Surgical versus non-surgical treatment for sciatica: systematic review and meta-analysis of randomised controlled trials

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Additional material is published online only. To view please visit the journal online.

Cite this as: *BMJ* 2023;381:e070730
http://dx.doi.org/10.1136/bmj-2022-070730

Accepted: 13 March 2023

ABSTRACT

OBJECTIVE

To investigate the effectiveness and safety of surgery compared with non-surgical treatment for sciatica.

DESIGN

Systematic review and meta-analysis.

DATA SOURCES

Medline, Embase, CINAHL, Cochrane Central Register of Controlled Trials, ClinicalTrials.gov, and the World Health Organisation International Clinical Trials Registry Platform from database inception to June 2022.

ELIGIBILITY CRITERIA FOR SELECTING STUDIES

Randomised controlled trials comparing any surgical treatment with non-surgical treatment, epidural steroid injections, or placebo or sham surgery, in people with sciatica of any duration due to lumbar disc herniation (diagnosed by radiological imaging).

DATA EXTRACTION AND SYNTHESIS

Two independent reviewers extracted data. Leg pain and disability were the primary outcomes. Adverse events, back pain, quality of life, and satisfaction with treatment were the secondary outcomes. Pain and disability scores were converted to a scale of 0 (no pain or disability) to 100 (worst pain or disability). Data were pooled using a random effects model. Risk of bias was assessed with the Cochrane Collaboration's tool and certainty of evidence with the grading of recommendations assessment, development, and evaluation (GRADE) framework. Follow-up times were into immediate term (≤six weeks), short term (>six weeks and ≤three months), medium term (>three and <12 months), and long term (at 12 months).

RESULTS

24 trials were included, half of these investigated the effectiveness of discectomy compared with non-surgical treatment or epidural steroid injections (1711 participants). Very low to low certainty evidence showed that discectomy, compared with non-surgical treatment, reduced leg pain: the effect size was moderate at immediate term (mean difference −12.1 (95% confidence interval −23.6 to −0.5)) and short term (−11.7 (−18.6 to −4.7)), and small at medium term (−6.5 (−11.0 to −2.1)). Negligible effects were noted at long term (−2.3 (−4.5 to −0.2)). For disability, small, negligible, or no effects were found. A similar effect on leg pain was found when comparing discectomy with epidural steroid injections. For disability, a moderate effect was found at short term, but no effect was observed at medium and long term. The risk of any adverse events was similar between discectomy and non-surgical treatment (risk ratio 1.34 (95% confidence interval 0.91 to 1.98)).

CONCLUSION

Very low to low certainty evidence suggests that discectomy was superior to non-surgical treatment or epidural steroid injections in reducing leg pain and disability in people with sciatica with a surgical indication, but the benefits declined over time. Discectomy might be an option for people with sciatica who feel that the rapid relief offered by discectomy outweighs the risks and costs associated with surgery.

SYSTEMATIC REVIEW REGISTRATION

PROSPERO CRD42021269997.

WHAT IS ALREADY KNOWN

Discectomy and other surgical procedures are widely used for the treatment of sciatica secondary to lumbar disc herniation

Guidelines recommend discectomy when non-surgical treatments are unsuccessful, and imaging features are consistent with sciatica

Evidence supporting surgical treatment for sciatica is uncertain; reviews have substantial limitations in literature coverage, population selection, and method

WHAT THIS STUDY ADDS

Very low to low certainty evidence suggests that discectomy was superior to non-surgical treatment or epidural steroid injections in reducing leg pain and disability in people with sciatica with a surgical indication, but benefits reduced over time

Discectomy might be considered an early management option in people who the benefits of early improvement in leg pain or disability outweigh the costs and potential risks

Discectomy might cause surgical related complications, but trials included in this review are likely underpowered to detect harms with low incidences (eg, wound infection, recurrent disc herniation, and persistent postsurgical pain)

Introduction

Sciatica is a common condition with a lifetime prevalence of up to 43%.[1 2] In approximately 85-90% of cases, a herniated disc causes lumbar nerve root compression or inflammation.[3 4] Although the prognosis for patients with acute sciatica is generally favourable, 20-30% of patients still experience pain after a year.[3 5]

Guidelines recommend a stepwise model of treatment for sciatica starting with non-surgical treatment such as exercise, then progressing to pharmacological and interventional treatment if the pain is refractory. When non-surgical treatments have not been effective, surgery can then be considered if radiological findings are consistent with symptoms.[6-8]

Discectomy is the most common surgical treatment for sciatica due to disc herniation.[1] Around 180 000 discectomies are done in the USA per year,[9] and an increasing trend in its use has been reported in many high-income countries over the past 20 years.[10-12] However, evidence supporting surgical treatment for sciatica is uncertain.

Recent systematic reviews on this topic have several shortcomings. They have collated data from heterogeneous populations (eg, people with lumbar disc herniation, stenosis, and spondylolisthesis),[13] which have distinct clinical courses and require different surgical procedures.[14] Others have excluded studies published in languages other than English, newly published trials, and trials that compared surgery to other commonly used interventional treatments, such as epidural injections.[15] Another network meta-analysis combined data from different time points. A nuanced interpretation of the outcomes for pain and disability was not given.[16] Hence, current evidence supporting surgery for sciatica is undetermined and warrants a comprehensive update. The objective of this systematic review was to investigate the effectiveness or efficacy and safety of surgical treatment, compared with non-surgical treatment, in people with sciatica due to lumbar disc herniation.

Methods

We prospectively registered this review on PROSPERO (CRD42021269997) and have followed the PRISMA reporting guidelines.[17]

Data sources and searches

We searched Medline, EMBASE, CINAHL, Cochrane Central Register of Controlled Trials, ClinicalTrials.gov, and the World Health Organization's International Clinical Trials Registry Platform from their database inception to June 2022 (supplemental file 1). We also tracked citations on relevant systematic reviews and included studies. Two authors independently screened titles and abstracts, then full text articles. Disagreements were resolved by consensus (supplemental file 2).

Eligibility criteria

We included randomised controlled trials in adults with sciatica of any duration due to a herniated disc (diagnosed through radiological examination). Eligible interventions were any surgical treatment using any approach, including open, micro, or endoscopic discectomy; percutaneous (plasma) disc decompression; and chemonucleolysis. Comparators were any non-surgical treatment, including non-pharmacological, pharmacological, interventional treatments (eg, epidural injection), or combinations of these. We deemed studies using placebo or sham surgeries as comparators as also eligible.[18] Trials that reported data for pain, disability, or other outcomes of interest (see outcomes section for full details) were included. We did not restrict by language, geography, or publication date.

We excluded studies with mixed populations (eg, lumbar disc herniation and lumbar stenosis) if separate data for lumbar disc herniation could not be obtained. We also excluded studies that enrolled participants with lumbar disc herniation combined with spinal stenosis or spondylolisthesis or with any serious spinal pathologies (eg, infection, tumour, fractures, major trauma, systemic inflammatory diseases, or pregnancy related sciatica).

Data extraction

Two authors extracted data independently and were reviewed by a third author. We extracted data according to the hierarchy of between group differences (ie, mean difference) and 95% confidence intervals, post-treatment means and standard deviations, and then pretreatment to post-treatment within group change scores. When standard deviations were not reported, the Cochrane's RevMan calculator was used to estimate standard deviations.[19 20] When it was not possible to estimate standard deviations, we borrowed them from a similar study included in the review. When data were not available in the published manuscript, we sought to extract data from the trial registry, if available.

We classified follow-up times into immediate term (≤six weeks), short term (>six weeks and ≤three months), medium term (>three and <12 months), and long term (at 12 months). In studies with multiple time points, we extracted data from the time point closest to six weeks and to months three, six, and 12. Outcomes longer than 12 months were also extracted.

Outcomes

The primary outcomes were leg pain intensity (eg, Numerical Pain Rating Scale, Visual Analogue Scale) and disability (eg, Oswestry Disability Index, Roland Morris Disability Questionnaire). Secondary outcomes were back pain intensity, health related quality of life (eg, short form-36), adverse events (any adverse event and serious adverse events as defined by each study), and satisfaction with treatment (eg, Likert Scale).

Risk of bias and certainty of evidence

Two authors independently assessed the risk of bias (selection, performance, detection, attrition, and reporting bias) of included trials using the Cochrane risk of bias tool.[20] We assessed funding and conflict of interest statements as part of assessing other bias (eg, industry funded trials without declaration of investigator autonomy was judged to be at high risk; supplemental file 11). We rated the certainty of evidence for each of the outcomes by using the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) framework.[21] For each GRADE domain, the quality of evidence was downgraded by one level if a serious flaw was present, that is: risk of bias (>25% of participants in this comparison were from studies at high risk of bias (supplemental file 3), inconsistency (substantial unexplained interstudy heterogeneity, I^2 >50), imprecision (95% confidence interval were 20 points different to the point estimates), and, and

small study effects (>25% of participants were from small studies (<100 participants per arm)).[21] Certainty of evidence was rated as high, moderate, low, or very low. Any discrepancies between the evaluation of risk of bias and certainty of evidence were resolved through consensus, or, when required, by arbitration with a third reviewer.

Data synthesis and analysis

We grouped the studies by surgical procedures. Then, within each surgical procedure, comparators were grouped as non-surgical (non-pharmacological or pharmacological) treatment, epidural steroid injections, and placebo or sham surgery (eg, intradiscal injection of saline solution). We presented discectomy as the primary surgical procedure because this procedure is most widely used for sciatica due to lumbar disc herniation.[1]

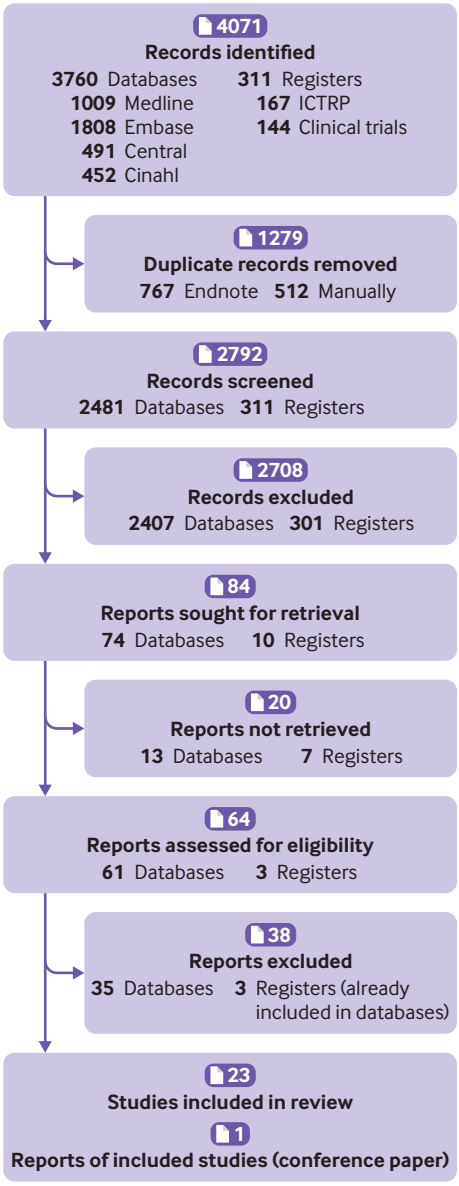

Fig 1 | Study flow diagram. ICTRP=International Clinical Trials Registry Platform

Where appropriate, we converted continuous pain and disability outcomes to a common 0-100 scale (0 represents no pain or disability, 100 represents worst pain or disability) (supplemental files 3-5).[19 22] We pooled data where possible, reported continuous outcomes as mean difference and 95% confidence intervals, and reported dichotomous outcomes as risk ratios and 95% confidence intervals. Statistical heterogeneity was determined with the I^2 test. A random effects model was used for all pooled comparisons.

Rather than selecting an arbitrary minimum clinically important threshold, we adopted a system of reporting consistent with the recommendations from the American College of Physicians' 2017 guidelines for low back pain.[23] For pain and disability measured on a 0-100 point scale, an effect size of 5-10 points was considered small, 10-20 points moderate, and more than 20 points large. After reviewing the data, we considered effect size below 5 to be negligible.

Subgroup and exploratory meta-regression

We conducted preplanned subgroup analyses of our estimates of treatment effect (leg pain and disability) at each follow-up time to explore the influence of mean duration of symptom (< 3 months or >3 months), approach of discectomy (micro or open). We also did post hoc subgroup analyses to explore the influence of analgesics in the comparator group (yes or no), small study effects (<100 participants in each arm), and unsuccessful non-surgical treatment (yes or no).

We performed univariate meta-regression analyses of difference of means (leg pain and disability) on year of publication, duration of symptom, and sample size as continuous variables, in the comparison of discectomy versus non-surgical treatment across all time points.

Patient and public involvement

Due to the lack of funding, patients or the public were not involved in the design, conduct, or reporting of this study.

Results

Our search yielded 4071 records, of which 1279 were duplicates. From 26 publications, 24 trials were included; 23 were peer reviewed journal articles[1 2 4 25-53] and one was a conference abstract[54] (fig 1, table 1, table 2). Three trials were funded by industry[40 50 53]; one of which included authors who were consultants for the industry sponsor.[40]

The 24 trials investigated various surgical procedures: discectomy (n=12), chemonucleolysis with chymopapain (n=5), chemonucleolysis with condoliase (n=2), plasma disc decompression (n=4), and ozone ablation (n=1). The comparators were classified as non-surgical treatment (n=14), epidural steroid injections (n=4), and placebo or sham surgery (n=6).

Twenty one (88%) of 24 trials had at least one domain classified as high risk of bias (supplemental file 11). Eighteen trials did not mask the participants and trial staff and, therefore, were at high risk of

Table 1 | Characteristics of included trials comparing surgery to non-surgical treatment for sciatica. Data are number (percentage), unless otherwise given

Trial	No of participants (surgery/control)	Mean age (years), (surgery /control)	No of female individuals (surgery /control)	Mean duration of symptom (surgery/control)	Comparator	Loss to follow-up (surgery /control)	Crossover (surgery to non-surgical/non-surgical to surgery)
Discectomy							
Weber et al (1983)[26]	60/66	40/41.7	28 (46.7)/30 (45.5)	NR	Inpatient rehabilitation	0 (0)/0 (0) (at 12 month)	0 (0)/18 (30)
Greenfield et al (2003)[54]	44/44	40.1/39.5	22 (50.0)/16 (36.4)	NR	Physical activity group: proactive exercise and education: Back School book, low tech physical therapy	NR	NR
Buttermann et al (2004)[31]	50/50	40/41	NR	3.8 months/3.3 months	Epidural steroid injections	0 (0)/25 (50.0)(at 12 months)	0 (0)/27 (54.0)
Osterman et al (2006)[34]	28/28	37/38	13 (46.4)/9 (32.1)	77 days/60 days	Physiotherapeutic instructions initially and continued with isometric exercises after randomisation	7 (25.0)/8 (28.6)(at 12 months)	0 (0)/11 (39.3)
Weinstein et al (2006, 2008, 2014)[1 38 46]	245/256	41.7/43	101 (43.5)/93 (38.8)	‹6 months since recent episode: 189 (81.5)/183 (76.3)	Non-operative treatment: at least active physical therapy, education/counselling with home exercise instruction, and non-steroidal anti-inflammatory drugs, if tolerated	34 (14.7)/29 (12.1) (at 12 months)	92 (39.7)/107 (44.6)
Peul et al (2007, 2008, 2013)[36 37 44]	141/142	41.7/43.4	52 (36.9)/45 (31.7)	9.43 weeks/9.48 weeks	Non-surgical treatments: education, analgesics, physiotherapy	1 (0.7)/1 (0.7) (at 12 months)	16 (11.3)/55 (38.7) (at 12 months)
Zou et al (2009)[39]	60/60	39.4/38.8	20 (33.3)/18 (30.0)	49.7 days/45.3 days	Manual therapy, traditional Chinese medicine, lumbar traction	NR	NR
McMorland et al (2010)[41]	20/20	Male 42.9, female 40.1/ male 36.4, female 48.3	7 (35.0)/9 (45.0)	3-6 months: 3 (15.0)/6 (30.0), 6-12 months: 5 (25.0%)/6 (30.0), ›12 months: 12 (60.0)/8 (40.0)	Spinal manipulative therapy	0 (0)/0 (0) (at 3 months)	3 (15.0)/8 (40.0)
Huo et al (2016)[47]	26/20	50.1/45.8	9 (34.6)/7 (35.0)	NR	Bed rest, sacral injection, traction, analgesics, traditional Chinese medicine	NR	NR
Abou-Elroos et al (2017)[49]	30/30	37.4/34.5	5 (18.5)/6 (20.7)	70 days/65 days	Activity modification; soft tissue massage; electrotherapy; static exercises for abdominal muscles, back muscles, and hip extensors; stretching exercises to the hamstring as well as range of motion exercises; muscle relaxants, analgesics, anti-inflammatory medication, pregabalin, and vitamin B complex	3 (10.0)/1 (3.3) (at 6 months)	NR
Bailey et al (2020, 2021)[51 55]	64/64	38.0/37.1	27 (42.2)/25 (39.1)	7.3 months/7.7 months	Non-surgical treatment: education, activity and exercise, oral analgesics, physiotherapy, could receive epidural glucocorticoid injection	13 (20.3)/17 (26.6) (at 12 months)	8 (12.5)/22 (34.4)
Wilby et al (2021)[52]	83/80	43.5/41.2	46 (55.4)/40 (50.0)	21.5 weeks/21.1 weeks	Transforaminal epidural steroid injections	40 (48.2)/41 (51.3) (at 12 months)	4 (4.8)/28 (35.0)

NR=not reported.

Table 2 | Characteristics of included trials comparing surgery to non-surgical treatment for sciatica. Data are number (percentage), unless otherwise given

Trial	No of participants (surgery /control)	Mean age (years), (surgery /control)	No of female individuals (surgery /control)	Mean duration of symptom (surgery /control)	Comparator	Loss to follow-up (surgery /control)	Crossover (surgery to non-surgical/ non-surgical to surgery)
Plasma disc decompression							
Gerszten et al (2010)[40]	45/40	46/42	24 (53.3)/19 (47.5)	12 months/24 months	Transforaminal epidural steroid injections	16 (35.5)/12 (30.0) (at 6 months)	NR
Erginousakis et al (2011)[42]	31/31	38/36	12 (38.7)/14 (45.2)	NR	Six weeks non-surgical treatment: education and counselling of the patient, physical therapy, and use of nonsteroidal anti-inflammatory drugs, muscle relaxants, and analgesics	NR	NR
Wang et al (2014)[45]	33/32	56.1 (both arms together)	30 (46.2) (both arms together)	4.98 years (both arms together)	Bed rest, intravenous mannitoli, tuina, traction, acupuncture, physical therapy	NR	NR
Nikoobakht et al (2016)[48]	89/88	37.6/38.0	53 (59.6)/45 (51.1)	18.6 months/25.9 months	Bed rest, active physical therapy, education and counselling with home exercise instruction, spinal manipulation, narcotic analgesics, muscle relaxants, analgesics, and non-steroidal anti-inflammatory local injection	4 (4.5)/5 (5.7) (at 12 months)	NR
Chemonucleolysis with chymopapain							
Schwetschenau et al (1976, 1978)[24 25]	31/35	38.1/34.9	12 (38.7)/10 (28.6)	13.6 weeks/9.9 weeks	Intradisc injection of placebo (sodium iothalamate)	NR	NR
Feldman et al (1986)[27]	20/19	41.5/43.4	7 (35.0)/13 (68.4)	NR	Intradisc injection of placebo (distilled water)	NR	NR
Javid et al (1983)[56]	55/53	37.9/39.9	20 (36.4)/25 (47.2)	24.6 weeks/26.3 weeks	Intradisc injection of placebo (distilled water)	0 (0)/0 (0)	0 (0)/0 (0)
Fraser et al (1984)[57] Gogan et al (1992)[28]	30/30	37.1/37.2	15 (50.0)/6 (20.0)	Less than 6 weeks: 4 (13.3)/2 (6.7), 6 weeks to 6 months: 22 (73.3)/23 (76.7), greater than 6 months: 4 (13.3)/5 (17)	Intradisc injection of placebo (normal saline solution)	6 (20.0)/8 (26.7)	NR
Burton et al (2000)[30]	20/20	41.9 (both arms together)	21 (52.5) (both arms together)	32 weeks/30 weeks	Manipulative treatment	5 (25.0)/5 (25.0)	NR
Chemonucleolysis with condoliase							
Matsuyama et al (2018)[53]	(49, 49, 49)/47	(41.9, 37.9, 36.2)/34.0	(11 (22.4), 16 (32.7), 15 (30.6))/16 (34.0)	(138 days, 147 days, 109 days)/144 days	Intradiscal injection of placebo	(10 (20.4), 10 (20.4), 12 (24.5))/15 (31.9) (at 12 months)	NR
Chiba et al (2018)[50]	82/81	39.5/39.2	31 (37.8)/33 (40.7)	142 days/127 days	Intradiscal injection of placebo	20 (24.4)/24 (29.6) (at 12 months)	NR
Ozone ablation combined with the radiofrequency thermocoagulation							
Xu et al (2012)[43]	80/80	44.3/42.7	36 (45.0)/32 (40.0)	3.8 years/3.1 years	Traditional Chinese Medicine, exercise, tuina, lumbar traction	NR	NR

NR=not reported.

performance and detection bias. Eight trials had high numbers lost to follow-up and were rated at high risk of attrition bias. We regarded the three industry sponsored trials also to be a high risk of bias because the independence of the investigators was not stated.

Discectomy

Twelve trials (n=1711 participants) investigated the effectiveness of discectomy compared with non-surgical treatment (10 trials) or epidural steroid injections (two trials).

Seven trials reported leg pain and disability outcomes for discectomy compared with non-surgical treatment. Very low to low certainty evidence showed that discectomy resulted in a moderate reduction in leg pain at the immediate term (mean difference −12.1 (95% confidence interval −23.6 to −0.5)) and short term (−11.7 (−18.6 to −4.7)), a small reduction at medium term (−6.5 (−11.0 to −2.1)), but negligible effect at long term (−2.3 (−4.5 to −0.2); table 3,fig 2, fig 3). For disability, discectomy only resulted in small effects

Table 3 | Summary of findings and certainty of evidence for leg pain, disability, and back pain (discectomy)

Length of term	No of participants (No of trials)	Mean difference (95% CI), 0-100	Risk of bias*	Inconsistency	Imprecision	Small study effects	Certainty of evidence
Leg pain							
Discectomy *v* non-surgical treatments:							
Immediate term	959 (6)	−12.1 (−23.6 to −0.5)	Downgraded	Downgraded†	Downgraded‡	Downgraded§	Very low
Short term	1019 (7)	−11.7 (−18.6 to −4.7)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Medium term	978 (6)	−6.5 (−11.0 to −2.1)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Long term	968 (6)	−2.3 (−4.5 to −0.2)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
(Micro)discectomy *v* epidural steroid injections:							
Immediate term	100 (1)	−27.0 (−34.8 to −19.2)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Short term	77 (1)	−15.1 (−23.5 to −6.7)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Medium term	94 (1)	−14.8 (−28.3 to −1.3)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Long term	157 (2)	−7.3 (−14.4 to −0.3)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Disability							
Discectomy *v* non-surgical treatments:							
Immediate term	1033 (6)	−7.1 (−10.7 to −3.6)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Short term	1029 (7)	−7.2 (−11.7 to −2.7)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Medium term	1017 (7)	−5.4 (−9.4 to −1.4)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Long term	1064 (7)	−4.8 (−8.0 to −1.6)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Discectomy *v* epidural steroid injections:							
Short term	100 (1)	−13.1 (−20.9 to 5.3)	Downgraded	Not downgraded	Downgraded‡	Downgraded§	Very low
Medium term	174 (2)	−1.1 (−6.2 to 4.1)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Long term	165 (2)	0.0 (−5.5 to 5.5)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Back pain							
Discectomy *v* non-surgical treatments:							
Immediate term	498 (4)	−6.8 (−15.3 to 1.6)	Downgraded	Downgraded†	Downgraded‡	Downgraded§	Very low
Short term	570 (5)	−11.0 (−19.6 to −2.5)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Medium term	568 (5)	−10.2 (−18.7 to −1.7)	Downgraded	Downgraded†	Not downgraded	Downgraded§	Very low
Long term	554 (5)	−7.0 (−15.4 to 1.5)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Discectomy *v* epidural steroid injections:							
Immediate term	100 (1)	−10.0 (−17.8 to −2.2)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Short term	77 (1)	−8.4 (−16.2 to −0.6)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Very low
Medium term	94 (1)	−2.6 (−14.8 to −9.6)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low
Long term	156 (2)	−3.3 (−10.7 to 4.2)	Downgraded	Not downgraded	Not downgraded	Downgraded§	Low

CI=confidence interval.
*Downgraded by one level because >25% of participants in this comparison were from studies at high risk of bias.
†Downgraded by one level because heterogeneity (I^2) >50%.
‡Downgraded by one level because the limits of the 95% confidence interval were 20 points different to the point estimates.
§Downgraded by one level owing to small study bias.

at the immediate term (−7.1 (−10.7 to −3.6)), short term (−7.2 (−11.7 to −2.7)), and medium term (−5.4 (−9.4 to −1.4)), but negligible effect at long term (−4.8 (−8.0 to −1.6); table 3 and fig 4, fig 5).

Five trials reported outcomes after 12 months.[1 26 34 36 55] At 24 months, discectomy did not reduce leg pain (−1.1 (−3.6 to 1.4)) or disability (−1.5 (−4.3 to 1.3)) compared with non-surgical treatment. Similar findings were also observed at months 36, 48, 60, and 96 (fig 2, fig 3, fig 4, fig 5).

Secondary outcomes

Five trials reported findings for back pain.[34 36 47 51 54] Compared with non-surgical treatment, evidence was of very low certainty that discectomy did not reduce back pain at the immediate term (medium difference −6.8 (95% confidence interval −15.3 to 1.6)) and long term (−7.0 (−15.4 to 1.5)), but did so at the short term (−11.0 (−19.6 to −2.5)) and medium term (−10.2 (−18.7 to −1.7); supplemental file 12).

Five trials[1 34 36-38 41 44 46 51 55] reported outcomes for quality of life and four[1 26 34 38 44 51 55] reported treatment satisfaction (not pooled due to heterogeneity). For quality of life, except for one trial at the short term follow-up,[36] the included trials found no between group differences at all time points. Conflicting results were found for treatment satisfaction (supplemental file 8).

Discectomy versus epidural steroid injections

Two trials compared the effectiveness of discectomy with epidural steroid injections.[31 52] Very low to low certainty of evidence showed that discectomy reduced leg pain at all time points. The effect was large at immediate term (medium difference −27.0 (95% confidence interval −34.8 to −19.2)), moderate at short term (−15.1 (−23.5 to −6.7)) and medium term (−14.8 (−28.3 to −1.3)), and small at long term (−7.3 (−14.4 to −0.3)).

Compared with epidural steroid injections, discectomy provided moderate effects on disability at

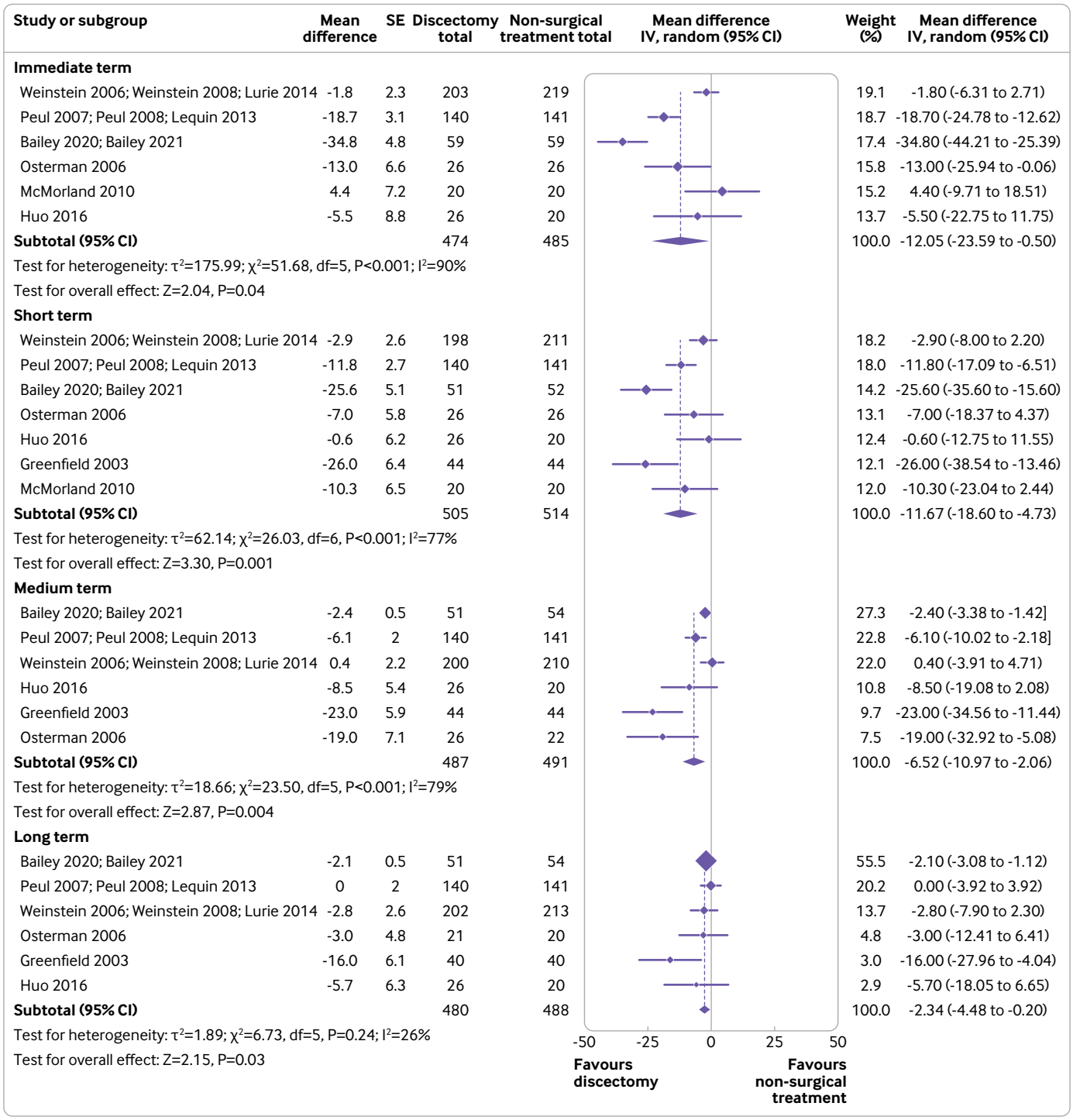

Fig 2 | Mean differences (95% CI) for leg pain in trials assessing the effectiveness of discectomy versus non-surgical treatment. Pain intensity is expressed on a 0-100 scale. Studies are ordered by weight. SE=standard error; CI=confidence interval; IV=inverse variance

short term, but had no effects at medium and long term. For back pain, small effects were observed at short and medium term and no effect at long term (table 3 and supplemental file 13). No trials reported outcomes for quality of life and treatment satisfaction.

Other surgical procedures

Three trials compared plasma disc decompression with non-surgical treatment.[40 42 48] Very low to low certainty evidence showed that plasma disc decompression reduced leg pain at the immediate and long term (moderate effects), but had no effect at short term (supplemental files 6, 14a); and reduced disability at immediate, short, and long term (moderate to large effects; supplemental files 7, 14b). Compared with epidural steroid injections, plasma disc decompression resulted in moderate to large effects on leg pain and disability at the immediate, short, and medium term

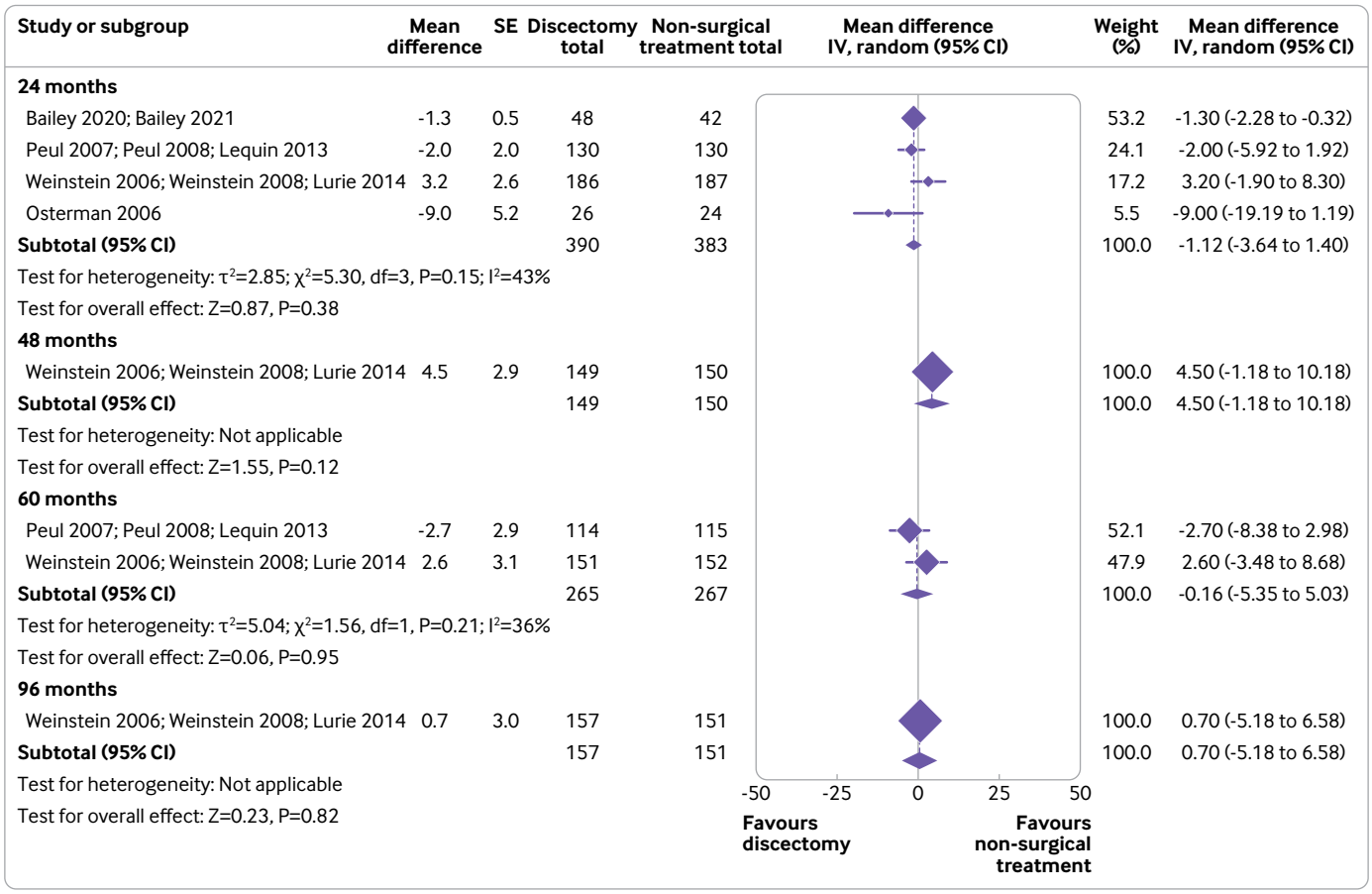

Fig 3 | Mean differences (95% CI) for leg pain in trials assessing the effectiveness of discectomy versus non-surgical treatment. Pain intensity is expressed on a 0-100 scale. Studies are ordered by weight. SE=standard error; CI=confidence interval; IV=inverse variance

(low certainty evidence; supplemental files 6, 7, and 15). Outcomes for quality of life and treatment satisfaction are presented in supplemental file 8.

Chemonucleolysis

Two trials compared chemonucleolysis using condoliase with placebo.[50 53 56] Low certainty evidence indicated moderate effects on leg pain at all time points, and small effects on disability at short and long term (supplemental file 16).

Five trials investigated the effectiveness or efficacy of chemonucleolysis with chymopapain compared with placebo (n=4)[24 25 27 56 57] or manipulative therapy (n=1).[30] Very low to low certainty evidence indicated (except for chemonucleolysis with chymopapain versus placebo at immediate term) that this treatment combination did not reduce leg pain, disability, and back pain in any time points specified (supplemental files 17 and 18). Other outcomes are presented in supplemental file 8.

Safety

Eight trials reported at least one safety outcome for discectomy.[1 26 31 34 36-38 44 46 51 52] Low certainty evidence showed no between group differences in the risk of any adverse events between discectomy and non-surgical treatment (risk ratio 1.34 (95% confidence interval 0.91 to 1.98); supplemental file 19a). Compared with epidural steroid injections, discectomy had a slightly higher risk of any adverse event (1.76 (1.03 to 3.02); supplemental file 19b). Surgery related complications were reported by seven trials. Dural tears and wound complications were the most frequently reported adverse events (supplemental file 9). All cause mortality was rare and similar between discectomy and non-surgical groups (1.73 (0.19 to 15.36); supplemental files 9). No trials reported any surgery related deaths.

The risks of adverse events in plasma disc decompression and chemonucleolysis were also similar between the surgical and non-surgical groups. The results could not be pooled because of the low number of studies (supplemental file 9).

Subgroup and meta-regression analyses

Detailed results for the subgroup and exploratory sensitivity analysis are presented in supplemental file 10. Discectomy had smaller effects on leg pain (mean difference −3.1 (95% confidence interval −5.7 to −0.4)) in trials that included analgesics in the comparators than did trials without analgesics (−21.4 (−30.3 to −12.4)) at the medium term. In small studies, discectomy had greater effects on disability (−10.1 (−13.9 to −6.3)) compared with larger studies (−4.4 (−7.7 to −1.0)). A post-hoc analysis indicated

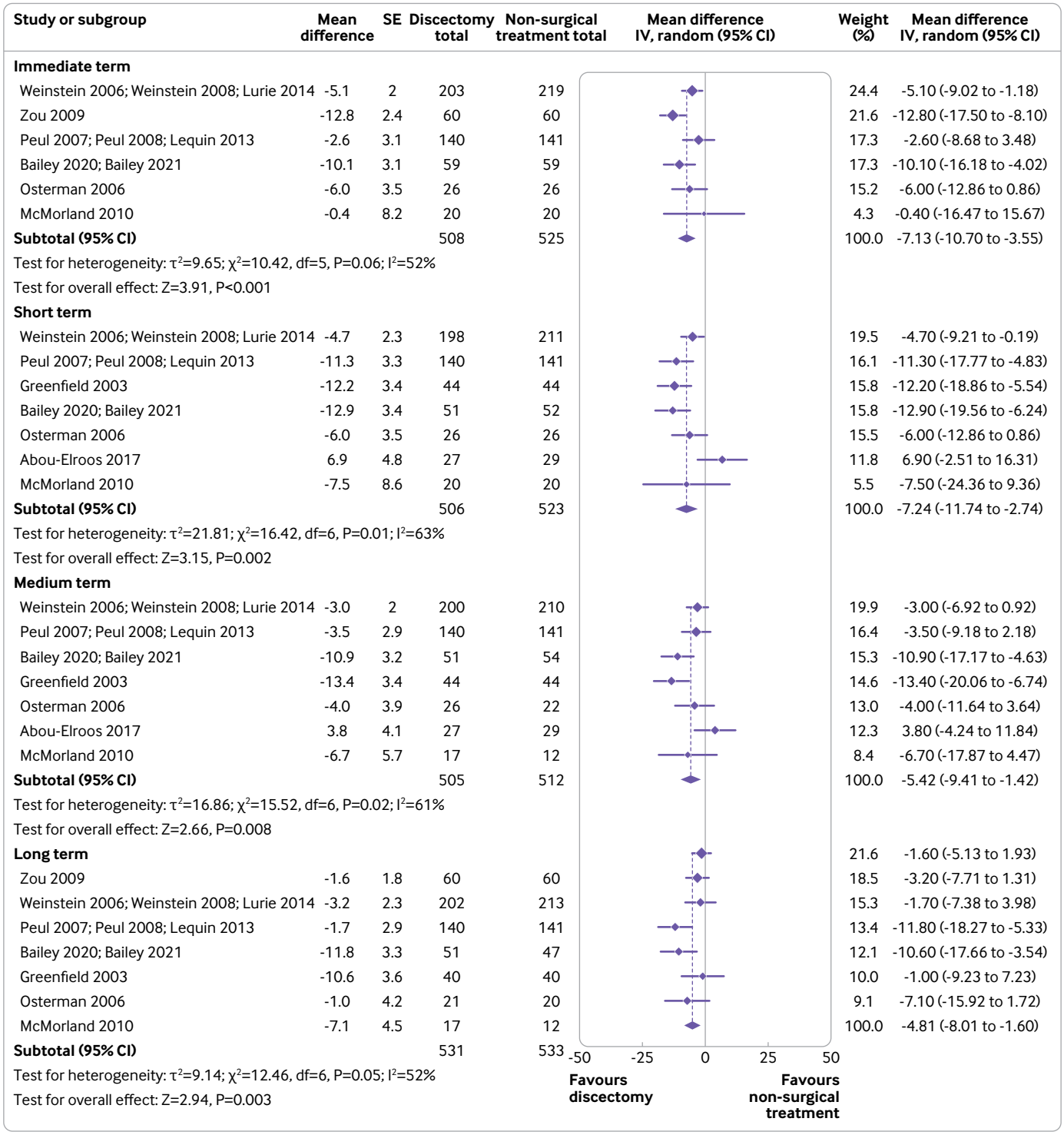

Fig 4 | Mean differences (95% CI) for disability in trials assessing the effectiveness of discectomy versus non-surgical treatment. Disability is expressed on a 0-100 scale. Studies are ordered by weight. SE=standard error; CI=confidence interval; IV=inverse variance

that in trials that did not specify unsuccessful non-surgical treatment as a prerequisite of entering the trial, discectomy had larger effects in reducing leg pain at immediate term (−19.3 (−30.4 to −8.2) *v* −1.2 (−5.5 to 3.1)) and improving disability at short term (−10.6 (−14.0 to −7.3) *v* −1.3 (−9.8 to 7.3)) than did trials that only included participants who had unsuccessful non-surgical treatment. Mean symptom duration at baseline (less or greater than three months), and the approach of discectomy (micro or open), did not influence treatment outcomes.

Discussion

Summary of main findings

We found very low to low certainty evidence that discectomy, compared with non-surgical treatment,

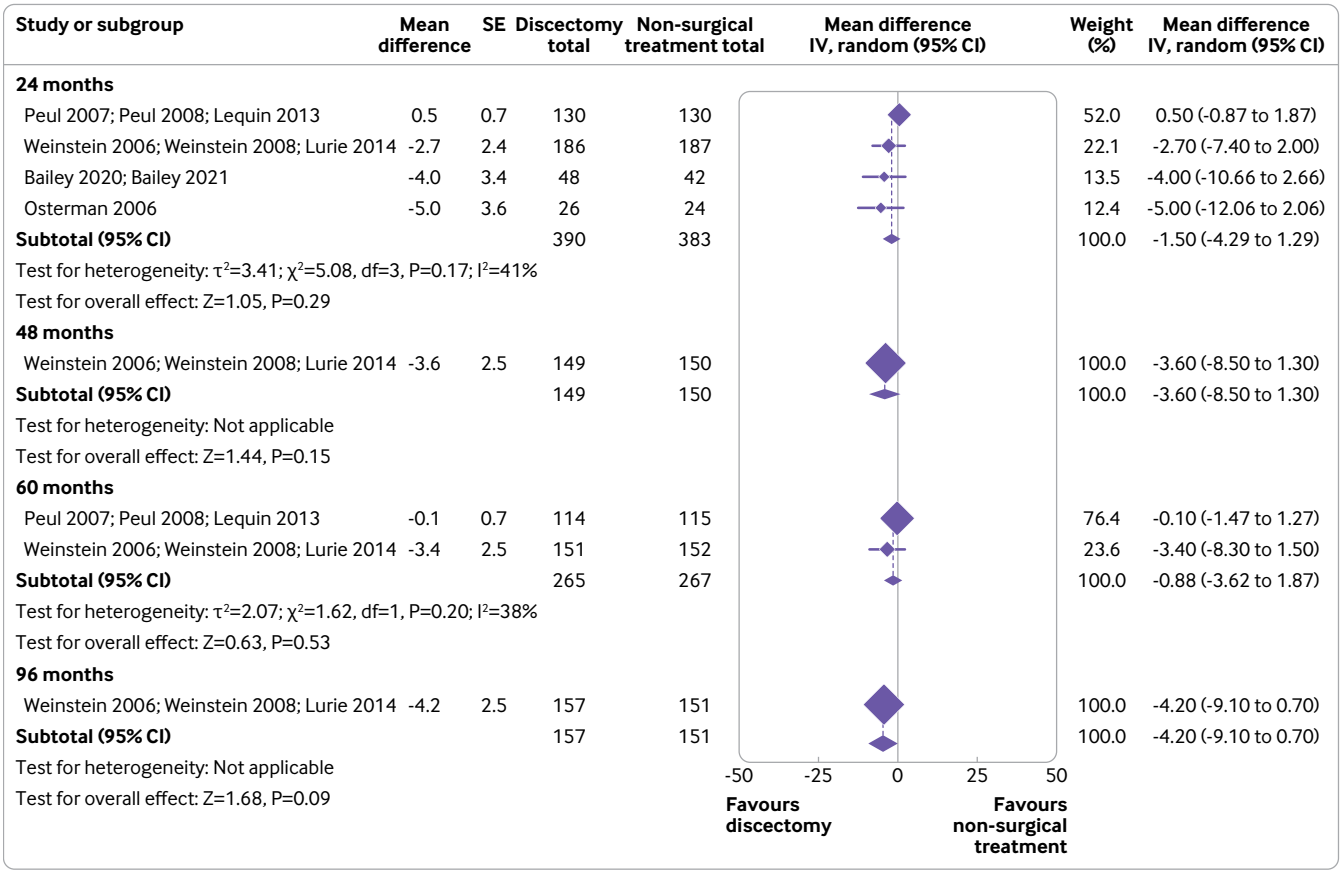

Fig 5 | Mean differences (95% CI) for disability in trials assessing the effectiveness of discectomy versus non-surgical treatment. Disability is expressed on a 0-100 scale. Studies are ordered by weight. SE=standard error; CI=confidence interval; IV=inverse variance

reduced leg pain and disability. The effect sizes of leg pain reduction declined from moderate at immediate and short term, to negligible effect over a year. The extent of the benefit on disability was smaller, with small effect sizes observed up to the medium term follow-up only. No benefits on pain or disability were noted at or after 12 months. Discectomy was also superior to epidural steroid injections, but the size of the effects also reduced over time from large at immediate term to small at long term. Data for disability was equivocal, because a moderate effect size was only observed at short term, but no other benefits were observed at any other time point. Evidence supported plasma disc decompression and chemonucleolysis with condoliase at some time points but was of low certainty.

We did not find an increased risk of adverse events when discectomy was compared with non-surgical treatment. But the reporting might have been inconsistent: the included trials had a high crossover rate between groups and were likely underpowered to detect adverse events. However, one example in a review of observational studies of discectomy complication rates (n=42 studies; >4000 participants)[58] showed 12.5-13.3% people had an adverse event. Reoperation, recurrent disc complications, dural tear, nerve root injury, and wound complications were the most common adverse events in open or micro discectomy. These data provide further context and insights into the safety profile of discectomy for sciatica.

Strengths of this review

This review provides the most comprehensive synthesis of the evidence on surgical procedures for sciatica to date. Different from recent reviews,[13 15 16] we included trials of a homogeneous population, surgical procedure, comparator, studies published in English and other languages,[27 33 39 43 47] and new robust trials,[50-53 55] making this review the most comprehensive update on the evidence for the surgical management of sciatica.

Limitations

This review has limitations. Although we included a larger number of trials compared with previous reviews,[13 15] the certainty of evidence ranged from low to very low. High crossover rates from the non-surgical arm to the surgical arm (ranged from 30% to 54%) occurred in many trials, which means the effects of surgery on clinical outcomes could have been underestimated, particularly in the later time points. As mentioned previously, the included trials are underpowered and inappropriately designed to effectively evaluate adverse event occurrence.

Reporting of non-surgical comparators was generally poor, with most trials not describing what types of

treatments participants received, who provided these treatments, how they were provided, and how much treatment they received. For example, the SPORT trial reported the type of non-surgical treatment received by participants (physical therapy (73% of patients), epidural injections (50%), and medical treatments (eg, non-steroidal anti-inflammatory drugs; >50%) without specifying other details.[1] Similarly Bailey and colleagues' trial only reported that education, activity and exercise, oral analgesics, physiotherapy, and epidural glucocorticoid injection were used in the non-surgical group, without providing specific data on the proportion of patients receiving each of these non-surgical treatments.[51] Furthermore, non-surgical treatments varied considerably within and between countries. For example, the use of epidural steroid injections varies widely among different US states, as do referrals to physiotherapy between Denmark and the Netherlands.[59 60] The two included Chinese trials used traditional Chinese medicine in the non-surgical group, which lacks evidence supporting its effectiveness.[39 47 61] In our review, we grouped all non-surgical interventions together, however, these interventions were not only poorly detailed but also highly heterogeneous. Therefore, questions remain as to whether non-surgical treatment provided in the control arms of many trials represents a suboptimal approach to treating sciatica, in addition to the ramifications that this uncertainty would have on its comparison to discectomy.[62] However, evidence is scarce in supporting many non-surgical treatments for sciatica.[63 64]

Other than radiographical evidence of disc herniation and corresponding signs or symptoms, the included studies varied in their method of identifying patients who would be considered for surgery. Differences were apparent in the requirement of unsuccessful non-surgical treatment,[13 141] having incapacitating sciatica,[36] or having persistent (>four months) sciatica.[51] Seven (58.3%) of 12 trials did not specify how they identified patients.[26 34 39 47 49 52 54] Thus, the study populations might vary across included trials. Also, participants were not typical patients with sciatica from the community because they were assessed for eligibility by surgeons.[1 36 51]

Evidence update and meaning of the study

Compared with the most recent review, which only pooled data for disability within 24 months,[15] our review provides results on leg pain, disability, back pain, and adverse events from the immediate term to five years after randomisation. Thus, unlike the equivocal benefits previously reported,[13] we found that discectomy was initially beneficial but the effect declined over time, compared with either non-surgical care or epidural steroid injections. Generally, discectomy resulted in faster relief in pain and disability, but only up to 12 months. We also investigated the optimal timing of surgery for sciatica by conducting a subgroup analysis by symptom duration (less or greater than three months). Greater reductions in leg pain were reported in people with symptoms for less than three months at immediate and medium term, however, the differences were not significant. A post hoc exploratory subgroup analysis of unsuccessful non-surgical treatment suggests that trials without specifying the non-surgical treatment in the inclusion criteria reported higher effects in reducing leg pain (immediate term) and improving disability (short term) than did trials with unsuccessful non-surgical treatment.

We presented discectomy primarily because this surgical treatment is the most widely used for lumbar disc herniation.[1] Nevertheless, the choice of surgical treatment by surgeon varies between countries.[65] Thus, in our review, we presented results for a broader range of surgical procedures. Plasma disc decompression showed a moderate effect on leg pain and disability when compared with non-surgical treatment or epidural steroid injections. Similarly, chemonucleolysis with condoliase was shown to have moderate effects on leg pain and slight effects on disability.

Implications for clinical practice and policy

International guidelines generally recommend surgical treatment for sciatica secondary to lumbar disc herniation if patients have not responded to comprehensive non-surgical treatment.[6-8] These recommendations are because many people with acute sciatica will have improvements in their condition over time.[3] Generally, our review supports these recommendations because non-surgical treatment was shown to be able to lead to similar outcomes at long term or even longer follow-ups. However, benefits could vary among different groups of people with sciatica. Attempts have been made to specify who might benefit more from early discectomy for people with sciatica.[66 67] People with more severe pain in their leg and disability were shown to be more likely to have persistent and debilitating symptoms at 12 months.[67] Thus, this subgroup might benefit from early discectomy because our review has shown that surgical treatment might lead to faster leg pain reduction. Added to that is the evidence that early discectomy is cost effective compared with prolonged non-surgical treatment in the context of the Dutch health system.[68] These findings challenge the notion that non-surgical treatment should always be the first line treatment for sciatica. In people with sciatica who regard rapid pain relief as an important treatment goal, and who feel that the benefits of discectomy outweigh the risks and costs, discectomy could be an early management option.

As a result of the treatment's invasive nature and the substantial costs of surgery, we would encourage clinicians to discuss with their patients that discectomy can provide rapid relief of leg pain, but that non-surgical treatment can achieve similar results, although at a slower pace and with a potential chance of requiring delayed surgery if they do not respond to non-surgical treatment.

Future research

Although discectomy is widely used, the certainty of evidence supporting its use is only low to very low. All trials evaluating discectomy were not blinded and had high crossover rates. Evidence on plasma disc decompression and chemonucleolysis is limited by the low number of studies and small sample sizes. Large placebo controlled trials evaluating surgical treatment for sciatica have the potential to advance this field. However, the use of placebo controls in surgical trials has challenges.[18] Furthermore, investigations into which group of people with sciatica are likely to benefit from early surgery is also key for clinicians to make individualised recommendations.

Conclusions

Very low to low certainty evidence suggests that discectomy was superior to non-surgical treatment or epidural steroid injections in reducing leg pain and disability in people with sciatica with a surgical indication, but the benefits over non-surgical care reduced over time. Discectomy might be an option for people who require rapid leg pain relief and disability improvement, when the benefits outweigh the risks and costs related to surgery.

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Contributors: All authors contributed to the review protocol. CL, GEF, CAS, and C-WCL designed the search strategy and selected studies. CL, GEF, and QC extracted the data. CL analysed the data. CL drafted the manuscript and GEF, CAS, and C-WCL contributed to the drafting of the review. IAH, CSB, WCP, and BK revised the manuscript critically for important intellectual content. All authors approved the final version of the article. All authors had access to all the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. CL is guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Funding: No specific funding was received for this research. CL reports receipt of a PhD scholarship from the National Health Medical Research Council (NHMRC) of Australia. GEF reports receipt of Australia's NHMRC Investigator Grant (APP2009808). C-WCL is funded by an Australia's NHMRC Investigator Grant (APP1193939).

Competing interests: All authors have completed the ICMJE uniform disclosure form at www.icmje.org/disclosure-of-interest and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years. CSB, WCP, and BK report being involved in trials included in the review,[51 36] and declare that they were not taking any part in assessing that trial in this review.

Ethical approval: Not required.

Data sharing: No additional data are available.

The lead author (CL) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no important aspects of the study have been omitted.

Dissemination to participants and related patient and public communities: We plan to collaborate with the media office of the authors' institutes to disseminate the findings. The strategy may include press releases, dissemination via media outlets and social media platforms, explainer articles for clinicians and patients, and presentations at professional conferences.

Provenance and peer review: Not commissioned; externally peer reviewed.

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Web appendix: Online appendix