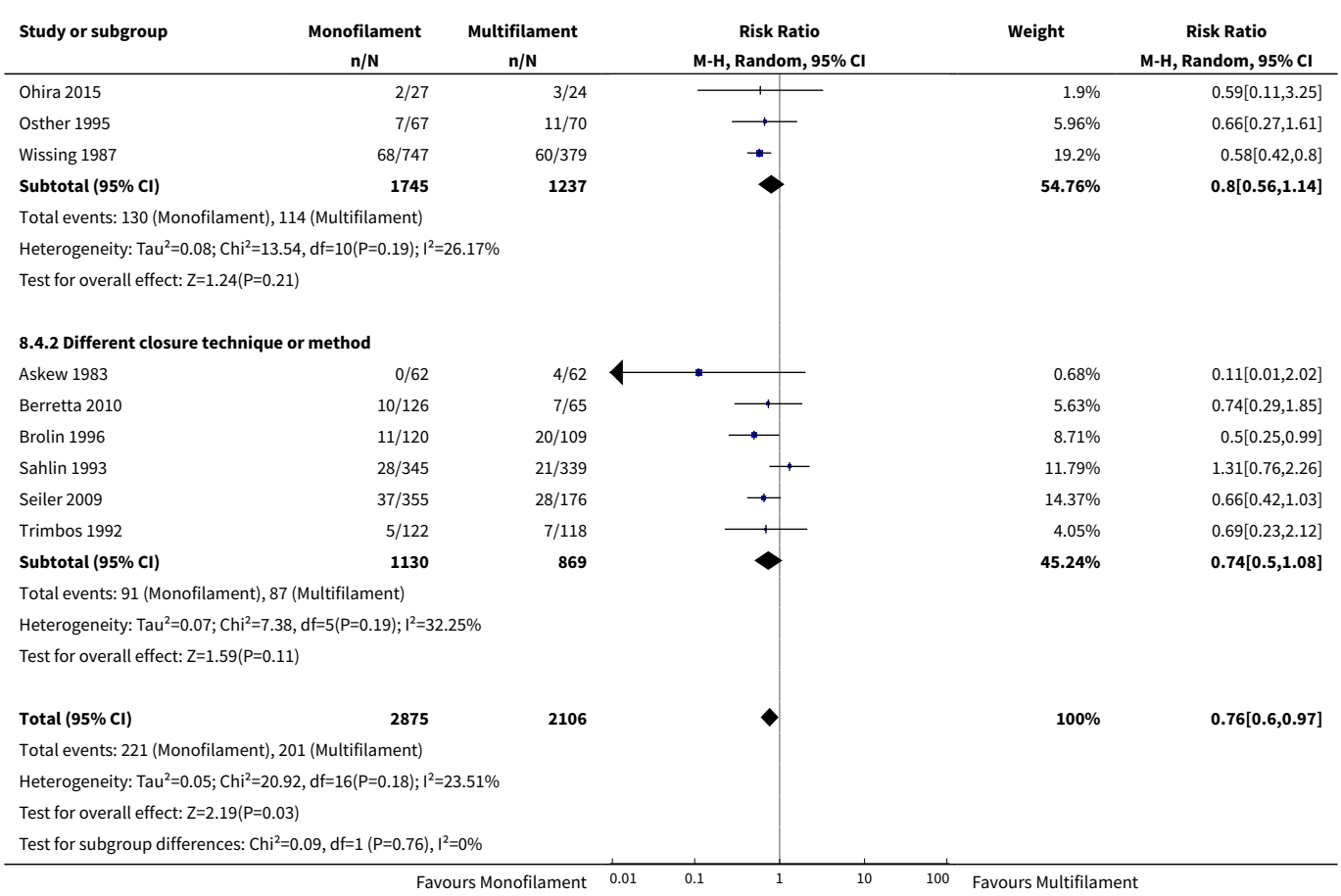


Favours Continuous — Favours Experimental

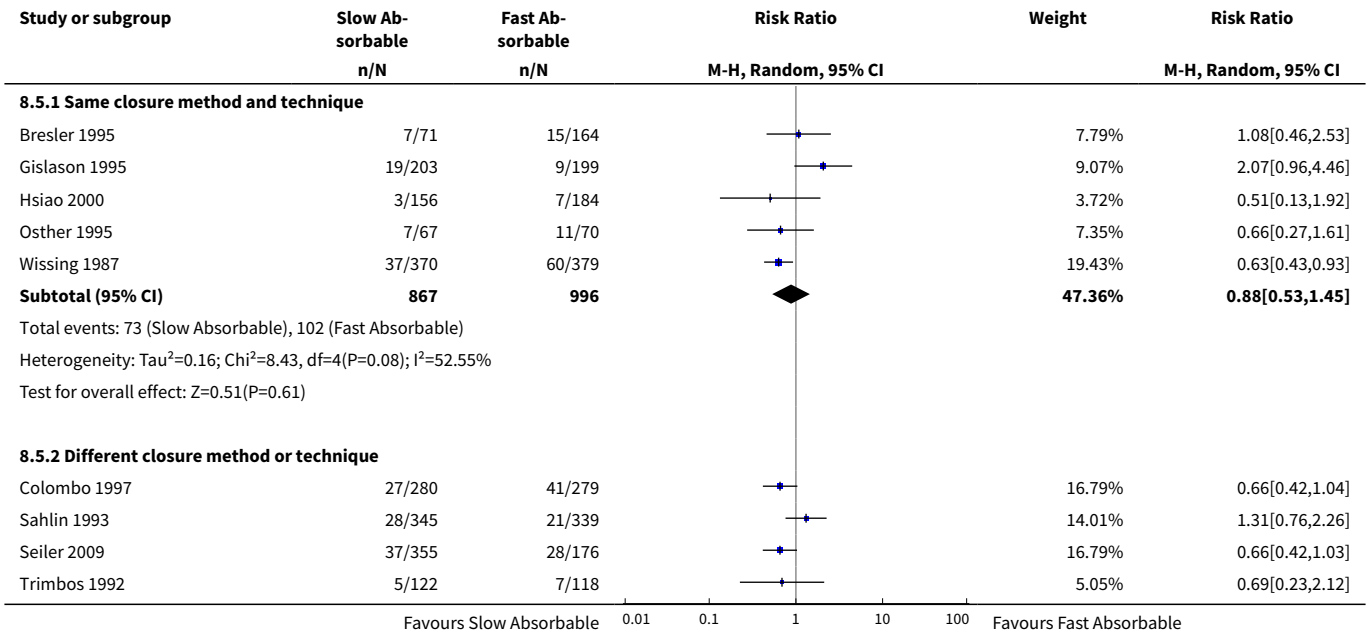
Analysis 8.4. Comparison 8 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up did not have developed incisional hernia, Outcome 4 Monofilament versus multifilament (hernia).

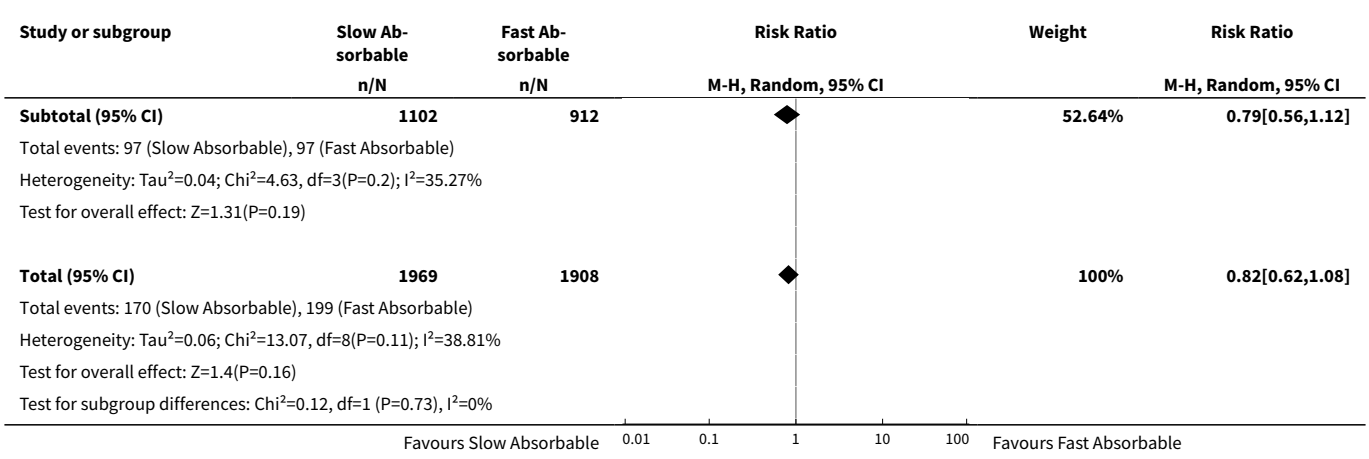
Study or subgroup	Monofilament n/N	Multifilament n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
8.4.1 Same closure technique and method					
Agrawal 2009	4/39	4/36		3.07%	0.92[0.25,3.42]
Agrawal 2009	3/36	6/40		3.07%	0.56[0.15,2.06]
Bresler 1995	15/164	7/71		6.34%	0.93[0.4,2.18]
Carlson 1995	4/113	7/112		3.58%	0.57[0.17,1.88]
Deitel 1990	4/42	0/42		0.69%	9[0.5,162.1]
Donaldson 1982	1/151	0/80		0.57%	1.6[0.07,38.8]
Gislason 1995	19/203	9/199		7.43%	2.07[0.96,4.46]
Hsiao 2000	3/156	7/184		2.96%	0.51[0.13,1.92]

Favours Monofilament — Favours Multifilament



Analysis 8.5. Comparison 8 Sensitivity analysis: inclusion of missing data, assuming loss to follow-up did not have developed incisional hernia, Outcome 5 Slow absorbable versus fast absorbable (hernia).





ADDITIONAL TABLES

Table 1. Factors associated with incisional hernia

In surgeon's control	Other factors
Type of incision • Midline • Paramedian • Pfannenstiel • Maylard, etc	**Postoperative inflammatory response to sutures, which may be suture-specific**. For example, studies have shown that synthetic absorbable materials tend to induce lower levels of inflammation compared to catgut (Nilsson 1983; Postlethwait 1975)
Incision technique • 2 scalpel (1 for skin and 1 for deeper tissue) versus single scalpel • Single stroked versus multiple stroked incision • Scalpel versus cautery using cutting current versus cautery using coagulation current versus carbon dioxide laser	**Associated co-morbid conditions** • Advanced age of the patient • Nutritional status of the patient • Severe obesity • Diabetes • Malignancy • Jaundice • Abdominal distension • Chronic steroid therapy • Wound infections in the primary laparotomy • Smoking • Chronic obstructive pulmonary disease
Preoperative surgical preparation of incision site and pre-operative antibiotics	**Nature of wound** • Clean • Clean-contaminated • Contaminated
Use of subcutaneous drains	**Neoadjuvant therapies** • Chemotherapy • Radiation • Immunotherapy

Table 1. Factors associated with incisional hernia *(Continued)*

Suture material • Absorbable versus non-absorbable suture material • Monofilament versus multifilament suture material
Suture technique • Mass versus layered closure • Continuous versus interrupted sutures • Suture length: wound length ratio

Table 2. Sutures assessed

Suture material	Trade name(s)	Absorbability	Monofilament or multifilament
Catgut chromic	Catgut chromic	Fast absorbable	Monofilament
Polyamide (nylon)	Ethilon (monofilament), Nurolon (multifilament)	Non-absorbable	Both
Polydioxanone	PDS	Slow absorbable	Monofilament
Polyester	Ethibond	Non-absorbable	Multifilament
Polyglactin-910	Vicryl	Fast absorbable	Multifilament
Polyglycolic acid	PGA, Dexon	Fast absorbable	Available in both
Polyglyconate	Maxon	Slow absorbable	Monofilament
Polypropylene	Prolene, Premilene	Non-absorbable	Monofilament
Silk	Silk	Non-absorbable	Multifilament
Steel	Steel	Non-absorbable	Monofilament

Table 3. Findings from previous analyses for incisional hernia

	Absorbable versus non-absorbable	Mass versus layered	Continuous versus interrupted closure	Slow versus fast absorbable
Hodgson 2000	Favours non-absorbable sutures (13 trials)	N/A	Favours continuous closure (6 trials)	N/A
Rucinski 2001	Favours non-absorbable sutures over braided absorbable (unclear number of trials)	N/A	N/A	N/A
Sajid 2011	No difference (8 trials)	N/A	N/A	N/A

Table 3. Findings from previous analyses for incisional hernia *(Continued)*

Van't Riet 2002	No difference between slow absorbable and non-absorbable sutures (5 trials)	N/A	No difference (7 trials)	Favours slow absorbable sutures (1 trial)
Weiland 1998	Favours non-absorbable sutures (7 studies)	Favours layered closure (9 studies)	Favours continuous closure (8 trials)	N/A

APPENDICES

Appendix 1. CENTRAL search strategy

#1 (sutur* near (continuous* or interrupt* or length))

#2 (closur* near (mass or layer*))

#3 (#1 OR #2)

#4 (sutur*)

#5 MeSH descriptor Sutures explode all trees

#6 (silk)

#7 MeSH descriptor Silk explode all trees

#8 (capromed dc)

#9 (stapling or staples)

#10 MeSH descriptor Surgical Staplers explode all trees

#11 (polydioxanone)

#12 MeSH descriptor Polydioxanone explode all trees

#13 (pds)

#14 (polypropylene*)

#15 MeSH descriptor Polypropylenes explode all trees

#16 (prolene*)

#17 MeSH descriptor Polyglactin 910 explode all trees

#18 (polyglactin 910)

#19 (ethilon)

#21 MeSH descriptor Nylons explode all trees

#22 (catgut)

#23 MeSH descriptor Catgut explode all trees

#24 (steel)

#25 MeSH descriptor Steel explode all trees

#26 (vicryl)

#27 (polyglycolic acid)

#28 MeSH descriptor Polyglycolic Acid explode all trees

#29 (maxon)

#30 (mersilene*)

#31 (#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30)

#32 (#3 OR #31)

#33 (laparotomy)

#34 MeSH descriptor Laparotomy explode all trees

#35 (hysterectomy)

#36 MeSH descriptor Hysterectomy explode all trees

#37 (abdom*)

#38 MeSH descriptor Abdomen explode all trees

#39 (#37 OR #38)

#40 (injury)

#41 MeSH descriptor Abdominal Injuries explode all trees

#42 (wall)

#43 MeSH descriptor Abdominal Wall explode all trees

#44 (hernia)

#45 MeSH descriptor Hernia, Abdominal explode all trees

#46 (surger*)

#47 (closure*)

#48 (fascia*)

#49 MeSH descriptor Fascia explode all trees

#50 (wound)

#51 (#40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50)

#52 (#39 AND #51)

#53 (#33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #52)

#54 (#32 AND #53)

#55 (rat* or rabbit* or rect* or anal* or laparoscop*):ti

#56 (#54 NOT #55)

Appendix 2. MEDLINE (Ovid) search strategy

1. (sutur* adj3 (continuous* or interrupt* or length)).mp.

2. (closur* adj3 (mass or layer*)).mp.

3. 1 or 2

4. (sutur* or silk or capromed or stapling or staples or polydioxanone* or pds or polypropylene* or prolene* or polyglactin 910 or polyglactin or ethilon or nylon* or catgut or steel or vicryl or polyglycolic acid or maxon or mersilene*).mp.

5. exp Sutures/

6. exp Silk/

7. exp Surgical Staplers/

8. exp Polydioxanone/

9. exp Polypropylenes/

10. exp Polyglactin 910/

11. exp Nylons/

12. exp Catgut/

13. exp Steel/

14. exp Polyglycolic Acid/

15. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14

16. 3 or 15

17. (laparotom* or hysterectom*).mp.

18. exp Laparotomy/

19. exp Hysterectomy/

20. (abdom* adj3 (injury or wall or defect or hernia or surger* or closure* or fascia* or wound)).mp.

21. exp Abdomen/

22. exp Abdominal Injuries/

23. Abdominal Wall/

24. exp Hernia, Abdominal/

25. exp Fascia/

26. 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25

27. 16 and 26

28. randomized controlled trial.pt.

29. controlled clinical trial.pt.

30. randomized.ab.

31. placebo.ab.

32. clinical trials as topic.sh.

33. randomly.ab.

34. trial.ti.

35. 28 or 29 or 30 or 31 or 32 or 33 or 34

36. exp animals/ not humans.sh.

37. 35 not 36

38. 27 and 37

39. (rat* or rabbit* or rect* or anal* or laparoscop*).m_titl.

40. 38 not 39

Appendix 3. Embase (Ovid) search strategy

1. (sutur* adj3 (continuous* or interrupt* or length)).mp.

2. (closur* adj3 (mass or layer*)).mp.

3. 1 or 2

4. (sutur* or silk or capromed or stapling or staples or polydioxanone* or pds or polypropylene* or prolene* or polyglactin 910 or polyglactin or ethilon or nylon* or catgut or steel or vicryl or polyglycolic acid or maxon or mersilene*).mp.

5. exp suture/

6. exp SILK/

7. exp stapler/

8. exp POLYDIOXANONE/

9. exp polypropylene/

10. exp polyglactin/

11. exp nylon/

12. exp CATGUT/

13. exp STEEL/

14. exp polyglycolic acid/

15. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14

16. 3 or 15

17. (laparotom* or hysterectom*).mp.

18. exp LAPAROTOMY/

19. exp HYSTERECTOMY/ or exp ABDOMINAL HYSTERECTOMY/

20. (abdom* adj3 (injury or wall or defect or hernia or surger* or closure* or fascia* or wound)).mp.

21. exp abdominal injury/su [Surgery]

22. exp abdominal wall/su [Surgery]

23. exp abdominal wall hernia/su [Surgery]

24. exp FASCIA/su [Surgery]

25. 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24

26. 16 and 25

27. CROSSOVER PROCEDURE.sh.

28. DOUBLE-BLIND PROCEDURE.sh.

29. SINGLE-BLIND PROCEDURE.sh.

30. (crossover* or cross over*).ti,ab.

31. placebo*.ti,ab.

32. (doubl* adj blind*).ti,ab.

33. allocat*.ti,ab.

34. trial.ti.

35. RANDOMIZED CONTROLLED TRIAL.sh.

36. random*.ti,ab.

37. 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36

38. (exp animal/ or exp invertebrate/ or animal.hw. or nonhuman/) not (exp human/ or human cell/ or (human or humans or man or men or wom?n).ti.)

39. 37 not 38

40. 26 and 39

41. (rat* or rabbit* or rect* or anal* or laparoscop*).m_titl.

42. 40 not 41

Appendix 4. ClinicalTrials.gov search strategy

Search Term: Suture OR Closure

Outcome = Hernia

Condition: Laparotomy

Appendix 5. WHO ICTRP

Laparotomy AND hernia AND closure

Laparotomy AND hernia AND suture

Appendix 6. Criteria for judging risk of bias in the Cochrane 'Risk of bias' assessment tool

Random sequence generation	
Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence	
Criteria for a judgement of 'low risk' of bias	The investigators describe a random component in the sequence generation process such as: • referring to a random number table; • using a computer random number generator; • coin tossing; • shuffling cards or envelopes; • throwing dice; • drawing of lots; • minimisation[a]. [a]Minimisation may be implemented without a random element, and this is considered to be equivalent to being random.
Criteria for the judgement of 'high risk' of bias	The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach, for example: • ·sequence generated by odd or even date of birth; • sequence generated by some rule based on date (or day) of admission;

(Continued)

	• sequence generated by some rule based on hospital or clinic record number. Other non-random approaches happen much less frequently than the systematic approaches mentioned above and tend to be obvious. They usually involve judgement or some method of non-random categorisation of participants, for example: • allocation by judgement of the clinician; • allocation by preference of the participant; • allocation based on the results of a laboratory test or a series of tests; • allocation by availability of the intervention.
Criteria for the judgement of 'unclear risk' of bias	Insufficient information about the sequence generation process to permit judgement of 'low risk' or 'high risk'

Allocation concealment

Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment

Criteria for a judgement of 'low risk' of bias	Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation: • central allocation (including telephone, web-based and pharmacy-controlled randomisation); • sequentially numbered drug containers of identical appearance; • sequentially numbered, opaque, sealed envelopes.
Criteria for the judgement of 'high risk' of bias	Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on: • using an open random allocation schedule (e.g. a list of random numbers); • ·assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or nonopaque or not sequentially numbered); • alternation or rotation; • date of birth; • case record number; • any other explicitly unconcealed procedure
Criteria for the judgement of 'unclear risk' of bias	Insufficient information to permit judgement of 'low risk' or 'high risk'. This is usually the case if the method of concealment is not described or not described in sufficient detail to allow a definite judgement – for example if the use of assignment envelopes is described, but it remains unclear whether envelopes were sequentially numbered, opaque and sealed.

Blinding of participants and personnel

Performance bias due to knowledge of the allocated interventions by participants and personnel during the study

Criteria for a judgement of 'low risk' of bias	Any one of the following: • no blinding or incomplete blinding, but the review authors judge that the outcome is not likely to be influenced by lack of blinding; • blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken.
Criteria for the judgement of 'high risk' of bias	Any one of the following: • no blinding or incomplete blinding, and the outcome is likely to be influenced by lack of blinding; • blinding of key study participants and personnel attempted, but likely that the blinding could have been broken, and the outcome is likely to be influenced by lack of blinding.

(Continued)

Criteria for the judgement of 'unclear risk' of bias	Any one of the following: • insufficient information to permit judgement of 'low risk' or 'high risk'; • the study did not address this outcome.

Blinding of outcome assessment

Detection bias due to knowledge of the allocated interventions by outcome assessors

Criteria for a judgement of 'low risk' of bias	Any one of the following: • no blinding of outcome assessment, but the review authors judge that the outcome measurement is not likely to be influenced by lack of blinding; • blinding of outcome assessment ensured, and unlikely that the blinding could have been broken.
Criteria for the judgement of 'high risk' of bias	Any one of the following: • no blinding of outcome assessment, and the outcome measurement is likely to be influenced by lack of blinding; • blinding of outcome assessment, but likely that the blinding could have been broken, and the outcome measurement is likely to be influenced by lack of blinding
Criteria for the judgement of 'unclear risk' of bias	Any one of the following: • insufficient information to permit judgement of 'low risk' or 'high risk'; • the study did not address this outcome.

Incomplete outcome data

Attrition bias due to amount, nature or handling of incomplete outcome data

Criteria for a judgement of 'low risk' of bias	Any one of the following: • no missing outcome data; • reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); • missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; • for dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; • for continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; • missing data have been imputed using appropriate methods.
Criteria for the judgement of 'high risk' of bias	Any one of the following: • reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; • for dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; • for continuous outcome data, plausible effect size (difference in means or standardised difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; • 'as-treated' analysis done with substantial departure of the intervention received from that assigned at randomisation; • potentially inappropriate application of simple imputation.

(Continued)

Criteria for the judgement of 'unclear risk' of bias	Any one of the following: • insufficient reporting of attrition/exclusions to permit judgement of 'low risk' or 'high risk' (e.g. number randomised not stated, no reasons for missing data provided); • the study did not address this outcome.

Selective reporting

Reporting bias due to selective outcome reporting

Criteria for a judgement of 'low risk' of bias	Any of the following: • the study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; • the study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).
Criteria for the judgement of 'high risk' of bias	Any one of the following: • not all of the study's pre-specified primary outcomes have been reported; • one or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified; • one or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); • one or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; • the study report fails to include results for a key outcome that would be expected to have been reported for such a study.
Criteria for the judgement of 'unclear risk' of bias	Insufficient information to permit judgement of 'low risk' or 'high risk'. It is likely that the majority of studies will fall into this category.

Other bias

Bias due to problems not covered elsewhere in the table

Criteria for a judgement of 'low risk' of bias	The study appears to be free of other sources of bias.
Criteria for the judgement of 'high risk' of bias	There is at least one important risk of bias. For example, the study: • had a potential source of bias related to the specific study design used; or • has been claimed to have been fraudulent; or • had some other problem.
Criteria for the judgement of 'unclear risk' of bias	There may be a risk of bias, but there is either: • insufficient information to assess whether an important risk of bias exists; or • insufficient rationale or evidence that an identified problem will introduce bias.

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Conceiving the review: RN
Designing the review: RN, SSV, SS
Co-ordinating the review: SSV, SVP, DP
Undertaking manual searches: SSV, SS

Screening search results: SSV, SS, RN, SVP, DP
Organising retrieval of papers: SSV, SVP
Screening retrieved papers against inclusion criteria: SSV, SS, SVP, DP
Appraising quality of papers: SSV, SS, RN, SVP, DP
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Performing previous work that was the foundation of current study: RN
Guarantor for the review: RN

DECLARATIONS OF INTEREST

SVP: none
DP: none
RN: none
SSV: none
SS: none

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External sources

- None, Other.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

1. We analysed hernia outcomes at one year or later follow-up. We did not include this outcome for trials that did not follow up participants for at least one year. If a trial had multiple follow-up periods after one year, we only included the results at one year.
2. Due to the heterogeneous interventions used in the studies, we did not assess suture material and technique as a whole. Instead we compared sutures based on absorption (absorbable versus non-absorbable and fast absorbable versus slow absorbable, any closure technique or method), closure technique (continuous versus interrupted, any suture material or method), closure method (mass versus layered, any suture material or technique) and filament (multifilament versus monofilament, any absorption, material, technique or method).
3. We did not explore further subgroup analyses (such as classification of wound contamination, type of surgery, etc.) due to the high variability between studies for these factors which make defining these factors for these potential analyses very difficult.
4. Updated the risk of bias methods to the most recent version of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011b).

INDEX TERMS

Medical Subject Headings (MeSH)

*Abdominal Wound Closure Techniques; *Laparotomy; *Suture Techniques; *Sutures; Fistula [epidemiology]; Incisional Hernia [epidemiology] [*prevention & control]; Randomized Controlled Trials as Topic; Surgical Wound Dehiscence [epidemiology]; Surgical Wound Infection [epidemiology]

MeSH check words

Humans