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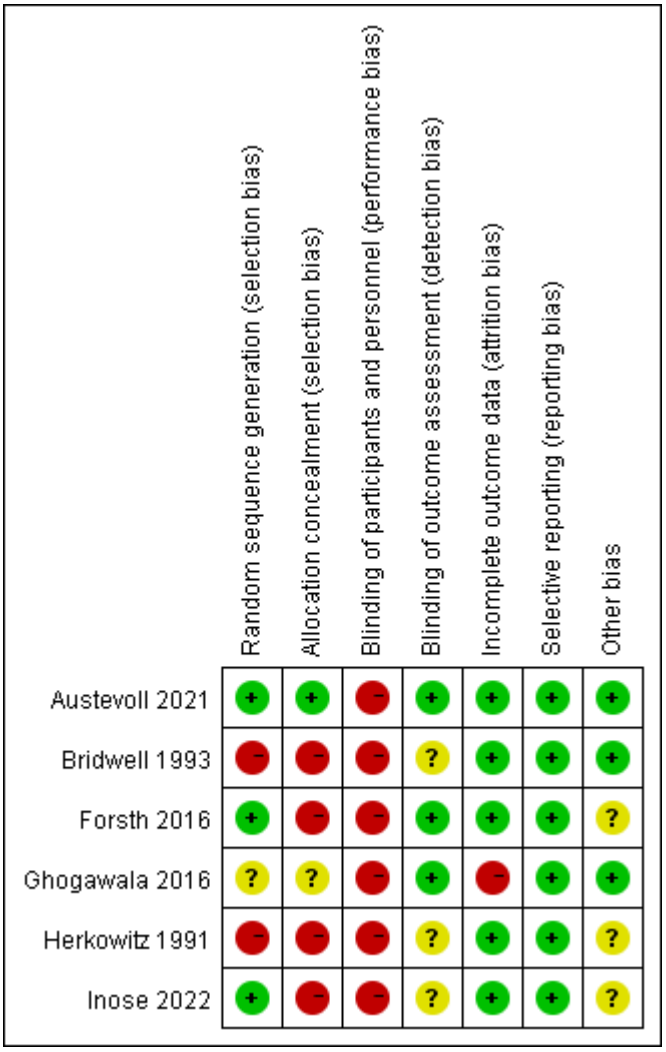
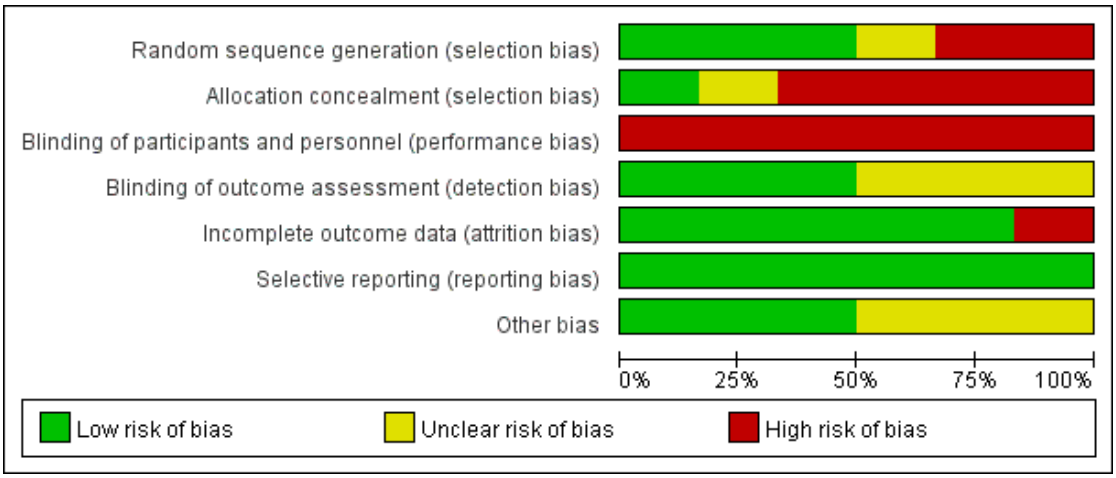
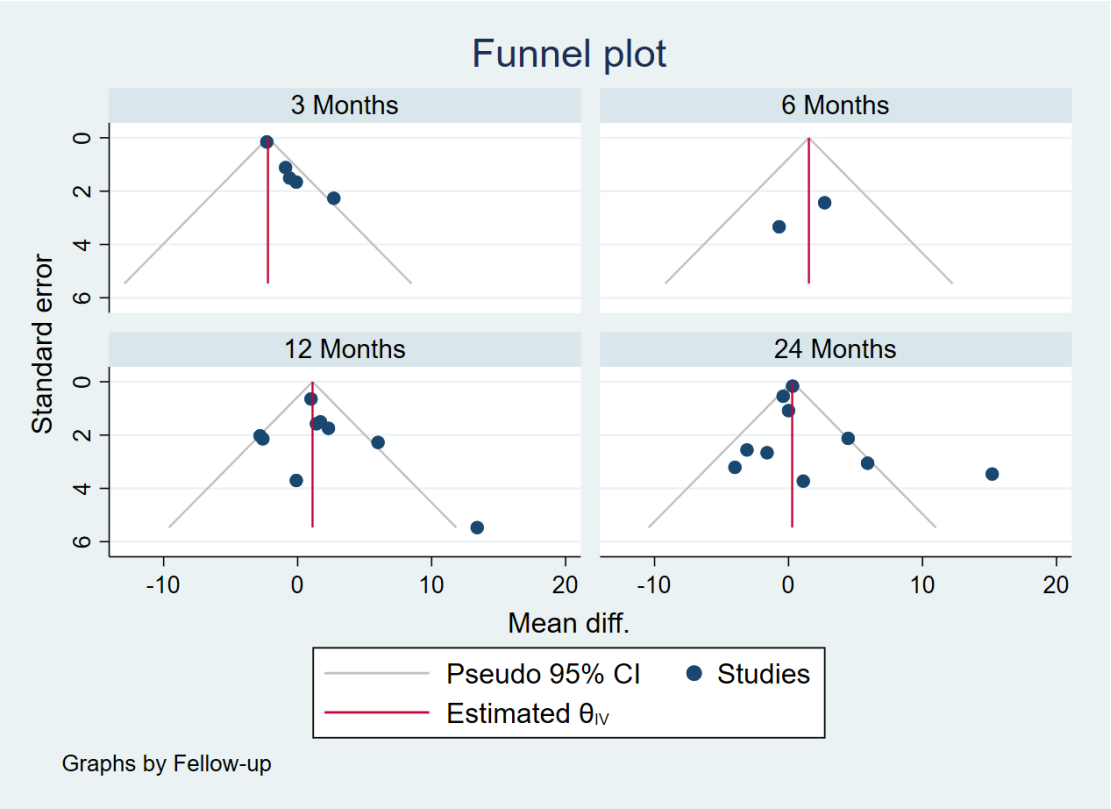
eFigure 1. Risk of bias summary of included RCTs.



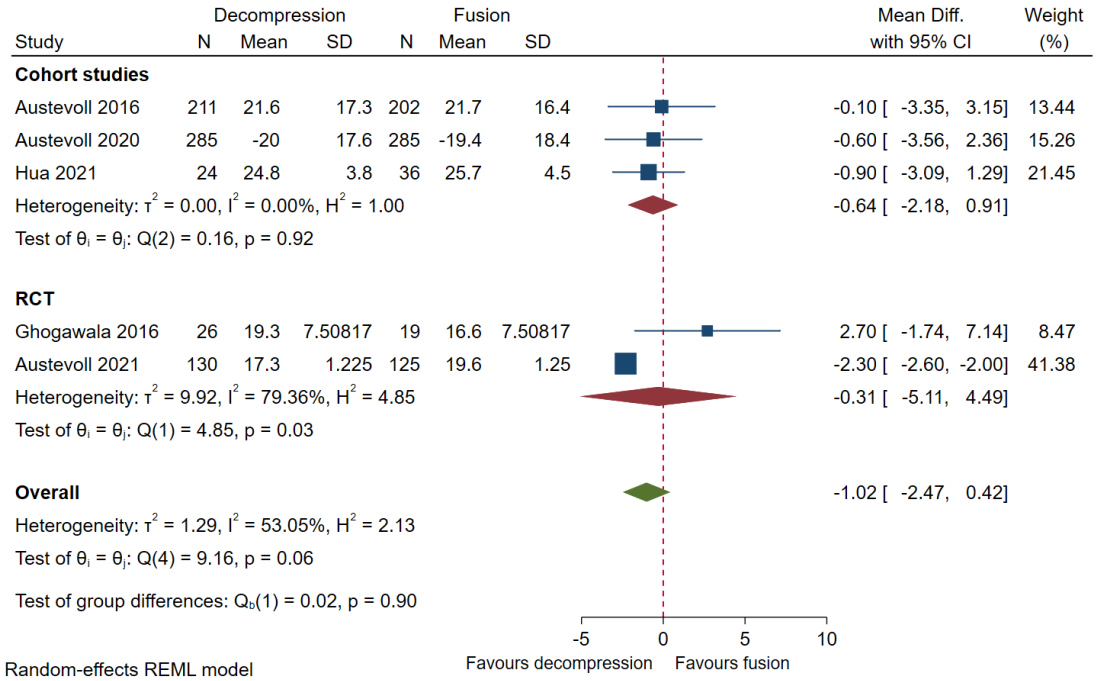
eFigure 2. Risk of bias of included RCTs.



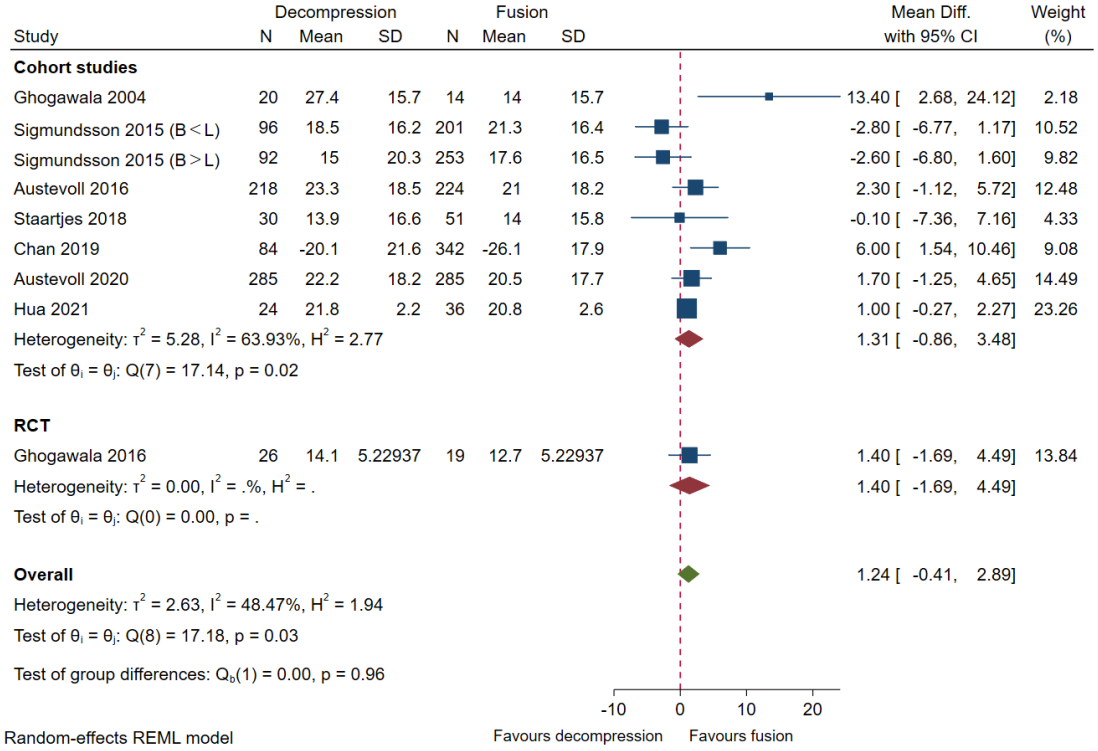
eFigure 3. Funnel plot of ODI.



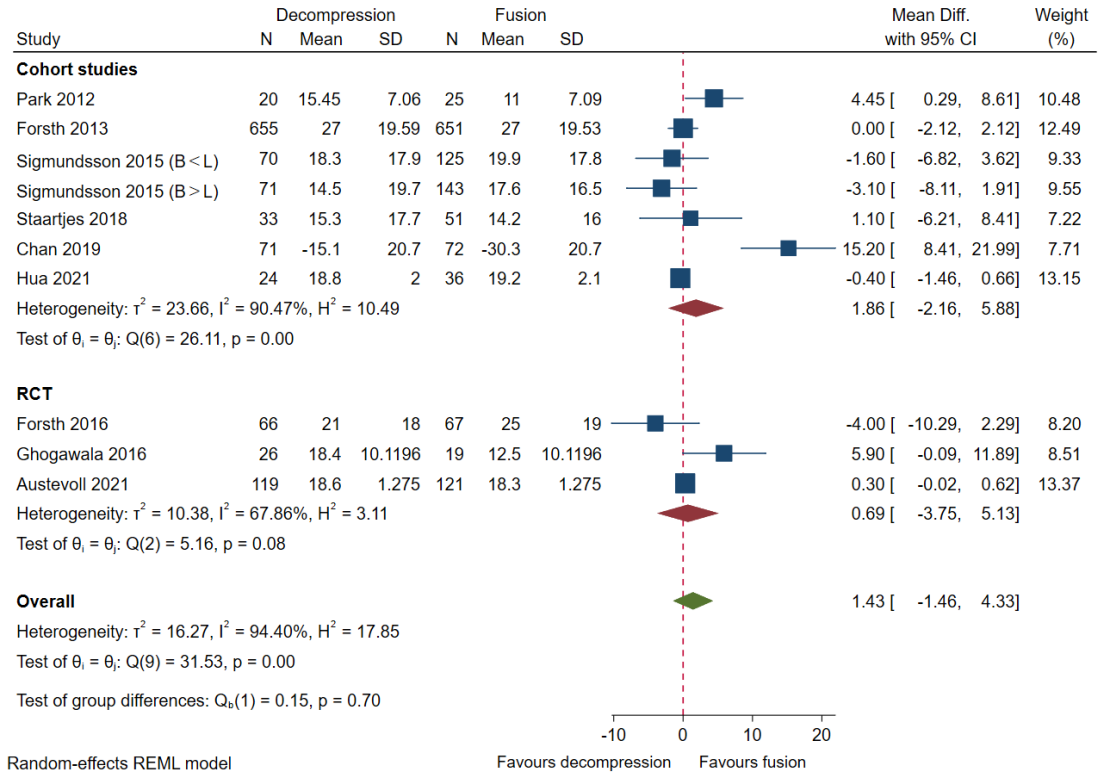
eFigure 4. Subgroup analysis of ODI on the 3rd post-operative month.



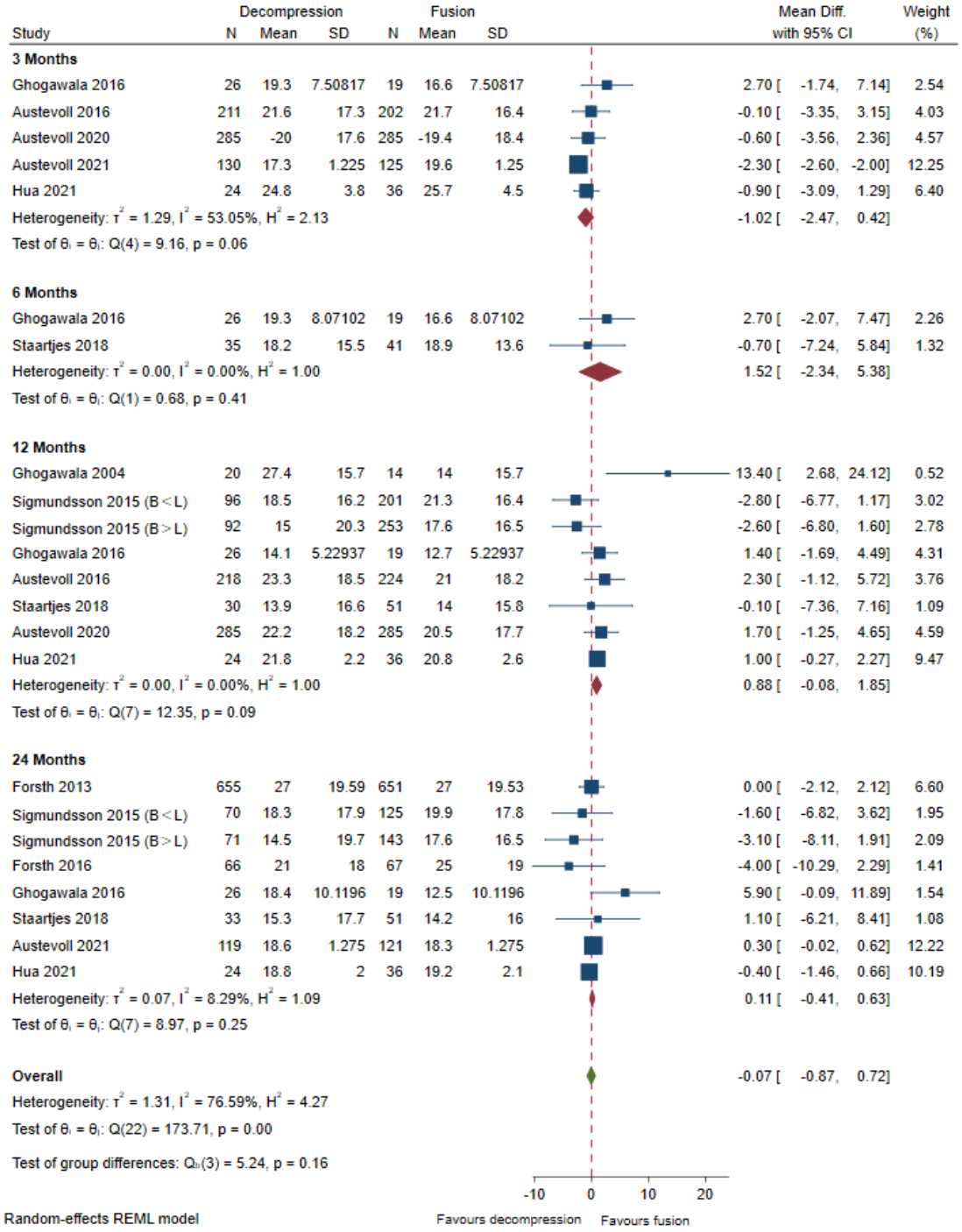
eFigure 5. Subgroup analysis of ODI on the 12th post-operative month.



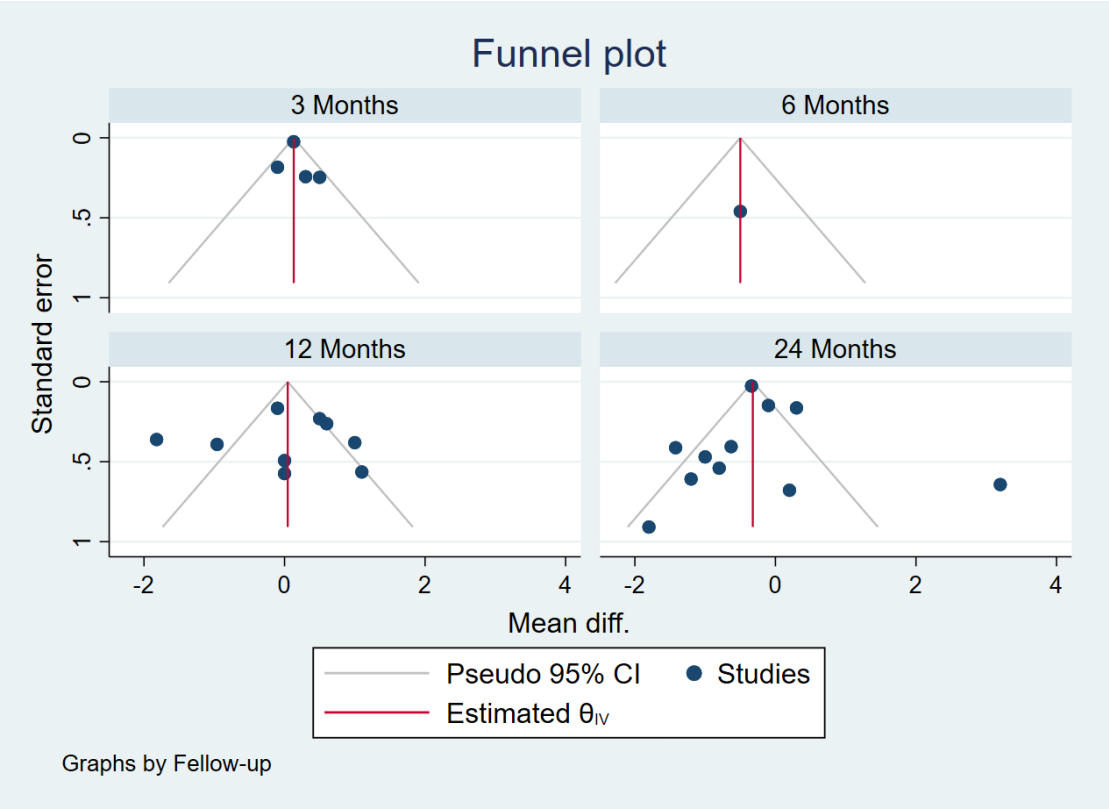
eFigure 6. Subgroup analysis of ODI on the 24th post-operative month.



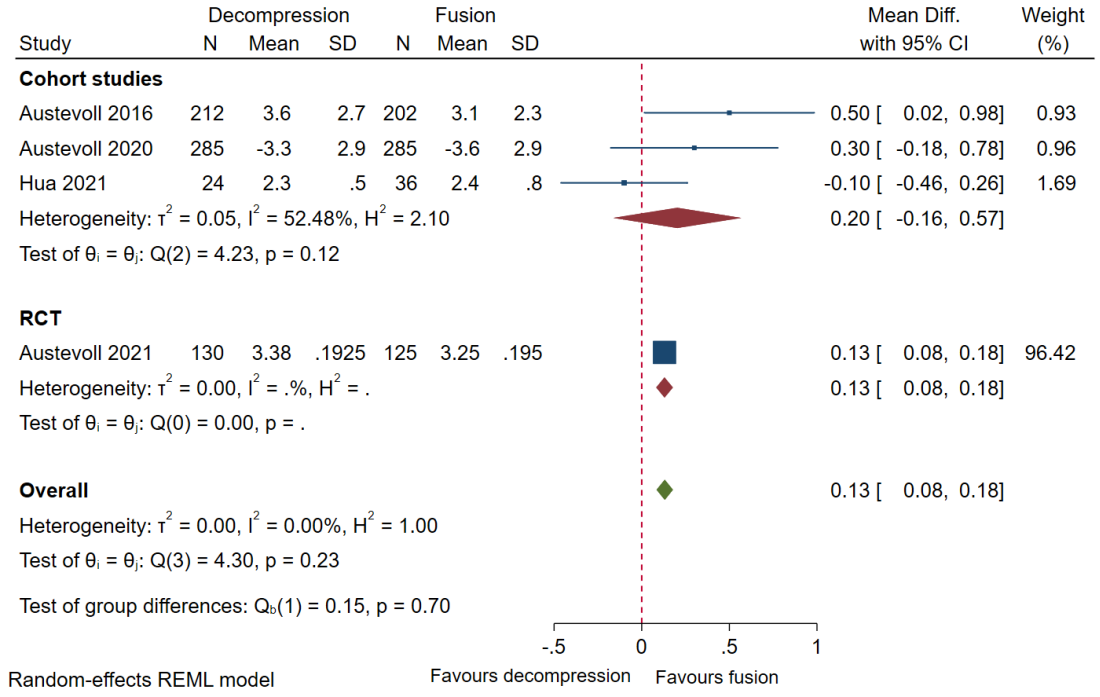
eFigure 7. Sensitivity analysis of ODI between decompression and decompression with fusion groups (excluding Chan 2019a and Chan 2019b).



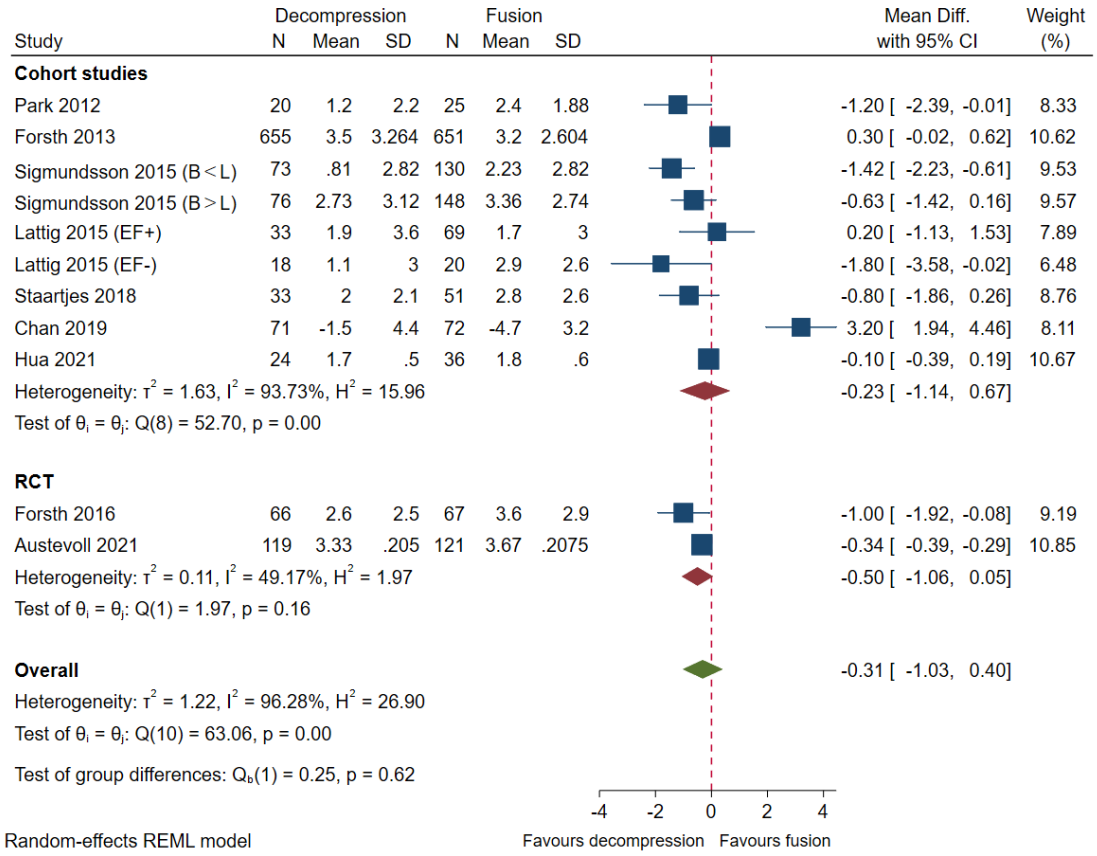
eFigure 8. Funnel plot of back pain scores.



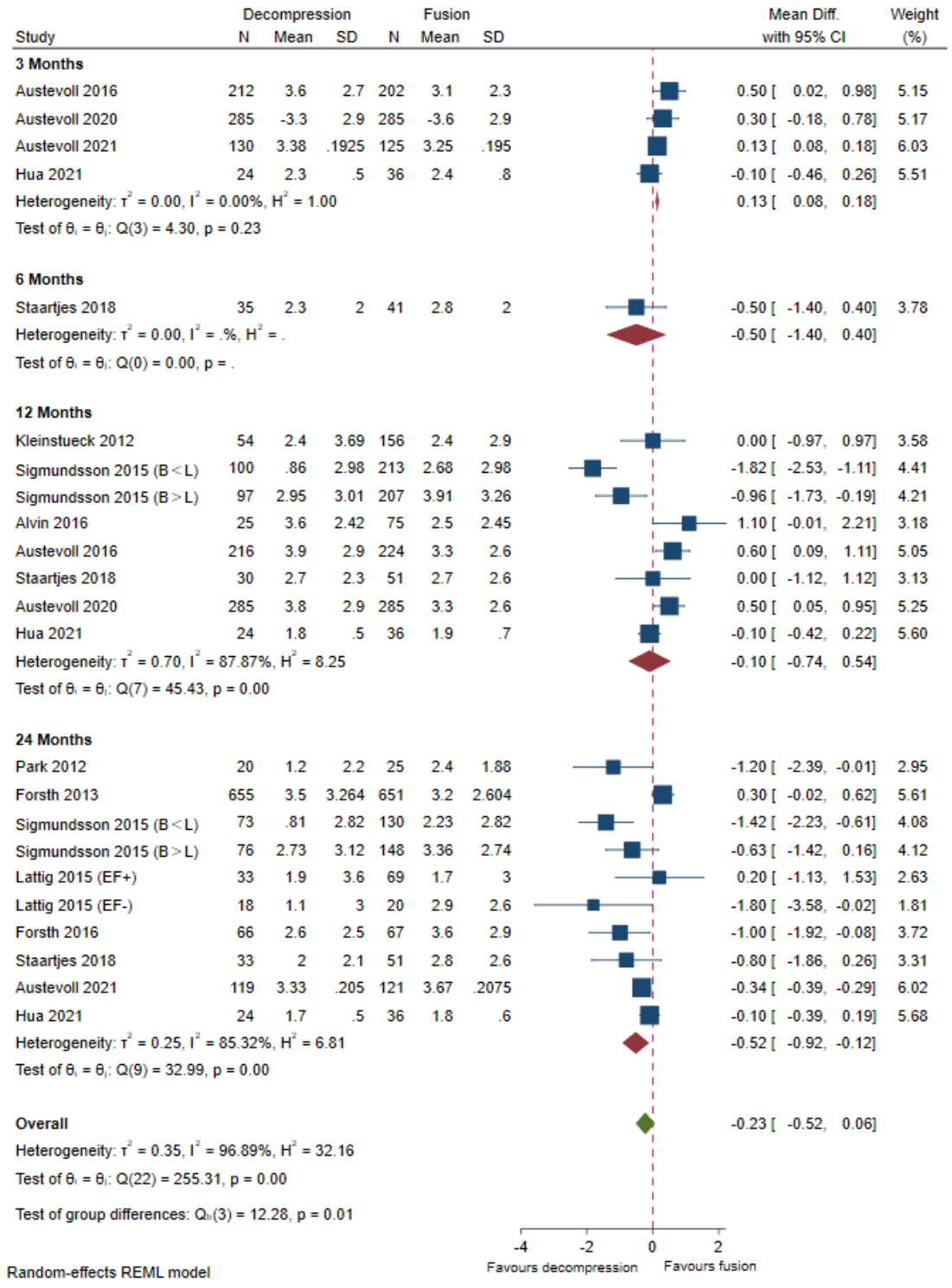
eFigure 9. Subgroup analysis of back pain scores on 3rd post-operative month.



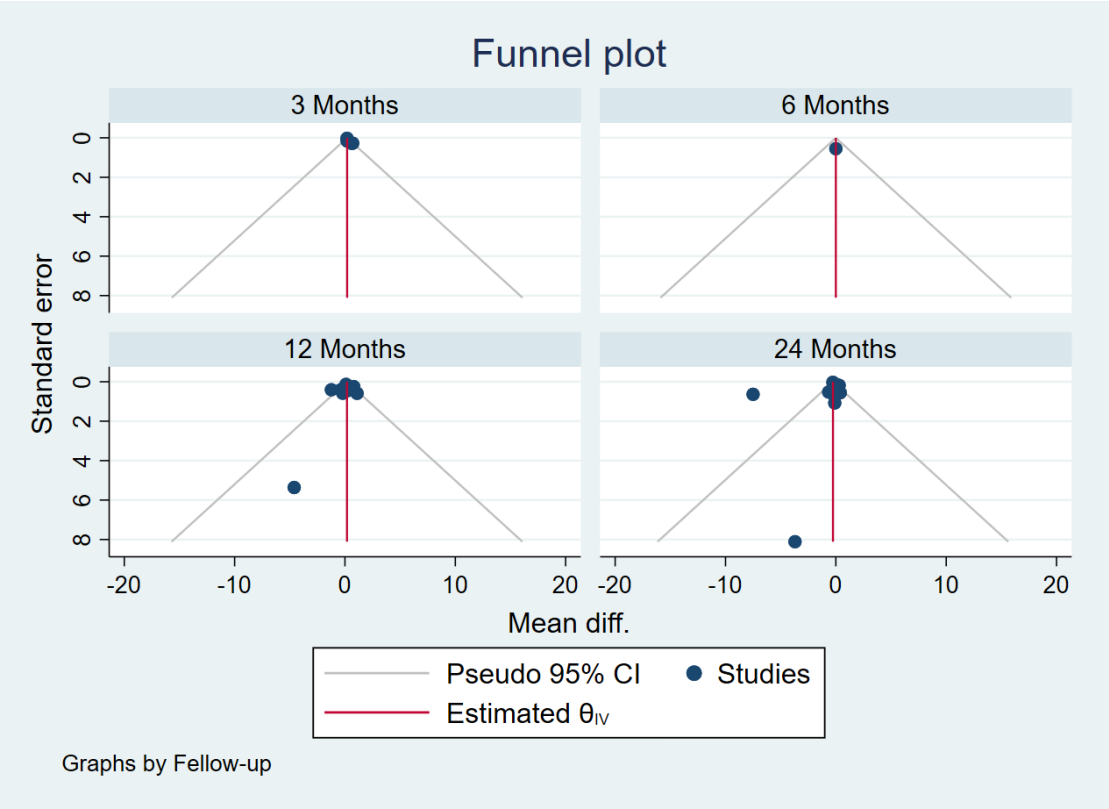
eFigure 10. Subgroup analysis of back pain scores on 24th post-operative month.



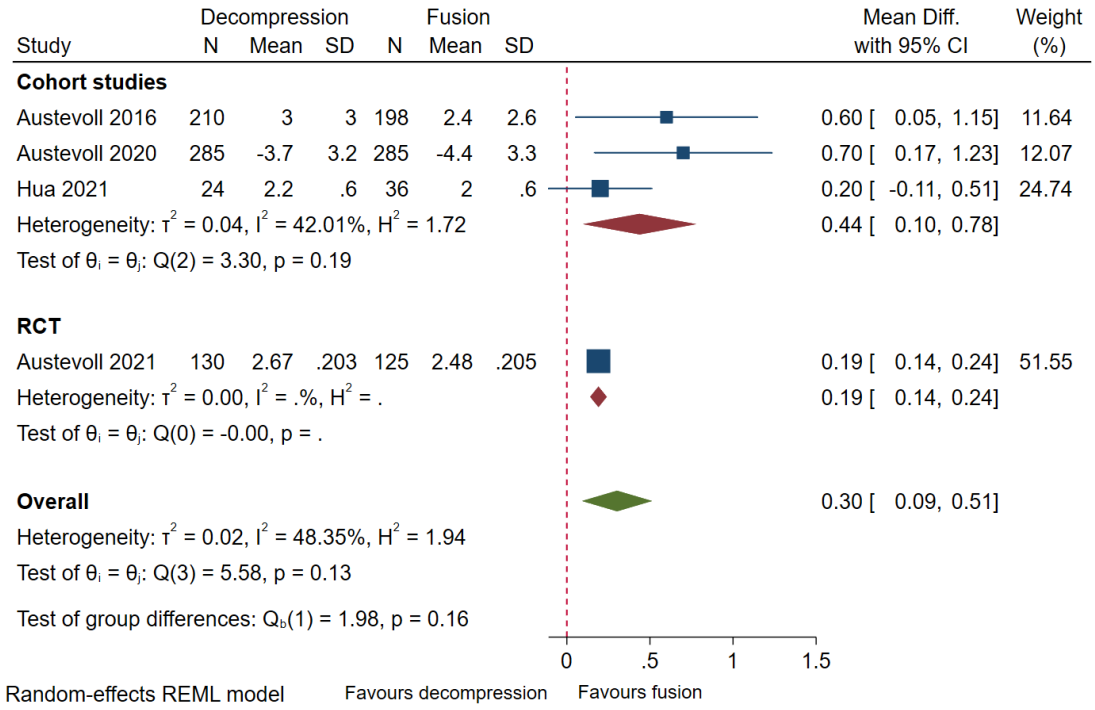
eFigure 11. Sensitivity analysis of back pain between decompression and decompression with fusion groups (excluding Chan 2019a and Chan 2019b)**.**



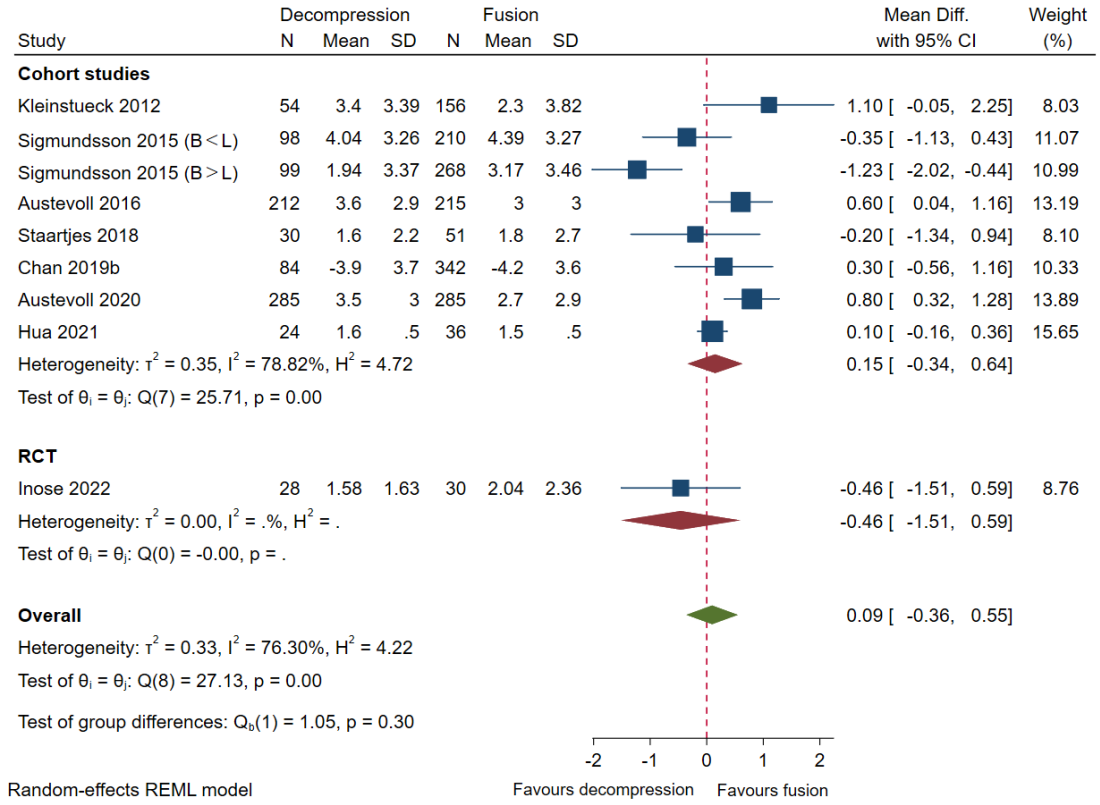
eFigure 12. Funnel plot of leg pain scores.



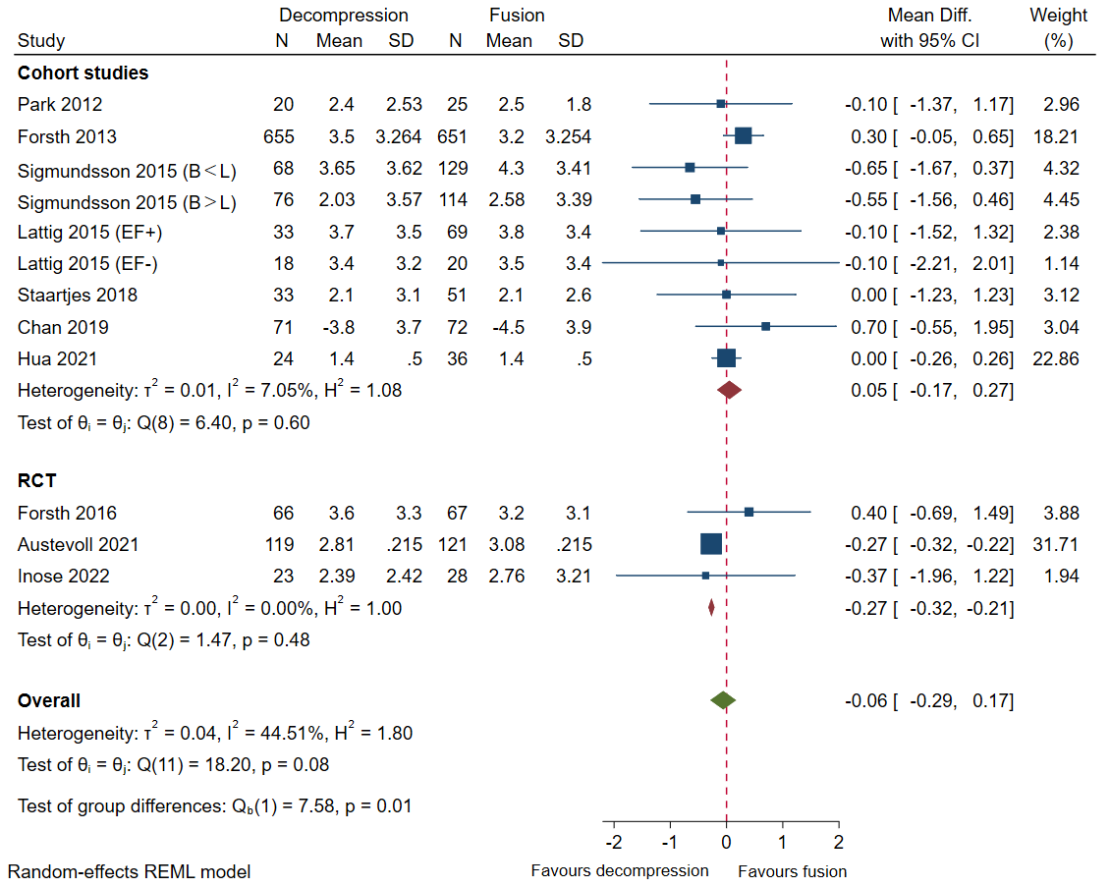
eFigure 13. Subgroup analysis of leg pain scores on 3rd post-operative month.



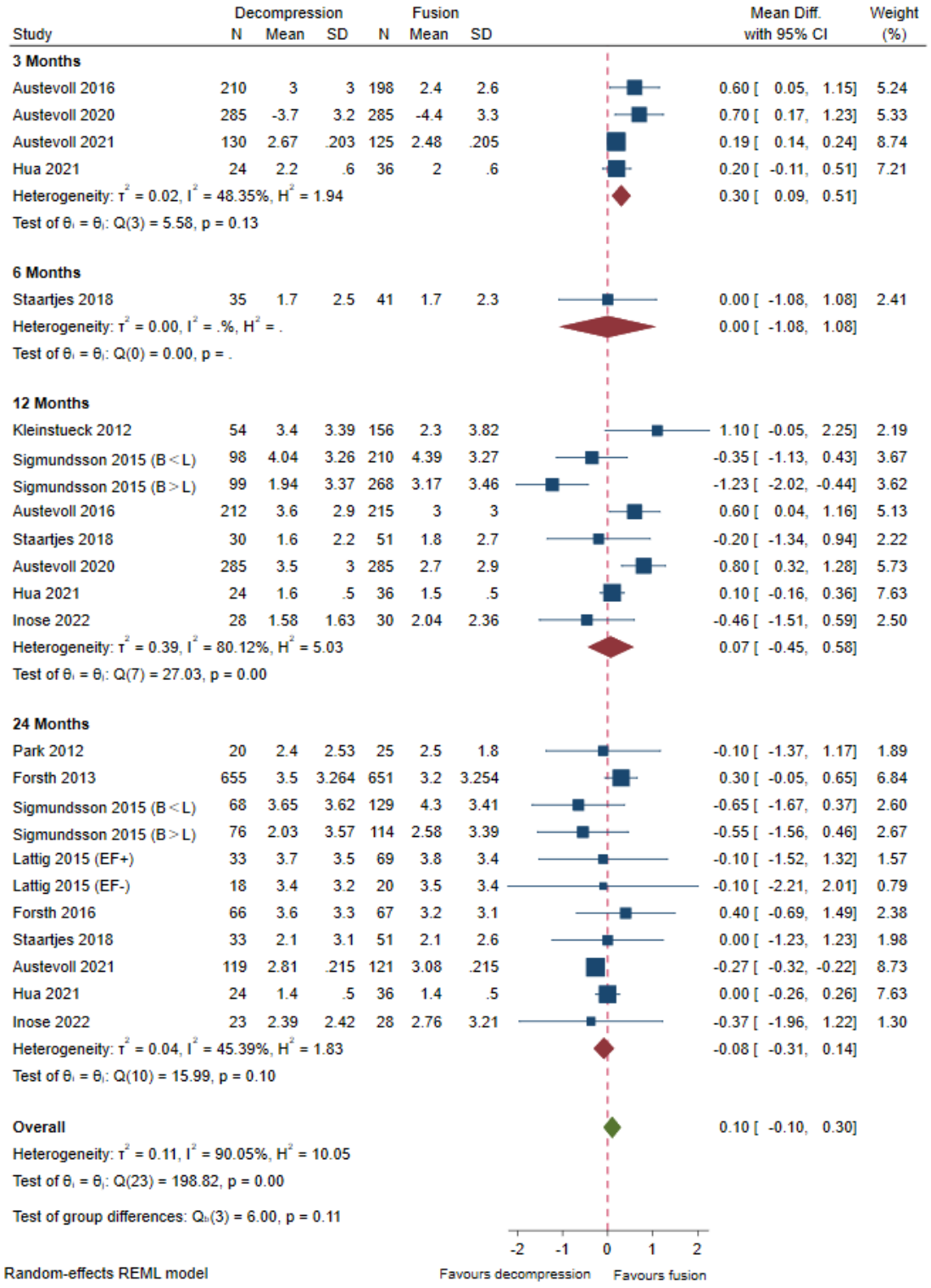
eFigure 14. Subgroup analysis of leg pain scores on 12th post-operative month.



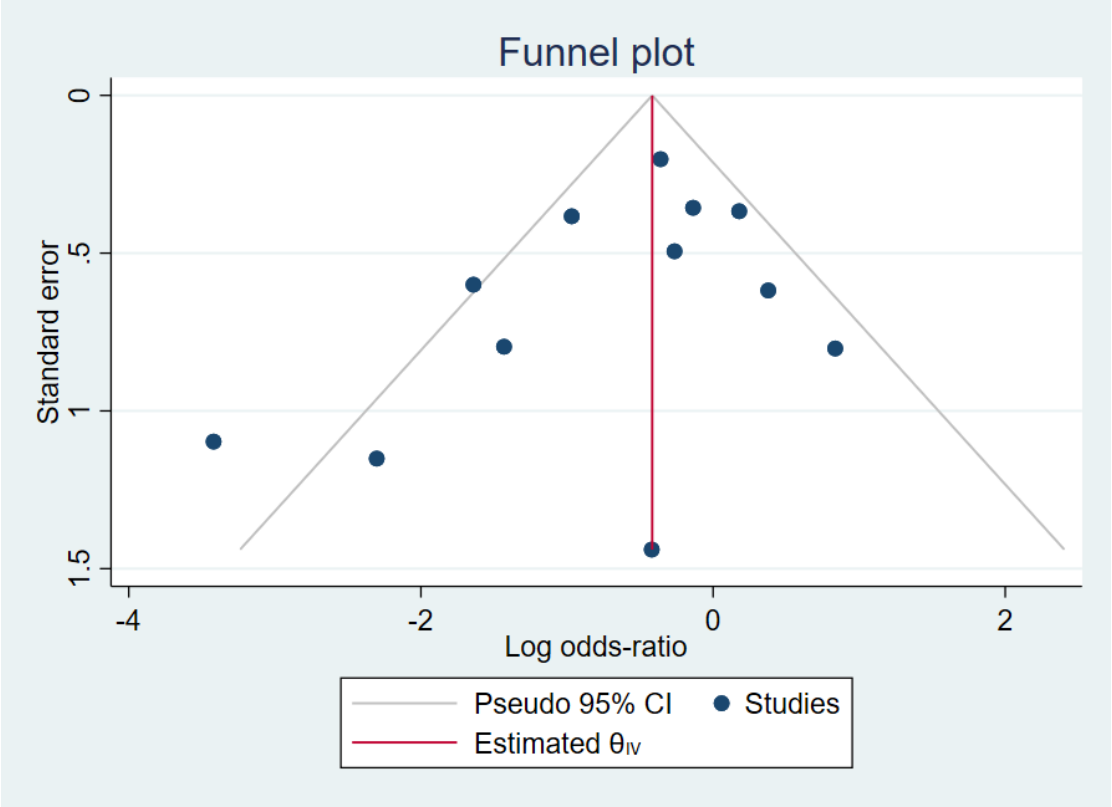
eFigure 15. Subgroup analysis of leg pain scores on 24th post-operative month.



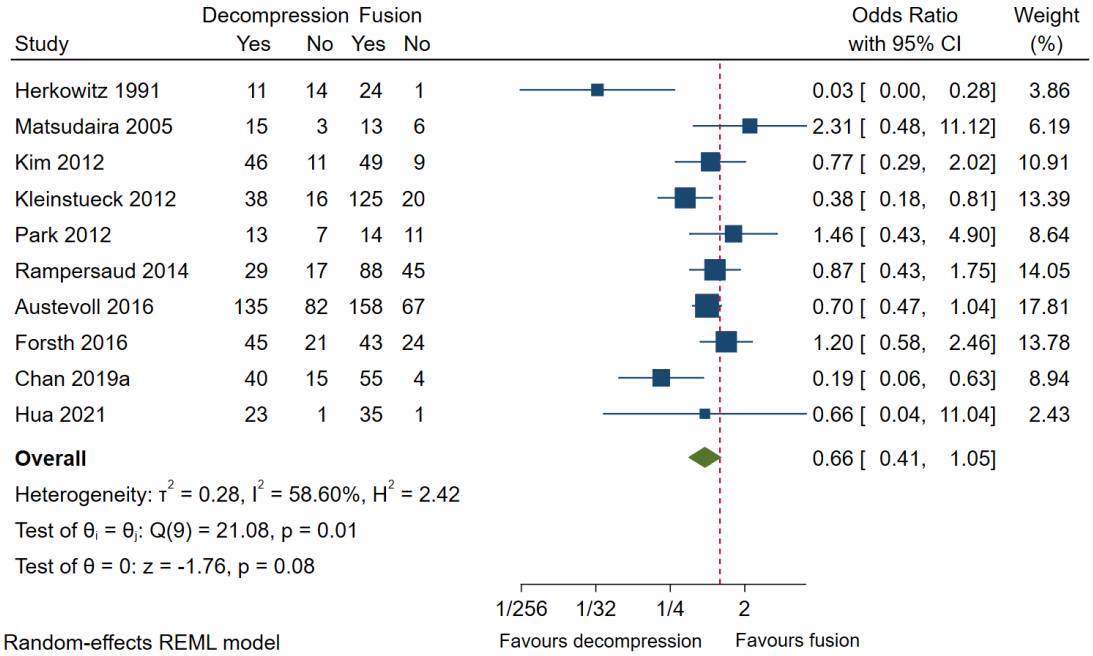
eFigure 16. Sensitivity analysis of leg pain between decompression and decompression with fusion groups (excluding Chan 2019a and Chan 2019b)**.**



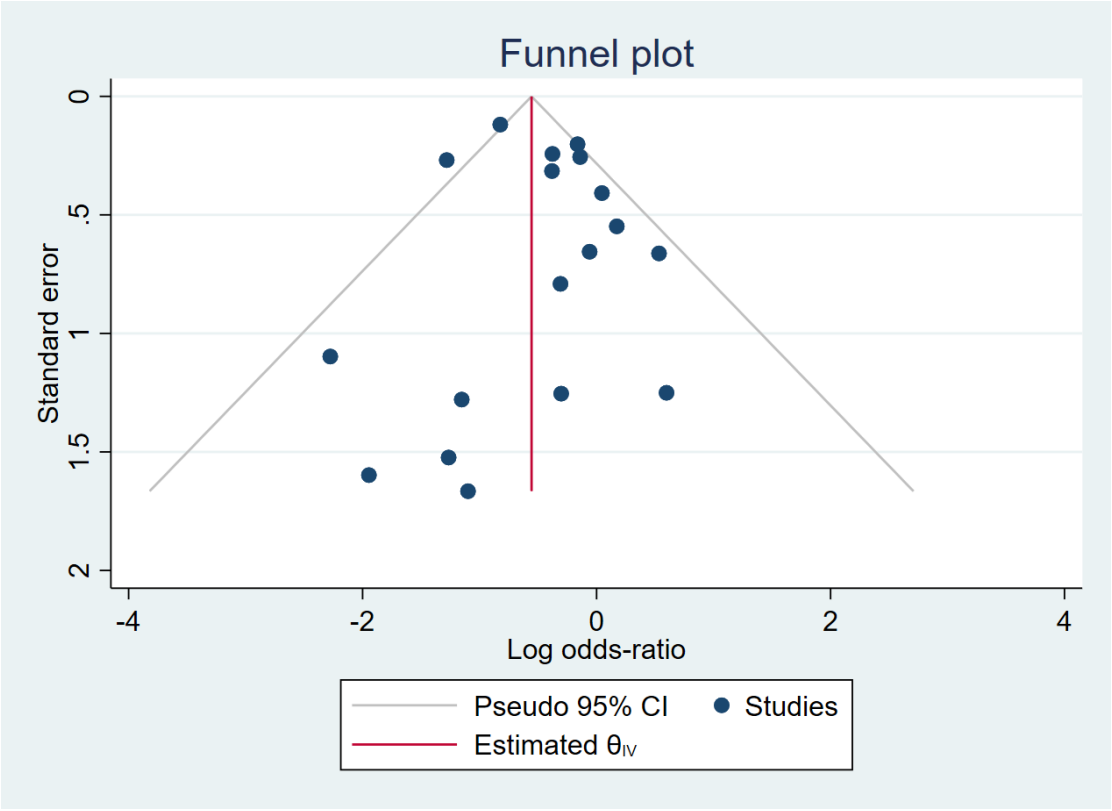
eFigure 17. Funnel plot of clinical satisfaction.



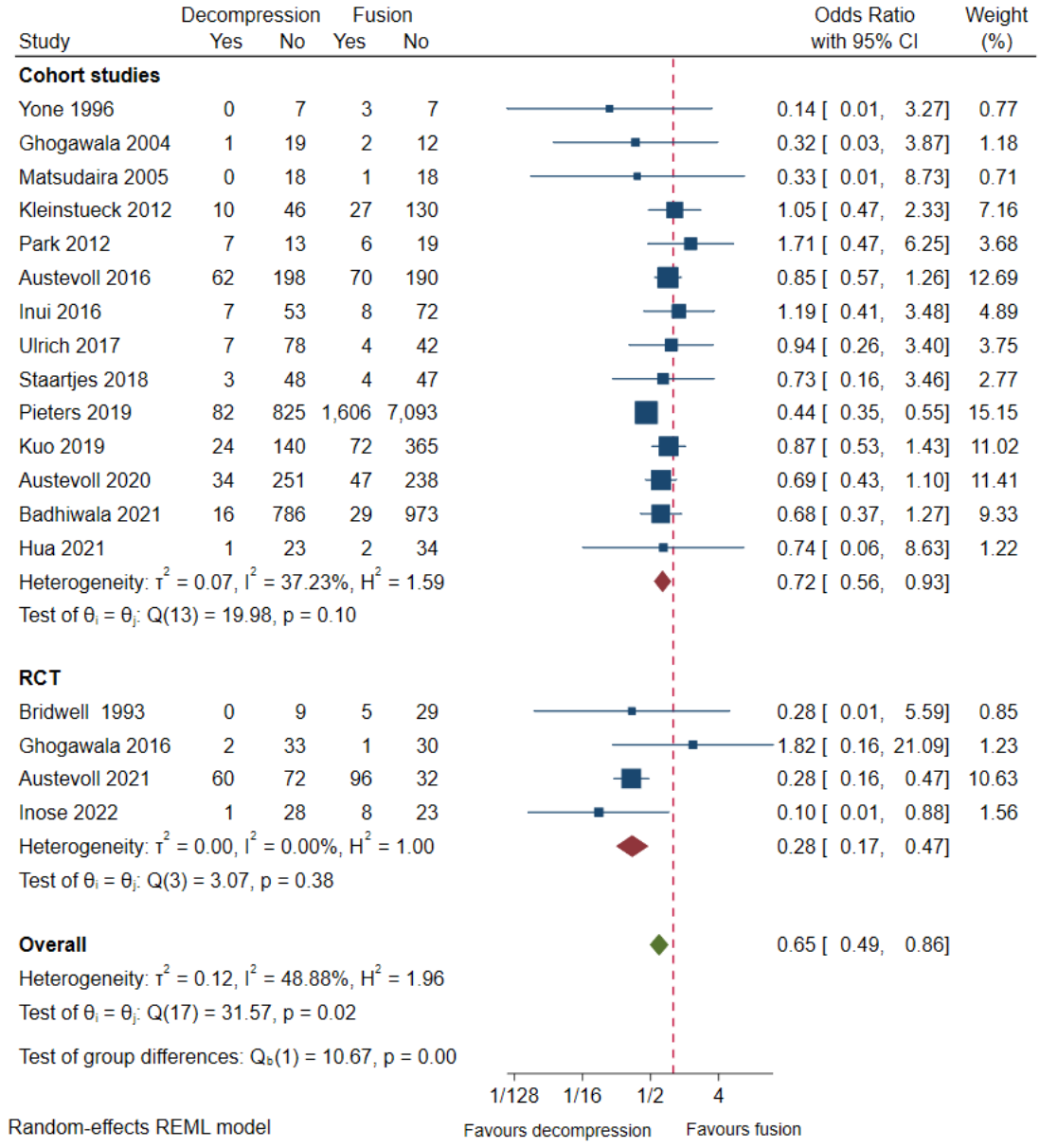
eFigure 18. Sensitivity analysis of clinical satisfaction between decompression and decompression with fusion groups (excluding Bridwell 1993; Yone 1996)**.**



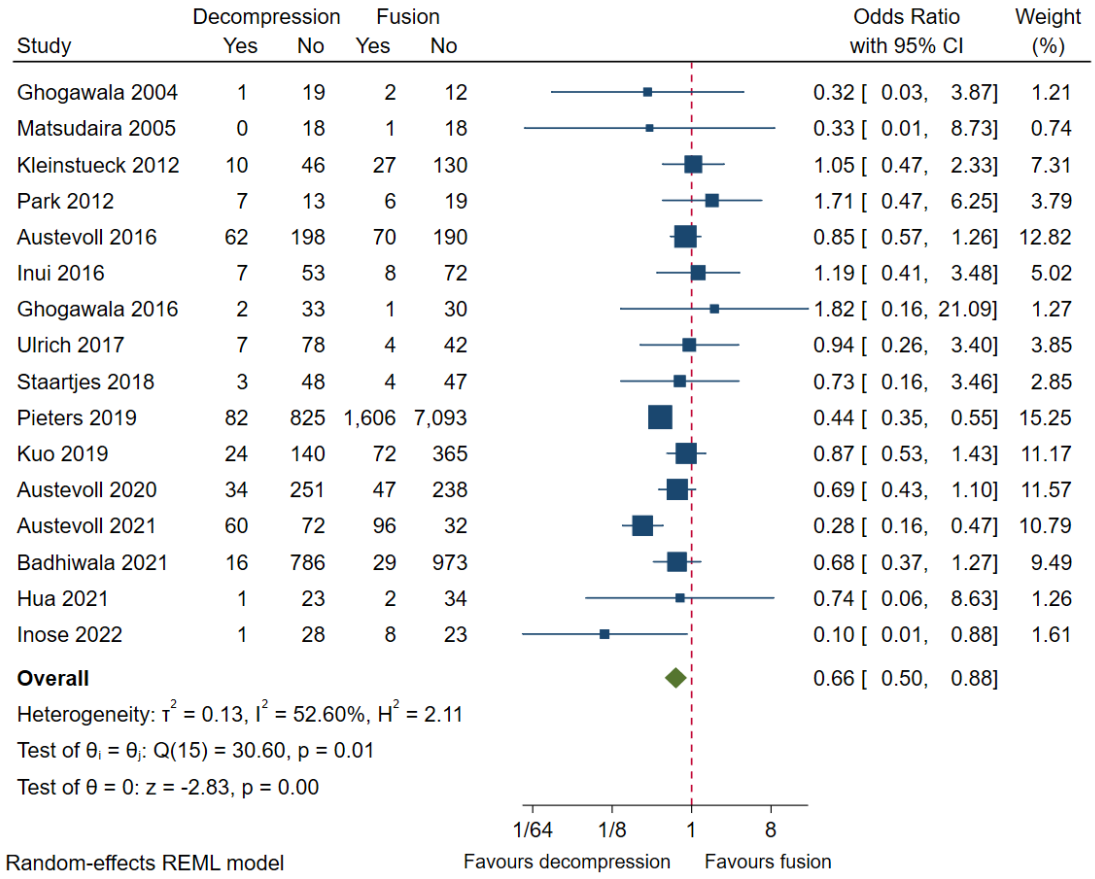
eFigure 19. Funnel plot of complication rates.



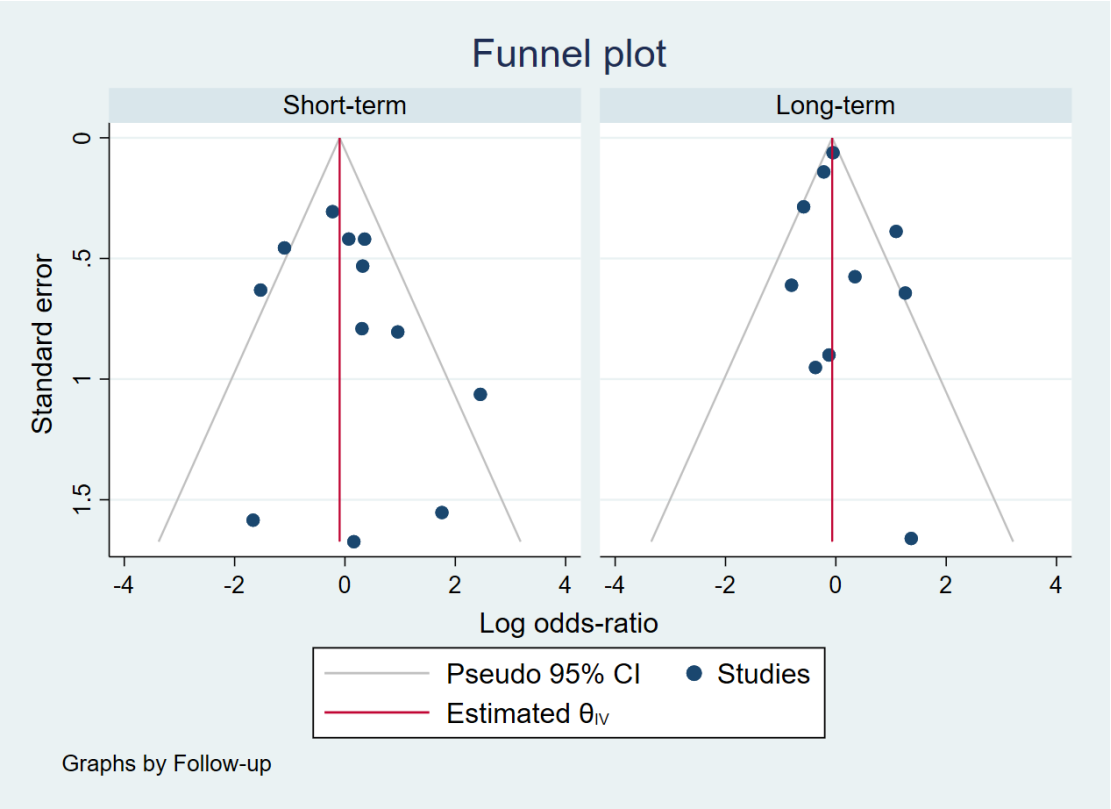
eFigure 20. Subgroup analysis of complication rates.



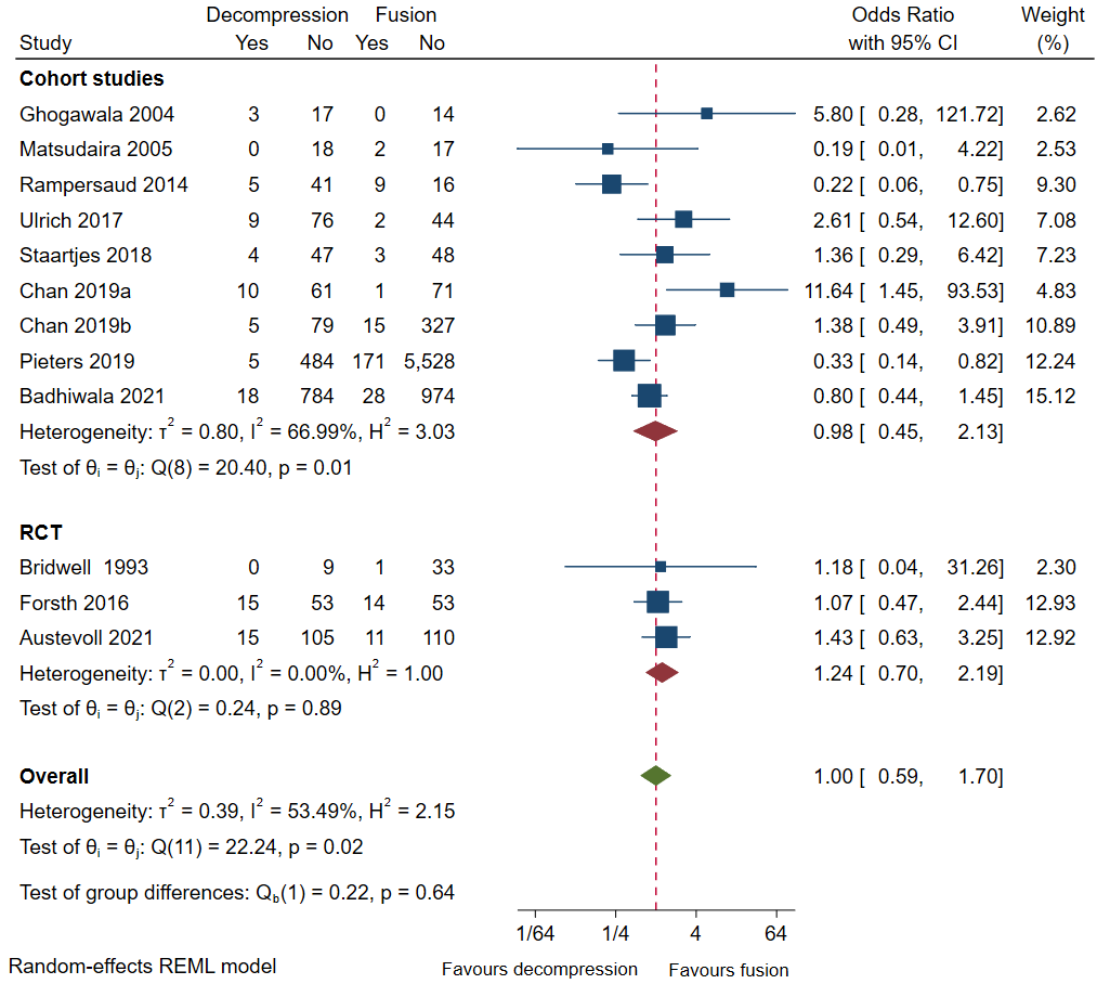
eFigure 21. Sensitivity analysis of complication rates between decompression and decompression with fusion groups (excluding Bridwell 1993; Yone 1996)**.**



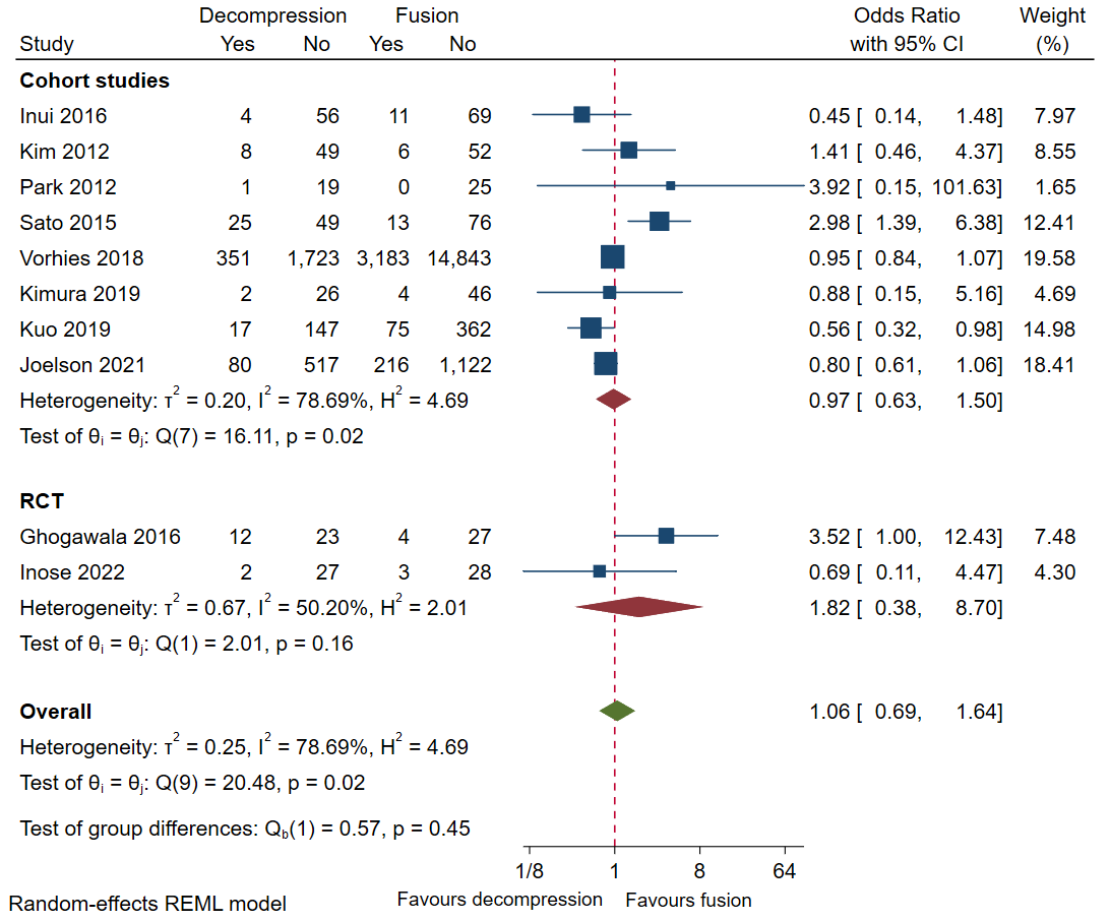
eFigure 22. Funnel plot of reoperation rates.



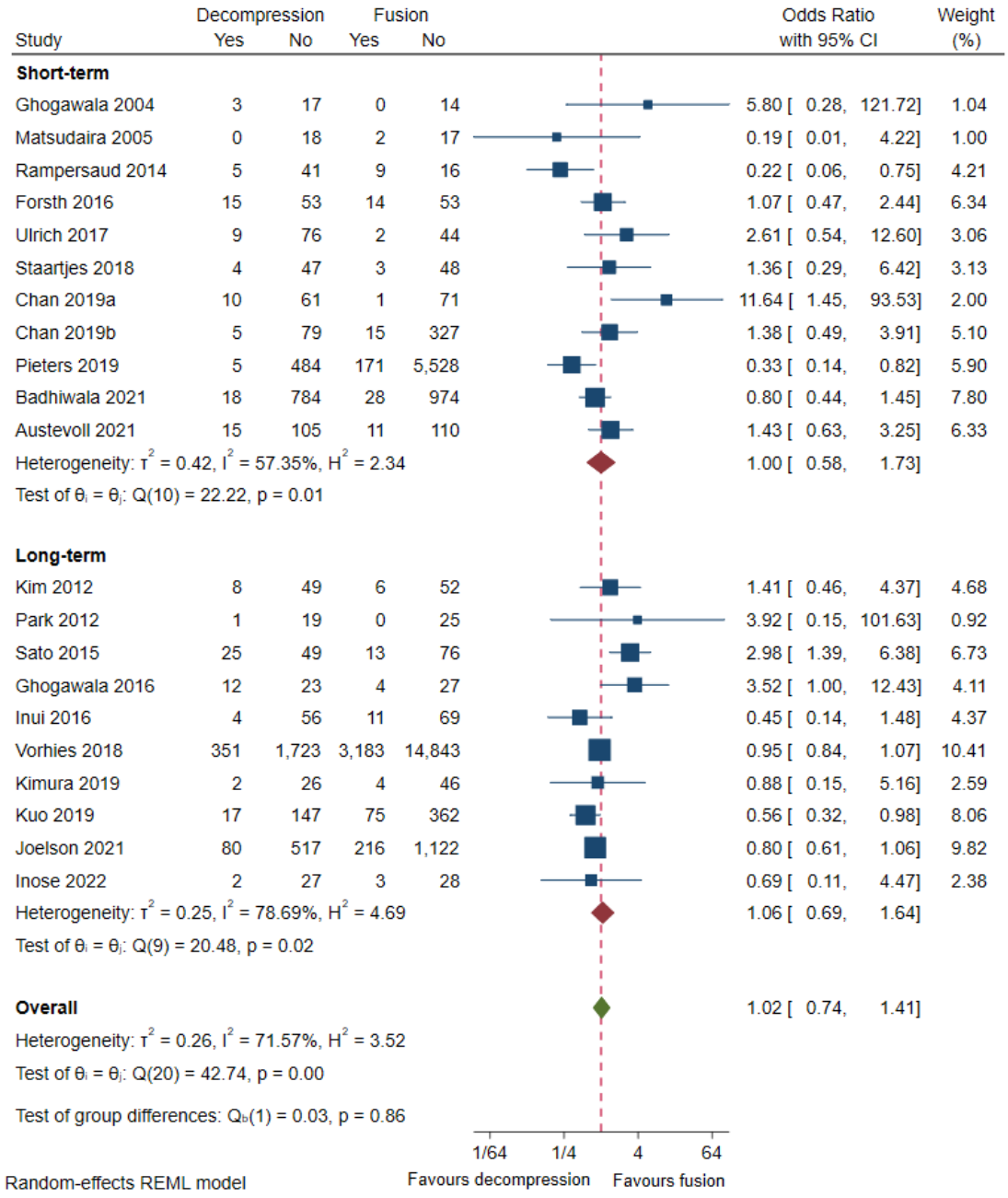
eFigure 23. Subgroup analysis of reoperation rates for short-term follow-up.



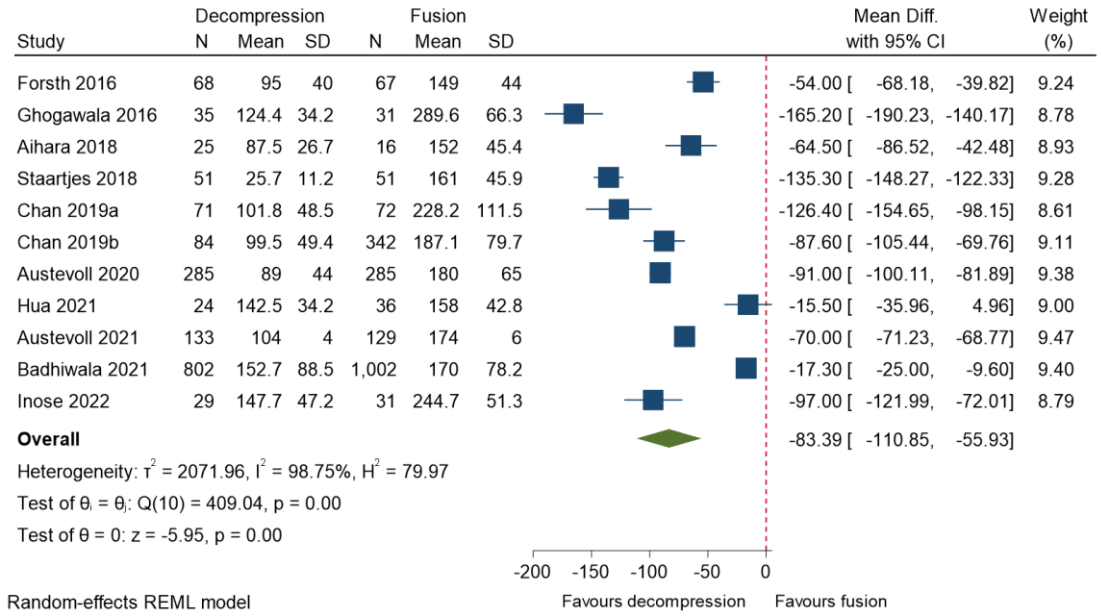
eFigure 24. Subgroup analysis of reoperation rates for long-term follow-up.



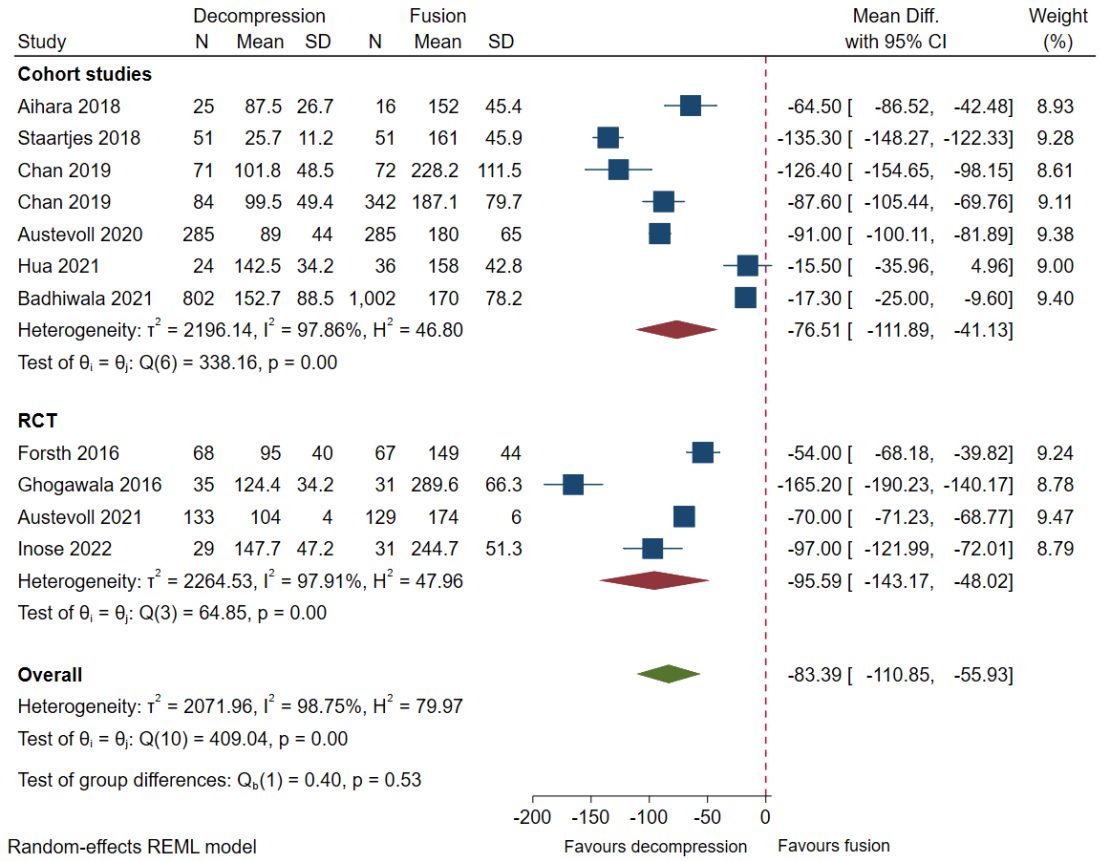
eFigure 25. Sensitivity analysis of reoperation rates between decompression and decompression with fusion groups (excluding Bridwell 1993)**.**



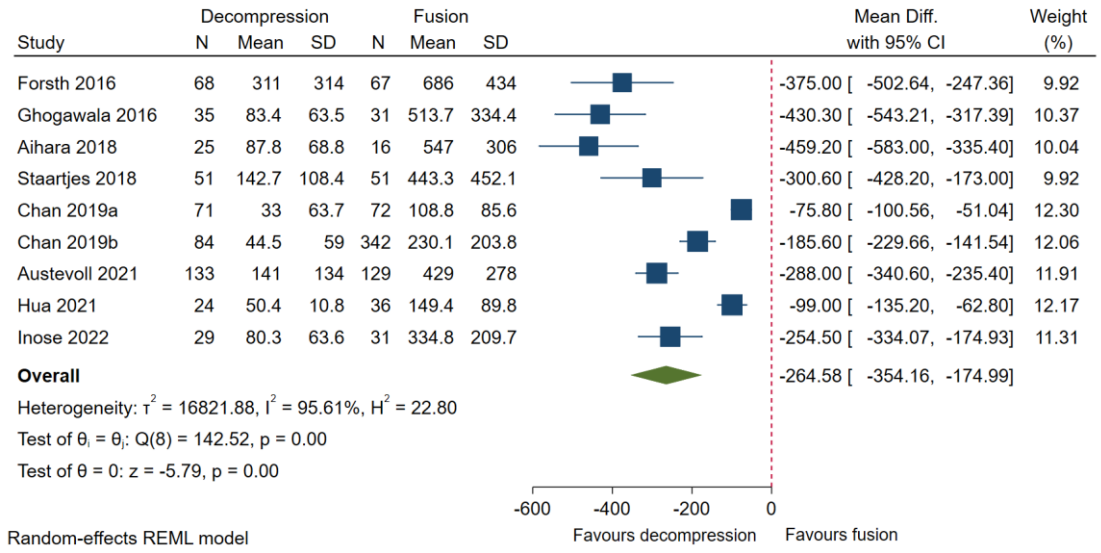
eFigure 26. The forest plot regarding operation time compared decompression with decompression with fusion group.



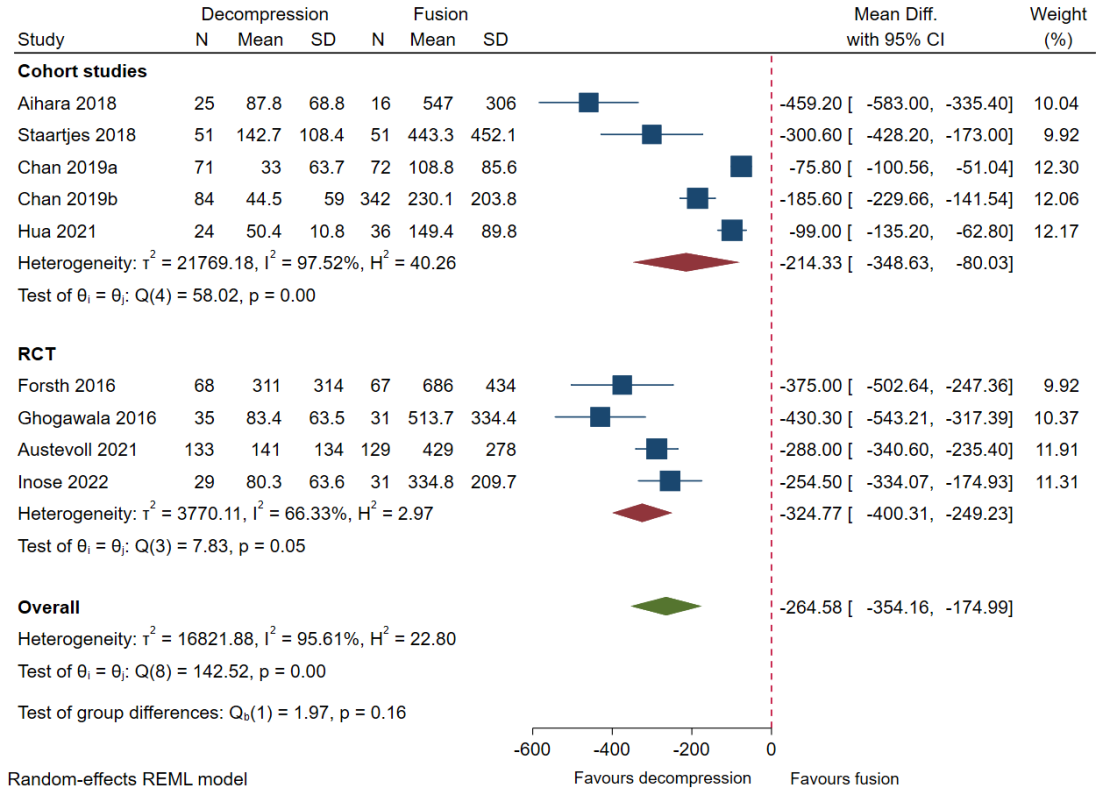
eFigure 27. Subgroup analysis of operation time.



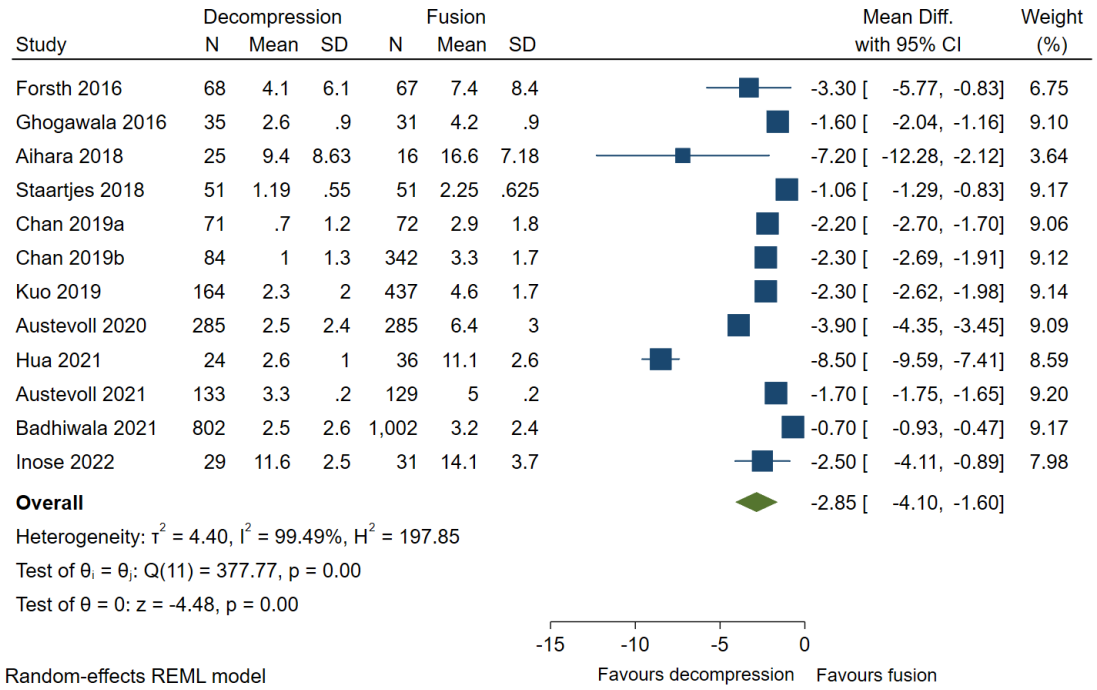
eFigure 28. The forest plot regarding intra-operative blood loss compared decompression with decompression with fusion group.



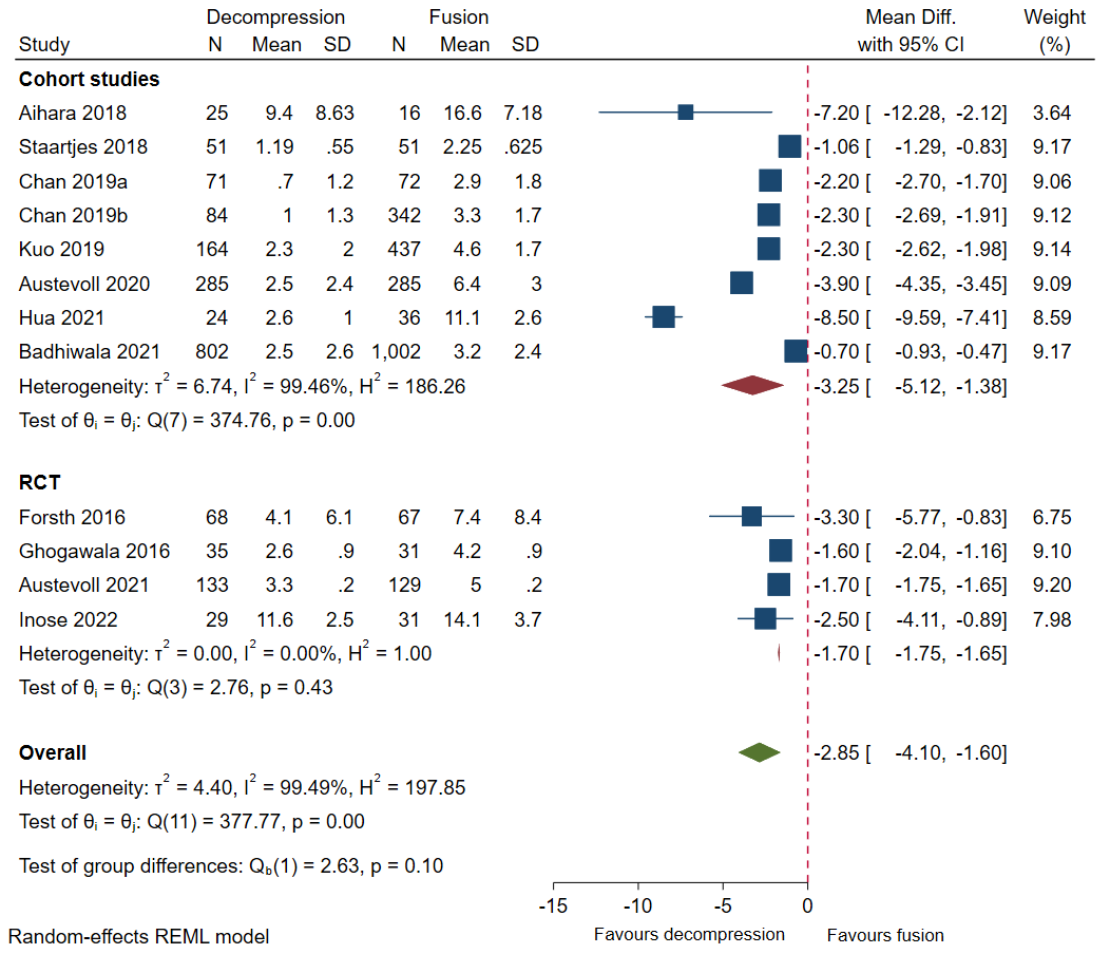
eFigure 29. Subgroup analysis of intra-operative blood loss.



eFigure 30. The forest plot regarding length of hospital stay compared decompression with decompression with fusion group.



eFigure 31. Subgroup analysis of length of hospital stay.



eTable 1. Search strategy

Database	Strategy
Pubmed	#1 "lumbar spondylolisthesis "[MeSH Terms] #2 "decompression"[MeSH Terms] OR "laminectomy"[MeSH Terms] OR "laminotomy"[MeSH Terms] OR " spinal fusion "[All Fields] OR " decompression and fusion"[All Fields] OR "intervertebral fusion"[All Fields] #3 #1 AND #2
Embase	#1 " lumbar spondylolisthesis "[All Fields] #2 "decompression"[All Fields] OR "laminectomy"[All Fields] OR "laminotomy"[All Fields] OR " spinal fusion "[All Fields] OR "decompression and fusion "[All Fields] OR "intervertebral fusion"[All Fields] #3 #1 AND #2
the Cochrane Library	#1 "lumbar spondylolisthesis"[TI,AB,KW] #2 "decompression"[TI,AB,KW] OR "laminectomy"[TI,AB,KW] OR " laminotomy"[TI,AB,KW] OR "spinal fusion "[TI,AB,KW] OR "decompression and fusion "[TI,AB,KW] OR " intervertebral fusion"[TI,AB,KW] #3 #1 AND #2

eTable 2. Inclusion/exclusion criteria of literature

PICOS	Inclusion	Exclusion
P	18 years or older suffering from degenerative lumbar spondylolisthesis.	1) Isthmic spondylolisthesis. 2) Patients suffering from trauma, spinal tumors, or infection.
I	1) Decompression alone (including open decompression and minimally invasive decompression). 2) Decompression plus fusion. 3) Each group had at least 5 patients.	Operated with an anterior approach.
C	Decompression alone or decompression plus fusion.	Operated with an anterior approach.
O	1) Primary outcomes including ODI, pain, clinical satisfaction, complication rates and reoperation rates. 2) Secondary outcome included blood loss, operative time, and hospital stay.	Relevant outcomes were missing.
S	RCTs, prospective cohort studies, and retrospective comparative studies in our analysis.	1) Non-controlled; 2) Studies that were repeatedly published or had qualitative outcomes; 3) Quasi-experimental studies, crossover, and observational studies.

eTable 3. Risk of bias table.

1	Random sequence generation (selection bias)
2	Allocation concealment (selection bias)
3	Blinding of participants and personnel (performance bias)
4	Blinding of outcome assessment (detection bias)
5	Incomplete outcome data (attrition bias)
6	Selective reporting (reporting bias)
7	Other bias

eTable 4. Characteristics of the Included Trials and Participants.

Number	Study	Country	Study design	Comparison groups	Number of participants	Age, years	Gender (Female/Male)	Grade(s) of DLS	Length of follow-up	Primary Outcomes	Clinical satisfaction	Complication details
1	Inose 2022	Japan	RCT	1) decompression alone 2) decompression with fusion	1) 28 2) 30	1) 63.4±8.7 2) 63.5±6.8	1) 12 /16 2) 20 /10	NA	1) 4355.3 (658.4) days 2) 4573.5 (883.6) days	VAS, reoperations rate, complication rate	NA	NA
2	Austevoll 2021	Norway	RCT	1) decompression alone 2) decompression with instrumented fusion	1) 133 2) 129	1) 66.0±7.4 2) 66.5±7.9	1) 92 /41 2) 88 /41	NA	24 months	ODI, NRS, reoperations rate, complication rate	NA	Dural tear, surgery on the wrong side, hematoma, wound infection, cardiovascular complications, venous thromboembolism, urologic complication, respiratory complication, deterioration
3	Badhiwala 2021	Canada	CS	1) laminectomy alone 2) laminectomy alone with fusion	1) 802 2) 1002	1) 64.4±11.6 2) 62.7±12.1	1) 497 /305 2) 654 /348	NA	24 months	reoperations rate, complication rate	NA	Pneumonia, deep vein thrombosis, pulmonary embolism, cardiac event, deep wound infection, stroke, sepsis
4	Hua 2021	China	CS	1) lumbar endoscopic unilateral laminotomy bilateral decompression 2) minimally invasive transforaminal lumbar interbody fusion	1) 24 2) 36	1) 59.0±7.9 2) 59.9±8.6	1) 16 /8 2) 26 /10	I	24 months	ODI, VAS, complication rate	Four scales: Macnab criteria (24months)	Dural tears, cauda equina injury, transient urinary retention, pleural effusion, incision fat liquefaction, incision infection, implant dislodgement
5	Joelson 2021	Sweden	CS	1) decompression alone 2) decompression with fusion	1) 597 2) 1338	1) 69 ± 9.9 2) 65±9.1	1) 407 /190 2) 1027 /311	NA	1) 7.9 (1.8) years 2) 7.8 (1.6) years	Reoperations rate	NA	NA
6	Austevoll 2020	Norway	CS	1) microdecompression alone 2) decompression with instrumented fusion	1) 285 2) 285	1) 64.6 ± 9.8 2) 64.8 ± 9.2	1) 205 /80 2) 208 /77	NA	1) 205 (72) months 2) 208 (73) months	ODI, NRS, complication rate	NA	Dural tears, nerve root lesion, operation on wrong side/level, blood transfusion, misplaced implants, cardiac complication, superficial wound infection, deep wound infection, deep venous thrombosis, lung thrombosis, pneumonia, urinary tract infection
7	Chan 2019a	USA	CS	1) minimally invasive decompression 2) transforaminal lumbar interbody fusion	1) 71 2) 72	1) 72.3 ± 9.7 2) 62.1 ± 10.6	1) 39 /32 2) 40 /32	I	24 months	ODI, NRS, reoperations rate	Four scales: the NASS satisfaction (24 months)	NA
8	Chan 2019b	USA	CS	1) laminectomy 2) minimally invasive transforaminal lumbar interbody fusion	1) 84 2) 342	1) 69.9 ± 10.5 2) 60.7 ± 11.0	1) 41 /43 2) 211 /131	I	12 months	ODI, NRS, reoperations rate	NA	NA
9	Pieters 2019	USA	CS	1) Laminectomy 2) decompression with fusion	1) 907 2) 8699	NA	1) 544 /363 2) 5448 /3251	NA	24 months	Reoperations rate, complication rate	NA	Incisional infection, unplanned intubation, pulmonary embolism, progressive renal insufficiency, stroke, cardiac arrest requiring, myocardial infarction, deep venous thrombosis, sepsis, septic shock, wound disruption, pneumonia, urinary tract infection, transfusions
10	Kuo 2019	USA	CS	1) unilateral approach for bilateral decompression 2) decompression with fusion	1) 164 2) 437	1) 68.5 ± 9.6 2) 69.2 ± 9.6	1) 105 /59 2) 312 /125	NA	60 months	Reoperations rate, complication rate	NA	Durotomy, cardiac event, kidney failure, respiratory, surgical site infection, urinary tract infection, venous thromboembolism
11	Kimura 2019	Japan	CS	1) microendoscopic muscle-preserving interlaminar decompression 2) posterior lumbar interbody fusion	1) 28 2) 50	1) 70.0 (34-85) 2) 26 (46-83)	1) 17 /11 2) 34 /16	I	>60 months	VAS, reoperations rate, complication rate	NA	NA
12	Staartjes 2018	Switzerl and	CS	1) decompression alone 2) transforaminal lumbar interbody fusion	1) 51 2) 51	1) 52.7 ± 8.4 2) 53.5±11.1	1) 29 /22 2) 26 /25	I	24 months	ODI, NRS, reoperations rate, complication rate	NA	Durotomy, transient paresis, wound infection, spondylodiscitis

13	Aihara 2018	Japan	CS	1) microendoscopic decompression 2) decompression with fusion	1) 25 2) 16	1) 62.7 ± 9.74 2) 64.3 ± 8.98	1) 14 /11 2) 6 /10	NA	60 months	DOI, reoperations rate, complication rate	NA	NA
14	Inui 2017	Japan	CS	1) unilateral approach for bilateral decompression/bilateral approach for contralateral decompression 2) decompression+ posterior lumbar interbody fusion	1) 60 2) 80	1) 69.3±8.8 2) 63.6±8	1) 35 /25 2) 55 /25	I, II, III	1) 38 months 2) 77.9 months	Complication rate, reoperation rate	NA	Dural tear, transient motor weakness, deep infection, symptomatic postoperative hematoma
15	Ulrich 2017	Switzerland	CS	1) decompression alone 2) decompression with fusion + implantation	1) 85 2) 46	1) 75.4±7.6 2) 68±7.8	1) 53 /32 2) 23 /23	NA	12 months	NRS, reoperations rate, complication rate	NA	Vascular injury, durotomy, wound infection, osseous infection, urosepsis, hemorrhage, wound healing deficit
16	Vorhies 2017	America	CS	1) decompression alone 2) decompression with fusion	1) 6712 2) 68312	1) 69 2) 61	1) 3936 /2776 2) 42667 /25645	NA	60 months	Reoperations rate	NA	NA
17	Ghogawala 2016	America	RCT	1) Laminectomy 2) posterolateral fusion + pedicle screw	1) 35 2) 31	1) 66.5 ± 8 2) 66.7 ± 7.2	1) 27 /8 2) 26 /5	I	48 months	DOI, complications rate, reoperations rate	NA	Wound infection, new neurologic deficit, pneumonia
18	Forsth 2016	Sweden	RCT	1) decompression 2) decompression with fusion + instrumentation	1) 68 2) 67	1) 67±7 2) 68±7	1) 56 /12 2) 51 /16	NA	24 months	ODI, VAS, complication rate, reoperation rate	Three scales: satisfied, doubtful, dissatisfied(24 months)	NA
19	Austevoll 2016	Norway	CS	1) decompression 2) decompression with fusion + instrumentation	1) 260 2) 260	1) 66.7±10 2) 66.3±9.6	1) 187 /73 2) 195 /65	NA	12 months	ODI, NRS, complication rate	Seven scales: completely recovered, much improved, slightly improved, unchanged, slightly worse, much worse and worse than ever(12 months)	Perioperative complications, patient-reported complications
20	Alvin 2016	USA	CS	1) decompression 2) posterolateral fusion + instrumentation	1) 25 2) 25	1) 57.8±11.9 2) 62.7±5.1	1) 10 /15 2) 14 /11	I	12 months	VAS	NA	NA
21	Sigmundsson 2015	Sweden	CS	1) decompression[1] 2) posterolateral fusion + instrumentation[1] 3) decompression[2] 4) posterolateral fusion + instrumentation[2]	1) 125 2) 262 3) 120 4) 332	1) 73.8 ± 9.3 2) 68.8 ± 8.7 3) 73.2 ± 10.6 4) 69.1 ± 9.1	1) 87 /38 2) 202 /60 3) 89 /31 4) 270 /62	NA	24 months	ODI, VAS	NA	NA
22	Sato 2015	Japan	CS	1) Laminotomy 2) posterior lumbar interbody fusion + instrumentation	1) 74 2) 89	NA	NA	I	6 months	Reoperations rate	NA	NA
23	Lattig 2015	Germany	CS	1) decompression[3] 2) decompression with fusion+ instrumentation[3] 3) decompression[4] 4) decompression with fusion+ instrumentation[4]	1) 44 2) 76 3) 19 4) 21	1) 72.4 ± 9.7 2) 67.3 ± 9.3 3) 74.3 ± 7.0 4) 69.2 ± 7.6	1) 29 /15 2) 63 /13 3) 10 /9 4) 17 /4	NA	24 months	Core outcome measures index questionnaire	NA	NA
24	Rampersaud 2014	Canada	CS	1) unilateral approach for bilateral decompression 2) posterior lumbar interbody fusion or posterolateral fusion + pedicle screw	1) 46 2) 133	1) 67.8 ± 8.6 2) 62.5 ± 10.8	1) 27 /19 2) 98 /35	I	24 months	NA	Substantial clinical benefit(24 months)	NA
25	Forsth 2013	Sweden	CS	1) decompression 2) decompression with fusion	1) 655 2) 651	69	NA	NA	24 months	ODI, VAS, reoperations rate	NA	NA
26	Park 2012	Korea	CS	1) unilateral approach for bilateral decompression 2) posterior lumbar interbody fusion + instrumentation	1) 20 2) 25	1) 67.7±7.3 2) 61.9±8.0	1) 15 /5 2) 22 /3	I	1) 54.9 months 2) 69.4 months	ODI, NRS	Odom's criteria: excellent, good, fair, poor (Last Fellow-up)	Incidental durotomy, wound infection
27	Kleinstueck 2012	Switzerland	CS	1) decompression 2) decompression with fusion+	1) 56 2) 157	1) 73.0±8.0 2) 67.4±9.4	1) 33 /23 2) 122 /35	NA	12 months	Core outcome measures index questionnaire, complication rate	Two scales: good and poor(12 months)	bleeding in/outside spinal canal, dura lesion, wound infection,

				instrumentation								continuing pain, wound dehiscence necrotic wound
28	Kim 2012	Canada	CS	1) unilateral approach for bilateral decompression 2) decompression and instrumented fusion with or without an interbody fusion	1) 57 2) 58	1) 67.1±9.7 2) 63.7±9.7	1) 25 /32 2) 42 /16	I	120 months	Reoperation rate	Four scales: well, unwell no improvement and death (120 months)	NA
29	Matsudaira 2005	Japan	CS	1) decompression 2) posterolateral fusion + pedicle screw	1) 18 2) 19	1) 67±7 2) 68±7	NA	I	24 months	Complication rate, reoperation rate	Four scales: satisfied, slightly satisfied, slightly dissatisfied, dissatisfied (24 months)	Deep infection, migration of a pedicle screw, stenosis at an adjacent level
30	Ghogawala 2004	USA	CS	1) laminectomy 2) laminectomy or laminotomy + posterolateral fusion	1) 20 2) 14	68.8±8.0	23 /11	I	12 months	ODI, complication rate, reoperation rate	NA	Pneumonia, major wound infection, preexisting radiculopathy, cerebrospinal fluid leaks
31	Yone 1996	Japan	CS	1) laminotomy 2) laminectomy or laminotomy + posterolateral fusion	1) 7 2) 10	1) 69 2) 68	NA	NA	≥ 24 months	Complication rate	Four scales: according to the rate of improvement (≥ 24 months)	Compression fracture, nonunion, dislocation of a Knodt hook
32	Bridwell 1993	USA	RCT	1) decompression 2) posterolateral fusion 3) posterolateral fusion + pedicle screw	1) 9 2) 10 3) 24	1) 72.3 2) 65.6 3) 64.2	33 /10	NA	1) 34 months 2) 45 months 3) 36 months	Complication rate, reoperation rate	Worse, the same, significantly better (≥ 24 months)	Cerebrovascular accident, superficial wound infection, dural tear, poor lateral screw palcement
33	Herkowitz 1991	USA	RCT	1) Laminectomy 2) posterolateral fusion	1) 25 2) 25	1) 65±5.0 2) 63.5±5.2	36 /14	NA	36 months	NA	NA	NA

DLS: degenerative lumbar spondylolisthesis; CS: cohort studies; RCT: randomized controlled trial; DLS: degenerative lumbar spondylolisthesis; ODI: Oswestry disability index; VAS: visual analogue scores; NRS: numerical rating scale.

[1] Back pain<Leg pain； [2] Back pain>Leg pain

eTable 5. Scores of the Newcastle-Ottawa Quality Assessment Scale for 27 cohort studies.

Study	Selection	Comparability	Outcome	Total
Yone 1996	★★★	★	★★★	★★★★★★★
Ghogawala 2004	★★★★	★★	★★★	★★★★★★★★★
Matsudaira 2005	★★★	★	★★★	★★★★★★★
Kim 2012	★★★★	★	★★	★★★★★★★
Kleinstueck 2012	★★★★	-	★★★	★★★★★★★★
Park 2012	★★★★	★	★★★	★★★★★★★★
Forsth 2013	★★★★	★	★★★	★★★★★★★★
Rampersaud 2014	★★★★	-	★★★	★★★★★★★
Lattig 2015	★★★★	★	★★★	★★★★★★★★
Sato 2015	★★★	★	★★★	★★★★★★★
Sigmundsson 2015	★★★★	★★	★★★	★★★★★★★★★★
Alvin 2016	★★★★	★	★★	★★★★★★★
Austevoll 2016	★★★★	★★	★★★	★★★★★★★★★★
Vorhies 2017	★★★★	★	★★	★★★★★★★
Ulrich 2017	★★★★	★	★★★	★★★★★★★★
Inui 2017	★★★	★	★★★	★★★★★★★
Aihara 2018	★★★★	★	★★★	★★★★★★★★
Staartjes 2018	★★	★	★★★	★★★★★★
Kimura 2019	★★★★	★★	★★	★★★★★★★★
Kuo 2019	★★★★	★★	★★★	★★★★★★★★★★
Pieters 2019	★★★★	★	★★★	★★★★★★★★
Chan 2019	★★★★	-	★★	★★★★★★
Chan 2019	★★★★	-	★★	★★★★★★
Austevoll 2020	★★★★	★★	★★★	★★★★★★★★★★
Joelson 2021	★★★★	-	★★★	★★★★★★★
Hua 2021	★★★★	★★	★★★	★★★★★★★★★★
Badhiwala 2021	★★★★	★	★★★	★★★★★★★★