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Continuous passive motion following total knee arthroplasty in people with arthritis (Review)

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[Intervention Review]

Continuous passive motion following total knee arthroplasty in people with arthritis

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ABSTRACT

Background

Arthritis of the knee is a common problem causing pain and disability. If severe, knee arthritis can be surgically managed with a total knee arthroplasty. Rehabilitation following knee arthroplasty often includes continuous passive motion (CPM). CPM is applied by a machine that passively and repeatedly moves the knee through a specified range of motion (ROM). It is believed that CPM increases recovery of knee ROM and has other therapeutic benefits. However, it is not clear whether CPM is effective.

Objectives

To assess the benefits and harms of CPM and standard postoperative care versus similar postoperative care, with or without additional knee exercises, in people with knee arthroplasty. This review is an update of a 2003 and 2010 version of the same review.

Search methods

We searched the following databases: the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library* 2012, Issue 12), MEDLINE (January 1966 to 24 January 2013), EMBASE (January 1980 to 24 January 2013), CINAHL (January 1982 to 24 January 2013), AMED (January 1985 to 24 January 2013) and PEDro (to 24 January 2013).

Selection criteria

Randomised controlled trials in which the experimental group received CPM, and both the experimental and control groups received similar postoperative care and therapy following total knee arthroplasty in people with arthritis.

Data collection and analysis

Two review authors independently selected trials for inclusion, extracted data and assessed risk of bias. The primary outcomes of interest were active knee flexion ROM, pain, quality of life, function, participants' global assessment of treatment effectiveness, incidence of manipulation under anaesthesia and adverse events. The secondary outcomes were passive knee flexion ROM, active knee extension ROM, passive knee extension ROM, length of hospital stay, swelling and quadriceps strength. We estimated effects for continuous data as mean differences or standardised mean differences (SMD), and effects for dichotomous data as risk ratios; all with 95% confidence intervals (CI). If appropriate, we performed meta-analyses using random-effects models.

Main results

We identified 684 papers from the electronic searches after removal of duplicates and retrieved the full reports of 62 potentially eligible trials. Twenty-four randomised controlled trials of 1445 participants met the inclusion criteria; four of these trials were new to this update.

There was moderate-quality evidence to indicate that CPM does not have clinically important short-term effects on active knee flexion ROM: mean knee flexion was 78 degrees in the control group, CPM increased active knee flexion ROM by 2 degrees (95% CI 0 to 5) or absolute improvement of 2% (95% CI 0% to 4%). The medium- and long-term effects are similar although the quality of evidence is lower.

There was low-quality evidence to indicate that CPM does not have clinically important short-term effects on pain: mean pain was 3 points in the control group, CPM reduced pain by 0.4 points on a 10-point scale (95% CI -0.8 to 0.1) or absolute reduction of -4% (95% CI -8% to 1%).

There was moderate-quality evidence to indicate that CPM does not have clinically important medium-term effects on function: mean function in the control group was 56 points, CPM decreased function by 1.6 points (95% CI -6.1 to 2.0) on a 100-point scale or absolute reduction of -2% (95% CI -5% to 2%). The SMD was -0.1 standard deviations (SD) (95% CI -0.3 to 0.1).

There was moderate-quality evidence to indicate that CPM does not have clinically important medium-term effects on quality of life: mean quality of life was 40 points in the control group, CPM improved quality of life by 1 point on a 100-point scale (95% CI -3 to 4) or absolute improvement of 1% (95% CI -3% to 4%).

There was very low-quality evidence to indicate that CPM reduces the risk of manipulation under anaesthesia; risk of manipulation in the control group was 7.2%, risk of manipulation in the experimental group was 1.6%, CPM decreased the risk of manipulation by 25 fewer manipulations per 1000 (95% CI 9 to 64) or absolute risk reduction of -4% (95% CI -8% to 0%). The risk ratio was 0.3 (95% CI 0.1 to 0.9).

There was low-quality evidence to indicate that CPM reduces the risk of adverse events; risk of adverse events in the control group was 16.3%, risk of adverse events in the experimental group was 15%, CPM decreased the risk of adverse event by 13 fewer adverse events per 1000 or absolute risk reduction of -1% (95% CI -5% to 3%). The risk ratio was 0.9 (95% CI 0.6 to 1.3). The estimates for risk of manipulation and adverse events are very imprecise and the estimate for the risk of adverse events does not distinguish between a clinically important increase and decrease in risk.

There was insufficient evidence to determine the effect of CPM on participants' global assessment of treatment effectiveness.

Authors' conclusions

CPM does not have clinically important effects on active knee flexion ROM, pain, function or quality of life to justify its routine use. It may reduce the risk of manipulation under anaesthesia and risk of developing adverse events although the quality of evidence supporting these findings are very low and low, respectively. The effects of CPM on other outcomes are unclear.

PLAIN LANGUAGE SUMMARY

Continuous passive motion after knee replacement surgery

Background

Knee replacement surgery is common for the management of arthritis but can cause knee stiffness. Knee stiffness can make it difficult to perform certain activities including standing up from a seated position. Continuous passive motion (CPM) is a way of providing regular movement to the knee using a machine. This Cochrane review presents what we know about the effects of CPM following knee surgery. After searching for all relevant studies in January 2013, we found 24 studies with 1445 participants who had knee replacement surgery primarily for knee arthritis. CPM was started from the first to the fourth day post surgery and applied for 1.5 to 24 hours a day, over 1 to 17 days. The review showed that CPM following knee replacement surgery probably improves the ability to bend the knee slightly and the person's quality of life but may not improve pain or function. We are uncertain about the effects of CPM on need for manipulation under anaesthesia, participants' perceptions of treatment effectiveness or risk of complications.

Best estimates of what happens to people who have CPM after knee replacement surgery are:

Range of motion - active knee flexion (i.e. ability to bend the knee)

People who had CPM were able to bend their knees an average of 2 degrees more (0 to 5 degrees more) than those who did not have CPM at six weeks (2% absolute improvement, 0 to 4% absolute improvement)

- People who had CPM were able to bend their knees an average of 80 degrees.

- People who did not have CPM were able to bend their knees an average of 78 degrees.

Pain (higher scores means worse or more severe pain)

People who had CPM rated their pain an average of 0.4 points lower (0.8 points lower to 0.1 points higher) on a 0 to 10 point scale at six weeks (4% absolute reduction, 8% reduction to 1% increase)

- People who had CPM rated their pain an average of 2.6 points on a 0 to 10 scale.

- People who did not have CPM rated their pain an average of 3 points on a 0 to 10 scale.

Function (higher scores means better function)

People who had CPM had a loss in function equivalent to an average of 1.6 points on a 0- to 100-point scale at six months (2% absolute reduction, 5% reduction to 2% increase).

- People who had CPM had function equivalent to an average of 56 points on a 0- to 100-point scale.

- People who did not have CPM had function equivalent to an average of 57.6 points on a 0- to 100-points scale.

Quality of life (higher scores means better quality of life)

People who had CPM had an increase in quality of life equivalent to an average of 1 point on a 0- to 100-point scale at six months (1% absolute improvement, 3% reduction to 4% increase).

- People who had CPM had a quality of life equivalent to an average of 41 points on a 0- to 100-point scale.

- People who did not have CPM had function equivalent to an average of 40 points on a 0- to 100-points scale.

Manipulation under anaesthesia

People who had CPM had a decrease in the risk of requiring manipulation under anaesthesia equivalent to an average of 25 fewer manipulations per 1000 patients (4% absolute risk reduction, 8% risk reduction to 0% risk reduction).

- People who had CPM had on average a 1.6% risk of requiring manipulation under anaesthesia.

- People who did not have CPM had on average a 7.2% risk of requiring manipulation under anaesthesia.

Adverse events

People who had CPM had a decrease in the risk of developing adverse events equivalent to an average of 13 fewer adverse events per 1000 patients (1% absolute risk reduction, 5% risk reduction to 3% risk increase).

- People who had CPM had on average a 15% risk of developing adverse events.

- People who did not have CPM had on average a 16.3% risk of developing adverse events.

Summary of findings for the main comparison. Primary comparison for continuous passive motion (CPM) versus no CPM

Primary comparison for continuous passive motion (CPM) versus no CPM

Patient or population: hospitalised patients who have undergone knee replacement surgery
Settings: hospital
Intervention: Continuous passive motion (CPM) versus no CPM

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Primary comparison				
Active knee flexion ROM Goniometer. Scale: 0 to 130 Follow-up: 6 weeks	The mean active knee flexion ROM in the control groups was **78 degrees**	The mean active knee flexion ROM in the intervention groups was **2 higher** (0 to 5 higher)	-	470 (10 studies)	⊕⊕⊕⊖ **moderate** [1]	Absolute risk difference 2% (0 to 4); relative percent change 0% (2 to 5); not statistically significant[2]
Pain Visual analogue scale. Scale: 0 to 10 (lower score better) Follow-up: 6 weeks	The mean pain in the control groups was **3 points**	The mean pain in the intervention groups was **0.4 lower** (0.8 lower to 0.1 higher)	-	414 (8 studies)	⊕⊕⊖⊖ **low** [1,3,4]	Absolute risk difference -4% (-8 to 1); relative percent change -80% (-36 to 8); not statistically significant[5]
Function Various. Scale: 0 to 100 (higher score better) Follow-up: 6 months	The mean function in the control groups was **56 points** [6]	The mean function in the intervention groups was **1.6 lower** (6.1 lower to 2 higher)[7]	-	405 (6 studies)	⊕⊕⊕⊖ **moderate** [1,3]	SMD -0.1 (-0.3 to 0.1); absolute risk difference -2% (-5 to 2); relative percent change -4 (-12 to 5)[8]
Quality of life SF-12. Scale from: 0 to 100 (higher score better). Follow-up: 6 months	The mean quality of life in the control groups was **40 points**	The mean quality of life in the intervention groups was **1 higher** (3 lower to 4 higher)		156 (2 studies)	⊕⊕⊕⊖ **moderate** [1,3]	Absolute risk difference 1% (-3 to 4) ; Relative percent change -8% (-8 to 13); non-statistically significant[9]

Participants' global assessment of treatment effectiveness Questionnaire. Scale: 0 to 7 Follow-up: 6 weeks	See comment	See comment	Not estimable	211 (3 studies)	⊕⊖⊖⊖ **very low** 1,3,10,11	Not estimable[12]
Manipulation under anaesthesia Counts of manipulation under anaesthesia Follow-up: 6 weeks	**72 per 1000**	**25 per 1000** (9 to 64)	**RR 0.34** (0.13 to 0.89)	581 (8 studies)	⊕⊖⊖⊖ **very low** 4,13,14	Absolute risk difference -4% (-8 to 0); relative percent decrease -67% (-87 to 11); NNTB 21 (16 to 126)
Adverse events Counts of adverse events Follow-up: 6 weeks	**163 per 1000**	**150 per 1000** (103 to 216)	**RR 0.92** (0.63 to 1.33)	1040 (16 studies)	⊕⊕⊖⊖ **low** 1,15	Absolute risk difference -1% (-5 to 3); relative percent decrease -9% (-37 to 33); not statistically significant

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (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; **NNTB:** number needed to treat for an additional beneficial outcome; **ROM:** range of motion; **RR:** risk ratio; SF-12: Short-Form 12-Item Health Survey.

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] The methodological quality of at least some of the included trials were susceptible to bias.
[2] Relative percentage change based on baseline mean of Sahin 2006 (105 degrees).
[3] This outcome included self-report from participants who were not blinded to the intervention. This can cause bias.
[4] There are inconsistencies between the trials.
[5] Relative percentage change based on baseline mean of Lenssen 2008 (1.05 points on a 0- to 10-point scale converted from a 0- to 100-points scale for consistency with other trials).
[6] This is the mean final score of the control participants of Bennett 2005 (mean 56; standard deviation (SD) 21.63). Results are expressed in relationship to Knee Society Score (0- to 100-point scale).
[7] Estimate of the effect is back-translated from standardised mean difference (SMD) -0.08 (95% confidence interval (CI) -0.27 to 0.12) using the baseline SD of Bennett 2005 (SD 20.19). Results are expressed in relationship to Knee Society Score (0- to 1000-point scale).
[8] Absolute risk difference is based on the mean and SD of the control group at baseline in Bennett 2005 (mean 45.3; standard error 2.8; SD 20.19). Results are expressed in relationship to Knee Society Score (0- to 100-point scale).
[9] Relative percentage change based on baseline mean of Maniar 2012 (30.58 points).
[10] The point estimate of 1 trial favours the continuous passive motion (CPM) group and the point estimates of the other 2 trials favours the control group.
[11] The 95% CI of the estimate of each trial is wide.
[12] Data were not pooled.
[13] It is not clear whether those making the decisions about the need for manipulation were blinded.

14 The CI for the risk ratio is wide.
15 The 95% CI associated with the risk ratio includes the possibility of an important increase and decrease in the risk of adverse events with CPM.

BACKGROUND

Description of the condition

Total knee arthroplasties (TKA) are surgical procedures that involve replacing the knee joint with artificial components. They are commonly performed to reduce pain and increase function in people with severe arthritis such as osteoarthritis (OA) and rheumatoid arthritis (RA). A common problem post surgery is joint stiffness.

Description of the intervention

Continuous passive motion (CPM) was first introduced by Salter et al in the 1960s (Salter 1989). It is a way of providing regular movement to the knee using an external motorised device that passively moves the joint through a pre-set arc of motion (Sheppard 1995).

How the intervention might work

CPM is primarily advocated in the belief that it increases knee range of motion (ROM) (McCarthy 1992; Salter 1989). This is supported by animal studies, which have demonstrated that early movement minimises joint stiffness and improves ROM (Videman 1987). However, some scientists also claim that it reduces pain (Harms 1991), length of hospital stay (Fisher 1985; Schnebel 1989), and the need for manipulation under anaesthesia (a procedure that involves forcefully flexing the knee while the patient is anaesthetised to increase knee ROM (Fox 1981).

Why it is important to do this review

There remains uncertainty about whether CPM is therapeutic following TKA. For example, CPM continues to be prescribed as part of postoperative care following TKA, commercial companies continue to advertise CPM machines as a way to improve outcomes following TKA and research attention continues to be directed at determining the effects of CPM. Therefore, the purpose of this systematic review was to update two earlier versions of the same review with the overall aim of providing an objective synthesise of the evidence about the effectiveness of CPM following TKA for people with arthritis.

OBJECTIVES

To assess the benefits and harms of CPM and standard postoperative care versus similar postoperative care, with or without additional knee exercises, in people with knee arthroplasty. This review is an update of a 2003 and 2010 version of the same review.

METHODS

Criteria for considering studies for this review

Types of studies

We included only randomised controlled trials (RCT), regardless of language. We accepted abstracts. We did not exclude trials based on quality assessment.

Types of participants

Participants could be of any age provided they were hospitalised following TKA. All participants needed to have a pre-surgery diagnosis of arthritis.

Types of interventions

We included trials if CPM and standard postoperative care were compared with similar postoperative care with or without additional knee exercises. Standard postoperative care could include muscle-strengthening exercises (isometric or dynamic), functional exercises, gait training, immobilisation or ice, provided both groups received the same intervention. Additional knee exercises could include instructions or supervised active or passive knee ROM exercises. They could not include knee exercises provided with any type of CPM device.

Types of outcome measures

Major outcomes

The primary outcomes of interest were active knee flexion ROM, pain, function, quality of life, participants' global assessment of treatment effectiveness, need for manipulation under anaesthesia and adverse events. If study authors did not distinguish between active and passive knee flexion ROM then it was assumed that the measurement was passive. Only direct measures of pain intensity were of interest. These included pain scales but not pain medication. These outcomes are presented in Summary of findings for the main comparison.

Secondary outcomes

Secondary outcomes were passive knee flexion ROM, active knee extension ROM, passive knee extension ROM, length of hospital stay, swelling and quadriceps strength. If authors did not distinguish between active and passive knee ROM then it was assumed that the measurement was passive. We interpreted "knee extension lag" as active knee extension ROM and "fixed deformity" as passive knee extension ROM.

All results, except need for manipulation and adverse events, were categorised into short-term effects of CPM (reflected in outcomes taken less than six weeks after randomisation), medium-term effects of CPM (reflected in outcomes taken six weeks to six months after randomisation) and long-term effects of CPM (reflected in outcomes taken more than six months after randomisation). Where trials collected data at multiple time periods within one of these categories, we used the data collected at the longest time since randomisation. Need for manipulation and adverse events were extracted regardless of time since randomisation.

Each of the primary outcomes were used in the 'Summary of findings' table. We used short-term effects except for function and quality of life where we used medium-term effects because either there were no data for the short-term effects or the data could not be pooled because of heterogeneity.

Search methods for identification of studies

Electronic searches

We searched the following databases:

- the Cochrane Central Register of Controlled Trials (CENTRAL) (2012, Issue 12);
- MEDLINE (January 1966 to January 24, 2013);
- EMBASE (January 1980 to January 24, 2013);
- CINAHL (January 1982 to January 24, 2013);
- AMED (January 1985 to January 24, 2013);
- PEDro (to January 24, 2013).

We applied no language restrictions. The database details and results of all the searches are recorded in Appendix 1; Appendix 2; Appendix 3; Appendix 4; Appendix 5; and Appendix 6.

Searching other resources

We checked the reference lists of all included trials for other potentially relevant trials.

Data collection and analysis

Selection of studies

Two independent review authors examined the titles and abstracts of trials identified by the search strategy for trials that potentially met the inclusion criteria. We retrieved all trials classified as potentially eligible by at least one of the review authors. We re-examined the retrieved articles to ensure that they met the inclusion criteria.

Data extraction and management

Two review authors independently extracted characteristics of included studies and results from each of the included trials. We resolved discrepancies by consensus. We addressed questions regarding the relative effectiveness of different dosages of CPM in a meta-regression (see 'Data synthesis' for details). We used standardised mean differences (SMDs) when different scales were used to measure the same construct (e.g. function). SMDs were calculated by dividing the difference between treated and control means by the pooled estimate of the SD. If authors of trials provided both intention-to-treat and per-protocol data, we used the intention-to-treat data. We did not impute missing data.

Assessment of risk of bias

Two review authors independently assessed the risk of bias in each trial using the method recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We assessed the following methodological domains:

1. random sequence generation;
2. allocation sequence concealment;
3. blinding of participants;
4. blinding of therapists;
5. blinding of outcome assessors;
6. incomplete outcome data;
7. selective outcome reporting; and
8. other potential sources of bias.

We rated each potential source of bias as high, low or unclear (either lack of information or uncertainty over the potential for bias). We attempted to contact all study authors to clarify any ambiguities.

We resolved disagreements in ratings by discussion or, where necessary, by consulting a third review author.

Measures of treatment effect

For continuous data, we presented summary estimates as mean differences (MD) and 95% confidence intervals (CI) for pain, ROM and quality of life (weighted by the inverse of the variances of the estimates) or SMD and 95% CI for outcomes measured on different scales (function). SMDs were back-translated to a typical scale (e.g. 0 to 100 for function) by multiplying the SMD by a typical among-person SD (e.g. the SD of the control group at baseline from the most representative trial).

For dichotomous outcomes, we presented results as risk ratios (RR) and 95% CI.

For outcomes where it was desirable to have a lower score (e.g. pain); a negative value indicated a beneficial treatment effect of CPM. Conversely, for outcomes where it was desirable to have a larger score (e.g. knee flexion ROM); a positive value indicates a beneficial treatment effect of CPM. For some outcomes, such as function, different outcomes were used in different trials and the direction of beneficial treatment effect was not consistent such that higher numbers sometimes indicated a better outcome while in other trials it was the opposite. To overcome this problem, we inverted some data to ensure all outcomes were consistent within the one analysis.

Unit of analysis issues

In trials with more than two groups, we extracted only data from the two groups with the most contrasting interventions and used these for analyses. For example, in trials with one control and two CPM groups, we included only the results of the control group and CPM group with the highest dosage in analyses. We adopted this approach to reduce complexity and increase the readability of the systematic review.

Dealing with missing data

If outcomes were only reported graphically, we estimated the mean scores and SDs from the graphs.

Data synthesis

We estimated the effect of CPM by taking the difference in the mean outcome of the groups that did and did not receive CPM. For the primary analysis, the standard postoperative care may or may not have included additional knee exercises to one or both groups. We conducted a secondary analysis on just those trials in which the standard postoperative care for the control group included additional knee exercises. These trials provide a head-to-head comparison of the effectiveness of CPM and additional knee exercises. We pooled the MDs in outcomes from each trial to obtain a summary estimate of the effectiveness of CPM provided the I^2 statistic was not greater than 50%. We used random-effects models throughout. We used random-effects meta-regression to explore the effect of mean total CPM time (hours) on passive knee flexion ROM in the short term. We used the user-written metareg routine in the Stata software package (version 10) for this purpose.

'Summary of findings' tables

We used the GRADE approach to summarise the quality of evidence about the effect of CPM on each of the primary outcomes (active knee flexion ROM, pain, function, quality of life, participants' global assessment of treatment effectiveness, need for manipulation under anaesthesia and adverse events). We used the short-term effects in the analyses except for function and quality of life where we used the medium-term effects because either there were no data for the short-term effects or the data could not be pooled because of heterogeneity. We defined levels of quality as follows:

1. high quality: randomised trials;
2. medium quality: downgraded randomised trials;
3. low quality: double-downgraded randomised trials; and
4. very low quality: triple-downgraded randomised trials.

The quality of evidence was downgraded if:

1. there were limitations in the design and implementation of available trials suggesting high likelihood of bias;
2. there was only indirect evidence (indirect population, intervention, control, outcomes);
3. there was unexplained heterogeneity or inconsistency of results (including problems with subgroup analyses);
4. the results were imprecise (wide CIs); and
5. there was a high probability of publication bias.

In the same way, the quality of evidence was upgraded if:

1. the effect sizes were large;
2. all confounding factors reduced a demonstrated effect or suggested a spurious effect in trials that showed no effect; and
3. there was a dose-response gradient.

We used GRADEpro software to compile the 'Summary of findings' table.

We re-expressed outcomes pooled using SMDs as a MD by multiplying the SMD by a representative control group baseline SD from a trial, using a familiar instrument.

In addition to the absolute and relative magnitude of effect provided in the 'Summary of findings' table, we have reported the absolute percent difference, the relative percent change from baseline, and the number needed to treat (NNT) for an additional beneficial outcome (NNTB) or for an additional harmful outcome (NNTH) (the NNT was only provided for outcomes that showed a statistically significant difference).

For dichotomous outcomes, we calculated the absolute risk difference using the risk difference statistic in Review Manager 5 (RevMan 2012), and expressed the result as a percentage; the relative percentage change as the RR - 1 and expressed it as a percentage; and the NNT from the control group event rate and the RR were determined using the Visual Rx NNT calculator (Cates 2008).

For continuous outcomes, we calculated the absolute risk difference as the MD between intervention and control groups in the original measurement units (divided by the scale), expressed as a percentage; the relative difference as the absolute change (or MD) divided by the baseline mean of the control group from a representative trial. As no continuous outcomes were significantly different between the intervention and control group, we did not calculate the NNT.

Subgroup analyses

We planned no subgroup analyses.

Sensitivity analyses

We planned no sensitivity analyses; however, we did look for small sample bias by re-doing all the analyses using a fixed-effect model and comparing results between the random-effects model and fixed-effect model of analyses for each outcome (Higgins 2011).

RESULTS

Description of studies

Results of the search

The electronic searches identified 931 records (see Table 1 and Figure 1). This included 516 records that were identified in 2009 and an additional 415 records that were identified in 2013. Once duplicates were removed, there were 684 records (327 from 2009 and 357 from 2013).

Figure 1. Study flow diagram. Results from the 2003 version of this systematic review are included in the 2009 search results because a full search was re-done in 2009 using a new search strategy.

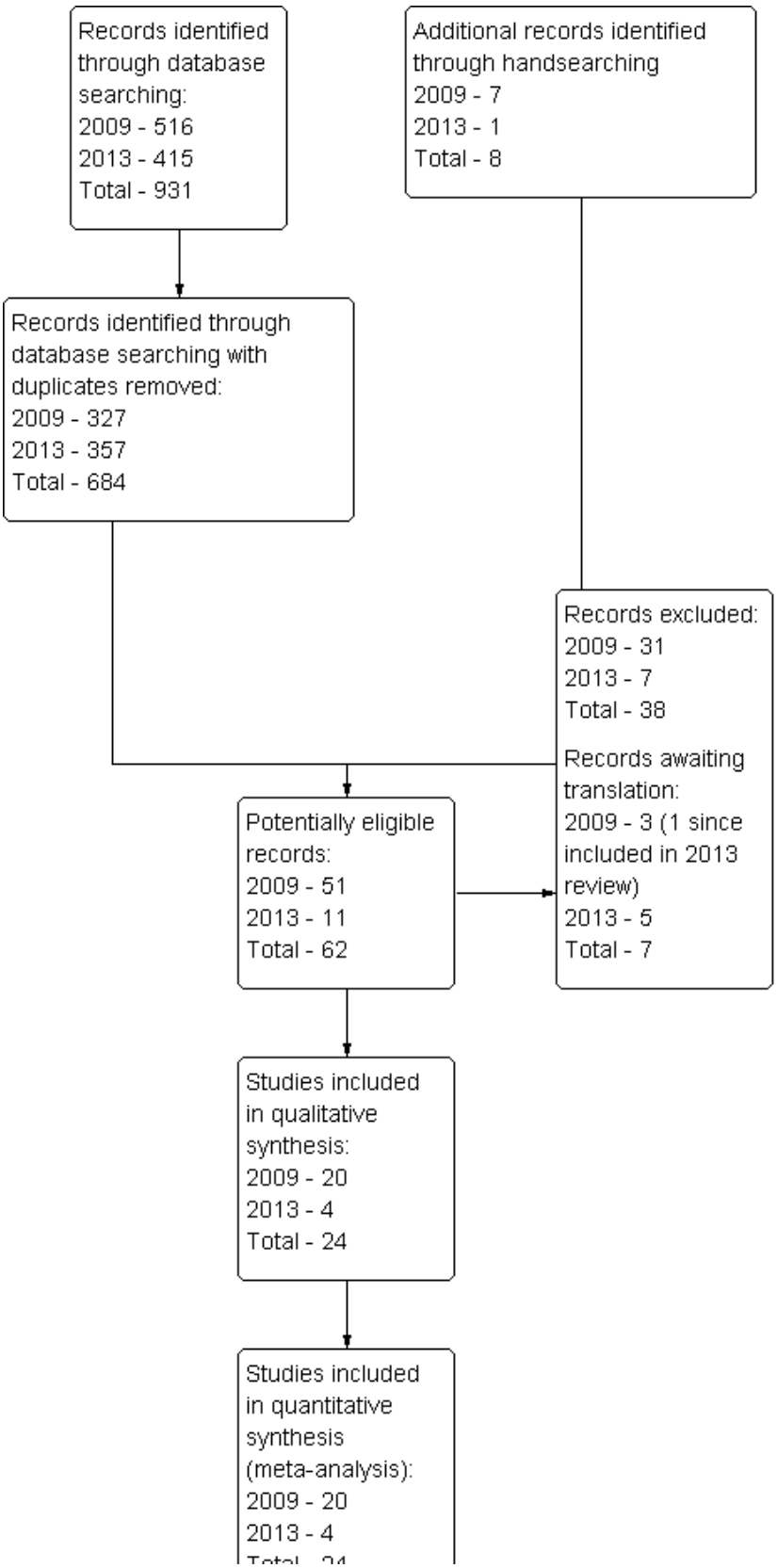
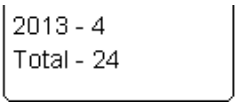


Figure 1. (Continued)



Included studies

Of the 684 records, 62 trials were potentially eligible. On inspection of the full reports, 24 met the inclusion criteria (Alkire 2010; Bennett 2005; Bruun-Olsen 2009; Can 1995; Chiarello 1997; Colwell 1992; Denis 2006; Harms 1991; Huang 2003; Kumar 1996; Lau 2001; Lenssen 2003a; Lenssen 2008; MacDonald 2000; Maniar 2012; May 1999; McInnes 1992; Montgomery 1996; Ng 1999; Nielsen 1988; Ritter 1989; Sahin 2006; Vince 1987; Worland 1998). Four new studies were included in this update (Alkire 2010; Bruun-Olsen 2009; Maniar 2012; Sahin 2006). All but one of the studies (Can 1995) were full papers. In the 24 included trials, CPM was administered from 1.5 to 24 hours a day (median 5.7, interquartile range 4 to 14) and for between 1 and 17 days (median 8, interquartile range 6 to 13) (see Characteristics of included studies table). A total of 1335 patients were randomised. Most patients had OA rather than RA. Treatments were initiated between the first and fourth postoperative day (POD) in all trials except one (May 1999), in which CPM treatment was initiated on transfer to a rehabilitation facility (between POD 2 and 13).

Excluded studies

Potentially eligible trials were most commonly excluded because the control group received something other than usual care with or without additional exercises (see Characteristics of excluded studies table). Seven trials are awaiting classification (see Characteristics of studies awaiting classification table).

Risk of bias in included studies

No trial blinded patients or treating therapists as this is not easily achievable in trials of this type (see Figure 2 and Figure 3). Only eight trials concealed allocation and used an adequate method to generate the random sequence. Selective reporting was potentially a problem in 16 of the 24 trials and there was incomplete reporting of data in at least eight trials. Probably the biggest threat to bias in trials of CPM come from the use of non-blinded assessors and only 10 trials blinded assessors. Sixteen trials had complete outcome data. Four trials were highly vulnerable to bias not satisfying any of the criteria used to assess methodological quality (Can 1995; Huang 2003; Vince 1987; Worland 1998).

Figure 2. Methodological quality summary: review authors' judgements about each methodological quality item for each included trial.

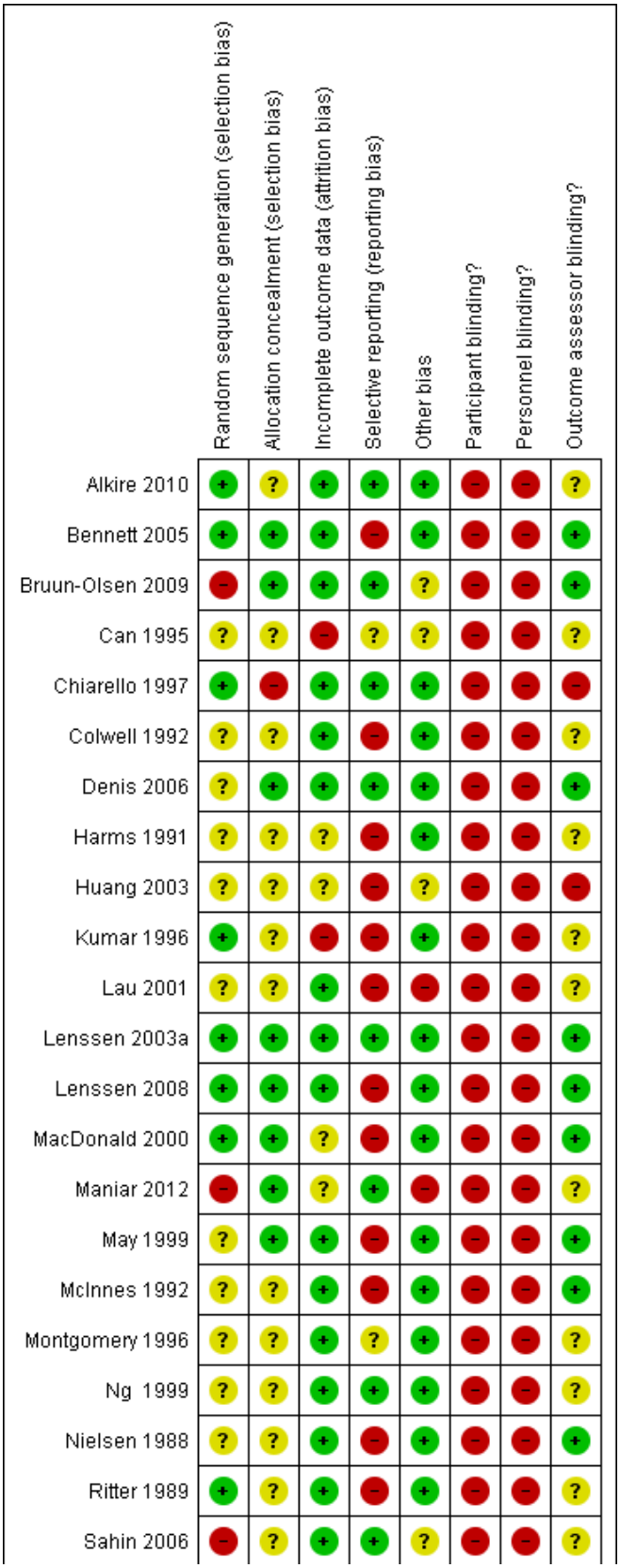


Figure 2. (Continued)

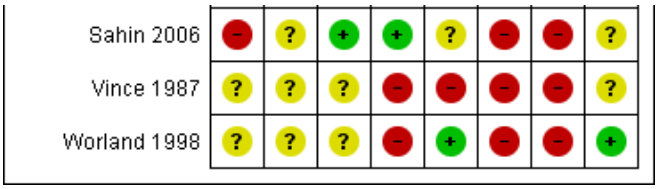
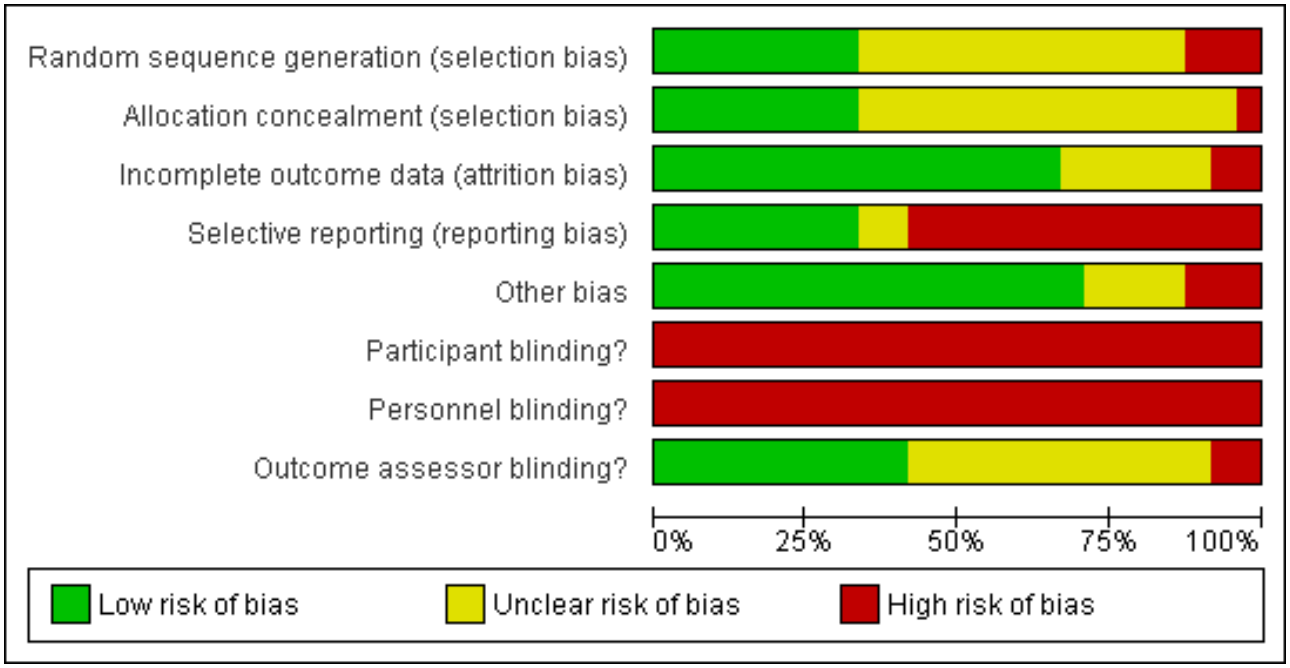


Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Effects of interventions

See: **Summary of findings for the main comparison** Primary comparison for continuous passive motion (CPM) versus no CPM

The primary comparisons compared CPM combined with standard postoperative care versus standard postoperative care with or without additional knee exercises to one or both groups. These analyses included all trials for which data were available. The results are summarised below and in the Summary of findings for the main comparison.

Major outcomes

1. Active knee flexion range of motion

Short-term effects: Twelve trials with 626 participants measured active knee flexion ROM (Bennett 2005; Bruun-Olsen 2009; Chiarello 1997; Denis 2006; Huang 2003; Lau 2001; Lenssen 2008; Maniar 2012; May 1999; McInnes 1992; Ng 1999; Sahin 2006). Ten trials with 470 participants provided useful data (Bruun-Olsen 2009; Chiarello 1997; Denis 2006; Huang 2003; Lau 2001; Lenssen 2008; May 1999; McInnes 1992; Ng 1999; Sahin 2006). Active knee flexion was measured with a goniometer in all trials. The MD was 2 degrees with more ROM for the CPM group (95% CI 0 to 5; P value = 0.07; I^2 = 43%; Analysis 1.1).

Medium-term effects: Seven trials with 411 participants measured active knee flexion ROM (Bennett 2005; Bruun-Olsen 2009; Huang 2003; Lau 2001; Lenssen 2008; Maniar 2012; Sahin 2006). Four trials with 195 participants provided useful data (Bruun-Olsen 2009; Huang 2003; Lenssen 2008; Sahin 2006). Active knee flexion was measured with a goniometer in all trials. There was considerable between-study heterogeneity in estimates of effect (I^2 = 69%), so we did not pool the data. Point estimates of effect ranged from -7 to 8 degrees (Analysis 1.2).

Long-term effects: Four trials with 232 participants measured active knee flexion ROM (Bennett 2005; Huang 2003; Lau 2001; Sahin 2006). Three trials with 132 participants provided useful data (Huang 2003; Lau 2001; Sahin 2006). Active knee flexion was measured with a goniometer in all trials. The MD was 3 degrees with more ROM for the CPM group (95% CI -1 to 7; P value = 0.16; I^2 = 54%; Analysis 1.3).

2. Pain

Short-term effects: Eleven trials with 683 participants measured pain (Bennett 2005; Bruun-Olsen 2009; Denis 2006; Harms 1991; Lenssen 2003a; Lenssen 2008; Maniar 2012; May 1999; McInnes 1992; Montgomery 1996; Sahin 2006). Eight trials with 414 participants provided useful data (Bruun-Olsen 2009; Denis 2006; Lenssen 2003a; Lenssen 2008; May 1999; McInnes 1992; Montgomery 1996; Sahin 2006). Pain was measured on a 10- or 100-point visual analogue scale but we converted all results to a 10-point scale for this review. The MD was -0.4 points on a 0- to 10-point scale with less pain for the CPM group (95% CI -0.8 to 0.1; P value = 0.1; I^2 = 50%; Analysis 1.4).

Medium-term effects: Four trials with 243 participants measured pain (Alkire 2010; Bruun-Olsen 2009; Lenssen 2008; Maniar 2012). Three trials with 179 participants provided useful data (Bruun-Olsen 2009; Lenssen 2008; Maniar 2012). Pain was measured on a 10- or 100-point visual analogue scale but we converted all results to a 10-point scale for this review. The MD was 0.3 points on a 0- to 10-point scale with more pain for the CPM group (95% CI -0.4 to 0.9; P value = 0.44; I^2 = 52%; Analysis 1.5).

Long-term effects: One trial with 28 participants measured pain using a 10-point visual analogue scale (Sahin 2006). The MD was 0.1 points on a 0- to 10-point scale with more pain for the CPM group (95% CI -0.8 to 0.9; P value = 0.87; Analysis 1.6).

3. Function

Short-term effects: Five trials with 227 participants measured function (Denis 2006; Lenssen 2003a; Lenssen 2008; Maniar 2012; May 1999). Four trials with 171 participants provided useful data (Denis 2006; Lenssen 2003a; Lenssen 2008; May 1999). Function was measured in a variety of ways including the Knee Society Score, The Hospital for Special Surgery Score, The Timed Up and Go Test and the 10-metre Walking Test. There was considerable between-study heterogeneity in estimates of effect (I^2 = 72%), so we did not pool the data. Point standardised estimates of effect ranged from -0.4 SD to 1 SD (Analysis 1.7).

Medium-term effects: Eight trials with 555 participants measured function (Alkire 2010; Bennett 2005; Bruun-Olsen 2009; Kumar 1996; Lenssen 2008; Maniar 2012; McInnes 1992; Worland 1998). Six trials with 405 participants provided useful data (Bennett 2005; Bruun-Olsen 2009; Kumar 1996; Lenssen 2008; Maniar 2012; Worland 1998). Function was measured in a variety of ways including the Knee Society Score, The Hospital for Special Surgery Score, and the Western Ontario and McMaster Universities Osteoarthritis Index Physical Function Subscore. The SMD was -0.1 SD with less function for the CPM group (95% CI -0.3 to 0.1; P value = 0.45; I^2 = 0%; Analysis 1.8).

Long-term effects: Four trials with 288 participants measured function (Bennett 2005; MacDonald 2000; Sahin 2006; Worland 1998). All four trials provided useful data. Function was measured in a variety of ways including the Knee Society Score and The Hospital for Special Surgery Score. The SMD was 0 SD (95% CI -0.2 to 0.3; P value = 0.89; I^2 = 0%; Analysis 1.9).

4. Quality of life

Short-term effects: No trial measured this outcome during this time periods.

Medium-term effects: Three trials with 197 participants measured quality of life(Bennett 2005; Kumar 1996; Maniar 2012). Two trials with 156 participants provided useful data (Bennett 2005; Maniar 2012). Quality of life was measured with the physical component subscore of the Short-Form 12-Item Health Survey (SF-12). The MD was 1 point on a 0- to 100-point scale with better quality of life for the CPM group (95% CI -3 to 4; P value = 0.66; Analysis 1.10).

Long-term effects: One trial with 100 participants measured quality of life(Bennett 2005), using the physical component subscore of the SF-12. The MD was 2 points on a 0- to 100-point scale with better quality of life for the CPM group (95% CI -4 to 8; P value = 0.48; Analysis 1.11).

5. Participants' global assessment of treatment effectiveness

Short-term effects: Three trials with 212 participants measured participants' global assessment of treatment effectiveness (Harms 1991; Lenssen 2003a; Lenssen 2008). All trials provided useful data. Participants' global assessment of treatment effectiveness was measured using a 7-point perceived effects scale or a 10-point visual analogue scale. There was considerable between-study heterogeneity in estimates of effect (I^2 = 67%), so we did not pool the data. Point estimates of effect ranged from -0.5 to 0.4 points (Analysis 1.12).

Medium-term effects: One trial with 60 participants measured participants' global assessment of treatment effectiveness (Lenssen 2008), using a 7-point perceived effects scale. The MD was -0.3 points on a 0- to 7-point scale with less perception of treatment effectiveness for the CPM group (95% CI -0.7 to 0.1; P value = 0.18; Analysis 1.13).

Long-term effects: No trial measured this outcome during this time periods.

6. Manipulation under anaesthesia

Nine trials with 600 participants measured incidence proportion of manipulation under anaesthesia (Alkire 2010; Denis 2006; Harms 1991; Kumar 1996; Lenssen 2008; Maniar 2012; May 1999; McInnes 1992; Vince 1987). Eight trials with 581 participants provided useful data (Denis 2006; Harms 1991; Kumar 1996; Lenssen 2008; Maniar 2012; McInnes 1992; Vince 1987). There were 25 manipulations under anaesthesia. The RR was 0.34 with less risk for the CPM group (95% CI 0.13 to 0.89; P value = 0.03; I^2 = 0%; Analysis 1.14).

7. Adverse events

Seventeen trials with 1104 participants reported incidence proportion of adverse events (Alkire 2010; Bennett 2005; Colwell 1992; Denis 2006; Harms 1991; Huang 2003; Kumar 1996; Lau 2001; Maniar 2012; McInnes 1992; Montgomery 1996; Ng 1999; Nielsen 1988; Ritter 1989; Sahin 2006; Vince 1987; Worland 1998). Sixteen trials with 1040 participants provided useful data (Bennett 2005; Colwell 1992; Denis 2006; Harms 1991; Huang 2003; Kumar 1996; Lau 2001; Maniar 2012; McInnes 1992; Montgomery 1996; Ng 1999; Nielsen 1988; Ritter 1989; Sahin 2006; Vince 1987; Worland 1998). Adverse events included delayed healing, haemarthrosis, falls, deep venous thromboses, wound infections, pulmonary emboli, knee haematoma and a patellar rupture. There were 178 adverse events in total. The RR was 0.92 with less risk for the CPM group (95% CI 0.63 to 1.33; P value = 0.65; I^2 = 39%; Analysis 1.15).

Secondary outcomes

1. Passive knee flexion range of motion

Short-term effects: Fifteen trials with 944 participants measured passive knee flexion ROM (Alkire 2010; Bennett 2005; Bruun-Olsen 2009; Chiarello 1997; Colwell 1992; Harms 1991; Kumar 1996; Lenssen 2003a; Lenssen 2008; Montgomery 1996; Ng 1999; Nielsen 1988; Ritter 1989; Vince 1987; Worland 1998). Eleven trials with 697 participants provided useful data (Bruun-Olsen 2009; Chiarello 1997; Harms 1991; Kumar 1996; Lenssen 2003a; Lenssen 2008; Montgomery 1996; Ng 1999; Nielsen 1988; Ritter 1989; Worland 1998). Passive knee flexion was measured with a goniometer in all trials. The MD was 2 degrees with more ROM for the CPM group (95% CI 0 to 4; P value = 0.03; I^2 = 22%; Analysis 1.16).

Medium-term effects: Seven trials with 447 participants measured passive knee flexion ROM (Alkire 2010; Bruun-Olsen 2009; Colwell 1992; Kumar 1996; MacDonald 2000; Ritter 1989; Worland 1998). Four trials with 264 participants provided useful data (Bruun-Olsen 2009; Kumar 1996; MacDonald 2000; Worland 1998). Passive knee flexion was measured with a goniometer in all trials. The MD was -2 degrees with less ROM for the CPM group (95% CI -5 to 2; P value = 0.29; I^2 = 29%; Analysis 1.17).

Long-term effects: Three trials with 177 participants measured passive knee flexion ROM (Colwell 1992; MacDonald 2000; Worland 1998). Two trials with 160 participants provided useful data (MacDonald 2000; Worland 1998). Passive knee flexion was measured with a goniometer in all trials. The MD was 0 degrees (95% CI -2 to 2; P value = 0.96; I^2 = 0%; Analysis 1.18).

2. Active knee extension range of motion

Short-term effects: Fifteen trials with 890 participants measured active knee extension ROM (Bennett 2005; Bruun-Olsen 2009; Chiarello 1997; Denis 2006; Harms 1991; Huang 2003; Lau 2001; Lenssen 2008; Maniar 2012; May 1999; McInnes 1992; Ng 1999; Nielsen 1988; Ritter 1989; Sahin 2006). Eleven trials with 574 participants provided useful data (Bruun-Olsen 2009; Chiarello 1997; Denis 2006; Harms 1991; Huang 2003; Lenssen 2008; May 1999; McInnes 1992; Ng 1999; Nielsen 1988; Sahin 2006). Active knee extension was measured with a goniometer in all trials. The MD was 1 degree with more ROM for the CPM group (95% CI 0 to 2; P value = 0.17; I^2 = 41%; Analysis 1.19).

Medium-term effects: Six trials with 355 participants measured active knee extension ROM (Bennett 2005; Bruun-Olsen 2009; Huang 2003; Lau 2001; Lenssen 2008; Sahin 2006). Four trials with 195 participants provided useful data (Bruun-Olsen 2009; Huang 2003; Lenssen 2008; Sahin 2006). Active knee extension was measured with a goniometer in all trials. The MD was 1 degree with more ROM for the CPM group (95% CI -1 to 2; P value = 0.33; I^2 = 41%; Analysis 1.20).

Long-term effects: Five trials with 312 participants measured active knee extension ROM (Bennett 2005; Huang 2003; Lau 2001; Sahin 2006; Worland 1998). Two trials with 108 participants provided useful data (Sahin 2006; Worland 1998). Active knee extension was measured with a goniometer in all trials. The MD was 0 degrees (95% CI 0 to 0; P value = 0.33; I^2 = 0%; Analysis 1.21).

3. Passive knee extension range of motion

Short-term effects: Fifteen trials with 876 participants measured passive knee extension ROM (Alkire 2010; Bennett 2005; Bruun-Olsen 2009; Chiarello 1997; Colwell 1992; Huang 2003; Kumar 1996; Lenssen 2003a; Lenssen 2008; May 1999; McInnes 1992; Ng 1999; Ritter 1989; Vince 1987; Worland 1998). Eleven trials with 629 participants provided useful data (Bruun-Olsen 2009; Chiarello 1997; Huang 2003; Kumar 1996; Lenssen 2003a; Lenssen 2008; May 1999; McInnes 1992; Ng 1999; Ritter 1989; Worland 1998). Passive knee extension was measured with a goniometer in all trials. The MD was 1 degree with more ROM for the CPM group (95% CI 0 to 2; P value = 0.16; I^2 = 47%; Analysis 1.22).

Medium-term effects: Seven trials with 411 participants measured passive knee extension ROM (Alkire 2010; Bennett 2005; Bruun-Olsen 2009; Colwell 1992; Huang 2003; Kumar 1996; Worland 1998). Four trials with 228 participants provided useful data (Bruun-Olsen 2009; Huang 2003; Kumar 1996; Worland 1998). Passive knee extension was measured with a goniometer in all trials. There was considerable between-study heterogeneity in estimates of effect (I^2 = 80%), so we did not pool the data. Point estimates of effect ranged from -3 to 3 degrees (Analysis 1.23).

Long-term effects: Five trials with 321 participants measured passive knee extension ROM (Bennett 2005; Colwell 1992; Huang 2003; MacDonald 2000; Worland 1998). Three trials with 204 participants provided useful data (Huang 2003; MacDonald 2000; Worland 1998). Passive knee extension was measured with a goniometer in all trials. The MD was 0 degrees (95% CI 0 to 1; P value = 0.59; I^2 = 0%; Analysis 1.24).

4. Length of hospital stay

Short-term effects: Fourteen trials with 840 participants measured length of hospital stay (Alkire 2010; Bennett 2005; Colwell 1992; Denis 2006; Harms 1991; Huang 2003; Kumar 1996; Lenssen 2003a; MacDonald 2000; May 1999; McInnes 1992; Montgomery 1996; Sahin 2006; Vince 1987). Ten trials with 614 participants provided useful data (Colwell 1992; Denis 2006; Harms 1991; Huang 2003; Kumar 1996; Lenssen 2003a; MacDonald 2000; McInnes 1992; Montgomery 1996; Sahin 2006). The MD was -0.4 days with shorter length of hospital stay for the CPM group (95% CI -1.0 to 0.2; P value = 0.15; I^2 = 39%; Analysis 1.25).

5. Swelling

Short-term effects: Seven trials with 464 participants measured swelling (Alkire 2010; Bruun-Olsen 2009; Maniar 2012; McInnes 1992; Montgomery 1996; Ritter 1989; Sahin 2006). Five trials with 300 participants provided useful data (Bruun-Olsen 2009; Maniar 2012; McInnes 1992; Montgomery 1996; Sahin 2006). Swelling was measured with a tape measure. There was considerable between-study heterogeneity in estimates of effect (I^2 = 71%), so we did not pool the data. Point estimates of effect ranged from -1.9 to 1.6 cm (Analysis 1.26).

Medium-term effects: Two trials with 119 participants measured swelling (Bruun-Olsen 2009; Maniar 2012). Both trials provided useful data. Swelling was measured with a tape measure. The MD was 0.8 cm with more swelling for the CPM group (95% CI -1.1 to 2.8; P value = 0.41; I^2 = 31%; Analysis 1.27).

Long-term effects: No trial measured this outcome during this time periods.

6. Quadriceps strength

Short-term effects: Two trials with 130 participants measured quadriceps strength (Lenssen 2003a; McInnes 1992). Both trials provided useful data. Strength was measured with a dynamometer (N) or manual muscle test (6-point scale). The SMD was 0.3 SD with more strength for the CPM group (95% CI -0.1 to 0.6; P value = 0.13; I^2 = 0%; Analysis 1.28).

Medium- and long-term effects: No trial measured this outcome during these time periods.

The **secondary comparison** compared CPM combined with standard postoperative care versus standard postoperative care plus additional knee exercises. These analyses provide a head-to-head comparison of the effectiveness of CPM and exercise. Analyses were performed on data from four trials (May 1999; Montgomery 1996; Ritter 1989; Worland 1998). Where it was possible to calculate pooled estimates, there was no indication of the superiority of either intervention (CPM or exercise).

The short-term effects of mean total continuous passive motion time on passive knee flexion range of motion

Eleven trials with 697 participants measured passive knee flexion ROM and provided sufficient data to estimate mean total CPM time (Bruun-Olsen 2009; Chiarello 1997; Harms 1991; Kumar 1996; Lenssen 2003a; Lenssen 2008; Montgomery 1996; Ng 1999; Nielsen 1988; Ritter 1989; Worland 1998). The duration of CPM had no effect on passive knee flexion ROM (mean increase of 0.01 degrees for every additional hour of CPM; 95% CI -0.04 to 0.06). This effect was not statistically significant (P value = 0.66).

Sensitivity analysis

Small sample size bias was not detected for any of the main comparisons.

DISCUSSION

Summary of main results

CPM following TKA is primarily advocated for its proposed benefits on knee ROM, particularly knee flexion. Knee flexion ROM is important for mobility tasks such as walking, transferring and performing activities of daily living (Rowe 2000). It is also important for activities such as squatting and kneeling, which are activities of daily living for many cultures (Hemmerich 2006). In interpreting the results of this review, it is important to consider how much additional knee flexion ROM is required to justify the use of CPM. Few people would claim that an added benefit of less than 5 degrees is functionally important, and most people would probably agree that considerably more than 5 degrees is required to justify the added time, cost and inconvenience of CPM. This being the case, the findings of this systematic review provide moderate-quality evidence to indicate that CPM does not have clinically important short-term effects on active knee flexion ROM (see Summary of findings for the main comparison and Analysis 1.1). The short-term effects on passive knee flexion, passive knee extension and active knee extension are similar with mean effects of 1 to 2 degrees. All estimates of the short-term effects of CPM on knee ROM are estimated with less than 5 degrees of uncertainty (as reflected in the 95% CI). The medium- and long-term effects of CPM on active knee flexion ROM, passive knee flexion ROM, active knee extension ROM or passive knee extension ROM are similar to the short-term effects - all have mean effects less than 3 degrees. Importantly, the upper 95% CIs of all but one of the eight estimates of the medium- and long-term effects are less than 5 degrees. The exception is the long-term effects on active knee flexion ROM, but this estimate was only based on three trials of 132 participants and the estimate is imprecise (95% CI -1 to 7 degrees). Taken together, this review provides moderate-quality evidence that CPM does not have sufficient effect on knee ROM to justify its widespread use.

Some people develop very stiff knees following TKA, irrespective of whether they receive CPM. One way to manage this problem is to manipulate the knee under anaesthesia. There is very low-quality evidence to suggest that CPM reduces the risk of manipulation. The reported effect is large in relative terms (RR 0.34) but the incidence proportion of manipulations following TKA is low (i.e. 7%) with only 25 manipulations reported in the eight trials involving 581 participants. An RR of 0.34 with this incidence proportion corresponds to an absolute reduction in risk of manipulation under anaesthesia of 4% (see Summary of findings for the main comparison). This means that one manipulation will be prevented in every 21 people provided with CPM (95% CI 16 to 126). However, the estimate of RR is imprecise (95% CI 0.13 to 0.89) and does not rule out the possibility of a trivially small effect (i.e. one manipulation prevented in every 126 people provided CPM). In addition, these results are based on just eight trials and it is not clear in any of the included trials whether the clinicians making decisions about the need for manipulation were blinded to allocation. Interestingly, while knee stiffness is the most common indication for manipulation under anaesthesia, the results from this systematic review indicate there was little difference in knee ROM of people who did and did not receive CPM. Therefore, the findings about risk of manipulation need to be interpreted with caution (see Summary of findings for the main comparison and Analysis 1.14).

One hundred and seventy-eight adverse events were reported in 16 trials comprising 1040 participants. The types of adverse events reported were delayed healing, haemarthrosis, falls, deep venous thromboses, wound infections, pulmonary emboli and a patellar rupture. Some of the adverse events were unlikely to be related to CPM but nonetheless were included in the analyses because they would not bias the findings. The point estimate provides low-quality evidence to indicate a decrease in the risk of adverse events with CPM (RR 0.92; 95% CI 0.63 to 1.33); however, the associated 95% CI includes an important increase and decrease in the risk of adverse events with CPM. It is, therefore, unclear whether CPM affects the risk of adverse events. The effect of CPM on participants' global assessment of treatment effectiveness was also unclear. The three trials that included this outcome provided contradictory results and the data were too heterogeneous to pool.

CPM clearly does not have clinically meaningful short-, medium- or long-term effects on pain (MDs range from -0.4 to 0.3 points on a 10-point scale; 95% CI range from -0.8 to 0.9) although the medium- and long-term effects are only based on three and one trials, respectively, and, therefore, need to be interpreted with caution. The short-, medium- and long-term effects of CPM on length of hospital stay, swelling and quadriceps strength are more difficult to interpret. While none of the meta-analyses on these outcomes

were statistically significant, it is not clear if they rule out clinically meaningful effects. Resolution of this issue requires clarification of what constitutes a clinically meaningful effect. For example, if a reduction in length of hospital stay of 2 days is considered clinically meaningful then the results of this systematic review clearly indicate that CPM does not have clinically meaningful effects (MD -0.4 days; 95% CI -1.0 to 0.2). However, if a reduction in length of hospital stay of 1 day is considered clinically meaningful then the data do not rule out the possibility of a clinically meaningful effect.

Perhaps the most important outcome is function because it reflects the implications of ROM, strength, swelling and pain on activities of daily living. However, function was not routinely included as an outcome measure and when it was, many different scales were used. The best estimate of the effect of CPM on function comes from trials that examined the medium-term effect. These trials provided moderate-quality evidence to suggest that CPM does not have clinically important effects on function unless a relative percent change in function of 5% is considered as worthwhile (relative percent change -4%; 95% CI -12 to 5; see Summary of findings for the main comparison). The precision of this estimate is surprisingly good given the multidimensional nature of the different measures used to measure function. For example, The Hospital and Knee Score used in some trials not only measures the ability of patients to walk, transfer and climb stairs but also measures knee ROM, pain, strength and instability. Future trials would benefit from some agreement on the most appropriate way to measure function in this group of patients.

Quality of life was only measured in two trials (Bennett 2005; Maniar 2012), yet together these trials provide moderate-quality evidence to indicate that CPM does not have clinically important effects. The medium-term effect was very small and the estimate surprisingly precise (MD of 1 point on a 0- to 100-point scale; 95% CI -3 to 4). This estimate does not rule out the possibility of a 4/100 point improvement in quality of life with CPM but most would consider this too small to justify its use. However, more trials are required to verify these findings.

Overall completeness and applicability of evidence

Many different protocols were used to administer CPM. For example, in some trials CPM was started immediately after the TKA operation whereas in other trials it was started days later. The CPM settings were also different between trials. In some trials, the settings were dictated by a protocol whereas in other trials they were determined by patient comfort or clinician discretion. All these variables may have influenced the observed effects of CPM. A meta-regression was used to explore the possibility that total CPM time influences passive knee flexion ROM. Passive knee flexion ROM was selected because this was the most commonly measured outcome. The meta-regression indicated that there was little or no effect of CPM duration on short-term passive knee flexion ROM. That is, trials that applied CPM for 24 hours a day over an extended time period did not report systematically more passive knee flexion ROM than those that only applied CPM for a few hours over one or two days.

Protocols for co-interventions were also highly variable. In a subset of four trials, control participants also received additional knee exercises. A secondary analysis explored the effect of CPM in this subset of trials. The purpose was to compare the effectiveness of CPM and knee exercises. This analysis was inconclusive because of the small number of trials. Nonetheless, it is unlikely that CPM would be more effective than knee exercises because the primary analysis indicated CPM is no more effective than usual care, with or without additional knee exercises.

There was usually a high degree of consistency (low between-study heterogeneity) in estimates of effects of pooled findings. Heterogeneity was only apparent in a small number of comparisons, typically where SMDs were used and when total sample sizes were small. The heterogeneity could have been due to any number of factors but was most likely due to the use of different tools to measure the same construct. This was particularly problematic for function, which was measured with outcomes as diverse as self reporting questionnaires and timed walking tests.

Interestingly, the applicability of the evidence about CPM is changing. CPM may no longer be a viable or appropriate treatment option, regardless of findings, because patients are now commonly discharged within a few days of surgery and often mobilised on the same day as surgery.

Quality of the evidence

The methodological quality of trials was variable (see Figure 2). Only 10 trials clearly blinded assessors. Not surprisingly, given the nature of the intervention, no trial blinded participants or therapists. Failure to blind assessors, participants and therapists exposes the trials to performance and detection biases. The failure to blind participants is potentially more of problem for outcomes that rely on self report (such as pain) than more objective measures (such as passive knee ROM). Only eight of the 24 trials concealed allocation and nearly all trials were selective in their reporting of data. These potential sources of bias led to a downgrading of the quality of evidence for all outcomes reported in the Summary of findings for the main comparison on the 'Risk of bias' criterion. Pain, manipulation under anaesthesia and participants' global assessment of treatment effectiveness were further downgraded because the results across trials for these outcomes were inconsistent. Imprecision of the point estimates were considered a serious problem for two of the primary outcomes, namely participants' global assessment of treatment effectiveness and manipulation under anaesthesia. Consequently, the findings for active knee flexion ROM, function and quality of life are based on moderate-quality evidence, the findings for pain and risk of adverse events are based on low-quality evidence, and the findings for participants' global assessment of treatment effectiveness and manipulation under anaesthesia are based on very low-quality evidence. These limitations notwithstanding, the main findings are probably robust because bias tends to inflate estimates of effects (Gluud 2006; Savovic 2012), and most estimates of treatment effects in this systematic review were very small.

Potential biases in the review process

The main potential source of bias in the review process arises from failure to identify all relevant trials. This may have occurred, particularly if trials were unpublished. However, retrieval bias generally tends to inflate estimates of effects (Dickersin 1993; Egger 1998), but this review reports small effects of CPM on most outcomes.

Agreements and disagreements with other studies or reviews

The original version of this systematic review was done in 2003. It was updated in 2010 and then again for this review in 2013. The main difference in conclusions between the original and the 2010 version related to length of hospital stay. In 2003, it was concluded that CPM reduces length of hospital stay. In the 2010 systematic review, it was concluded that CPM does not reduce length of hospital stay. However, in this present review it was concluded that the effects of CPM on length of hospital stay are inconclusive.

It is also worth noting that the original review performed in 2003 suggested that the effect of CPM on knee ROM may be dose dependent. Dose dependence was tested in the 2010 review and then again in this review by using a meta-regression to examine effects of mean total CPM time (hours) on passive knee flexion ROM in the short term. The results indicated that the response to CPM is not dose dependent.

Our findings are broadly consistent with the findings of similar systematic reviews (Grella 2008; Lenssen 2003b; van Dijk 2007; Viswanathan 2010). The only discrepancy is with the conclusions of Lenssen et al (Lenssen 2003b). These authors concluded that CPM had a short-term effect on knee flexion ROM (MD 8 degrees; 95% CI -2 to 18) despite the considerable uncertainty around the estimate. The difference between our estimate and that of Lenssen 2003b was probably due to differences in the trials included in the two meta-analyses. Our pooled estimate (MD 2 degrees, 95% CI 0 to 4) was based on 11 trials (697 participants) and the estimate of Lenssen 2003b was based of five trials (317 participants). There was only one trial in common in the two meta-analyses due to differences in the inclusion criteria and year of the reviews.

Other systematic reviews have investigated the effect of CPM following knee cartilage defect surgery (Fazalare 2010), shoulder rotator cuff repair (Du Plessis 2011), and anterior cruciate ligament reconstruction (Lobb 2012; Smith 2007). One review reported no evidence of benefit of CPM (Lobb 2012), two concluded that there was insufficient evidence (Fazalare 2010; Smith 2007), and one reported two clinical trials that demonstrated a treatment effect on ROM but this conclusion was not clearly supported from the findings of the two cited trials (Du Plessis 2011). While it is possible that the effects of CPM are different for various conditions, this would seem unlikely. Therefore, the results of the systematic reviews following different types of surgery lend further weight to the results of this systematic review indicating little if any benefit of CPM on at least knee ROM following TKA.

Summary

The findings of 24 RCTs of 1445 participants provide moderate-quality evidence that CPM does not have clinically important short-term effects on active knee flexion ROM or medium-term effects on function or quality of life. There is low-quality evidence to indicate that CPM does not have clinically important short-term effects on pain. The effects of CPM on participants' global assessment of treatment effectiveness, risk of manipulation, risk of adverse events, length of hospital stay, swelling and quadriceps strength remain unclear although there is very low-quality evidence to indicate that CPM reduces the risk of manipulation under anaesthesia.

AUTHORS' CONCLUSIONS

Implications for practice

The effects of continuous passive motion (CPM) on range of motion (ROM), pain, function and quality of life are too small to justify its use and costs but the effects of CPM on participants' global assessment of treatment effectiveness are unclear. This review provides very low-quality evidence that CPM reduces the risk of manipulation under anaesthesia; however, these findings need to be interpreted with caution because they are inconsistent with the moderate-quality evidence indicating that CPM has no effect on knee ROM even though the main indication for manipulation under anaesthesia is joint stiffness.

Implications for research

Future trialists should strive to improve the quality and reporting of their trials. The use of concealed allocation and blinded assessors is particularly important for reducing bias. In addition, attention should be given to stating when CPM starts and finishes, how long it is applied for and what settings are used. The accuracy of future meta-analyses could also be substantially improved if trialists consistently reported between-group differences with associated measures of variability for all outcomes and at all time points of data collection. In addition, researchers should strive to agree upon a standardised CPM protocol and appropriate outcome measures. This is particularly important for function and quality of life because researchers are using numerous different outcome measures, which makes pooling of results problematic. However, and regardless, we would only suggest further research to verify the effect of CPM on the need for manipulation under anaesthesia. Trials designed for this purpose should consider restricting the inclusion criteria to people at high risk of requiring manipulation under anaesthesia and ensuring those making the decision about the need for manipulation are blinded.

We would not recommend trials to determine the effect of CPM on knee joint ROM even though the evidence about the futility of CPM for improving active knee flexion is only moderate. The evidence was only downgraded from high to moderate because of the susceptibility of the included trials to bias. However, bias tends to inflate estimates of treatment effectiveness. Therefore, the real estimate is probably even less that reported in this review. In addition, the findings from passive knee flexion, active knee extension and passive knee extension were no more encouraging. Therefore, resources should not be wasted on further investigating the effect of CPM on knee joint ROM. However, without an effect of CPM on knee joint ROM there is no readily understandable way that CPM could affect any other variable. CPM is primarily prescribed for knee joint ROM. This suggests that trials designed to attain better estimates of the effects of CPM on some of the other outcomes may also be futile.

However, if trialists want to be more confident about the evidence supporting the conclusions of this trial, then they could look at improving quantification of the effects of CPM on function and quality of life because the findings on these outcomes are only based on a small number of trials and the quality of evidence is only moderate. More importantly, however, future trialists should focus on determining the effect of CPM on the need for manipulation. It is very difficult to reconcile the suggestion that CPM decreases the need for manipulation when CPM has little effect on knee joint

ROM. The apparent contradiction in findings could reflect the low-quality evidence supporting the findings on the decreased need for manipulation with CPM. Therefore, future trialists should pay particular attention to reducing bias.

This Cochrane review should only be updated if new evidence emerges that is likely to substantially change the conclusions of this review or shift the quality of evidence supporting the conclusions to high. However, it is unlikely that additional trials will change the conclusions about ROM because these estimates are reasonably precise and consistent, and we anticipate that with better quality trials the treatment effects will be smaller, not greater. If CPM does not affect knee joint ROM then it is most unlikely that CPM will affect any other outcomes because CPM is primarily prescribed on the basis of its benefits on knee joint ROM. With no effect on knee joint ROM, there are no obvious mechanisms for CPM to affect other outcomes. An update may, however, be justified if subsequent trials better clarify the effect of CPM on the need for manipulation.

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CHARACTERISTICS OF STUDIES

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

Alkire 2010

Methods	Randomised trial
Participants	Sample size: Gr1: 33; Gr2: 32 Inclusion: OA or RA, > 18 years Exclusion: cognitive/sensory deficits, patients residing in skilled nursing facilities, and non-English speaking patients. Initially participants with other co-morbidities were also excluded but this was later amended Mean age (no measure of variance) (yr): Gr1: 65.6; Gr2: 66.9

Alkire 2010 *(Continued)*

	Gender (F): Gr1: 87%; Gr2: 99% Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 70-90 dgr flexion. Provided 4 hr per session and 3 sessions per day for 3 days. Increased 10 dgr every session **Gr2: standard care** *Standard care for Gr1 and Gr2:* Provided twice a day (no details provided)
Outcomes	**Outcomes included in this review:** **Primary** 1. Pain: WOMAC-Pain (points)[a, ^] 2. Function: Knee Society Function Score (points)[a, ^] 3. Manipulation under anaesthesia: closed manipulation (number) **Secondary** 1. Passive knee flexion ROM (dgr)[a, ^] 2. Passive knee extension ROM (dgr)[a, ^] 3. Length of hospital stay (days)[a] 4. Adverse events: postoperative complications (number) 5. Swelling: mid-patellar girth (cm)[a, ^] **Other outcomes:** WOMAC-Function, WOMAC-Stiffness, drainage output, need for blood transfusion **Timing of outcome measures:** tested at POD 1, POD 2, 6 wk*, 3 mo† post randomisation
Notes	Swelling not tested at 6 wk so used POD 2 data for short-term effects.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "table of random numbers".
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	States: "no patients lost to follow-up".
Selective reporting (reporting bias)	Low risk	No indication of selective reporting.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.

Alkire 2010 *(Continued)*

Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Bennett 2005

Methods	Randomised trial
Participants	Sample size: Gr1: 48; Gr2: 52; Gr3: 47 Inclusion: 90 dgr knee flexion ROM with CPM in recovery, OA Exclusion: bilateral TKA, revision of TKA, RA, haemophilia Mean age (variance not reported) (yr): Gr1: 71; Gr2: 72; Gr3: 71 Gender (F): Gr1: 65%; Gr2: 67%; Gr3: 72% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:** **Gr1: early flexion CPM + standard care** CPM commenced POD 0. Initially 50-90 dgr. Provided for 6 hr/day. Increased 20-dgr flexion/day. Continued until POD 5 **Gr2: standard care** **Other groups:** **Gr3: standard CPM + standard care** CPM commenced POD 0. Initially 0-40 dgr. Provided 6 hr/day. Increased 10 dgr/day. Continued until POD 5 *Standard care for Gr1, Gr2, Gr3:* Commenced POD 1. Provided 1 hr/day. Included active assisted ROM, stretches, gait training, static quads, inner ROM quads, splint, transfer training, education
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr)[a] 2. Pain: VAS - mean score over 5 days (cm)[a, ^] 3. Function: Knee Society Score (points)[^] 4. Quality of life: SF-12 - Physical Component Summary (points)[^] 5. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr)[a, ^] 2. Active knee extension ROM (dgr)[a] 3. Passive knee extension ROM (dgr)[a] 4. Length of hospital stay - acute (days)[a] **Other outcomes:** SF-12 - Mental Component Summary, length of hospital stay - rehabilitation, pain: VAS daily.

Bennett 2005 *(Continued)*

Timing of outcome measures: tested at POD 5*, 3 mo†, 1 yr‡ post randomisation

Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "allocation by a block randomization". Clarified through personal communication that a random number generator was used.
Allocation concealment (selection bias)	Low risk	States: "surgeon and the independent assessor were blinded to group allocation". Although these people were not necessarily the people making the decisions about inclusion, it was clarified through personal communication that allocation schedule was kept in a locked cabinet and personnel responsible for recruiting did not have access to it.
Incomplete outcome data (attrition bias) All outcomes	Low risk	States: "one patient was subsequently excluded...results were analysed for remaining 147".
Selective reporting (reporting bias)	High risk	Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	*No other biases were present.*
Participant blinding?	High risk	States: "subjects were blinded to the study hypotheses". However, with CPM, it is not possible to blind participants to whether they did or did not receive CPM.
Personnel blinding?	High risk	States: "surgeon and the independent assessor were blinded to group allocation". However, with CPM, it is not possible to blind therapists to whether they did or did not administer CPM.
Outcome assessor blinding?	Low risk	States: "surgeon and the independent assessor were blinded to group allocation".

Bruun-Olsen 2009

Methods	Randomised trial
Participants	Sample size: Gr1: 30-34 (not clear); Gr2: 33-37 (not clear) Inclusion: OA, TKA, good cognitive function, fluent Norwegian Exclusion: RA, prosthesis in ipsilateral hip Mean age (SD) (yr): Gr1: 60 (10); Gr2: 71 (10) Gender (F): Gr1: 73%; Gr2: 67% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:** **Gr1: CPM + active exercise** CPM commenced POD 0. Initially 70-1030 dgr flexion. Provided 2 hr per session and initially 2 sessions then 3 sessions per day. Increased to 100 dgr on POD 2. Continued until POD 7.

Bruun-Olsen 2009 *(Continued)*

	Gr2: active exercise *Active exercise for Gr1, Gr2:* Commenced POD 1. Continued until discharge at 1 week. Non-standardised physiotherapy provided following discharge. Included active and assisted active ROM, gait training and static quads
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr) 2. Pain: VAS (points) 3. Function: timed 'Up and Go' test (points)^ **Secondary** 1. Passive knee flexion ROM (dgr) 2. Passive knee extension ROM (dgr) 3. Swelling: knee circumference (cm) **Other outcomes:** 40-m walk, up/down stairs. **Timing of outcome measures:** tested at 1 week*, 3 mo† post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Not stated.
Allocation concealment (selection bias)	Low risk	States: "closed, opaque envelopes".
Incomplete outcome data (attrition bias) All outcomes	Low risk	4/67 were lost at follow-up.
Selective reporting (reporting bias)	Low risk	Table 2 results correspond with reported outcome measures.
Other bias	Unclear risk	Some outcome data missing at 1 week and not clear if collected.
Participant blinding?	High risk	States: "single blind".
Personnel blinding?	High risk	States: "single blind".
Outcome assessor blinding?	Low risk	States: "single blind…the physiotherapist who performed the measures did not know".

Can 1995

Methods	Randomised trial

Can 1995 *(Continued)*

Participants	Sample size: Gr1: 26 knees; Gr2: 22 knees; (combined: 44 pts) Inclusion: primary TKA Exclusion: revision of TKA Age/gender: not reported Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-30 dgr. Provided for 4-6 hr/day. Increased 5-10 dgr/day. Continued for unreported period. **Gr2: standard care** *Standard care for Gr1, Gr2:* Commenced POD 0. Provided 2 x per day. Provided for unreported period. Included isometric exercises, assisted SLR, passive ROM, active ROM, stretches, inner ROM quad strengthening, gait training
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr)^ 2. Function: Knee Society Score (points)^ **Secondary** 1. Length of hospital stay (days)^ 2. Swelling: knee circumference (cm)^ 3. Quadriceps strength (points)^ **Other outcomes:** none **Timing of outcome measures:** tested at POD 3, POD 4, D/C*, 3 mo†, 1 yr‡ post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	High risk	Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Selective reporting (reporting bias)	Unclear risk	Not stated.
Other bias	Unclear risk	Not stated.
Participant blinding?	High risk	Not stated but not possible.

Can 1995 *(Continued)*

Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Chiarello 1997

Methods	Randomised trial
Participants	Sample size: Gr1: 8; Gr2: 10; Gr3: 8; Gr4: 9; Gr5: 11 Inclusion: degenerative joint disease, primary and unilateral TKA Exclusion: not reported Mean age (SD) (yr): Gr1: 74 (6); Gr2: 63 (10); Gr3: 71 (10); Gr4: 74 (9); Gr5: 71 (10) Gender (F): Gr1: 100%; Gr2: 70%; Gr3: 88%; Gr4: 56%; Gr5: 64% Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 1-3. Initial settings not reported. Provided for 10-12 hr/day. Increased 10 dgr/day. Continued until D/C or 2 wk post surgery **Gr2: standard care** **Other groups:** **Gr3: short duration CPM + standard care** CPM commenced POD 1-3. Initial settings not reported. Provided 3-5 hr/day. Increased 10 dgr/day. Continued until D/C or 2 wk post surgery **Gr4: short duration CPM + standard care** CPM commenced POD 1-3. Initial settings not reported. Provided 3-5 hr/day. Increased as tolerated. Continued until D/C or 2 wk post surgery **Gr5: long duration CPM + standard care** CPM commenced POD 1-3. Initial settings not reported. Provided 10-12 hr/day. Increased as tolerated. Continued until D/C or 2 wk post surgery *Standard care for Gr1, G2, Gr3, Gr4, Gr5:* Commenced POD 1-3. Provided daily. Included unspecified ROM exercises, gait training, transfer training, education, moist heat, strength and ROM exercises
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr) **Secondary** 1. Passive knee flexion ROM (dgr) 2. Active knee extension ROM (dgr) 3. Passive knee extension ROM (dgr) **Other outcomes:** none **Timing of outcome measures:** tested at D/C or 14 days* post randomisation

Chiarello 1997 *(Continued)*

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "randomly assigned...pre-determined randomized list".
Allocation concealment (selection bias)	High risk	Not stated where "pre-determined randomized list" was accessible to those recruiting participants. Clarified through personnel communication that allocation was not concealed.
Incomplete outcome data (attrition bias) All outcomes	Low risk	46/49 were present at follow-up.
Selective reporting (reporting bias)	Low risk	All data reported on all outcomes at all endpoints.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	High risk	States: "treating physical therapists collected data".

Colwell 1992

Methods	Randomised trial
Participants	Sample size: Gr1: 12; Gr2: 10 Inclusion: OA or RA, primary TKA Exclusion: TKA revisions, bilateral TKA, TKA requiring post-surgical manipulation under anaesthesia Mean age (variance not reported) (yr): Gr1: 73; Gr2: 74 Gender (F): Gr1: 67%; Gr2: 70% Type of arthritis: combined: 95% OA, 5% RA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-40 dgr. Provided for majority of day. Increased 10 dgr/day as tolerated. Continued until D/C (criteria = 90-dgr active ROM, independent SLR and activities of daily living) **Gr2: standard care** Physiotherapy and posterior splint for POD 1-3 *Standard care for Gr1, Gr2:* Commenced POD 1. Provided 2 x per day. Included transfer training, gait training, SLR, active ROM, passive ROM exercises

Colwell 1992 *(Continued)*

Outcomes	**Outcomes included in this review:** **Primary** None **Secondary** 1. Passive knee flexion ROM (dgr)[a] 2. Passive knee extension ROM (dgr)[a] 3. Length of hospital stay (days) **Other outcomes:** Hemovac output, pain medication **Timing of outcome measures:** tested at 1 mo*, 6 mo†, 1 yr‡ post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	21/22 were present at follow-up.
Selective reporting (reporting bias)	High risk	Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	-
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Denis 2006

Methods	Randomised trial
Participants	Sample size: Gr1: 27; Gr2: 27; Gr3: 26 Inclusion: OA, primary TKA, ambulatory, literate Exclusion: previous major lower-limb surgery, contralateral TKA, total hip arthroplasty < 12 mo. Medical condition preclude testing, comprehension problems, concurrent surgical intervention, neuromuscular or degenerative disease, infection, major health complication Mean age (SD) (yr): Gr1: 68 (7); Gr2: 67 (8); Gr3: 70 (7)

Denis 2006 *(Continued)*

	Gender (F): Gr1: 46%; Gr2: 52%; Gr3: 62% Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 2. Initially 35-45 dgr flexion. Provided for 2 hr/day. Increments determined by therapist. Continued until D/C or POD 8-9 **Gr2: standard care** **Other groups:** **Gr3: CPM + standard care** CPM commenced POD 2. Initially 35-45 dgr flexion. Provided 35 min/day. Increments determined by therapist. Continued until D/C or POD 8-9 *Standard care for Gr1, Gr2, Gr3:* Commenced POD 1. Provided daily. Include passive ROM, active ROM, gait training, inner ROM quads, static quads, transfer training, splint (POD 0 to POD 1), stairs
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr) 2. Pain: WOMAC - pain (points) 3. Function: Timed Up and Go Test (sec) 4. Manipulation under anaesthesia: closed manipulation (number) 5. Adverse events: postoperative complications (number) **Secondary** 1. Active knee extension ROM (dgr) 2. Length of hospital stay (days) **Other outcomes:** WOMAC - stiffness and functional difficulty, theoretical length of hospital stay, questionnaire - frequency and intensity of physical activity. **Timing of outcome measures:** tested at D/C* (approx. POD 8-9 post randomisation)
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "two strata were created for an equivalent distribution...one set of prenumbered, sealed envelopes was prepared". However, does not state how randomisation schedule was generated.
Allocation concealment (selection bias)	Low risk	States: "prenumbered sealed envelopes".
Incomplete outcome data (attrition bias) All outcomes	Low risk	81/81 were present at follow-up.
Selective reporting (reporting bias)	Low risk	All data reported on all outcomes at all endpoints.

Denis 2006 *(Continued)*

Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Low risk	States: "Assessment was performed…unaware of group allocation".

Harms 1991

Methods	Randomised trial
Participants	Sample size: Gr1: 55; Gr2: 58 Inclusion: OA or RA, primary TKA, knee flexion contracture < 40 dgr, presurgical. condition - able to walk 10 m within 2 min with walking aid, able to rise from chair with arm rests and seat height of 18 inches (45.7 cm) Exclusion: TKA revisions, concurrent knee surgery, condition comprising treatment Mean age (SD) (yr): Gr1: 69 (9); Gr2: 71 (10) Gender (F): Gr1: 78%; Gr2: 93% Type of arthritis: combined: 64% OA, 36% RA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-40 dgr at 2 dgr/sec. Provided for 6 hr/day. Increased 10 dgr/day as tolerated (after first 48 hr). Continued until 80 dgr of flexion achieved. Immobilised in splint or back slab while off CPM. **Gr2: standard care** *Standard care for Gr1, Gr2:* Commenced POD 1. Provided 20 min/day. Included: POD1: splint, static quads contractions progressing towards SLR, ankle and gluteal exercises POD2: mobilise with splint POD3: active knee flexion, inner ROM quads exercises, splint removed POD5: mobilise without splint if dynamic control of knee extension or proper SLR
Outcomes	**Outcomes included in this review:** **Primary** 1. Pain: VAS[a] 2. Participants' global assessment of treatment effectiveness: Ease Score (VAS) 3. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr) 2. Active knee extension ROM (dgr) 3. Length of hospital stay (days) **Other outcomes:** wound drainage, number of participants requiring outpatient physiotherapy, pain medication

Harms 1991 *(Continued)*

	Timing of outcome measures: tested at POD 7, POD 14*, D/C post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "random allocation table was generated". However, does not state how randomisation schedule was generated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not stated.
Selective reporting (reporting bias)	High risk	Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Huang 2003

Methods	Randomised trial
Participants	Sample size: Gr1: 23; Gr2: 21 Inclusion: primary TKA Exclusion: not reported Mean age (range) (yr): combined: 69 (20-92) Gender (F): combined: 82% Type of arthritis: combined: 77% OA, 23% RA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-40 dgr. Provided for 20 hr/day. Decreased on POD 3 to 16 hr/day. Continued until POD 14 **Gr2: standard care** *Standard care for Gr1, Gr2:* Commenced on POD 0. Provided for unreported period. Included isometric exercises, assisted SLR, passive ROM, active ROM, stretches, inner ROM quad strengthening
Outcomes	**Outcomes included in this review:**

Huang 2003 *(Continued)*

Primary

1. Active knee flexion ROM (dgr)
2. Adverse events: postoperative complications (number)

Secondary

1. Active knee extension ROM (dgr)[a]
2. Passive knee extension ROM (days)
3. Length of hospital stay (days)

Other outcomes: pain medication

Timing of outcome measures: tested at POD 7, POD 14*, 6 wk, 3 mo†, 6 mo, 1 yr‡ post randomisation

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not stated.
Selective reporting (reporting bias)	High risk	Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Unclear risk	Incomplete reporting of some outcomes.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	High risk	Not stated but not possible.

Kumar 1996

Methods	Randomised trial
Participants	Sample size: Gr1: 40 pts (46 knees); Gr2: 33 pts (37 knees) Inclusion: OA Exclusion: not reported Mean age (range) (yr): Gr1: 69 (52-86); Gr2: 68 (42-88) Gender (F): Gr1: 58%; Gr2: 67% Type of arthritis: not reported

Kumar 1996 *(Continued)*

Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-90 dgr. Provided for 10 hr/day. Increments not reported. Continued until D/C (criteria = dry wound, 80 dgr flexion, ambulation 300 feet 2 x per day with single crutch or walking stick, independent transfers). Immobilisation at night **Gr2: standard care** Immobilisation removed POD 1, passive ROM x 20 min (progressed to 30-45 min), 2 x per day 90 dgr flexion achieved at each session *Standard care for Gr1, Gr2:* Commencement not reported. Provided 2 hr/day. Included isometric exercises, passive ROM, active ROM, stretches, gait training (including stairs). FES if extensor lag > 30 dgr or if no independent SLR performed on POD 3
Outcomes	**Outcomes included in this review:** **Primary** 1. Function: Knee Society Score (points)^ 2. Quality of life: SF-36 (points)^ 3. Manipulation under anaesthesia: closed manipulation (number) 4. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr) 2. Passive knee extension ROM (dgr) 3. Length of hospital stay (days) **Other outcomes:** Knee Society Function Score, delay in physiotherapy due to wound drainage, length of acute stay (days), length of rehab stay (days). **Timing of outcome measures:** tested at POD 5*, 6 wk, 3 mo, 6 mo† post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "a random number generator".
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	High risk	46/77 were present at follow-up.
Selective reporting (reporting bias)	High risk	Not all data reported for all outcomes at all endpoints (e.g. SF-36).
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.

Kumar 1996 *(Continued)*

Outcome assessor blinding?	Unclear risk	Not stated.

Lau 2001

Methods	Randomised trial
Participants	Sample size: combined: 43 pts (60 knees) Inclusion: TKA for OA or RA Exclusion: not reported Mean age (range) (yr): combined: 70 (43-86) Gender (F): combined: 84% Type of arthritis (combined): OA: 72% pts, 75% knees; RA: 28% pts, 25% knees
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 1. Initially 0-60 dgr. Provided for 23 hr/day. Increased as tolerated. Continued until POD 7 **Gr2: standard care** Immobilised until POD 7 *Standard care for Gr1, Gr2:* Commenced on POD 7. Provided for unreported period. Included assisted ROM, gait training
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr)[a] 2. Pain: VAS[^] 3. Adverse events: postoperative complications (number) **Secondary** 1. Active knee extension ROM (dgr)[a] 2. Length of hospital stay (days)[^] **Other outcomes:** none **Timing of outcome measures:** tested at POD 3, POD 5, POD 7, POD 14*, POD 28, POD 42, 3 mo, 6 mo[†], 1 yr[‡] post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.

Lau 2001 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	38/43 patients (60/66 knees) were present at follow-up.
Selective reporting (reporting bias)	High risk	Does not clearly state what outcomes were measured. Does not report all outcomes for all endpoints. Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	High risk	Abandoned VAS.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Lenssen 2003a

Methods	Randomised trial
Participants	Sample size: Gr1: 20; Gr2: 20 Inclusion: OA, undergoing TKA Exclusion: not reported Mean age (SD) (yr): Gr1: 65 (9); Gr2: 66 (10) Gender (F): Gr1: 71%; Gr2: 63% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 1. Initial settings individually determined. Provided for 4 hr/day. Increased as tolerated. Continued until POD 4 **Gr2: standard care** *Standard care for Gr1, Gr2:* Commenced on POD 1. Provided for 40 min/day. Included active ROM, passive ROM exercises, inner ROM and static quads strengthening, gait training, joint mobilisation
Outcomes	**Outcomes included in this review:** **Primary** 1. Pain: 11-point Likert scale 2. Function: The Hospital for Special Surgery Scoring System **Secondary** 1. Passive knee flexion ROM (dgr) 2. Passive knee extension ROM (dgr) 3. Length of hospital stay (days) 4. Quadriceps strength (N)

Lenssen 2003a *(Continued)*

	Other outcomes: pain medication, satisfaction with physiotherapist's attention (11-point scale), satisfaction with physiotherapist's treatment (11-point scale), lowest pain in last 24 hr (points), worst pain in last 24 hr (points) **Timing of outcome measures:** tested at POD 4, POD 17* post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "computer-generated table".
Allocation concealment (selection bias)	Low risk	States: "independent...secretary without knowledge of the randomisation schedule called up the patients for operation". Clarified through personal communication that allocation was concealed.
Incomplete outcome data (attrition bias) All outcomes	Low risk	38/40 were present at follow-up.
Selective reporting (reporting bias)	Low risk	All data reported on all outcomes at all endpoints.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Low risk	States: "independent, blinded observer".

Lenssen 2008

Methods	Randomised trial
Participants	Sample size: Gr1: 30; Gr2: 30 Inclusion: primary unilateral TKA, < 80 dgr at POD 4, able to understand and speak Dutch, not suffering from mental disabilities, resident within the Maastricht Heuvelland region Exclusion: patients who need to stay in hospital > POD 5, showed relevant comorbidity influencing mobility (e.g. claudication, other prosthesis) or were operated upon by minimally invasive surgery, aged > 80 years, RA Mean age (SD) (yr): Gr1: 64 (8); Gr2: 65 (9) Gender (F): Gr1: 60%; Gr2: 70% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced when D/C from acute hospital care (approx. POD 4). Initial settings individually determined. Provided for 4 hr/day. Increased as tolerated. Continued until POD 17

Lenssen 2008 *(Continued)*

Gr2: standard care
Standard care for Gr1, Gr2:
Commenced on POD 4. Provided for 20 min/day. Included active ROM, passive ROM exercises, inner ROM and static quads strengthening, gait training (including stairs), sit to stand training

Outcomes

Outcomes included in this review:

Primary

1. Active knee flexion ROM (dgr)
2. Pain: WOMAC - pain subscale (points)
3. Function: Knee Society Score (points)
4. Participants' global assessment of treatment effectiveness: perceived effects (7-point Likert scale)
5. Manipulation under anaesthesia: closed manipulation (number)

Secondary

1. Passive knee flexion ROM (dgr)^
2. Active knee extension ROM (dgr)
3. Passive knee extension ROM (dgr)^

Other outcomes: WOMAC (measure of function), pain medication, satisfaction with treatment (11-point Likert scale), satisfaction with treatment results (11-point Likert scale), adherence to treatment protocol and use of CPM (hr), Knee Society Score - function, WOMAC (stiffness and difficulty sub scale)

Timing of outcome measures: tested at POD 17 (12 days after randomisation)*, 6 wk, 3 mo† post randomisation

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "blocked and concealed randomisation with a block size of four ensured equal distribution of patients over the 2 treatment group....groups were prestratified on pre-operative flexion mobility of the knee...randomly assigned". Clarified through personal communication that sequence was computer generated.
Allocation concealment (selection bias)	Low risk	States: "concealed randomisation".
Incomplete outcome data (attrition bias) All outcomes	Low risk	60/60 were present at follow-up.
Selective reporting (reporting bias)	High risk	Not all data reported for all outcomes at all endpoints (e.g. secondary outcomes at 3 mo).
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Low risk	States: "blinded...assessment and analysis".

MacDonald 2000

Methods	Randomised trial
Participants	Sample size: Gr1: 40; Gr2: 40; Gr3: 40 Inclusion: aged < 80 yr with primary OA, no previous surgery on the knee, normal functioning ipsilateral hips, ability to tolerate non-steroidal anti-inflammatory drugs and Marcaine (bupivacaine hydrochloride and epinephrine injection), ability to ambulate 30 m preoperatively, ability to climb 10 steps Exclusion: RA, > 15 dgr valgus or fixed flexion deformity Age/gender: not reported Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-50 dgr. Provided for 18-24 hr/day. Increased by 10 dgr/hr as tolerated. Continued until POD 1 **Gr2: standard care** **Other groups:** **Gr3: CPM + standard care** CPM commenced POD 0. Initially 70-110 dgr. Provided for 18-24 hr/day. Not increased. Continued until POD 1 *Standard care for Gr1, Gr2, G3:* Commenced POD 1. Provided 2 x per day for 6 wk. Included active ROM, passive ROM exercises, mobilised as tolerated using walker or crutches
Outcomes	**Outcomes included in this review:** **Primary** 1. Function: Knee Society Score (points)^ **Secondary** 1. Passive knee flexion ROM (dgr)^ 2. Passive knee extension ROM (dgr)^ 3. Length of hospital stay (days) **Other outcomes:** pain medication **Timing of outcome measures:** tested at D/C*, 6 wk†, 12 wk, 26 wk, 1 yr‡ post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	States: "computer generated randomised schedule".
Allocation concealment (selection bias)	Low risk	Not stated. Clarified through personal communication that allocation was concealed.
Incomplete outcome data (attrition bias)	Unclear risk	Not stated.

MacDonald 2000 *(Continued)*

All outcomes

Selective reporting (reporting bias)	High risk	Not all data reported for all outcomes at all endpoints (e.g. 26 wk).
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Low risk	States: "a blinded independent observer".

Maniar 2012

Methods	Randomised trial
Participants	Sample size: Gr1: 28 (33 knees); Gr2: 28 (33 knees); Gr3: 28 (33 knees) Inclusion: OA or RA, primary TKA, ambulatory Exclusion: Medical condition interfering with tests, neuromuscular or neurodegenerative disease Mean age (variance not reported) (yr): Gr1: 66; Gr2: 67; Gr3: 67 Gender (F): Gr1: 93%; Gr2: 93%; Gr3: 89% Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM for 3 days + standard care** CPM commenced POD 2. Initially 0-30 dgr flexion. Provided 15 min per session and 2 sessions per day. Increased 10 dgr every 5 min. Continued until POD 4 **Gr2: standard care** **Other groups:** **Gr3: CPM for 1 day + standard care** CPM commenced POD 2. Initially 0-30 dgr flexion. Provided 15 min per session and 2 sessions per day. Increased 10 dgr every 5 min. Continued for 1 day *Standard care for Gr1, Gr2, Gr3:* Commenced POD 0. Continued POD 4. Included active ROM, gait training, static quads, inner ROM quads, gait and stair training, transfer training
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr)[a, ^] 2. Pain: WOMAC-Pain (points)[a, ^] 3. Function: WOMAC-Physical function (points)[a, ^] 4. Quality of life: SF-12 (points)[a] 5. Manipulation under anaesthesia: closed manipulation (number)

Maniar 2012 *(Continued)*

6. Adverse events: postoperative complications (number)

Secondary

1. Active knee extension ROM (dgr)[a, ^]
2. Swelling: supra-patellar girth (cm)

Other outcomes: WOMAC-Stiffness, WOMAC-Total, timed 'Up and Go' test, calf girth, pain at rest, pain on walking

Timing of outcome measures: tested at POD 3, POD 5, POD 14*, POD 42, 90 days† post randomisation

Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Not stated.
Allocation concealment (selection bias)	Low risk	States: "using sealed envelopes".
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	States how many randomised but does not clearly state how many were available at follow-up.
Selective reporting (reporting bias)	Low risk	No indication of selective reporting.
Other bias	High risk	Use of results from bilateral TKA without consideration of dependency.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

May 1999

Methods	Randomised trial
Participants	Sample size: Gr1: 12; Gr2: 7 Inclusion: unilateral primary TKA, OA Exclusion: surgical revision or manipulation under anaesthesia of the involved knee, knee flexion ROM > 80 dgr upon admission to rehabilitation, > POD 14 TKA, inability to participate in hydrotherapy due to factors such as incontinence or wound infection, RA, inability or unwillingness to provide informed consent Mean age (SD) (yr): Gr1: 73 (4); Gr2: 66 (9) Gender (F): Gr1: 67%; Gr2: 71% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:**

May 1999 *(Continued)*

Gr1: CPM + standard care
CPM commenced when admitted to rehabilitation facility (POD 2-13). Initial settings individually determined. Provided for 3-5 hr/day. Increased as tolerated. Continued until 80 dgr active knee flexion was achieved or until D/C, whichever came first

Gr2: Lower Limb Mobility Board + standard care
Commenced when admitted to rehabilitation facility (POD 2-13). Provided 5-10 min for 6 x per day, 7 days/wk

Standard care for Gr1, Gr2:
Commenced not reported. Provided 1-1.5 hr/day, 5 days/wk. Included active assisted ROM, gait training, inner ROM and static quads strengthening, hydrotherapy

Outcomes

Outcomes included in this review:

Primary

1. Active knee flexion ROM (dgr)
2. Pain: VAS
3. Function: mean walk time for 10 m with walking aide permitted (sec)

Secondary

1. Active knee extension ROM (dgr)
2. Passive knee extension ROM (dgr)
3. Length of hospital stay (days)[a]

Other outcomes: none

Timing of outcome measures: tested on admission to rehabilitation facility (POD 2-13), D/C* (POD 12-31) post randomisation

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	States: "stratified random technique". However, does not state how randomisation schedule was generated.
Allocation concealment (selection bias)	Low risk	States: "one of two pieces of paper indicating group assignment was drawn from an envelope labelled by gender and surgeon".
Incomplete outcome data (attrition bias) All outcomes	Low risk	19/21 were present at follow-up.
Selective reporting (reporting bias)	High risk	Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Low risk	States: "one of two assessors....blinded to the subjects' group allocation".

McInnes 1992

Methods	Randomised trial
Participants	Sample size: Gr1: 48; Gr2: 45 Inclusion: RA or OA, primary TKA, passive knee flexion ROM of at least 90 dgr and no more than 20 dgr knee flexion contracture Exclusion: cognitive or sensory deficit, unable to understand or speak English, undergoing another surgical procedure prior or during TKA, weight > 136 kg Mean age (SD) (yr): Gr1: 66 (2); Gr2: 70 (1) Gender (F): Gr1: 65%; Gr2: 64% Type of arthritis: Gr1: 73% OA; Gr2: 89% OA; combined: 81% OA, 19% RA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initial settings individually determined. Provided on average, 9 hr/day for POD 0-7. Increased as tolerated. Continued until D/C **Gr2: standard care** *Standard care for Gr1, Gr2:* Commenced POD 1. Provided 1-2 x per day, 7 days/wk. Included inner ROM and static quads strengthening (from POD 1), active assisted ROM and passive ROM exercises (from POD 2), SLR, gait training, transfer training, bicycling, proning
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr) 2. Pain: VAS 3. Function: Health Assessment Questionnaire[a, ^] 4. Manipulation under anaesthesia: closed manipulation (number) 5. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr)^ 2. Active knee extension ROM (dgr) 3. Passive knee extension ROM (dgr) 4. Length of hospital stay (days) 5. Swelling: knee circumference (cm) 6. Quadriceps strength (Nm) **Other outcomes:** quadriceps strength (probit. Nm) **Timing of outcome measures:** tested at POD 7*, 6 wk† post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.

McInnes 1992 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	93/102 were present at follow-up.
Selective reporting (reporting bias)	High risk	Does not clearly state what outcomes were measured (e.g. at 6 wk). Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Low risk	States: "blinded to whether the patient was using CPM".

Montgomery 1996

Methods	Randomised trial
Participants	Sample size: Gr1: 28; Gr2: 32 Inclusion: gonarthrosis, primary TKA Exclusion: not reported Mean age (SD) (yr): Gr1: 74 (5); Gr2: 76 (6) Gender (F): Gr1: 86%; Gr2: 75% Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 1. Initial settings individually determined. Speed set at 2-6 min/cycle. Provided for 9 hr/day, 7 days/wk. Increased as tolerated. Continued until D/C (criteria = active ROM minimum 70 dgr, no wound problem, ability to walk and climb stairs, independent with activities of daily living) or up to 2 wk **Gr2: knee ex's + standard care** Commenced POD 1. Provided for 1 hr/day, 5 days/wk. Included active ROM and passive ROM (assisted by physiotherapist) *Standard care for Gr1, Gr2:* Encouraged to exercise and provided with instructions on gait
Outcomes	**Outcomes included in this review:** **Primary** 1. Pain: VAS **Secondary** 1. Passive knee flexion ROM (dgr) 2. Length of hospital stay (days)

Montgomery 1996 *(Continued)*

	3. Swelling: knee circumference (cm) **Other outcomes:** none **Timing of outcome measures:** tested at POD 1, POD 3, POD 5, D/C* post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	60/68 were present at follow-up.
Selective reporting (reporting bias)	Unclear risk	Does not clearly state what outcomes were measured.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Ng 1999

Methods	Randomised trial
Participants	Sample size: Gr1: 16; Gr2: 16; Gr3: 17 Inclusion: unilateral TKA, passive knee flexion ROM of 100 dgr or more, ambulant Exclusion: cardiopulmonary complications, previous trauma or pathology (or both) of the hip on affected side, neurological deficits, not assessed by physiotherapist preoperatively Age/gender: not reported Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: early knee flexion CPM + standard care** Commenced POD 0. Initially 70-100 dgr. Provided for 4 hr/day. Increased to 50-100 dgr on POD 1 and 0-100 dgr on POD 2. Continued for unreported period **Gr2: standard care** **Other groups:** **Gr3: conventional CPM + standard care**

Ng 1999 *(Continued)*

	Commenced POD 0. Initially 0-40 dgr. Provided for 4 hr/day. Increased 10 dgr/day. Continued for unreported period *Standard care for Gr1, Gr2, Gr3:* Commencement not reported. Provided for unreported period. Included active ROM, gait training, inner ROM and static quads strengthening exercises, transfer training, gluteal exercises
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr) 2. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr) 2. Active knee extension ROM (dgr) 3. Passive knee extension ROM (dgr) **Other outcomes:** number of days to achieve 90 dgr flexion ROM **Timing of outcome measures:** tested at POD 3, POD 5, POD 7* post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	49/55 were present at follow-up.
Selective reporting (reporting bias)	Low risk	All data reported on all outcomes at all endpoints.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Nielsen 1988

Methods	Randomised trial
Participants	Sample size: Gr1: 24; Gr2: 26

Nielsen 1988 *(Continued)*

	Inclusion: arthritis, primary TKA Exclusion: previous TKA in contralateral knee Mean age (range) (yr): Gr1: 71 (40-83); Gr2: 72 (37-83) Gender (F): Gr1: 70%; Gr2: 70% Type of arthritis: not reported
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 2. Initially 0-25 dgr. Provided for 4 hr/day. Increased 5-10 dgr/day. Continued until POD 12 **Gr2: standard care** *Standard care for Gr1, G2:* Commenced POD 2. Provided for unreported period. Included inner ROM quads and static quads strengthening, active ROM with full weight bearing
Outcomes	**Outcomes included in this review:** **Primary** 1. Pain: VAS^ **Secondary** 1. Passive knee flexion ROM (dgr) 2. Active knee extension ROM (dgr) **Other outcomes:** flexion deterioration, number of people with improvement, no change or deterioration. **Timing of outcome measures:** tested at POD 14* post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	50/54 were present at follow-up.
Selective reporting (reporting bias)	High risk	Does not clearly state what outcomes were measured. Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.

Nielsen 1988 *(Continued)*

Outcome assessor blinding?	Low risk	States: "the evaluation was carried out...who was uninformed".

Ritter 1989

Methods	Randomised trial
Participants	Sample size: Gr1: 50 pts (100 knees); Gr2: 50 pts (100 knees) Inclusion: preoperative range > 90 dgr Exclusion: not reported Mean age (range) (yr): combined: 73 (43-85) Gender (F): combined: 34% Type of arthritis: combined: 94% OA, 6% RA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 2. Initially settings individually determined. Provided for 20-24 hr/day. Increased as tolerated. Continued until POD 7 **Gr2: standard care** Knee extension splint at night until independent SLR achieved *Standard care for Gr1, Gr2:* Commenced POD 0. Provided 2 x per day. Included active ROM, stretches, static quads exercises, SLR
Outcomes	**Outcomes included in this review:** **Primary** 1. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr)[a] 2. Active knee extension ROM (dgr)[a] 3. Passive knee extension ROM (dgr) 4. Swelling: knee circumference (cm)[ł] **Other outcomes:** suprapatella and distal to patella circumference. **Timing of outcome measures:** tested at 1 wk*, 8 wk, 6 mo†, 1 yr‡ post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Not stated. Clarified through personal communication that sequence was computer generated.
Allocation concealment (selection bias)	Unclear risk	Not stated. Clarified through personal communication that sequence was stored on computer but not clear if concealed.

Ritter 1989 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Low risk	47/50 were present at follow-up.
Selective reporting (reporting bias)	High risk	Not all data reported for all outcomes at all endpoints (e.g. knee extension ROM at POD 61). Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated. Clarified through personal communication that unblinded assessors were used for short-term assessments and blinded assessors were used for medium- and long-term assessments.

Sahin 2006

Methods	American Knee Society
Participants	Sample size: Gr1: 15; Gr2: 16 Inclusion: TKA for primary OA Exclusion: TKA for secondary OA or inflammatory joint disease, cognitive or sensorial deficit; speech problems; bilateral TKA Mean age (SD) (yr): Gr1: 61 (6.0); Gr2: 61.6 (7.5) Gender (F): Gr1: 86%; Gr2: 86% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 1. Initially 0-40 dgr flexion. Provided 2.5 hr per session for 2 sessions per day. Increased by 10 dgr each day. Continued until POD 7 **Gr2: standard care** *Standard care for Gr1, Gr2:* Commenced POD 1. Provided for 30 min, 2 x per day for 1 wk. Continued until discharge (approx. POD 14). Home exercise programme provided following discharge until week 6. Included active and assisted active ROM, gait training, static quads, SLR, gluteal contractions and ankle pumping exercises
Outcomes	**Outcomes included in this review:** **Primary** 1. Active knee flexion ROM (dgr) 2. Pain during activity: VAS (points)^ 3. Function: American Knee Society Function score (points)^ 4. Adverse events: postoperative complications (number)

Sahin 2006 *(Continued)*

Secondary

1. Active knee extension ROM (dgr)
2. Swelling: knee circumference (cm)^

Other outcomes: pain at rest, American Knee Society Knee score.

Timing of outcome measures: tested at 2 weeks*, 6 weeks† and 6 months‡ post randomisation

Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	High risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Low risk	28/31 completed.
Selective reporting (reporting bias)	Low risk	All outcomes reported as per stated protocol.
Other bias	Unclear risk	Not stated how randomisation schedule was generated.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	States - "same physician". Looks unlikely that he/she was blinded.

Vince 1987

Methods	Randomised trial
Participants	Sample size: Gr1: 42; Gr2: 20 Inclusion: primary unilateral TKA Exclusion: obese (> 109 kg), bilateral TKA Mean age (range) (yr): Gr1: 68 (44-80); Gr2: 66 (47-83) Gender (F): Gr1: 69%; Gr2: 85% Type of arthritis: combined: 87% OA, 13% RA
Interventions	**Groups included in this review:** **Gr1: CPM + standard care** CPM commenced POD 0. Initially 0-30 dgr. Provided for 20 hr/day. Increased as tolerated. Continued until D/C **Gr2: standard care** *Standard care for Gr1, Gr2:*

Vince 1987 *(Continued)*

	Commenced POD 3. Provided for unreported period. Included active assisted ROM exercises, gait training
Outcomes	**Outcomes included in this review:** **Primary** 1. Manipulation under anaesthesia: closed manipulation (number) 2. Adverse events: postoperative complications (number) **Secondary** 1. Passive knee flexion ROM (dgr)[a] 2. Passive knee extension ROM (dgr)[a] 3. Length of hospital stay (days)[a] **Other outcomes:** time (days) to achieve 90 dgr flexion ROM **Timing of outcome measures:** tested at POD 4, POD 5, D/C* (POD 15-16) post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not stated.
Selective reporting (reporting bias)	High risk	Not clear what was measured. Key outcomes reported incompletely preventing their contribution to the meta-analysis.
Other bias	High risk	Unclear whether random allocated really was used. States: "The patients were assigned to the control or CPM group randomly". However, the imbalance in the size of the two groups was unlikely to occur by chance and nothing to suggest that blocked randomisation was used.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.
Outcome assessor blinding?	Unclear risk	Not stated.

Worland 1998

Methods	Randomised trial
Participants	Sample size: Gr1: 37 pts (49 knees); Gr2: 43 pts (54 knees)

Worland 1998 *(Continued)*

	Inclusion: unilateral and bilateral TKA, OA Exclusion: concomitant medical problems, serious drainage from wounds postoperatively Mean age (range) (yr): Gr1: 69 (54-81); Gr2: 71 (44-86) Gender (F): Gr1: 61%; Gr2: 71% Type of arthritis: combined: 100% OA
Interventions	**Groups included in this review:** **Gr1: CPM** CPM commenced when D/C from acute hospital care (approx. POD 3-4). Initially 90 dgr. Provided for 3 hr/day. Increments not reported. Continued for 10 days **Gr2: standard care** Commenced when D/C from acute hospital care (approx. POD 3-4). Provided for 1 hr, 3 x per wk. Continued for 2 wk. Included home exercises consisting of strengthening, stretching, gait training, SLR
Outcomes	**Outcomes included in this review:** **Primary** 1. Function: Hospital for Special Surgery scoring system^ **Secondary** 1. Passive knee flexion ROM (dgr) 2. Active knee extension ROM (dgr)^ 3. Passive knee extension ROM (dgr) **Other outcomes:** none **Timing of outcome measures:** tested at baseline upon randomisation (2 wk post operation)*, 6 wk†, 6 mo‡ post randomisation
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not stated.
Allocation concealment (selection bias)	Unclear risk	Not stated.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not stated.
Selective reporting (reporting bias)	High risk	Not all data reported for all outcomes at all endpoints (e.g. 2 wk).
Other bias	Low risk	No other biases were present.
Participant blinding?	High risk	Not stated but not possible.
Personnel blinding?	High risk	Not stated but not possible.

Worland 1998 *(Continued)*

Outcome assessor blinding?	Low risk	States: "All patients were evaluated by our senior author, who did not know which therapy the patient received".

*: endpoint included in analysis of short-term effect; †: endpoint included in analysis of medium-term effect; ‡: endpoint included in analysis of long-term effect; [a]: no measure of variability provided for at least one endpoint; ^: no data provided for at least one endpoint; ł: calculated SD implausible so not reported; approx.: approximately; cm: centimetre; CPM: continuous passive motion; D/C: discharge; dgr: degree; F: female; FES: functional electrical stimulation; Gr: group; hr: hour; kg: kilogram; m: metre; min: minutes; mo: month; Nm: newton metres; OA: osteoarthritis; POD: postoperative day; pts: patients; RA: rheumatoid arthritis; ROM: range of motion; SD: standard deviation; SF-12: Short-Form 12-Item Health Survey; SF-36: Short-Form 36-Item Health Survey; SLR: straight leg raise; TKA: total knee arthroplasty; VAS: visual analogue scale; wk: weeks; WOMAC: Western Ontario and McMaster Osteoarthritis Index; yr: years.

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

Study	Reason for exclusion
Beaupré 2001	Participants. Mixed population
Chen 2000	Participants. Unclear if all OA
Coutts 1983	Design. Not RCT
Davis 1984	Participants. Unclear if all OA
Haug 1988	Comparison. CPM + electrical stimulation versus CPM
Johnson 1990	Comparison. CPM + exercises involving full extension versus splinting + SLR
Johnson 1992	Comparison. CPM + full extension versus splinting + SLR
Kim 1995	Comparison. CPM versus alternative flexion + extension splinting regime
Kim 2009	Comparison and not true randomisation: allocated according to day of surgery. Passive ROM exercises provided by a therapist versus no passive ROM exercises
Leach 2006	Design. Not RCT
Leonard 2007	Comparison. One protocol of CPM versus another protocol of CPM
Lynch 1988	Participants. Mixed population
Maloney 1990	Design. Not RCT
Odenbring 1989	Participants. Osteotomy, not TKA
Pope 1997	Randomisation. Allocated according to admission
Simkin 1999	Intervention. CPM for the hip
Ververeli 1995	Design. Not RCT
Walker 1991	Participants. Unclear if all OA
Woog 2008	Comparison. One protocol of CPM versus another protocol of CPM
Yashar 1997	Comparison. One protocol of CPM versus another protocol of CPM

Study	Reason for exclusion
Young 1984	Design. Not RCT (retrospective study)

CPM: continuous passive motion; OA: osteoarthritis; RCT: randomised controlled trial; ROM: range of motion; SLR: straight leg raise; TKA: total knee arthroplasty.

Characteristics of studies awaiting assessment *[ordered by study ID]*

Aubriot 1993

Methods	Not known
Participants	Not known
Interventions	Not known
Outcomes	Not known
Notes	Only abstract in English. Manuscript in French

Cui 2009

Methods	Randomised controlled trial
Participants	20 participants following TKA
Interventions	2 groups: CPM versus no CPM
Outcomes	Knee ROM
Notes	Only abstract in English. Manuscript in Chinese

Ersozlu 2009

Methods	Randomised controlled trial
Participants	86 participants following TKA
Interventions	3 groups: conventional therapy versus CPM started on day 1 versus CPM started on day 3
Outcomes	Knee ROM; Knee Society Rating
Notes	Only abstract in English. Manuscript in Turkish

Li 2010

Methods	Between-group study but not clear if randomised
Participants	60 participants following TKA

Li 2010 *(Continued)*

Interventions	2 groups: velocity of CPM determined by protocol versus velocity of CPM determined by patient comfort
Outcomes	Knee Hospital for Special Surgery, pain and Barthel Index
Notes	Only abstract in English. Manuscript in Chinese. Comparison may exclude trial from this review

Li 2010a

Methods	Not known
Participants	Not known
Interventions	Not known
Outcomes	Not known
Notes	Only abstract in English. Manuscript in Chinese

Liu 2011

Methods	Between-group study but not clear if randomised
Participants	266 participants following TKA
Interventions	2 groups: CPM versus active exercises
Outcomes	Knee Society Score, ROM, pain
Notes	Only abstract in English. Manuscript in Chinese. Authors concluded KSS scores and ROM were higher in active exercises group at 3 months

Sosin 2000

Methods	Randomised controlled trial
Participants	76 participants following TKA
Interventions	2 groups: CPM versus no CPM
Outcomes	Knee Society Score
Notes	Only abstract in English. Manuscript in Polish. Authors conclude "no statistically significant differences" between the 2 groups

CPM: continuous passive motion; ROM: range of motion; TKA: total knee arthroplasty.

DATA AND ANALYSES

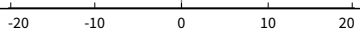
Comparison 1. Main comparison

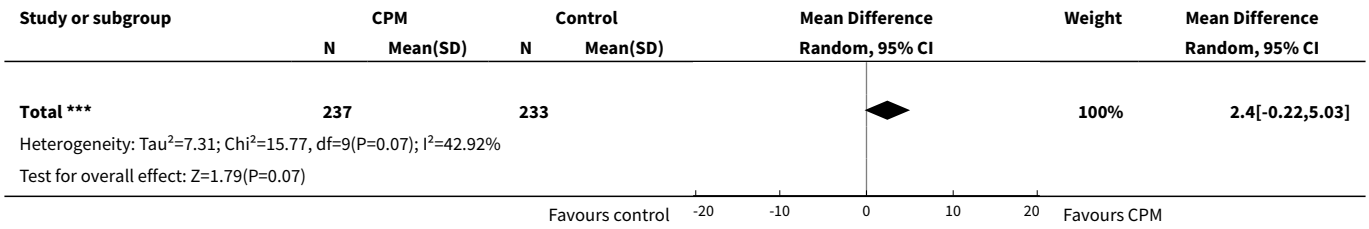
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Active knee flexion ROM - short-term effects	10	470	Mean Difference (IV, Random, 95% CI)	2.40 [-0.22, 5.03]
2 Active knee flexion ROM - medium-term effects	4		Mean Difference (IV, Random, 95% CI)	Totals not selected
3 Active knee flexion ROM - long-term effects	3	132	Mean Difference (IV, Random, 95% CI)	2.85 [-1.16, 6.87]
4 Pain - short-term effects	8	414	Mean Difference (IV, Random, 95% CI)	-0.38 [-0.84, 0.08]
5 Pain - medium-term effects	3	179	Mean Difference (IV, Random, 95% CI)	0.26 [-0.41, 0.94]
6 Pain - long-term effects	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
7 Function - short-term effects [standardised mean]	4		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
8 Function - medium-term effects [standardised mean]	6	405	Std. Mean Difference (IV, Random, 95% CI)	-0.08 [-0.27, 0.12]
9 Function - long-term effects [standardised mean]	4	288	Std. Mean Difference (IV, Random, 95% CI)	0.02 [-0.22, 0.25]
10 Quality of life - medium-term effects	2	156	Mean Difference (IV, Random, 95% CI)	0.75 [-2.58, 4.08]
11 Quality of life - long-term effects	1	100	Mean Difference (IV, Fixed, 95% CI)	2.20 [-3.90, 8.30]
12 Participants' global assessment of treatment effectiveness - short-term effects [points]	3		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
13 Participants' global assessment of treatment effectiveness - medium-term effects	1	60	Mean Difference (IV, Random, 95% CI)	-0.30 [-0.74, 0.14]
14 Manipulation under anaesthesia [number]	8	581	Risk Ratio (M-H, Random, 95% CI)	0.34 [0.13, 0.89]
15 Adverse events [number]	16	1040	Risk Ratio (M-H, Random, 95% CI)	0.92 [0.63, 1.33]
16 Passive knee flexion ROM - short-term effects	11	697	Mean Difference (IV, Random, 95% CI)	2.03 [0.21, 3.86]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
17 Passive knee flexion ROM - medium-term effects	4	264	Mean Difference (IV, Random, 95% CI)	-1.85 [-5.25, 1.55]
18 Passive knee flexion ROM - long-term effects	2	160	Mean Difference (IV, Random, 95% CI)	0.06 [-2.22, 2.35]
19 Active knee extension ROM - short-term effects	11	574	Mean Difference (IV, Random, 95% CI)	0.85 [-0.36, 2.06]
20 Active knee extension ROM - medium-term effects	4	195	Mean Difference (IV, Random, 95% CI)	0.77 [-0.78, 2.31]
21 Active knee extension ROM - long-term effects	2	108	Mean Difference (IV, Random, 95% CI)	0.06 [-0.06, 0.18]
22 Passive knee extension ROM - short-term effects	11	629	Mean Difference (IV, Random, 95% CI)	0.64 [-0.26, 1.55]
23 Passive knee extension ROM - medium-term effects	4		Mean Difference (IV, Random, 95% CI)	Totals not selected
24 Passive knee extension ROM - long-term effects	3	204	Mean Difference (IV, Random, 95% CI)	0.13 [-0.34, 0.59]
25 Length of hospital stay	10	614	Mean Difference (IV, Random, 95% CI)	-0.44 [-1.03, 0.16]
26 Swelling - short-term effects	5		Mean Difference (IV, Random, 95% CI)	Totals not selected
27 Swelling - medium-term effects	2	119	Mean Difference (IV, Random, 95% CI)	0.82 [-1.14, 2.77]
28 Quadriceps strength - short-term effects [standardised mean]	2	130	Std. Mean Difference (IV, Random, 95% CI)	0.27 [-0.08, 0.61]

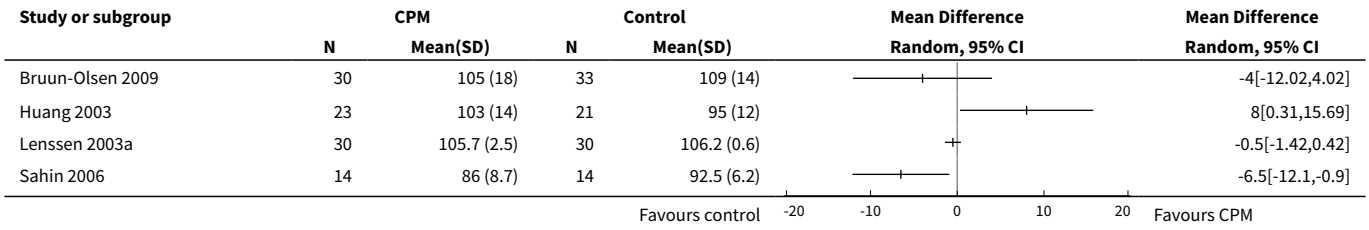
Analysis 1.1. Comparison 1 Main comparison, Outcome 1 Active knee flexion ROM - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	85 (13)	33	83 (16)		8.68%	2[-5.17,9.17]
Chiarello 1997	8	74.7 (12.5)	10	71 (12.1)		4.33%	3.7[-7.76,15.16]
Denis 2006	27	83.3 (11.9)	27	80.4 (11.8)		10.14%	2.9[-3.42,9.22]
Huang 2003	23	81 (12)	21	71 (15)		7.4%	10[1.92,18.08]
Lau 2001	30	78 (15)	30	74 (19)		6.69%	4[-4.66,12.66]
Lenssen 2008	30	89.9 (9.1)	30	86.7 (8.5)		14.4%	3.2[-1.26,7.66]
May 1999	12	79.7 (3.5)	7	79.4 (8.8)		9.26%	0.3[-6.51,7.11]
McInnes 1992	47	82 (11.8)	45	75 (11.5)		13.6%	7[2.24,11.76]
Ng 1999	16	67 (8.6)	16	71.9 (8.3)		11.06%	-4.9[-10.76,0.96]
Sahin 2006	14	82 (6.1)	14	82.9 (5.9)		14.43%	-0.9[-5.35,3.55]

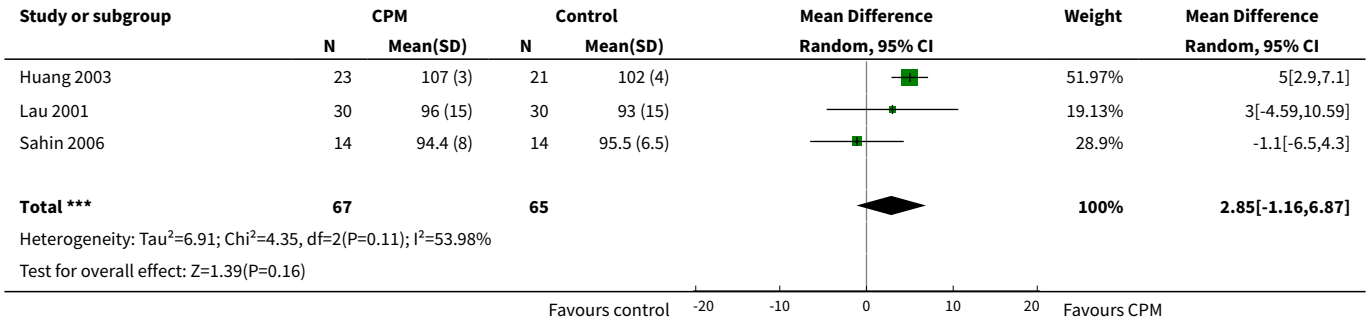




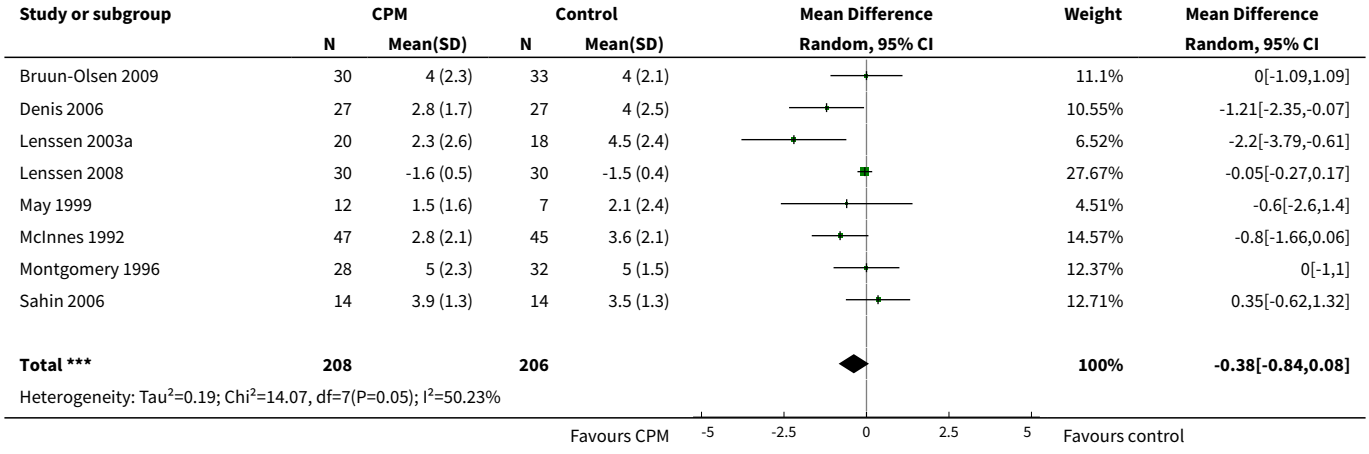
Analysis 1.2. Comparison 1 Main comparison, Outcome 2 Active knee flexion ROM - medium-term effects.



Analysis 1.3. Comparison 1 Main comparison, Outcome 3 Active knee flexion ROM - long-term effects.



Analysis 1.4. Comparison 1 Main comparison, Outcome 4 Pain - short-term effects.



Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Test for overall effect: Z=1.64(P=0.1)							

Analysis 1.5. Comparison 1 Main comparison, Outcome 5 Pain - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	2.9 (2.2)	33	1.9 (1.5)		27.81%	1[0.06,1.94]
Lenssen 2008	30	-1.7 (0.4)	30	-1.7 (0.1)		59.25%	0.02[-0.12,0.16]
Maniar 2012	28	3 (3.3)	28	3.2 (3)		12.94%	-0.2[-1.86,1.46]
Total ***	**88**		**91**			**100%**	**0.26[-0.41,0.94]**
Heterogeneity: Tau^2=0.19; Chi^2=4.17, df=2(P=0.12); I^2=52.09%							
Test for overall effect: Z=0.77(P=0.44)							

Analysis 1.6. Comparison 1 Main comparison, Outcome 6 Pain - long-term effects.

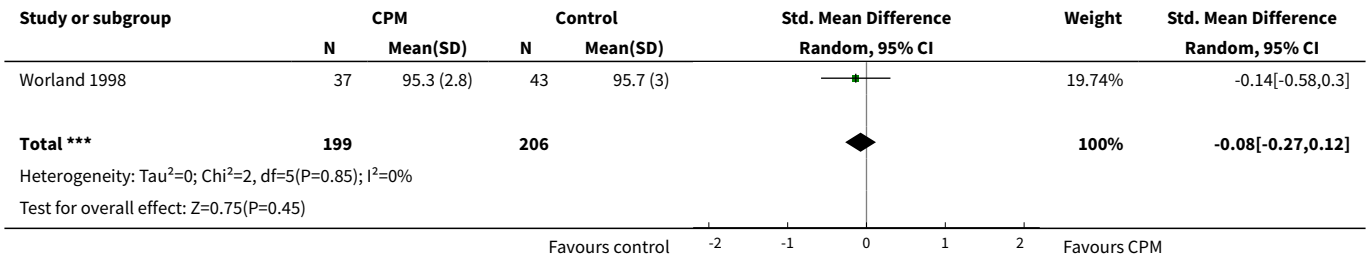
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Mean Difference Random, 95% CI
Sahin 2006	14	1.2 (1.1)	14	1.1 (1.2)		0.07[-0.77,0.91]

Analysis 1.7. Comparison 1 Main comparison, Outcome 7 Function - short-term effects [standardised mean].

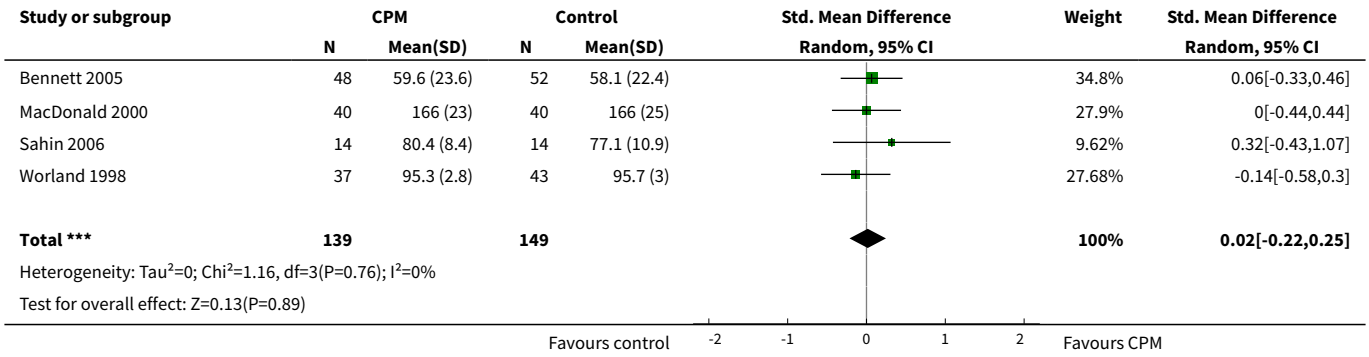
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Std. Mean Difference Random, 95% CI
Denis 2006	27	-52.3 (34.9)	27	-41.9 (21.4)		-0.35[-0.89,0.18]
Lenssen 2003a	20	66.2 (10.1)	18	54.2 (12.8)		1.03[0.34,1.71]
Lenssen 2008	30	67.6 (19.6)	30	67.3 (14.9)		0.02[-0.49,0.52]
May 1999	12	-35.6 (41.8)	7	-24.1 (18.2)		-0.31[-1.25,0.63]

Analysis 1.8. Comparison 1 Main comparison, Outcome 8 Function - medium-term effects [standardised mean].

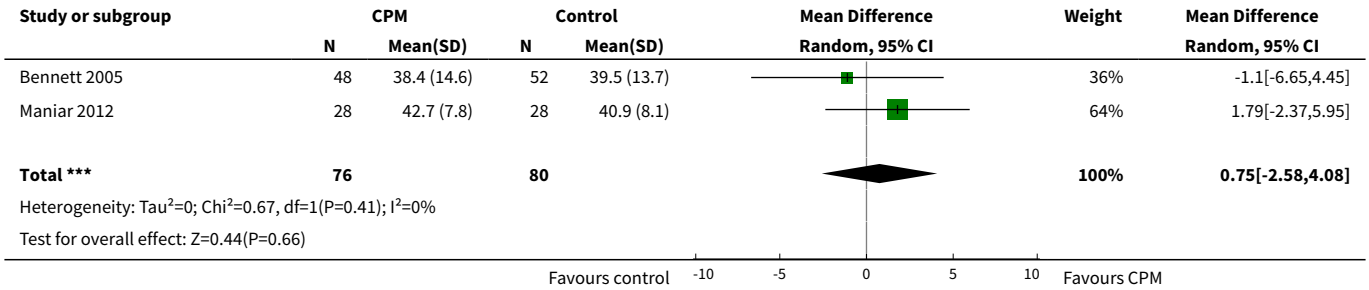
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
Bennett 2005	48	52.2 (22.2)	52	56 (21.6)		24.73%	-0.17[-0.57,0.22]
Bruun-Olsen 2009	30	11 (5)	33	12 (6)		15.57%	-0.18[-0.67,0.32]
Kumar 1996	26	82.7 (25.8)	20	80.7 (22.6)		11.24%	0.08[-0.5,0.66]
Lenssen 2008	30	80.4 (5.3)	30	78.8 (9.2)		14.83%	0.21[-0.3,0.72]
Maniar 2012	28	-11.6 (8)	28	-10.4 (9.7)		13.9%	-0.13[-0.65,0.39]



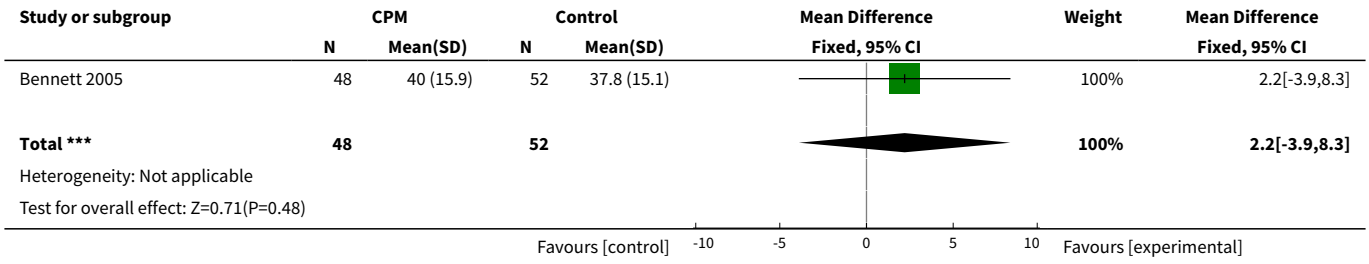
Analysis 1.9. Comparison 1 Main comparison, Outcome 9 Function - long-term effects [standardised mean].



Analysis 1.10. Comparison 1 Main comparison, Outcome 10 Quality of life - medium-term effects.

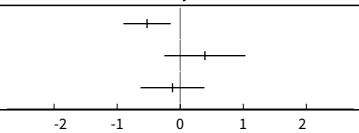


Analysis 1.11. Comparison 1 Main comparison, Outcome 11 Quality of life - long-term effects.



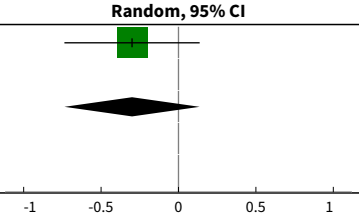
Analysis 1.12. Comparison 1 Main comparison, Outcome 12 Participants' global assessment of treatment effectiveness - short-term effects [points].

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Std. Mean Difference Random, 95% CI
Harms 1991	55	41 (24)	58	54 (25)		-0.53[-0.9,-0.15]
Lenssen 2003a	20	9 (1)	18	8.6 (1)		0.39[-0.25,1.04]
Lenssen 2008	30	2.3 (0.8)	30	2.4 (0.9)		-0.12[-0.63,0.38]



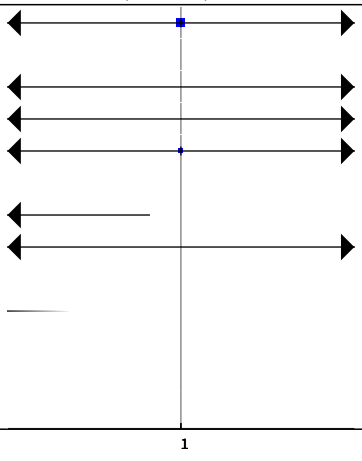
Analysis 1.13. Comparison 1 Main comparison, Outcome 13 Participants' global assessment of treatment effectiveness - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Lenssen 2008	30	2.1 (0.7)	30	2.4 (1)		100%	-0.3[-0.74,0.14]
Total ***	**30**		**30**			**100%**	**-0.3[-0.74,0.14]**
Heterogeneity: Not applicable							
Test for overall effect: Z=1.35(P=0.18)							



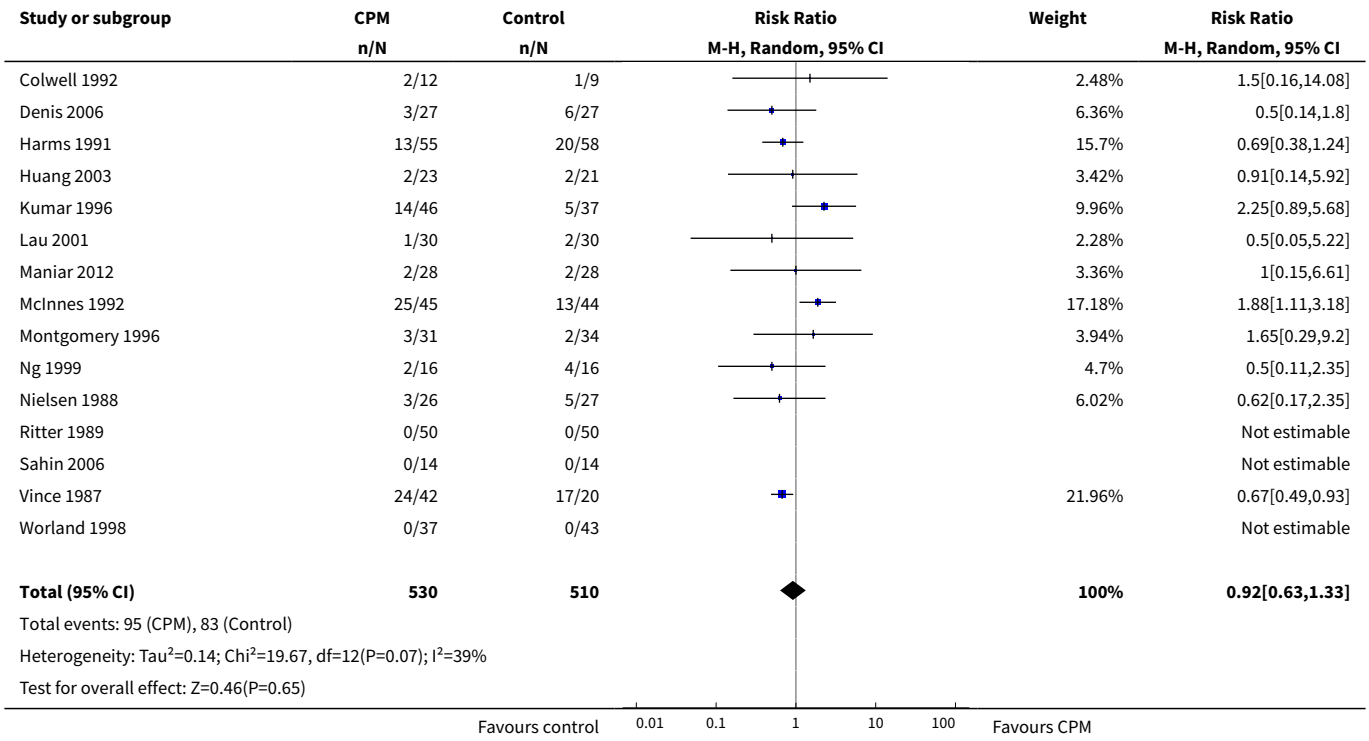
Analysis 1.14. Comparison 1 Main comparison, Outcome 14 Manipulation under anaesthesia [number].

Study or subgroup	CPM n/N	Control n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Alkire 2010	2/32	2/32		26.09%	1[0.15,6.67]
Denis 2006	0/27	0/27			Not estimable
Harms 1991	1/55	5/58		21%	0.21[0.03,1.75]
Kumar 1996	1/46	3/37		19.04%	0.27[0.03,2.47]
Lenssen 2008	1/30	1/30		12.65%	1[0.07,15.26]
Maniar 2012	0/28	0/28			Not estimable
McInnes 1992	0/45	8/44		11.79%	0.06[0,0.97]
Vince 1987	0/42	1/20		9.42%	0.16[0.01,3.83]
Total (95% CI)	**305**	**276**		**100%**	**0.34[0.13,0.89]**
Total events: 5 (CPM), 20 (Control)					
Heterogeneity: Tau^2=0; Chi^2=4.07, df=5(P=0.54); I^2=0%					
Test for overall effect: Z=2.19(P=0.03)					

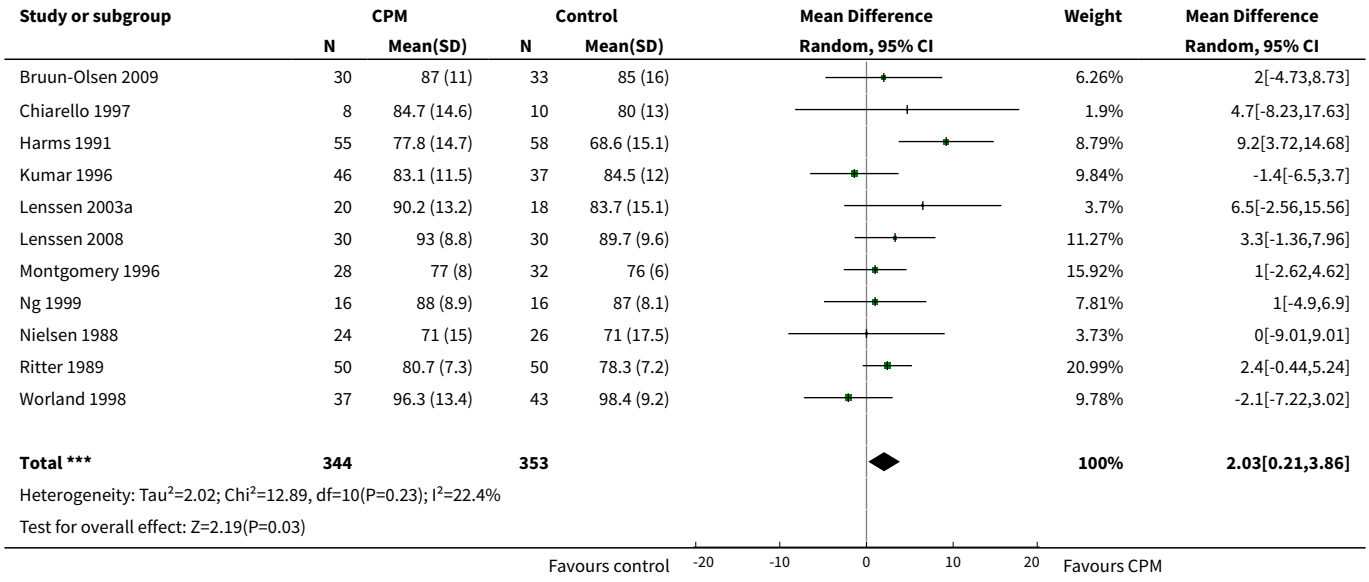


Analysis 1.15. Comparison 1 Main comparison, Outcome 15 Adverse events [number].

Study or subgroup	CPM n/N	Control n/N	Risk Ratio M-H, Random, 95% CI	Weight	Risk Ratio M-H, Random, 95% CI
Bennett 2005	1/48	4/52		2.66%	0.27[0.03,2.34]



Analysis 1.16. Comparison 1 Main comparison, Outcome 16 Passive knee flexion ROM - short-term effects.

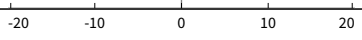


Analysis 1.17. Comparison 1 Main comparison, Outcome 17 Passive knee flexion ROM - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	108 (18)	33	112 (14)		14.86%	-4[-12.02,4.02]
Kumar 1996	27	115.2 (11.3)	14	113.9 (8.8)		21.84%	1.3[-4.98,7.58]
MacDonald 2000	40	98 (11)	40	104 (14)		26.29%	-6[-11.52,-0.48]
Worland 1998	37	105.7 (10.4)	43	105.6 (8.5)		37.02%	0.1[-4.11,4.31]
Total ***	**134**		**130**			**100%**	**-1.85[-5.25,1.55]**

Heterogeneity: Tau^2=3.53; Chi^2=4.23, df=3(P=0.24); I^2=29.08%

Test for overall effect: Z=1.07(P=0.29)



Analysis 1.18. Comparison 1 Main comparison, Outcome 18 Passive knee flexion ROM - long-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
MacDonald 2000	40	113 (8)	40	112 (9)		37.59%	1[-2.73,4.73]
Worland 1998	37	117.6 (7.2)	43	118.1 (5.8)		62.41%	-0.5[-3.4,2.4]
Total ***	**77**		**83**			**100%**	**0.06[-2.22,2.35]**

Heterogeneity: Tau^2=0; Chi^2=0.39, df=1(P=0.53); I^2=0%

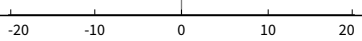
Test for overall effect: Z=0.05(P=0.96)

Analysis 1.19. Comparison 1 Main comparison, Outcome 19 Active knee extension ROM - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	-8 (4)	33	-11 (6)		12.14%	3[0.5,5.5]
Chiarello 1997	8	-20.5 (7.5)	10	-20.3 (18)		0.93%	-0.2[-12.51,12.11]
Denis 2006	27	-6.5 (3.7)	27	-8 (3.5)		15.41%	1.5[-0.42,3.42]
Harms 1991	55	-5.2 (4.9)	58	-8.3 (5.1)		15.89%	3.1[1.25,4.95]
Huang 2003	23	-5 (6)	21	-4 (6)		7.94%	-1[-4.55,2.55]
Lenssen 2008	30	-6.3 (3.9)	30	-8.1 (4.8)		13.67%	1.8[-0.41,4.01]
May 1999	12	-18.6 (9)	7	-15.2 (5.9)		2.87%	-3.4[-10.11,3.31]
McInnes 1992	48	-24 (19.3)	45	-25 (18.7)		2.22%	1[-6.74,8.74]
Ng 1999	16	-22.3 (4.4)	16	-21.3 (6.8)		6.78%	-1[-4.97,2.97]
Nielsen 1988	24	-5 (3.8)	26	-4 (5)		12.44%	-1[-3.44,1.44]
Sahin 2006	14	5.3 (4.1)	14	6.7 (4.1)		9.72%	-1.4[-4.44,1.64]
Total ***	**287**		**287**			**100%**	**0.85[-0.36,2.06]**

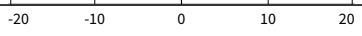
Heterogeneity: Tau^2=1.5; Chi^2=16.89, df=10(P=0.08); I^2=40.81%

Test for overall effect: Z=1.38(P=0.17)



Analysis 1.20. Comparison 1 Main comparison, Outcome 20 Active knee extension ROM - medium-term effects.

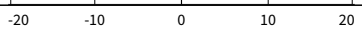
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	-4 (4)	33	-7 (6)		23.63%	3[0.5,5.5]
Huang 2003	23	-2 (2)	21	-3 (5)		26.21%	1[-1.29,3.29]
Lenssen 2008	30	-4.8 (3.9)	30	-4.3 (4.7)		27.62%	-0.5[-2.69,1.69]
Sahin 2006	14	4.2 (3.4)	14	4.5 (3.6)		22.54%	-0.3[-2.89,2.29]
Total ***	**97**		**98**			**100%**	**0.77[-0.78,2.31]**
Heterogeneity: Tau^2=1.01; Chi^2=5.05, df=3(P=0.17); I^2=40.57%							
Test for overall effect: Z=0.97(P=0.33)							



Favours control — Favours CPM

Analysis 1.21. Comparison 1 Main comparison, Outcome 21 Active knee extension ROM - long-term effects.

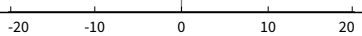
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Sahin 2006	14	1.9 (2.4)	14	2 (2.7)		0.4%	-0.1[-1.99,1.79]
Worland 1998	37	0 (0)	43	-0.1 (0.4)		99.6%	0.06[-0.06,0.18]
Total ***	**51**		**57**			**100%**	**0.06[-0.06,0.18]**
Heterogeneity: Tau^2=0; Chi^2=0.03, df=1(P=0.87); I^2=0%							
Test for overall effect: Z=0.98(P=0.33)							



Favours control — Favours CPM

Analysis 1.22. Comparison 1 Main comparison, Outcome 22 Passive knee extension ROM - short-term effects.

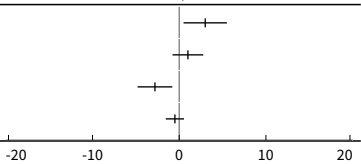
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	-7 (5)	33	-10 (6)		7.44%	3[0.28,5.72]
Chiarello 1997	8	-3 (6.4)	10	-6 (5.5)		2.36%	3[-2.58,8.58]
Huang 2003	23	-3 (3)	21	-4 (2)		13.96%	1[-0.49,2.49]
Kumar 1996	46	-9.3 (4.5)	37	-9.2 (5.5)		9.69%	-0.1[-2.3,2.1]
Lenssen 2003a	20	-4.2 (3.4)	18	-7.9 (5.9)		6.18%	3.7[0.59,6.81]
Lenssen 2008	30	-4.3 (3.1)	30	-5.7 (4.6)		10.82%	1.4[-0.58,3.38]
May 1999	12	-10.1 (6.4)	7	-10.3 (3.8)		3.33%	0.2[-4.39,4.79]
McInnes 1992	47	-7 (5.6)	45	-6 (5.5)		9.28%	-1[-3.28,1.28]
Ng 1999	16	-10.3 (4.5)	16	-11.9 (3.3)		7.38%	1.6[-1.13,4.33]
Ritter 1989	50	-2.8 (2.1)	50	-3 (2.2)		18.83%	0.17[-0.67,1.01]
Worland 1998	37	-4.2 (5.4)	43	-2.1 (3.3)		10.74%	-2.1[-4.1,-0.1]
Total ***	**319**		**310**			**100%**	**0.64[-0.26,1.55]**
Heterogeneity: Tau^2=0.95; Chi^2=18.94, df=10(P=0.04); I^2=47.19%							
Test for overall effect: Z=1.39(P=0.16)							



Favours control — Favours CPM

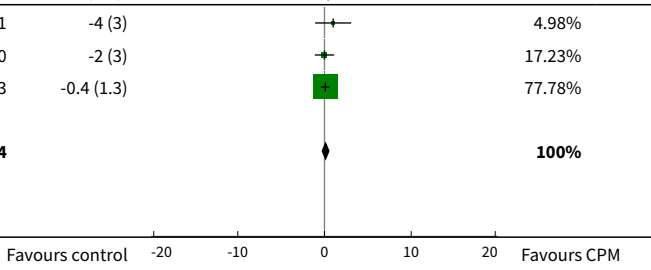
Analysis 1.23. Comparison 1 Main comparison, Outcome 23 Passive knee extension ROM - medium-term effects.

Study or subgroup	CPM		Control		Mean Difference	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI	Random, 95% CI
Bruun-Olsen 2009	30	-2 (4)	33	-5 (6)		3[0.5,5.5]
Huang 2003	23	-2 (3)	21	-3 (3)		1[-0.77,2.77]
Kumar 1996	27	-3.5 (5)	14	-0.7 (1.3)		-2.8[-4.81,-0.79]
Worland 1998	37	-1.3 (2.8)	43	-0.8 (1.8)		-0.5[-1.55,0.55]



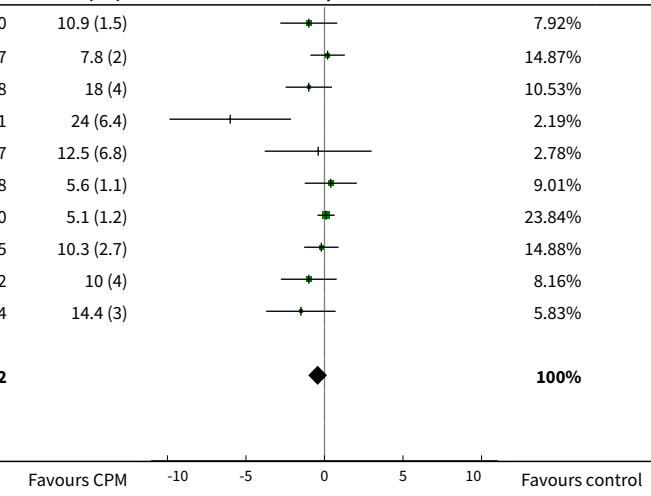
Analysis 1.24. Comparison 1 Main comparison, Outcome 24 Passive knee extension ROM - long-term effects.

Study or subgroup	CPM		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI		Random, 95% CI
Huang 2003	23	-3 (4)	21	-4 (3)		4.98%	1[-1.08,3.08]
MacDonald 2000	40	-2 (2)	40	-2 (3)		17.23%	0[-1.12,1.12]
Worland 1998	37	-0.3 (1.1)	43	-0.4 (1.3)		77.78%	0.1[-0.43,0.63]
Total ***	**100**		**104**			**100%**	**0.13[-0.34,0.59]**
Heterogeneity: Tau^2=0; Chi^2=0.74, df=2(P=0.69); I^2=0%							
Test for overall effect: Z=0.54(P=0.59)							



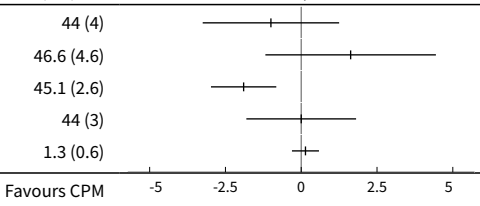
Analysis 1.25. Comparison 1 Main comparison, Outcome 25 Length of hospital stay.

Study or subgroup	CPM		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Random, 95% CI		Random, 95% CI
Colwell 1992	12	9.9 (2.8)	10	10.9 (1.5)		7.92%	-1[-2.81,0.81]
Denis 2006	27	8 (2.1)	27	7.8 (2)		14.87%	0.2[-0.89,1.29]
Harms 1991	55	17 (4)	58	18 (4)		10.53%	-1[-2.48,0.48]
Huang 2003	23	18 (6.7)	21	24 (6.4)		2.19%	-6[-9.87,-2.13]
Kumar 1996	46	12.1 (9)	37	12.5 (6.8)		2.78%	-0.4[-3.8,3]
Lenssen 2003a	20	6 (3.6)	18	5.6 (1.1)		9.01%	0.4[-1.26,2.06]
MacDonald 2000	40	5.2 (1.3)	40	5.1 (1.2)		23.84%	0.1[-0.45,0.65]
McInnes 1992	47	10.1 (2.7)	45	10.3 (2.7)		14.88%	-0.2[-1.29,0.89]
Montgomery 1996	28	9 (3)	32	10 (4)		8.16%	-1[-2.78,0.78]
Sahin 2006	14	12.9 (2.9)	14	14.4 (3)		5.83%	-1.5[-3.71,0.71]
Total ***	**312**		**302**			**100%**	**-0.44[-1.03,0.16]**
Heterogeneity: Tau^2=0.31; Chi^2=14.79, df=9(P=0.1); I^2=39.13%							
Test for overall effect: Z=1.44(P=0.15)							



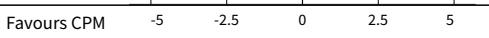
Analysis 1.26. Comparison 1 Main comparison, Outcome 26 Swelling - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	43 (5)	33	44 (4)		-1[-3.25,1.25]
Maniar 2012	28	48.2 (6)	28	46.6 (4.6)		1.63[-1.18,4.44]
McInnes 1992	48	43.2 (2.7)	45	45.1 (2.6)		-1.9[-2.98,-0.82]
Montgomery 1996	28	44 (4)	32	44 (3)		0[-1.81,1.81]
Sahin 2006	14	1.4 (0.6)	14	1.3 (0.6)		0.14[-0.31,0.59]



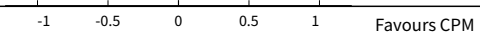
Analysis 1.27. Comparison 1 Main comparison, Outcome 27 Swelling - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Bruun-Olsen 2009	30	41 (4)	33	41 (4)		60.03%	0[-1.98,1.98]
Maniar 2012	28	47.1 (5.3)	28	45.1 (4.9)		39.97%	2.04[-0.63,4.71]
Total ***	**58**		**61**			**100%**	**0.82[-1.14,2.77]**
Heterogeneity: Tau^2=0.65; Chi^2=1.45, df=1(P=0.23); I^2=31.01%							
Test for overall effect: Z=0.82(P=0.41)							



Analysis 1.28. Comparison 1 Main comparison, Outcome 28 Quadriceps strength - short-term effects [standardised mean].

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
Lenssen 2003a	18	99 (45.6)	20	80.3 (31)		28.64%	0.47[-0.17,1.12]
McInnes 1992	47	19.1 (8.7)	45	17.5 (8.5)		71.36%	0.19[-0.22,0.59]
Total ***	**65**		**65**			**100%**	**0.27[-0.08,0.61]**
Heterogeneity: Tau^2=0; Chi^2=0.55, df=1(P=0.46); I^2=0%							
Test for overall effect: Z=1.52(P=0.13)							



Comparison 2. Secondary comparison - subgroup of studies in which control participants received additional knee exercises

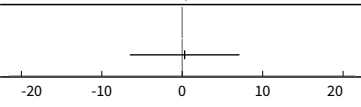
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Active knee flexion ROM	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.1 Short-term effects (< 6 wk)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2 Passive knee flexion ROM	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
2.1 Short-term effects (< 6 wk)	3	240	Mean Difference (IV, Random, 95% CI)	1.14 [-1.09, 3.38]
2.2 Medium-term effects (6 wk to 6 mo)	1	80	Mean Difference (IV, Random, 95% CI)	0.10 [-4.11, 4.31]
2.3 Long-term effects (> 6 mo)	1	80	Mean Difference (IV, Random, 95% CI)	-0.5 [-3.40, 2.40]
3 Active knee extension ROM	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.1 Short-term effects (< 6 wk)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
3.2 Long-term effects (> 6 mo)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
4 Passive knee extension ROM	3		Mean Difference (IV, Random, 95% CI)	Totals not selected
4.1 Short-term effects (< 6 wk)	3		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
4.2 Medium-term effects (6 wk to 6 mo)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
4.3 Long-term effects (> 6 mo)	1		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
5 Length of hospital stay	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
6 Function	2		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
6.1 Short-term effect (< 6 wk)	1		Std. Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
6.2 Medium-term effects (6 wk to 6 mo)	1		Std. Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
6.3 Long-term effects (> 6 mo)	1		Std. Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
7 Pain	2		Std. Mean Difference (IV, Random, 95% CI)	Totals not selected
7.1 Short-term effects (6 wk to 6 mo)	2		Std. Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]
8 Swelling	2		Mean Difference (IV, Random, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.1 Short-term effects (6 wk to 6 mo)	2		Mean Difference (IV, Random, 95% CI)	0.0 [0.0, 0.0]

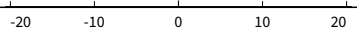
Analysis 2.1. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 1 Active knee flexion ROM.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Mean Difference Random, 95% CI
2.1.1 Short-term effects (< 6 wk)						
May 1999	12	79.7 (3.5)	7	79.4 (8.8)		0.3[-6.51,7.11]



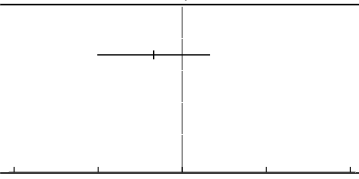
Analysis 2.2. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 2 Passive knee flexion ROM.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
2.2.1 Short-term effects (< 6 wk)							
Montgomery 1996	28	77 (8)	32	76 (6)		32.96%	1[-2.62,4.62]
Ritter 1989	50	80.7 (7.3)	50	78.3 (7.2)		49.37%	2.4[-0.44,5.24]
Worland 1998	37	96.3 (13.4)	43	98.4 (9.2)		17.67%	-2.1[-7.22,3.02]
Subtotal ***	**115**		**125**			**100%**	**1.14[-1.09,3.38]**
Heterogeneity: Tau^2=0.53; Chi^2=2.29, df=2(P=0.32); I^2=12.78%							
Test for overall effect: Z=1(P=0.32)							
2.2.2 Medium-term effects (6 wk to 6 mo)							
Worland 1998	37	105.7 (10.4)	43	105.6 (8.5)		100%	0.1[-4.11,4.31]
Subtotal ***	**37**		**43**			**100%**	**0.1[-4.11,4.31]**
Heterogeneity: Not applicable							
Test for overall effect: Z=0.05(P=0.96)							
2.2.3 Long-term effects (> 6 mo)							
Worland 1998	37	117.6 (7.2)	43	118.1 (5.8)		100%	-0.5[-3.4,2.4]
Subtotal ***	**37**		**43**			**100%**	**-0.5[-3.4,2.4]**
Heterogeneity: Not applicable							
Test for overall effect: Z=0.34(P=0.74)							



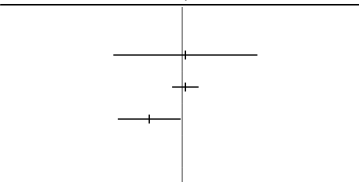
Analysis 2.3. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 3 Active knee extension ROM.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Mean Difference Random, 95% CI
2.3.1 Short-term effects (< 6 wk)						
May 1999	12	-18.6 (9)	7	-15.2 (5.9)		-3.4[-10.11,3.31]
2.3.2 Long-term effects (> 6 mo)						
Worland 1998	37	0 (0)	43	-0.1 (0.4)		Not estimable



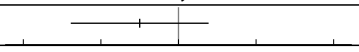
Analysis 2.4. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 4 Passive knee extension ROM.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Mean Difference Random, 95% CI
2.4.1 Short-term effects (< 6 wk)						
May 1999	12	-10.1 (6.4)	7	-10.3 (3.8)		0.2[-4.39,4.79]
Ritter 1989	50	-2.8 (2.1)	50	-3 (2.2)		0.2[-0.64,1.04]
Worland 1998	37	-4.2 (5.4)	43	-2.1 (3.3)		-2.1[-4.1,-0.1]
2.4.2 Medium-term effects (6 wk to 6 mo)						
Worland 1998	37	-1.3 (2.8)	43	-0.8 (1.8)		-0.5[-1.55,0.55]
2.4.3 Long-term effects (> 6 mo)						
Worland 1998	37	-0.3 (1.1)	43	-0.4 (1.3)		0.1[-0.43,0.63]



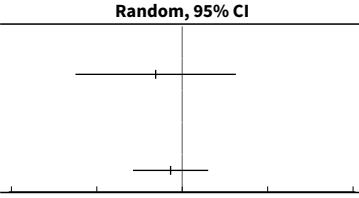
Analysis 2.5. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 5 Length of hospital stay.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Weight	Mean Difference Random, 95% CI
Montgomery 1996	28	9 (3)	32	10 (4)		0%	-1[-2.78,0.78]



Analysis 2.6. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 6 Function.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Std. Mean Difference Random, 95% CI
2.6.1 Short-term effect (< 6 wk)						
May 1999	12	-35.6 (41.8)	7	-24.1 (18.2)		-0.31[-1.25,0.63]
2.6.2 Medium-term effects (6 wk to 6 mo)						
Worland 1998	37	95.3 (2.8)	43	95.7 (3)		-0.14[-0.58,0.3]



Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Std. Mean Difference Random, 95% CI
2.6.3 Long-term effects (> 6 mo)						
Worland 1998	37	95.3 (2.8)	43	95.7 (3)		-0.14[-0.58,0.3]
				Favours control	-2 -1 0 1 2	Favours CPM

Analysis 2.7. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 7 Pain.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Random, 95% CI	Std. Mean Difference Random, 95% CI
2.7.1 Short-term effects (6 wk to 6 mo)						
May 1999	12	1.5 (1.6)	7	2.1 (2.4)		-0.3[-1.24,0.64]
Montgomery 1996	28	5 (2.3)	32	5 (1.5)		0[-0.51,0.51]
				Favours CPM	-2 -1 0 1 2	Favours control

Analysis 2.8. Comparison 2 Secondary comparison - subgroup of studies in which control participants received additional knee exercises, Outcome 8 Swelling.

Study or subgroup	Experimental N	Experimental Mean(SD)	Control N	Control Mean(SD)	Mean Difference Random, 95% CI	Mean Difference Random, 95% CI
2.8.1 Short-term effects (6 wk to 6 mo)						
Montgomery 1996	28	44 (4)	32	44 (3)		0[-1.81,1.81]
Ritter 1989	50	40.7 (0)	50	41.1 (0)		Not estimable
				Favours CPM	-2 -1 0 1 2	Favours control

Comparison 3. Main comparison - sensitivity analysis using fixed-effect model

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Active knee flexion ROM - short-term effects	10	470	Mean Difference (IV, Fixed, 95% CI)	2.29 [0.39, 4.20]
2 Active knee flexion ROM - medium-term effects	4		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3 Active knee flexion ROM - long-term effects	3	132	Mean Difference (IV, Fixed, 95% CI)	4.12 [2.22, 6.02]
4 Pain - short-term effects	8	414	Mean Difference (IV, Fixed, 95% CI)	-0.14 [-0.34, 0.05]
5 Pain - medium-term effects	3	179	Mean Difference (IV, Fixed, 95% CI)	0.04 [-0.10, 0.18]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 Pain - long-term effects	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
7 Function - short-term effects [standardised mean]	4		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
8 Function - medium-term effects [standardised mean]	6	405	Std. Mean Difference (IV, Fixed, 95% CI)	-0.08 [-0.27, 0.12]
9 Function - long-term effects [standardised mean]	4	288	Std. Mean Difference (IV, Fixed, 95% CI)	0.02 [-0.22, 0.25]
10 Quality of life - medium-term effects	2	156	Mean Difference (IV, Fixed, 95% CI)	0.75 [-2.58, 4.08]
11 Quality of life - long-term effects [points]	1	100	Mean Difference (IV, Fixed, 95% CI)	2.20 [-3.90, 8.30]
12 Participants' global assessment of treatment effectiveness - short-term effects [points]	3		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
13 Participants' global assessment of treatment effectiveness - medium-term effects	1	60	Mean Difference (IV, Fixed, 95% CI)	-0.30 [-0.74, 0.14]
14 Manipulation under anaesthesia [number]	8	581	Risk Ratio (M-H, Fixed, 95% CI)	0.26 [0.11, 0.64]
15 Adverse events [number]	16	1040	Risk Ratio (M-H, Fixed, 95% CI)	0.95 [0.75, 1.21]
16 Passive knee flexion ROM - short-term effects	11	697	Mean Difference (IV, Fixed, 95% CI)	2.01 [0.50, 3.52]
17 Passive knee flexion ROM - medium-term effects	4	264	Mean Difference (IV, Fixed, 95% CI)	-1.69 [-4.46, 1.08]
18 Passive knee flexion ROM - long-term effects	2	160	Mean Difference (IV, Fixed, 95% CI)	0.06 [-2.22, 2.35]
19 Active knee extension ROM - short-term effects	11	574	Mean Difference (IV, Fixed, 95% CI)	1.18 [0.33, 2.02]
20 Active knee extension ROM - medium-term effects	4	195	Mean Difference (IV, Fixed, 95% CI)	0.74 [-0.45, 1.92]
21 Active knee extension ROM - long-term effects	2	108	Mean Difference (IV, Fixed, 95% CI)	0.06 [-0.06, 0.18]
22 Passive knee extension ROM - short-term effects	11	629	Mean Difference (IV, Fixed, 95% CI)	0.44 [-0.12, 1.00]
23 Passive knee extension ROM - medium-term effects	4		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

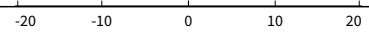
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
24 Passive knee extension ROM - long-term effects	3	204	Mean Difference (IV, Fixed, 95% CI)	0.13 [-0.34, 0.59]
25 Quadriceps strength - short-term effects [standardised mean]	2	130	Std. Mean Difference (IV, Fixed, 95% CI)	0.27 [-0.08, 0.61]
26 Length of hospital stay	10	614	Mean Difference (IV, Fixed, 95% CI)	-0.20 [-0.58, 0.19]
27 Swelling - short-term effects	5		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
28 Swelling - medium-term effects	2	119	Mean Difference (IV, Fixed, 95% CI)	0.72 [-0.87, 2.31]

Analysis 3.1. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 1 Active knee flexion ROM - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	85 (13)	33	83 (16)		7.03%	2[-5.17,9.17]
Chiarello 1997	8	74.7 (12.5)	10	71 (12.1)		2.75%	3.7[-7.76,15.16]
Denis 2006	27	83.3 (11.9)	27	80.4 (11.8)		9.05%	2.9[-3.42,9.22]
Huang 2003	23	81 (12)	21	71 (15)		5.55%	10[1.92,18.08]
Lau 2001	30	78 (15)	30	74 (19)		4.82%	4[-4.66,12.66]
Lenssen 2008	30	89.9 (9.1)	30	86.7 (8.5)		18.21%	3.2[-1.26,7.66]
May 1999	12	79.7 (3.5)	7	79.4 (8.8)		7.79%	0.3[-6.51,7.11]
McInnes 1992	47	82 (11.8)	45	75 (11.5)		15.95%	7[2.24,11.76]
Ng 1999	16	67 (8.6)	16	71.9 (8.3)		10.54%	-4.9[-10.76,0.96]
Sahin 2006	14	82 (6.1)	14	82.9 (5.9)		18.3%	-0.9[-5.35,3.55]
Total * **	**237**		**233**			**100%**	**2.29[0.39,4.2]**

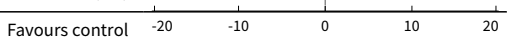
Heterogeneity: Tau^2=0; Chi^2=15.77, df=9(P=0.07); I^2=42.92%

Test for overall effect: Z=2.36(P=0.02)



Analysis 3.2. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 2 Active knee flexion ROM - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	105 (18)	33	109 (14)		-4[-12.02,4.02]
Huang 2003	23	103 (14)	21	95 (12)		8[0.31,15.69]
Lenssen 2003a	30	105.7 (2.5)	30	106.2 (0.6)		-0.5[-1.42,0.42]
Sahin 2006	14	86 (8.7)	14	92.5 (6.2)		-6.5[-12.1,-0.9]



Analysis 3.3. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 3 Active knee flexion ROM - long-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Huang 2003	23	107 (3)	21	102 (4)		81.38%	5[2.9,7.1]
Lau 2001	30	96 (15)	30	93 (15)		6.26%	3[-4.59,10.59]
Sahin 2006	14	94.4 (8)	14	95.5 (6.5)		12.37%	-1.1[-6.5,4.3]
Total ***	**67**		**65**			**100%**	**4.12[2.22,6.02]**

Heterogeneity: Tau²=0; Chi²=4.35, df=2(P=0.11); I²=53.98%

Test for overall effect: Z=4.25(P<0.0001)

Analysis 3.4. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 4 Pain - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	4 (2.3)	33	4 (2.1)		3.26%	0[-1.09,1.09]
Denis 2006	27	2.8 (1.7)	27	4 (2.5)		3.01%	-1.21[-2.35,-0.07]
Lenssen 2003a	20	2.3 (2.6)	18	4.5 (2.4)		1.54%	-2.2[-3.79,-0.61]
Lenssen 2008	30	-1.6 (0.5)	30	-1.5 (0.4)		77.96%	-0.05[-0.27,0.17]
May 1999	12	1.5 (1.6)	7	2.1 (2.4)		0.98%	-0.6[-2.6,1.4]
McInnes 1992	47	2.8 (2.1)	45	3.6 (2.1)		5.27%	-0.8[-1.66,0.06]
Montgomery 1996	28	5 (2.3)	32	5 (1.5)		3.9%	0[-1,1]
Sahin 2006	14	3.9 (1.3)	14	3.5 (1.3)		4.09%	0.35[-0.62,1.32]
Total ***	**208**		**206**			**100%**	**-0.14[-0.34,0.05]**

Heterogeneity: Tau²=0; Chi²=14.07, df=7(P=0.05); I²=50.23%

Test for overall effect: Z=1.42(P=0.16)

Analysis 3.5. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 5 Pain - medium-term effects.

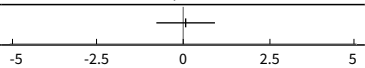
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	2.9 (2.2)	33	1.9 (1.5)		2.15%	1[0.06,1.94]
Lenssen 2008	30	-1.7 (0.4)	30	-1.7 (0.1)		97.16%	0.02[-0.12,0.16]
Maniar 2012	28	3 (3.3)	28	3.2 (3)		0.69%	-0.2[-1.86,1.46]
Total ***	**88**		**91**			**100%**	**0.04[-0.1,0.18]**

Heterogeneity: Tau²=0; Chi²=4.17, df=2(P=0.12); I²=52.09%

Test for overall effect: Z=0.56(P=0.57)

Analysis 3.6. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 6 Pain - long-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
Sahin 2006	14	1.2 (1.1)	14	1.1 (1.2)		0.07[-0.77,0.91]

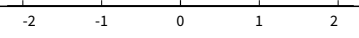


Analysis 3.7. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 7 Function - short-term effects [standardised mean].

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Fixed, 95% CI	Std. Mean Difference Fixed, 95% CI
Denis 2006	27	-52.3 (34.9)	27	-41.9 (21.4)		-0.35[-0.89,0.18]
Lenssen 2003a	20	66.2 (10.1)	18	54.2 (12.8)		1.03[0.34,1.71]
Lenssen 2008	30	67.6 (19.6)	30	67.3 (14.9)		0.02[-0.49,0.52]
May 1999	12	-35.6 (41.8)	7	-24.1 (18.2)		-0.31[-1.25,0.63]

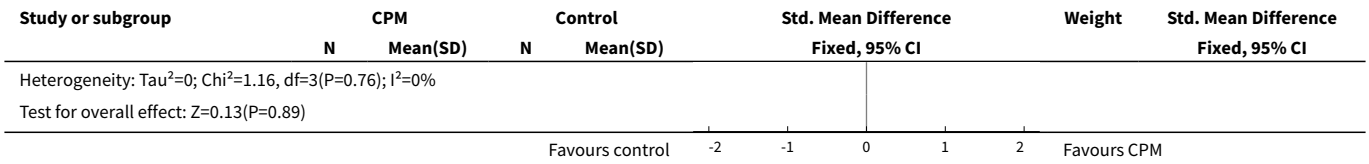
Analysis 3.8. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 8 Function - medium-term effects [standardised mean].

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Bennett 2005	48	52.2 (22.2)	52	56 (21.6)		24.73%	-0.17[-0.57,0.22]
Bruun-Olsen 2009	30	11 (5)	33	12 (6)		15.57%	-0.18[-0.67,0.32]
Kumar 1996	26	82.7 (25.8)	20	80.7 (22.6)		11.24%	0.08[-0.5,0.66]
Lenssen 2008	30	80.4 (5.3)	30	78.8 (9.2)		14.83%	0.21[-0.3,0.72]
Maniar 2012	28	-11.6 (8)	28	-10.4 (9.7)		13.9%	-0.13[-0.65,0.39]
Worland 1998	37	95.3 (2.8)	43	95.7 (3)		19.74%	-0.14[-0.58,0.3]
Total ***	**199**		**206**			**100%**	**-0.08[-0.27,0.12]**
Heterogeneity: Tau^2=0; Chi^2=2, df=5(P=0.85); I^2=0%							
Test for overall effect: Z=0.75(P=0.45)							

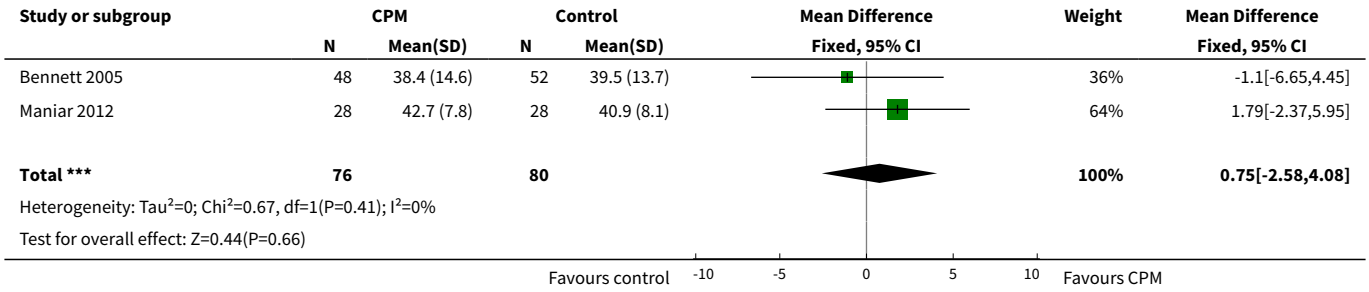


Analysis 3.9. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 9 Function - long-term effects [standardised mean].

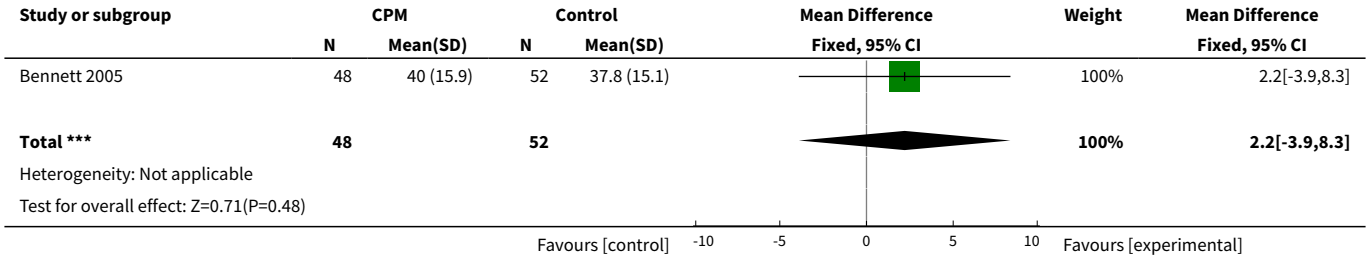
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Bennett 2005	48	59.6 (23.6)	52	58.1 (22.4)		34.8%	0.06[-0.33,0.46]
MacDonald 2000	40	166 (23)	40	166 (25)		27.9%	0[-0.44,0.44]
Sahin 2006	14	80.4 (8.4)	14	77.1 (10.9)		9.62%	0.32[-0.43,1.07]
Worland 1998	37	95.3 (2.8)	43	95.7 (3)		27.68%	-0.14[-0.58,0.3]
Total ***	**139**		**149**			**100%**	**0.02[-0.22,0.25]**



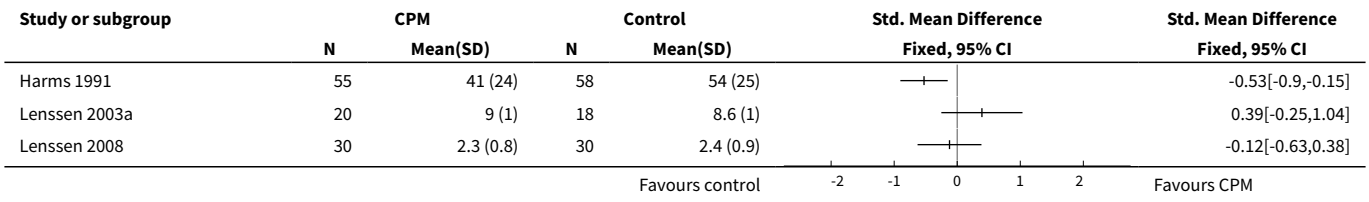
Analysis 3.10. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 10 Quality of life - medium-term effects.



Analysis 3.11. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 11 Quality of life - long-term effects [points].

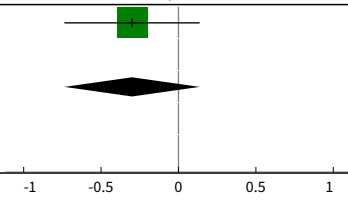


Analysis 3.12. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 12 Participants' global assessment of treatment effectiveness - short-term effects [points].



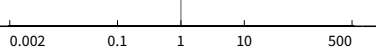
Analysis 3.13. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 13 Participants' global assessment of treatment effectiveness - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Lenssen 2008	30	2.1 (0.7)	30	2.4 (1)		100%	-0.3[-0.74,0.14]
Total ***	**30**		**30**			**100%**	**-0.3[-0.74,0.14]**
Heterogeneity: Not applicable							
Test for overall effect: Z=1.35(P=0.18)							



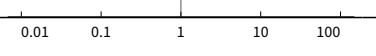
Analysis 3.14. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 14 Manipulation under anaesthesia [number].

Study or subgroup	CPM n/N	Control n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Alkire 2010	2/32	2/32		9.17%	1[0.15,6.67]
Denis 2006	0/27	0/27			Not estimable
Harms 1991	1/55	5/58		22.33%	0.21[0.03,1.75]
Kumar 1996	1/46	3/37		15.25%	0.27[0.03,2.47]
Lenssen 2008	1/30	1/30		4.59%	1[0.07,15.26]
Maniar 2012	0/28	0/28			Not estimable
McInnes 1992	0/45	8/44		39.42%	0.06[0,0.97]
Vince 1987	0/42	1/20		9.25%	0.16[0.01,3.83]
Total (95% CI)	**305**	**276**		**100%**	**0.26[0.11,0.64]**
Total events: 5 (CPM), 20 (Control)					
Heterogeneity: Tau^2=0; Chi^2=4.07, df=5(P=0.54); I^2=0%					
Test for overall effect: Z=2.94(P=0)					

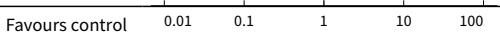


Analysis 3.15. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 15 Adverse events [number].

Study or subgroup	CPM n/N	Control n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Bennett 2005	1/48	4/52		4.31%	0.27[0.03,2.34]
Colwell 1992	2/12	1/9		1.28%	1.5[0.16,14.08]
Denis 2006	3/27	6/27		6.74%	0.5[0.14,1.8]
Harms 1991	13/55	20/58		21.86%	0.69[0.38,1.24]
Huang 2003	2/23	2/21		2.35%	0.91[0.14,5.92]
Kumar 1996	14/46	5/37		6.22%	2.25[0.89,5.68]
Lau 2001	1/30	2/30		2.25%	0.5[0.05,5.22]
Maniar 2012	2/28	2/28		2.25%	1[0.15,6.61]
McInnes 1992	25/45	13/44		14.76%	1.88[1.11,3.18]
Montgomery 1996	3/31	2/34		2.14%	1.65[0.29,9.2]
Ng 1999	2/16	4/16		4.49%	0.5[0.11,2.35]
Nielsen 1988	3/26	5/27		5.51%	0.62[0.17,2.35]

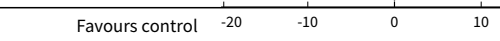


Study or subgroup	CPM n/N	Control n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Ritter 1989	0/50	0/50			Not estimable
Sahin 2006	0/14	0/14			Not estimable
Vince 1987	24/42	17/20		25.86%	0.67[0.49,0.93]
Worland 1998	0/37	0/43			Not estimable
Total (95% CI)	**530**	**510**		**100%**	**0.95[0.75,1.21]**
Total events: 95 (CPM), 83 (Control)					
Heterogeneity: Tau²=0; Chi²=19.67, df=12(P=0.07); I²=39%					
Test for overall effect: Z=0.39(P=0.69)					



Analysis 3.16. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 16 Passive knee flexion ROM - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	87 (11)	33	85 (16)		5.05%	2[-4.73,8.73]
Chiarello 1997	8	84.7 (14.6)	10	80 (13)		1.37%	4.7[-8.23,17.63]
Harms 1991	55	77.8 (14.7)	58	68.6 (15.1)		7.61%	9.2[3.72,14.68]
Kumar 1996	46	83.1 (11.5)	37	84.5 (12)		8.79%	-1.4[-6.5,3.7]
Lenssen 2003a	20	90.2 (13.2)	18	83.7 (15.1)		2.78%	6.5[-2.56,15.56]
Lenssen 2008	30	93 (8.8)	30	89.7 (9.6)		10.52%	3.3[-1.36,7.96]
Montgomery 1996	28	77 (8)	32	76 (6)		17.44%	1[-2.62,4.62]
Ng 1999	16	88 (8.9)	16	87 (8.1)		6.57%	1[-4.9,6.9]
Nielsen 1988	24	71 (15)	26	71 (17.5)		2.81%	0[-9.01,9.01]
Ritter 1989	50	80.7 (7.3)	50	78.3 (7.2)		28.33%	2.4[-0.44,5.24]
Worland 1998	37	96.3 (13.4)	43	98.4 (9.2)		8.72%	-2.1[-7.22,3.02]
Total ***	**344**		**353**			**100%**	**2.01[0.5,3.52]**
Heterogeneity: Tau²=0; Chi²=12.89, df=10(P=0.23); I²=22.4%							
Test for overall effect: Z=2.6(P=0.01)							

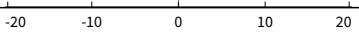


Analysis 3.17. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 17 Passive knee flexion ROM - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	108 (18)	33	112 (14)		11.93%	-4[-12.02,4.02]
Kumar 1996	27	115.2 (11.3)	14	113.9 (8.8)		19.47%	1.3[-4.98,7.58]
MacDonald 2000	40	98 (11)	40	104 (14)		25.21%	-6[-11.52,-0.48]
Worland 1998	37	105.7 (10.4)	43	105.6 (8.5)		43.39%	0.1[-4.11,4.31]
Total ***	**134**		**130**			**100%**	**-1.69[-4.46,1.08]**
Heterogeneity: Tau²=0; Chi²=4.23, df=3(P=0.24); I²=29.08%							
Test for overall effect: Z=1.2(P=0.23)							

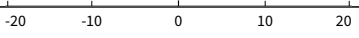
Analysis 3.18. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 18 Passive knee flexion ROM - long-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
MacDonald 2000	40	113 (8)	40	112 (9)		37.59%	1[-2.73,4.73]
Worland 1998	37	117.6 (7.2)	43	118.1 (5.8)		62.41%	-0.5[-3.4,2.4]
Total ***	**77**		**83**			**100%**	**0.06[-2.22,2.35]**
Heterogeneity: Tau²=0; Chi²=0.39, df=1(P=0.53); I²=0%							
Test for overall effect: Z=0.05(P=0.96)							



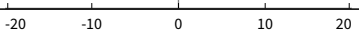
Analysis 3.19. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 19 Active knee extension ROM - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	-8 (4)	33	-11 (6)		11.5%	3[0.5,5.5]
Chiarello 1997	8	-20.5 (7.5)	10	-20.3 (18)		0.47%	-0.2[-12.51,12.11]
Denis 2006	27	-6.5 (3.7)	27	-8 (3.5)		19.44%	1.5[-0.42,3.42]
Harms 1991	55	-5.2 (4.9)	58	-8.3 (5.1)		21.06%	3.1[1.25,4.95]
Huang 2003	23	-5 (6)	21	-4 (6)		5.69%	-1[-4.55,2.55]
Lenssen 2008	30	-6.3 (3.9)	30	-8.1 (4.8)		14.65%	1.8[-0.41,4.01]
May 1999	12	-18.6 (9)	7	-15.2 (5.9)		1.59%	-3.4[-10.11,3.31]
McInnes 1992	48	-24 (19.3)	45	-25 (18.7)		1.2%	1[-6.74,8.74]
Ng 1999	16	-22.3 (4.4)	16	-21.3 (6.8)		4.55%	-1[-4.97,2.97]
Nielsen 1988	24	-5 (3.8)	26	-4 (5)		12.07%	-1[-3.44,1.44]
Sahin 2006	14	5.3 (4.1)	14	6.7 (4.1)		7.78%	-1.4[-4.44,1.64]
Total ***	**287**		**287**			**100%**	**1.18[0.33,2.02]**
Heterogeneity: Tau²=0; Chi²=16.89, df=10(P=0.08); I²=40.81%							
Test for overall effect: Z=2.73(P=0.01)							



Analysis 3.20. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 20 Active knee extension ROM - medium-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	-4 (4)	33	-7 (6)		22.6%	3[0.5,5.5]
Huang 2003	23	-2 (2)	21	-3 (5)		26.91%	1[-1.29,3.29]
Lenssen 2008	30	-4.8 (3.9)	30	-4.3 (4.7)		29.53%	-0.5[-2.69,1.69]
Sahin 2006	14	4.2 (3.4)	14	4.5 (3.6)		20.96%	-0.3[-2.89,2.29]
Total ***	**97**		**98**			**100%**	**0.74[-0.45,1.92]**
Heterogeneity: Tau²=0; Chi²=5.05, df=3(P=0.17); I²=40.57%							



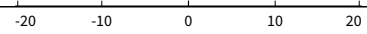
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Test for overall effect: Z=1.22(P=0.22)							

Analysis 3.21. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 21 Active knee extension ROM - long-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Sahin 2006	14	1.9 (2.4)	14	2 (2.7)		0.4%	-0.1[-1.99,1.79]
Worland 1998	37	0 (0)	43	-0.1 (0.4)		99.6%	0.06[-0.06,0.18]
Total ***	**51**		**57**			**100%**	**0.06[-0.06,0.18]**
Heterogeneity: Tau^2=0; Chi^2=0.03, df=1(P=0.87); I^2=0%							
Test for overall effect: Z=0.98(P=0.33)							

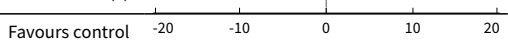
Analysis 3.22. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 22 Passive knee extension ROM - short-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	-7 (5)	33	-10 (6)		4.22%	3[0.28,5.72]
Chiarello 1997	8	-3 (6.4)	10	-6 (5.5)		1%	3[-2.58,8.58]
Huang 2003	23	-3 (3)	21	-4 (2)		13.97%	1[-0.49,2.49]
Kumar 1996	46	-9.3 (4.5)	37	-9.2 (5.5)		6.46%	-0.1[-2.3,2.1]
Lenssen 2003a	20	-4.2 (3.4)	18	-7.9 (5.9)		3.23%	3.7[0.59,6.81]
Lenssen 2008	30	-4.3 (3.1)	30	-5.7 (4.6)		7.92%	1.4[-0.58,3.38]
May 1999	12	-10.1 (6.4)	7	-10.3 (3.8)		1.48%	0.2[-4.39,4.79]
McInnes 1992	47	-7 (5.6)	45	-6 (5.5)		6%	-1[-3.28,1.28]
Ng 1999	16	-10.3 (4.5)	16	-11.9 (3.3)		4.17%	1.6[-1.13,4.33]
Ritter 1989	50	-2.8 (2.1)	50	-3 (2.2)		43.73%	0.17[-0.67,1.01]
Worland 1998	37	-4.2 (5.4)	43	-2.1 (3.3)		7.8%	-2.1[-4.1,-0.1]
Total ***	**319**		**310**			**100%**	**0.44[-0.12,1]**
Heterogeneity: Tau^2=0; Chi^2=18.94, df=10(P=0.04); I^2=47.19%							
Test for overall effect: Z=1.55(P=0.12)							



Analysis 3.23. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 23 Passive knee extension ROM - medium-term effects.

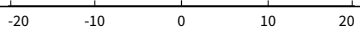
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
Bruun-Olsen 2009	30	-2 (4)	33	-5 (6)		3[0.5,5.5]



Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Mean Difference Fixed, 95% CI
Huang 2003	23	-2 (3)	21	-3 (3)		1[-0.77,2.77]
Kumar 1996	27	-3.5 (5)	14	-0.7 (1.3)		-2.8[-4.81,-0.79]
Worland 1998	37	-1.3 (2.8)	43	-0.8 (1.8)		-0.5[-1.55,0.55]

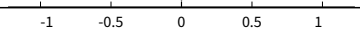
Analysis 3.24. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 24 Passive knee extension ROM - long-term effects.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Huang 2003	23	-3 (4)	21	-4 (3)		4.98%	1[-1.08,3.08]
MacDonald 2000	40	-2 (2)	40	-2 (3)		17.23%	0[-1.12,1.12]
Worland 1998	37	-0.3 (1.1)	43	-0.4 (1.3)		77.78%	0.1[-0.43,0.63]
Total ***	**100**		**104**			**100%**	**0.13[-0.34,0.59]**
Heterogeneity: Tau²=0; Chi²=0.74, df=2(P=0.69); I²=0%							
Test for overall effect: Z=0.54(P=0.59)							



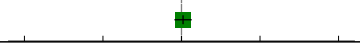
Analysis 3.25. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 25 Quadriceps strength - short-term effects [standardised mean].

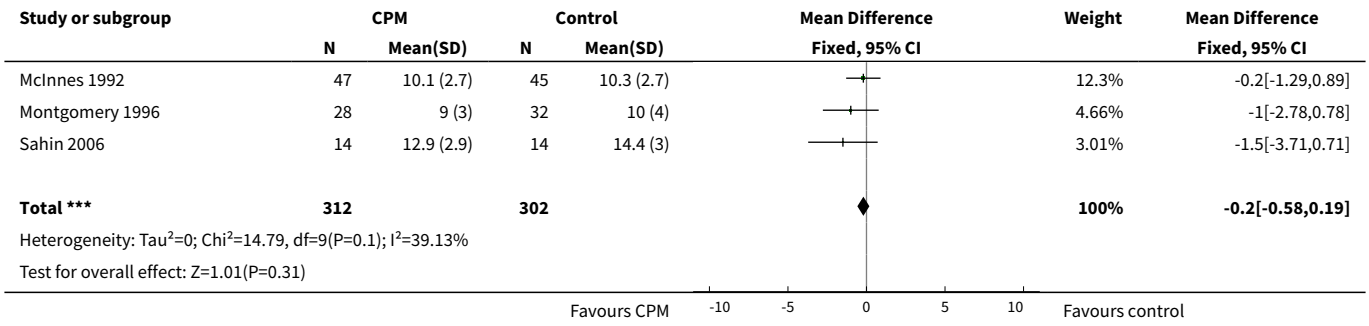
Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
Lenssen 2003a	18	99 (45.6)	20	80.3 (31)		28.64%	0.47[-0.17,1.12]
McInnes 1992	47	19.1 (8.7)	45	17.5 (8.5)		71.36%	0.19[-0.22,0.59]
Total ***	**65**		**65**			**100%**	**0.27[-0.08,0.61]**
Heterogeneity: Tau²=0; Chi²=0.55, df=1(P=0.46); I²=0%							
Test for overall effect: Z=1.52(P=0.13)							



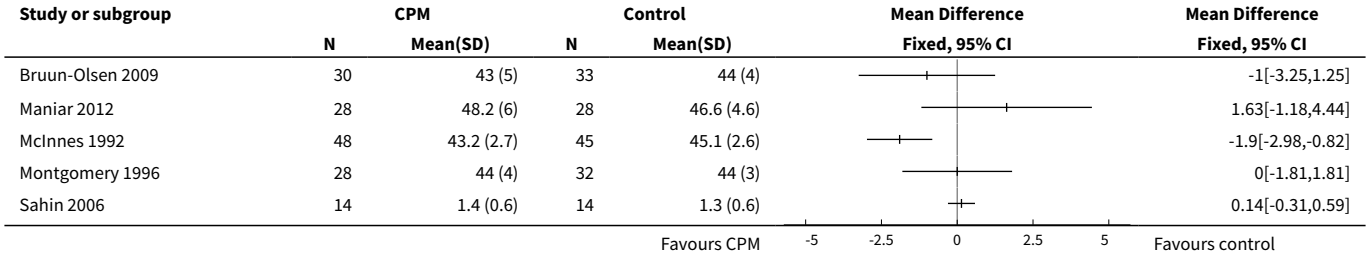
Analysis 3.26. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 26 Length of hospital stay.

Study or subgroup	CPM N	CPM Mean(SD)	Control N	Control Mean(SD)	Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
Colwell 1992	12	9.9 (2.8)	10	10.9 (1.5)		4.48%	-1[-2.81,0.81]
Denis 2006	27	8 (2.1)	27	7.8 (2)		12.29%	0.2[-0.89,1.29]
Harms 1991	55	17 (4)	58	18 (4)		6.75%	-1[-2.48,0.48]
Huang 2003	23	18 (6.7)	21	24 (6.4)		0.98%	-6[-9.87,-2.13]
Kumar 1996	46	12.1 (9)	37	12.5 (6.8)		1.27%	-0.4[-3.8,3]
Lenssen 2003a	20	6 (3.6)	18	5.6 (1.1)		5.35%	0.4[-1.26,2.06]
MacDonald 2000	40	5.2 (1.3)	40	5.1 (1.2)		48.91%	0.1[-0.45,0.65]

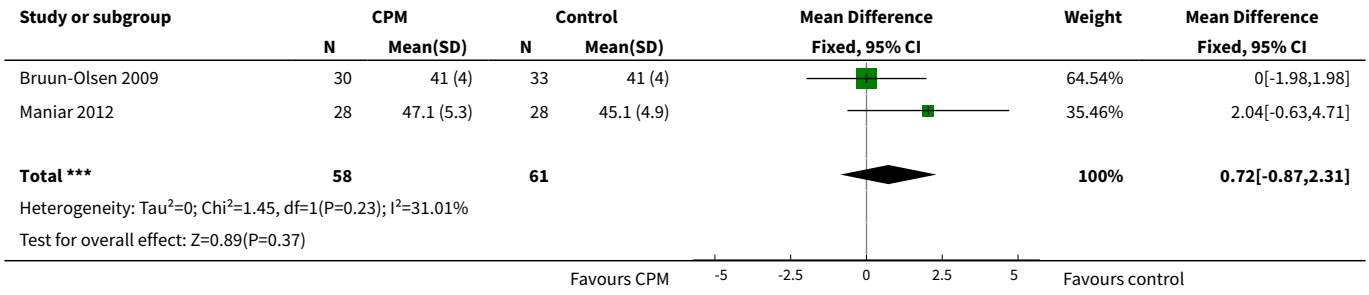




Analysis 3.27. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 27 Swelling - short-term effects.



Analysis 3.28. Comparison 3 Main comparison - sensitivity analysis using fixed-effect model, Outcome 28 Swelling - medium-term effects.



ADDITIONAL TABLES

Table 1. Results from each electronic database for 2009-2013 search

Database name, platform and time span	Update search date	Number of results
The Cochrane Library, Issue 12, December 2012 from database inception	January 2009 to 24 January 2013	1
MEDLINE(R) Ovid 1966 to January week 3 2013 and MEDLINE(R) Ovid In-Process & Other Non-Indexed Citations 23 January 2013	January 2009 to 24 January 2013	126

Table 1. Results from each electronic database for 2009-2013 search *(Continued)*

EMBASE Ovid 1980 to 2013 week 3	January 2009 to 24 January 2013	146
EBSCOhost CINAHL 1981 to 23 January 2013	January 2009 to 24 January 2013	1
AMED Ovid (Allied and Complementary Medicine Database) 1985 to January 2013	January 2009 to 24 January 2013	140
Physiotherapy Evidence Database (PEDro)	January 2009 to 24 January 2013	1
-	**TOTAL**	415
-	**Total AFTER duplicates removed**	**4**

APPENDICES

Appendix 1. Cochrane Central Register of Controlled Trials (CENTRAL) (to January 2013)

1. MeSH descriptor Arthroplasty, Replacement, Knee explode all trees
2. MeSH descriptor Knee Prosthesis explode all trees
3. tkr:ti,ab
4. MeSH descriptor Knee explode all trees
5. knee*:ti,ab
6. (#4 OR #5)
7. MeSH descriptor Arthroplasty explode all trees
8. MeSH descriptor Joint Prosthesis explode all trees
9. (arthroplast* or prosthe* or replac*):ti,ab
10. (#7 OR #8 OR #9)
11. (#6 AND #10)
12. (#1 OR #2 OR #3 OR #11)
13. MeSH descriptor Exercise Therapy explode all trees
14. MeSH descriptor Physical Therapy Modalities explode all trees
15. physical NEXT therap*:ti,ab
16. physiotherap*:ti,ab
17. "continuous passive motion":ti,ab
18. cpm:ti,ab
19. gait NEXT therap*:ti,ab
20. exercis* NEXT therap*:ti,ab
21. therapeutic NEAR/3 exercis*:ti,ab
22. (#13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21)
23. (#12 AND #21)

Appendix 2. MEDLINE search strategy (1966 to January 2013)

1. Arthroplasty, Replacement, Knee/

2. Knee Prosthesis/

3. tkr.tw.

4. exp Knee/

5. knee$.tw.

6. 4 or 5

7. exp arthroplasty/

8. Joint Prosthesis/

9. (arthroplast$ or prosthe$ or replac$).tw.

10. or / 7-9

11. 6 and 10

12. or / 1-3,11

13. exp Exercise Therapy/

14. physical therapy modalities/

15. (physical adj therap$).tw.

16. physiotherap$.tw.

17. continuous passive motion.tw.

18. cpm.tw.

19. (gait adj therap$).tw.

20. (exercis$ adj therap$).tw.

21. (therapeutic adj3 exercis$).tw.

22. or / 13-21

23. 12 and 22

24. randomized controlled trial.pt.

25. controlled clinical trial.pt.

26. randomized.ab.

27. placebo.ab.

28. drug therapy.fs.

29. randomly.ab.

30. trial.ab.

31. groups.ab.

32. or / 24-31

33. (animals not (humans and animals)).sh.

34. 32 not 33

35. 23 and 34

Appendix 3. EMBASE (1980 to January 2013)

1. exp ARTHROPLASTY/
2. exp Joint Prosthesis/
3. exp "Prostheses and Orthoses"/
4. exp KNEE/
5. or / 1-3
6. 4 and 5
7. exp Knee Arthroplasty/

8. exp Knee Prosthesis/
9. tka.tw.
10. (knee$ and (replace$ or arthroplast$ or prosthe$ or endoprosthe$ or implant$)).tw.
11. or / 6-10
12. exp kinesiotherapy/
13. exp physiotherapy/
14. (physical adj therap$).tw.
15. physiotherap$.tw.
16. continuous passive motion.tw.
17. cpm.tw.
18. (gait adj therap$).tw.
19. (exercis$ adj therap$).tw.
20. (therapeutic adj3 exercis$).tw.
21. or / 12-20
22. 11 and 21
23. random$.ti,ab.
24. factorial$.ti,ab.
25. (crossover$ or cross over$ or cross-over$).ti,ab.
26. placebo$.ti,ab.
27. (doubl$ adj blind$).ti,ab.
28. (singl$ adj blind$).ti,ab.
29. assign$.ti,ab.
30. allocat$.ti,ab.
31. volunteer$.ti,ab.
32. crossover procedure.sh.
33. double blind procedure.sh.
34. randomized controlled trial.sh.
35. single blind procedure.sh.
36. or / 23-35
37. exp animal/ or nonhuman/ or exp animal experiment/
38. exp human/
39. 37 and 38
40. 37 not 39
41. 36 not 40
42. 22 and 41

Appendix 4. CINAHL (1982 to January 2013)

S23 S11 and S21
S22 S11 and S21

S21 S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20
S20 ti therapeutic N3 exercis* or ab therapeutic N3 exercis*
S19 ti exercis* therap* or ab exercis* therap*
S18 ti gait therap* or ab gait therap*
S17 ti cpm or ab cpm

S16 ti continuous passive motion or ab continuous passive motion
S15 ti physiotherap* or ab physiotherap*

S14 ti physical therap* or ab physical therap*

S13 (MH "Physical Therapy+")

S12 (MH "Therapeutic Exercise+")

S11 S1 or S2 or S10

S10 S5 and S9

S9 S6 or S7 or S8

S8 ab arthroplast* or ab prosthe* or ab replac*

S7 ti arthroplast* or ti prosthe* or ti replac*

S6 (MH "Joint Prosthesis")

S5 S3 or S4

S4 ti knee* or ab knee*

S3 (MH "Knee")

S2 ti tkr or ab tkr

S1 (MH "Arthroplasty, Replacement, Knee")

Appendix 5. AMED (1985 to January 2013)

1. arthroplasty replacement knee/
2. Knee prosthesis/
3. tkr.tw.
4. knee/
5. knee$.tw.
6. 4 or 5
7. exp Arthroplasty/
8. exp Joint prosthesis/
9. (arthroplast$ or prosthe$ or replac$).tw.
10. or / 7-9
11. 6 and 10
12. or / 1-3,11
13. exp exercise therapy/
14. exp physical therapy modalities/
15. (physical adj therap$).tw.
16. physiotherap$.tw.
17. continuous passive motion.tw.
18. cpm.tw.
19. (gait adj therap$).tw.
20. (exercis$ adj therap$).tw.
21. (therapeutic adj3 exercis$).tw.
22. or / 13-21
23. 12 and 22

Appendix 6. PEDro (up to January 2013)

Search 1 Continuous Passive Motion in Abstract & Title AND Lower leg or knee in Body Part

Search 2 cpm Motion in Abstract & Title AND Lower leg or knee in Body Part

WHAT'S NEW

Date	Event	Description
3 March 2014	Amended	Fixed minor typing errors in plain language summary, and a calculating error in the abstract.

HISTORY

Review first published: Issue 2, 2003

Date	Event	Description
8 January 2014	New citation required but conclusions have not changed	Four new studies were included in the update (Alkire 2010; Brun-Olsen 2009; Maniar 2012; Sahin 2006); bringing the total number of included studies to 24 (from 20 since the last update). Some outcomes of the review presented in the summary of findings tables were changed to align with the Cochrane Musculoskeletal Group's recommended default outcomes. Reporting of the methods and results of the review were altered to align with the reporting standards recommended by the Cochrane Collaboration's Methodological Expectations of Cochrane Intervention Reviews (MECIR) project.
9 September 2013	New search has been performed	A new search was conducted on 24 January 2013, and the review updated upon request from editors.
2 May 2013	Amended	Corrected an error - Kumar was missing from the short-term effects of passive knee flexion ROM - so added. Removed studies from meta-analysis in which SDs were imputed. Details are: Active knee extension ROM - short term effects (Bennett 2005; Lau 2001; Ritter 1989); Passive knee extension ROM - short term effects (Bennett 2005; Colwell 1992). Lengh of hospital stay - short term effects (Bennett 2005; May 1999; Vince 1987).
17 February 2010	New citation required and conclusions have changed	Change in authors and conclusions
10 June 2009	New search has been performed	A new search was conducted and the review updated. Eight new trials were included in the update: four published since the original search was conducted in the 2003 review (Bennett 2005; Denis 2006; Lenssen 2003a; Lenssen 2008); two trials published but not identified in the original search (Ng 1999; Ritter 1989); and two additional trials previously excluded met new inclusion criteria and added to the update (Lau 2003; Worland 1998). The update also includes changes to the selection criteria: participants restricted to those with pre-surgery diagnosis of arthritis and comparisons were CPM and standard postoperative care versus CPM and standard postoperative care with active or passive knee exercises; and methods were updated in accordance with current Cochrane Collaboration recommendations: risk of bias assessment and Summary of Findings Tables added, and used updated Cochrane search filter for identifying RCTs
25 July 2008	Amended	Converted to new review format.

Date	Event	Description
		CMSG ID: C019-R

CONTRIBUTIONS OF AUTHORS

LA Harvey: rewriting the manuscript in 2010 and 2013, conducting the updated search, screening potentially eligible trials, extracting all data reported in the original review and additional data required for the update, analysing data, interpreting results, updating reference list and creating the 'Summary of findings' table.
L Brosseau: 2003 version of this review: extracting data, updating the reference list, updating the analyses and updating the interpretation of results; 2013 version of this review: interpreting the results and editing the manuscript.
RD Herbert: 2010 version of this review: screening potentially eligible trials, extracting additional data required for the update, analysing data, interpreting results, conducting the mega-regression and creating the 'Summary of findings' table; 2013 version of this review: conducting the mega-regression, interpreting the results and editing the manuscript.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- The University of Ottawa, Canada.
- The Rehabilitation Studies Unit, Sydney School of Medicine/Northern, University of Sydney, Australia, Other.

External sources

- NHMRC, Australia.

  fellowship for RDH

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The protocol was modified when the review was updated in 2010. The modifications were:

1. participants restricted to those with pre-surgery diagnosis of arthritis;
2. comparisons were changed from continuous passive motion (CPM) and physiotherapy versus physiotherapy alone to CPM and standard postoperative care versus CPM and standard postoperative care with active or passive knee exercises;
3. updated methods based on current Cochrane Collaboration recommendations for risk of bias assessment, 'Summary of findings' table, and the updated Cochrane search filter for identifying randomised controlled trials;
4. endpoints were classified as short, medium and long term;
5. only one observation was extracted for each outcome within a particular endpoint (short, medium or long term);
6. in trials with more than two groups, only data from the two groups with the most contrasting interventions were extracted and used for analyses;
7. the comparisons were divided into primary and secondary comparisons;
8. pain outcomes were restricted to direct measures of pain intensity (e.g. visual analogue scale); data on pain medication were not extracted.

The protocol was modified when the review was updated in 2013. The modifications were:

1. missing standard deviations (SD) were not imputed. Instead, studies with missing SDs were removed from the analyses;
2. studies that stated that they reported outcomes but did not provide the data were included in the counts of studies that collected the outcomes; however, these studies were not included in the meta-analyses;
3. primary and secondary outcomes were changed and added on request of the Editorial Committee of the Cochrane Musculoskeletal Group. It was requested that the original protocol be ignored and that the primary outcomes be changed to: active knee flexion, function, quality of life, participants' global assessment of treatment effectiveness, incidence of manipulation and adverse events. This necessitated adding outcomes that were not in the original protocol or the previous version of the review. It also required moving primary outcomes to secondary outcomes and vice versa;

4. only the primary outcomes were used in the 'Summary of findings' table. The choice between short, medium or long term were based on which ever had the most number of trials;
5. need for manipulation and adverse events were not categorised into short-, medium- or long-term effects. Instead, each of these outcomes were collated regardless of time of occurrence since randomisation.

INDEX TERMS

Medical Subject Headings (MeSH)

*Motion Therapy, Continuous Passive; Arthroplasty, Replacement, Knee [adverse effects] [*rehabilitation]; Osteoarthritis, Knee [*surgery]; Randomized Controlled Trials as Topic; Range of Motion, Articular

MeSH check words

Humans