Decision Aid Title

Herniated disc in the lower back

Grid Description

Herniated disk is a bulging of the cushion (disk) between the bones in your back and can cause back or leg pain, or numbness and tingling in your legs. It might limit what you can do. Herniated disk often does not cause symptoms. If you have no symptoms, there is no need to treat a herniated disk. If you have symptoms for less than 6 weeks, you will be asked to try treatment without surgery or shots.

January 8, 2019

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Methods

Using an established, structured template that delineates key elements for scoping (i.e., the population, interventions, and key outcomes to consider), we collaboratively agreed with UKSH on the scope of the present evidence report. Initial scoping was completed on August 29, 2018 and refined January 7, 2019 following feedback discussions with UKSH on structured templates for evidence review reports.

Results – Criteria Selection for Critical Appraisal

Population:

Inclusion criteria

Patients with typical radicular pain in the legs associated with herniated disc of the lower back

Diagnosis of herniated disc in lower back (anatomic correlate for symptoms; e.g., MRI)

All age groups

Symptoms for >6 weeks

Systematic conservative therapy for >6 weeks.

> If prior use of such therapy is not explicitly reported in the inclusion criteria or patient characteristics, then if the inclusion criteria specify referral for nonconservative/invasive treatment, the assumption will be made that conservative therapy was attempted before such referral was allowed.

Intention for or consideration of invasive therapy for treatment

Exclusion criteria

Clear indication for surgery (e.g., cauda equina symptoms)

Intervention and Comparator:

Conservative/noninvasive care (treatment without surgery)

The intervention is considered an "active intervention" and not a control state (i.e., not a natural history or prognosis without treatment). The intervention must include some form of physiotherapy and may include other noninvasive modalities such as pharmacotherapy. The intervention includes the option for surgery in the future and is applied to avoid or delay surgery. The intervention of greatest interest could be phrased "physiotherapy-based treatment to delay or avoid surgery"

The comparator must include surgery and the decision of interest is surgery now or delaying/avoiding surgery.

Epidural corticosteroid injections

The intervention must include injection of corticosteroids, may include local anesthetics, and does not include other injection therapies. Injections must be applied to lumbar region and no other spinal level.

The comparator must include placebo control (injections with saline or local anesthetics without steroids).

Open surgery

The intervention includes diskectomy or microdiskectomy, performed through a surgical incision. Physiotherapy or rehabilitation programs are expected to be part of the overall treatment plan.

The comparator may include treatment without surgery (as described above) or minimally-invasive surgery.

Minimally-invasive surgery (percutaneous surgery)

The intervention includes microscopic or endoscopic modalities with minimal incision lengths (typically <1 inch) and/or percutaneous interventions that help minimize tissue disruption compared to invasive options. Physiotherapy or rehabilitation programs are expected to be part of the overall treatment plan.

The comparator may include treatment without surgery (as described above) or conventional (open) surgery.

Outcomes:

FAQ 1: What does the treatment involve?

Include a description of the treatment or procedure. Include frequency of intervention if relevant. Include length of stay if relevant.

Descriptive responses are acceptable, and this does not involve systematic evidence searches, critical appraisal, or evidence synthesis.

FAQ 2: Will it help pain or function?

Pain and function are combined into a single FAQ for this evidence review because functional limitation is primarily related to pain. Include resolution of symptoms, improvement in pain, time to pain relief, and improvement in function.

We will report absolute effect estimates and relative effect estimates from randomized trials (or systematic reviews of randomized trials). We will select the most representative outcome(s) available for the specific question of "Will it help my pain or function?". If it is not possible to report these estimates due to the data available, we will summarize the effect estimates available and what these data mean in terms of comparative efficacy.

We will also report the earliest time point where efficacy is noted given patients' interest in how soon they might improve. Where efficacy is not clearly established, we will report the earliest time point for which pain and/or function outcomes are first reported.

FAQ 3: What are the side effects?

Side effects of Interest – in addition to those in the literature – include short-term problems with epidural injections (e.g., hematoma, worsening of pain, headache, flushing in the face, dysphonia/change in voice, cerebrospinal fluid leak) and duration of postprocedural pain.

In the absence of adequate sample size to assess for adverse effects in randomized trial evidence, cohort studies will be considered.

FAQ 4: What are the risks?

Risks of interest – in addition to those in the literature – include the general risks of anesthesia, infection, and surgical complications.

In the absence of adequate sample size to assess for adverse effects in randomized trial evidence, cohort studies will be considered.

FAQ 5: How long does it take to recover?

Questions of specific interest are time to return to usual activity and time to return to work. Time to return to driving was not of specific interest for the UKSH report but is included due to interest for other stakeholders.

FAQ 6: Might I get surgery later?

Outcomes of interest will be rates of initial surgery for nonsurgical options and rates of repeat surgery for surgical options.

Evidence report for herniated disc in the lower back

Part 2 - Search and Selection for Critical Appraisal

Prepared by EBSCO Information Services

January 10, 2019

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Methods

First-round searching will consist of searching DynaMed Plus summaries pertinent to the topic. The search starts with DynaMed Plus because DynaMed Plus content is based on a thorough, systematic search and active literature surveillance system.

> Systematic literature surveillance (SLS) has been a cornerstone of creating DynaMed content since its inception. Currently, the SLS team works closely with members of McMaster University's Department of Health Research Methods, Evidence, and Impact to define and refine optimal search strategies, utilizing search terms for methodology and for clinical concepts (especially diagnosis and treatment) for each journal. These filters for PubMed searches are derived from PubMed Clinical Queries, McMaster University Hedges system, and DynaMed search filters and were found to capture >95% of relevant valid articles for use in DynaMed.[1]
>
> [1]Alper BS, Iorio A. Optimising search filters for active literature surveillance: a concordance study. Global Evidence Summit. Cape Town, South Africa; September 2017.
>
> The SLS team, in collaboration with McMaster University, continually evaluates and improves these filters to keep abreast of the ever-changing medical literature landscape. PubMed searches are performed daily. Each article is assessed by an external screener for clinical relevance, then reviewed by internal staff for both clinical relevance and validity. Any disagreements are settled by the Deputy Editor of the SLS team.
>
> In addition, the SLS team continually monitors the Journal source list against the list of journals catalogued in MEDLINE and existing DynaMed content to determine the set of journals that provide the highest yield for valid, clinically relevant content. As of November 2018, 507 Journals are systematically searched (see http://dynamed.com/home/content/content-sources). The journal selection threshold leads to routine adjustments to the number of journals selected.

Second-round searching will involve PubMed/MEDLINE® searches for intervention-specific systematic reviews that are more recent than those identified in first-round searching.

Third-round searching will involve original study tracing from systematic reviews, guidelines or other relevant sources. This may be done to identify additional evidence sources if the results from the first two rounds of searching are insufficient.

Fourth-round searching will involve searches for original evidence reports. Such searching will be limited to areas considered insufficiently addressed by earlier searches, such as focused concepts published after search dates in systematic reviews.

Additional selective searching, such as tracing citations from articles found or seeking related articles, may be done for additional concepts discovered.

FAQ List

Results

First-round searching – DynaMed Plus:

DynaMed Plus subsection	Number of article citations	Number of studies critically appraised	Relevant for FAQ(s)
Lumbar disk herniation topic, Management section, Surgery and procedures subsection ➢ Surgery vs. nonsurgical treatment subsection (Jan 09, 2019)	9	6 (Chen 2018, Lurie 2014 [follow-up of Weinstein 2006], Österman 2006, Peul 2007, Peul 2008 [follow-up of Peul 2007], Weinstein 2006)	FAQ1, FAQ2, FAQ3, FAQ4, FAQ5, FAQ6
Lumbar disk herniation topic, Management section, Surgery and procedures subsection ➢ Comparison of surgical techniques subsection (Jan 10, 2019)	11	2 (Brouwer 2015, Rasouli 2014)	FAQ1, FAQ2, FAQ3, FAQ4, FAQ5, FAQ6
Epidural steroid injection topic, Efficacy section, Lumbosacral radiculopathy including sciatica subsection ➢ Effect on pain and disability subsection (Jan 09, 2019)	8	2 (Bhatia 2016, Chou 2015)	FAQ1, FAQ2, FAQ3, FAQ4

Second-round searching – searches for intervention-specific systematic reviews:

Database	Search string	Number of search results	Number of studies critically appraised	Relevant for FAQ(s)
PubMed January 11, 2019	(minimal OR minimally OR min*) AND (hernia* OR prolapse) AND (disc OR disk OR nucleus pulposus) AND systematic[sb] AND ("2014/01/01"[PDAT] : "3000/12/31"[PDAT])	19	1 (Alvi 2018)	FAQ2, FAQ3, FAQ4, FAQ5, FAQ6
PubMed January 11, 2019	(epidural injection AND (corticosteroids OR steroids)) AND ((hernia* OR prolapse) AND (disk OR disc OR nucleus pulposus)) AND systematic[SB] AND ("2015/01/01"[PDAT] : "3000/12/31"[PDAT])	9	1 (Lee 2018)	FAQ2, FAQ3, FAQ4, FAQ6
PubMed January 11, 2019	Systematic[SB] AND spinal AND Surgery AND driving	1	1 (Alhammoud 2017)	FAQ5

Third-round searching – **study tracing from systematic reviews and guidelines:**

Database	Search string	Number of search results	Number of studies critically appraised	Relevant for FAQ(s)
Chen 2018 systematic review	Tracing included randomized trials for detailed critical appraisal, limited to trials meeting specified criteria for open/conventional surgery	19	3 (Österman 2006, Peul 2008, Weinstein 2006) – already identified in first-round searching	FAQ2, FAQ3, FAQ4, FAQ5, FAQ6
Lee 2018 systematic review	Tracing of trials published subsequent to Chou 2015	2	2 (Ghai 2015, Nandi 2017)	FAQ2, FAQ3, FAQ4, FAQ6

Fourth-round searching – searches for original evidence reports:

Database	Search string*	Number of search results	Number of studies critically appraised	Relevant for FAQ(s)
PubMed January 9, 2019	(surgery OR surgical OR operative OR operation OR operating OR surg* OR operat*) AND (conservative OR nonsurgical OR nonoperative OR nonsurg* OR nonoperat* OR physical therapy OR physiotherapy) AND ((hernia* OR prolapse) AND (disk OR disc OR nucleus pulposus)) AND ((Randomized Controlled Trial[ptyp]) AND ("2017/05/01"[PDAT] : "3000/12/31"[PDAT]))	9	0	FAQ2, FAQ3, FAQ4, FAQ6
PubMed, January 11, 2019	(surgery OR surgical OR operative OR operation OR operating OR surg* OR operat*) AND (minimal OR minimally OR min*) AND ((hernia* OR prolapse) AND (disk OR disc OR nucleus pulposus)) AND ((Randomized Controlled Trial[ptyp]) AND ("2016/08/01"[PDAT] : "3000/12/31"[PDAT]))	9	2 (Brouwer 2017, Overdevest 2017)	FAQ2, FAQ3, FAQ4, FAQ5, FAQ6
PubMed, January 11, 2019	(lumbar or caudal) AND (epidural steroid injection) AND (adverse effects) AND (cohort)	74	7 (Botwin 2000, Botwin 2001, El Abd 2015, Karaman 2011, Kim 2010, Kranz 2015, Plastaras 2015)	FAQ3, FAQ4
PubMed, January 11, 2019	(epidural steroid injection) AND (dysphonia)	3	1 (Bhat 2005)	FAQ3
PubMed, January 11, 2019	((hernia* OR prolapse) AND (disk OR disc OR nucleus pulposus)) AND Surgery AND driving	10	1 (Thaler 2012)	FAQ5

Evidence report for herniated disc in the lower back
Part 3 - Critical Appraisal of Evidence Reports

Prepared by EBSCO Information Services

January 3, 2019

Minor revision January 23, 2019 (Alvi 2018; ranges of reoperation rates)

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Methods

For each study selected for critical appraisal, we assessed for criteria needed for Level 1 [likely reliable] evidence ratings in DynaMed's Levels of Evidence criteria in which evidence quality is labeled in 1 of 3 levels:

- **(level 1 [likely reliable] evidence)** for studies with clinical outcomes and minimal risk of bias;
- **(level 2 [mid-level] evidence)** for studies with clinical outcomes and significant methodological or statistical limitations; and
- **(level 3 [lacking direct] evidence)** for reports that do not include scientific analysis of clinical outcomes or for study types that do not include comparisons between groups.

The specific concepts we critically assessed are fully mapped to cover all the criteria used in GRADE. We summarized key concerns identified that reduce the certainty of evidence in categories used for GRADE methods (ie, risks of bias, indirectness, imprecision, inconsistency, and other considerations if relevant). In the study-level summaries, inconsistency assessment was applied to consistency of within-study results – this applies to consistency across related outcomes for both original studies and for systematic reviews, and also applies to consistency across studies when applied to systematic reviews.

FAQ List

Results

Characteristics and Results of Critically Appraised Studies/Sources

ALVI 2018

Alvi MA, Kerezoudis P, Wahood W, Goyal A, Bydon M. Operative Approaches for Lumbar Disc Herniation: A Systematic Review and Multiple Treatment Meta-Analysis of Conventional and Minimally Invasive Surgeries. World Neurosurg. 2018 Jun;114:391-407.e2. PubMed

Relevant to FAQ2, FAQ4, FAQ5

- **Study design:** systematic review of randomized and quasi-randomized trials
- **Population:** 1,707 adults with lumbar disc herniation (14 trials)
- **Intervention:** minimally-invasive approaches (including percutaneous discectomy, percutaneous endoscopic discectomy, and tubular discectomy)
- **Comparison(s):** conventional open/microdiscectomy
- **Outcomes:**
    - visual analog scale (VAS) leg pain, VAS back pain, Oswestry Disability Index (ODI) scores, length of stay, blood loss, total complications, dural tears, recurrent herniations, reoperations
    - pain and function were evaluated at 1 year and at last follow-up
- **Duration of follow-up:** range from mean 5 days to 36 months
- **Results and Certainty:**

Outcome[1]	**Sample Size (no. of trials)**	**Results (open vs. MIS)**[2]	**Certainty**[3]
VAS (leg) at 1 year	938 (6)	MD 0.10 (95% CI, -0.42 to 0.61)	very low (downgraded due to risk of bias and inconsistency)
VAS (leg) at last follow-up	553 (9)[4]	MD 0.11 (95% CI, -0.17 to 0.39	Very low (due to risk of bias and inconsistency)
VAS (back) at last follow-up	299 (3)[4]	MD 0.06 (95% CI, -0.55 to 0.68)	Very low (due to risk of bias and inconsistency)
ODI at 1 year	431 (4)	MD 0.51 (95% CI, -3 to 4.01)	Very low (due to risk of bias and inconsistency)
ODI at last follow-up	491 (5)	**MD 2.61 (95% CI, 0.88 to 4.35) favors MIS**	Very low (due to risk of bias and inconsistency)

Length of stay[5]	579 (6)	**MD 2.96 (95% CI, 0.2 to 5.72) favors MIS**	low (due to risk of bias)
Blood loss	515 (7)	**MD 30.53 (95% CI, 16.58 to 44.47) favors MIS**	very low (due to risk of bias and inconsistency)
Total complications	1961 (8)	OR 0.96 (95% CI, 0.75 to 1.22)	very low (due to risk of bias and inconsistency)
Dural tears	1739 (6)	OR 0.74 (95% CI, 0.44 to 1.25)	low (due to risk of bias)
Recurrent herniations	1879 (6)	**OR 0.61 (95% CI, 0.42 to 0.9) favors open**	low (due to risk of bias)
Reoperations	1080 (8)	**OR 0.53 (95% CI, 0.36 to 0.76) favors open**	very low (due to risk of bias and inconsistency)
		Range of 0% to 17.6% in open group and 0% to 64.5% in minimally-invasive group	

[1]ODI, Oswestry Disability Index (range 0-100); MD, mean difference; MIS, minimally-invasive surgery; OR, odds ratio; VAS, visual analog scale (range was not reported)

[2]Statistically significant results are in **bold**. Units for length of stay and blood loss were not reported, but assumed to be days and milliliters, respectively, and full-text review of Pan 2014 corroborates this.

[3]Certainty assessed with GRADE by Alvi 2018

[4]This is based on the number of studies and participants in the intervention arm (details regarding number in control arm/total number of participants included not reported for this analysis)

[5]Table 2 reports mean difference = 0.95 (0.43 to 2.09) which does not match Figure 4, which reports mean difference = 2.96 (0.2 to 5.72). We assumed that Figure 4 is correct and reported those results.

- **Other considerations:**
  - Alvi 2018 reported extracting data for ODI to assess function/disability, and we initially wondered whether that choice might have led to missing other scales of function/disability (e.g., Roland Morris Disability Questionnaire [RMDQ]) that could have an impact on the results. However, we determined this not to be a concern.
    - Only 1 trial that reported on function/disability reported on a scale other than ODI. This was Arts 2011 (original publication is Arts 2009 and follow-up publication is Overdevest 2017).
      - This was confirmed by first consulting Rasouli 2014 (briefly summarized in this report) and then determining that of the 3 trials published since Rasouli 2014, 1 (Belykh 2016) reported on function/disability (using ODI) as was accounted for in Alvi 2018, and 2 (Abrishamkar 2015, Pan 2014) did not report on function/disability.

- The results from Arts/Overdevest 2009/2011/2017 do not materially impact the conclusions regarding how minimally-invasive methods compare to open/conventional methods, as there were no clear differences for RMDQ between the conventional/open surgical group and the minimally-invasive group at any time point over the 5 years of follow-up *except for* the 52-week point, where RMDQ scores suggested a statistically-significant but clinically-questionable or -irrelevant difference favoring conservative/open surgery over minimally-invasive surgery (1.3 points better on a 0-23 scale; 95% CI, 0.1 point to 2.5 points). Therefore, we included only a brief summary of this trial in this report (see Overdevest 2017, which also includes data for VAS leg and back pain, which shows no clear difference between the groups at any of the time periods reported over the 5-year follow-up).

BHAT 2005

Bhat AL, Chow DW, DePalma MJ, et al. Incidence of vocal cord dysfunction after fluoroscopically guided steroid injections in the axial skeleton. Arch Phys Med Rehabil. 2005 Jul;86(7):1330-1332. PubMed
Relevant to FAQ3

- **Study design:** prospective cohort study
- **Population:** 100 patients (mean age 48 years, 52% female)
- **Intervention:** fluoroscopically guided therapeutic epidural injection (with 1% lidocaine plus betamethasone)
    - 62 lumbar selective nerve root injections (SNRIs) or transforaminal epidural injections (TFEIs) (12 mg of betamethasone)
    - 29 cervical SNRIs or TFEIs (6 mg)
    - 6 lumbar zygapophyseal joint injections (4.8 mg)
    - 3 sacroiliac joint injections (12 mg)
- **Comparison:** 2% lidocaine injection (performed prior to the steroid injection in all patients)
- **Outcomes:** dysphonia or associated throat symptoms
- **Duration of follow-up:** 7 days for all but 1 patient
    - 1 patient with persistent symptoms after 1 week was questioned again the following week
- **Certainty: High**
    - **Risk of bias:** Cohort study. Very small samples for some injection sites. 9 patients "did not undergo epidural deposition of steroid" but the authors did not explain why this happened or how it might have affected the findings.
    - **Precision:** No serious concerns
    - **Directness:** Findings may not be generalizable to older patients or to protocols other than those studied.
    - **Consistency:** No serious concerns
    - **Other considerations:** Findings supported objectively as 25% of patients had imaging to confirm edema. Higher certainty established by all-or-none response.
- **Results:**
    - 12 patients (8 lumbar SNRI, 4 cervical SNRI) developed dysphonia or other throat symptoms after epidural corticosteroid injection; none had such symptoms after diagnostic injection
    - Symptoms noted at 24 hours in 9 patients, 72 hours in 3 patients
    - Symptoms were transient and resolved within 1 week in 11 patients
    - 3 patients had vocal cord edema confirmed on imaging

BHATIA 2016

Reference: Bhatia A, Flamer D, Shah PS, Cohen SP. Transforaminal epidural steroid injections for treating lumbosacral radicular pain from herniated intervertebral discs: A systematic review and meta-analysis. Anesth Analg. 2016 Mar;122(3):857-870. PubMed

Relevant to FAQ2, FAQ3, FAQ4, FAQ6

- **Study design:** systematic review of randomized trials
- **Population:** adults with radiological diagnosis of herniated disk
- **Intervention:** transforaminal epidural injection of steroid plus local anesthetic
- **Comparison(s):** injection of saline or local anesthetic alone
- **Outcomes:** pain, physical and psychological disability, quality of life, risk of surgery, adverse events
- **Duration of follow-up:** up to 1 year; primary analyses focused on 1-3 months
- **Certainty: Unusable**
    - Because of lack of new trials included in this review and concerns about its methods, we did not use it for outcome data extraction or for assessing the quality and strength of the underlying trial evidence:
        - includes identical set of trials addressing comparison of transforaminal epidural injection of steroid vs. placebo as Chou 2015
        - Chou 2015 showed consistent effects with different injection approaches so unclear value of reporting or concluding on effects from transforaminal approach separately
        - inconsistency and ambiguity in methods review authors used for selecting at which time points they would extract pain and function outcome data, which has the potential for risk of bias if time points with more positive outcomes were preferentially selected for extraction
        - inclusion of nonrandomized trial (Vad 2002)
        - authors' judgment for risk of bias of each domain was reported but support for authors' judgment was not reported
        - sections of text were unclear, including their rationale for including the nonrandomized trial

BOTWIN 2000

Botwin KP, Gruber RD, Bouchlas CG, Torres-Ramos FM, Freeman TL, Slaten WK. Complications of fluoroscopically guided transforaminal lumbar epidural injections. Arch Phys Med Rehabil. 2000 Aug;81(8):1045-1050. PubMed

Relevant to FAQ3, FAQ4

- **Study design:** retrospective cohort study
- **Population:** 207 patients with radicular pain from either herniated nucleus pulposus (42 patients: mean age 38 years, 60% male, mean pain duration 6 months) or lumbar spinal stenosis (165 patients: mean age 72 years, 56% male, mean pain duration 43 months)
- **Intervention:** fluoroscopically guided lumbar transforaminal epidural injection of betamethasone (165 injections) or methylprednisolone (157 injections)
    - Patients received between 1 and 3 injections (average 1.6 injections per patient)
- **Comparison:** None

- **Outcomes:**
    - 24 hours after injection, patients were asked if they had any rash (discoloration of the skin), fever, increased pain, positional headache, nausea, vomiting, or other complaints.
    - They were also asked to estimate any change in their baseline pain level on a scale of ‘‘much better,’’ ‘‘better,’’ ‘‘same,’’ or ‘‘worse.’’ (findings not reported in this study)
- **Duration of follow-up:** Primary follow-up (by telephone) was at 24 hours after injection; physician follow-up visit occurred 1-3 weeks after injection
- **Certainty: Low**
    - **Risk of bias:** Retrospective cohort study
    - **Precision:** Confidence intervals were not reported
    - **Directness:** Also investigated patients with herniated nucleus pulposus as cause of symptoms; results reported here are limited to those with spinal stenosis
    - **Consistency:** No serious concerns
- **Results:**
    - incidence of side effects 8.8% per epidural injection in patients with spinal stenosis
        - nonpositional headaches (resolving within 24 hours) in 2.7%
        - increased back pain at injection site (resolving in 24 hours) in 1.9%
        - increased leg pain in 0.4%
        - facial flushing in 1.2%
        - vasovagal reaction in 0.4%
        - rash in 0.4%
        - leg weakness in 0.4%
        - dizziness in 0.4%
        - increased blood sugar (258 mg/dL) in an insulin-dependent diabetic in 0.4%
        - intraoperative hypertension in 0.4%
        - nausea in 0.4%

BOTWIN 2001

Botwin KP, Gruber RD, Bouchlas CG, et al. Complications of fluoroscopically guided caudal epidural injections. Am J Phys Med Rehabil. 2001 Jun;80(6):416-424. PubMed

Relevant to FAQ3, FAQ4

- **Study design:** retrospective cohort study
- **Population:** 139 patients (mean age 64 years, 58% female) with lumbosacral radiculopathy due to herniated disk or spinal stenosis (diagnosis-specific subgroups were not described or analyzed separately)
- **Intervention:** fluoroscopically guided caudal epidural injection of 18 to 28 mL of lidocaine plus 12 mg betamethasone acetate (120 injections)
- **Comparison:** fluoroscopically guided caudal epidural injection of 18 to 28 mL of lidocaine plus 80 mg triamcinolone acetonide (137 injections)
- **Outcomes:** complications self-reported by patients 24 hours after injection and/or in physician notes at follow-up visit 1-3 weeks later
- **Duration of follow-up:** up to 3 weeks
- **Certainty: Low**
    - **Risk of bias:** Retrospective cohort study.
    - **Precision:** Power calculations and confidence intervals were not reported.
    - **Directness:** Findings may not be generalizable to types and doses of steroids and injection techniques other than those studied.
    - **Consistency:** No serious concerns.

- **Results:**
  - incidence of side effects 15.6% per epidural injection
    - insomnia in 4.7%
    - nonpositional headaches (resolving within 24 hours) in 3.5%
    - increased back pain at injection site (resolving in 24 hours) in 3.1%
    - facial flushing in 2.3%
    - vasovagal reaction in 0.8%
    - nausea in 0.8%
    - increased leg pain in 0.4%

BROUWER 2015

Brouwer PA, Brand R, van den Akker-van Marle ME, et al. Percutaneous laser disc decompression versus conventional microdiskectomy in sciatica: a randomized controlled trial. Spine J. 2015 May;15(5):857-865. PubMed

Brouwer PA, Brand R, van den Akker-van Marle ME, et al. Percutaneous laser disc decompression versus conventional microdiscectomy for patients with sciatica: Two-year results of a randomised controlled *trial. Interv Neuroradiol. 2017* Jun;23(3):313-324. PubMed

Relevant to FAQ2, FAQ4, FAQ5, FAQ6

- **Study design:** randomized trial
- **Population:** 115 adult patients with sciatica, refractory to conservative management and disk herniation confirmed on MRI
  - laser group: 57 patients (mean age 43 years, 35% female)
    - sciatica symptoms: 8-26 weeks, 23%; 26-52 weeks, 40%; >52 weeks, 37%
    - mean duration of sciatica symptoms (mean +/- SD): 30.0 +/- 9
  - surgery group: 58 patients (mean age 44 years, 42% female)
    - sciatica symptoms: 8-26 weeks, 46%; 26-52 weeks, 21%; >52 weeks, 32%
    - mean duration of sciatica symptoms (mean +/- SD): 26.0 +/- 8
- **Intervention:** percutaneous laser disk decompression (PLDD)
- **Comparison:** conventional surgery (discectomy)
- **Outcomes assessed:**
  - Primary outcomes:
    - disability assessed on Roland-Morris Disability Questionnaire (RDQ; range 0-23, with higher scores indicating worse disability); MCID set as 4 as long as mean improvement is at least 11
    - perceived recovery based on 7-point Likert scale (“complete” or “nearly complete” recovery counted as “recovery”)
    - leg and back pain based on 0- to-100-mm visual analog scale
  - Secondary outcomes:
    - Pertaining to pain and function: functional Prolo scale, bodily pain and physical functioning scores on 36-Item Short Form Health Survey (SF-36), sciatica frequency and bothersomeness index scores
    - Also recorded complication, recovery, and reoperation outcomes
- **Results at duration of follow-up:** up to 1 year of follow-up [Brouwer 2015] and at 2 years of follow-up [Brouwer 2017]
- **Certainty: Low**
  - **Risk of bias**: Unblinded study. 77% vs. 53% of patients in minimally-invasive vs. open/conventional surgery had sciatica for 26 weeks or more (mostly from more having

sciatica for 26-52 weeks). 5 patients (9%) assigned to PLDD did not undergo PLDD due to laser malfunction (n = 1) or inability to reach the disc space (n = 4); 1 of these patients was free of complaints and was thus followed via ITT without surgical intervention, 4 received surgery, and 3 of these 4 needed another surgery within a year. 21 patients (38%) who had a technically-successful PLDD also underwent additional surgery in the following year, leading to a total of 24 patients (44%) assigned to PLDD needing reoperation in the first year. An additional 4 patients who had previously received a technically-successful PLDD treatment underwent surgery by year two (amounting to 25 patients [45%] who had previously had a successful PLDD treatment and 28 patients [51%] assigned to PLDD).

- **Precision**: No serious concerns
- **Directness**: No serious concerns
- **Consistency**: No serious concerns
- **Other considerations**:

- **Results:**
  - comparing PLDD vs. conventional surgery
    - Disability; higher scores indicate worse disability
      - RDQ at baseline. 15.7 vs. 15.5
      - ***RDQ at 4 weeks***, 10.8 vs. 13.2 (difference: 2.5 points better in PLDD group; 95% CI, 0.2 to 4.7 points)
      - RDQ at 8 weeks, 7.8 vs. 7.8
      - RDQ at 26 weeks, 7 vs. 4.8
      - RDQ at 52 weeks, 5.4 vs. 4.4
      - RDQ at 104 weeks, 4.3 vs. 4.4
    - Pain (leg)
      - VAS at baseline, 57 vs. 61
      - VAS at 4 weeks, 39 vs. 31
      - VAS at 8 weeks, 25 vs. 20
      - VAS at 26 weeks, 20 vs. 16
      - VAS at 52 weeks, 18 vs. 13
      - VAS at 104 weeks, 11 vs. 14
    - Pain (back)
      - VAS at baseline, 45 vs. 46
      - VAS at 4 weeks, 38 vs. 40
      - VAS at 8 weeks, 29 vs. 23
      - VAS at 26 weeks, 31 vs. 20
      - VAS at 52 weeks, 23 vs. 17
      - VAS at 104 weeks, 19 vs. 21
    - Pain; higher scores indicate better pain status
      - SF-36 at baseline, 33 vs. 30
      - SF-36 at 4 weeks, 40 vs. 36
      - SF-36 at 8 weeks, 51 vs. 51
      - ***SF-36 at 26 weeks***, 60 vs. 72 (difference 11.3 points worse in PLDD group; 95% CI, 2.4 to 20.1 points)
      - SF-36 at 52 weeks, 70 vs. 72
      - SF-36 at 104 weeks, 75 vs. 73

- Physical functioning; higher scores indicate better functional status
    - SF-36 at baseline, 41 vs. 39
    - ***SF-36 at 4 weeks***, 59 vs. 41 (difference 18.4 points better in PLDD group; 95% CI, 10.0 to 26.8 points)
    - SF-36 at 8 weeks, 68 vs. 62
    - SF-36 at 26 weeks, 71 vs. 74
    - SF-36 at 52 weeks, 78 vs. 81
    - SF-36 at 104 weeks, 82 vs. 77
- No clear differences between groups at any time point for sciatica frequency or bothersomeness
- Repeated measures analysis for overall effect of 10 different efficacy measures
    - Up to 52 weeks [Brouwer 2015], ***statistically significant for only VAS leg pain, with an effect that is clinically-questionable or -irrelevant*** (6.9 points better on a 0-100 scale in PLDD group versus open/conventional surgery group; 95% CI, 1.3 to 12.6 points)
        - Also statistically significant for "general health" (disregarding Bonferroni adjustment), but this outcome is not clearly described earlier in the report when describing outcomes they would consider (though this is a scorable item for SF-36 and is commented on in the 2017 report as being from SF-36), and is not considered further here (effects clinically-questionable or -irrelevant, anyway)
    - Up to 104 weeks [Brouwer 2017], ***statistically significant for only SF-36 physical functioning, but again with an effect that is clinically-questionable or -irrelevant*** (6.1 points better on a 0-100 scale in PLDD group versus open/conventional surgery group; 95% CI, 0.5 to 11.7 points)
        - Possibly driven by difference at 4 weeks, but no difference at any other time point
- Recovery
    - at 1 year in 69% vs. 75% (OR 0.81; 95% CI, 0.4 to 1.9)
    - significant difference in time to recovery comparing PLDD to open/conventional discectomy:
        - first-time recovery during the follow-up period was attained at a significantly slower rate in the PLDD group, resulting in an HR of 0.64 (95% CI, 0.42–0.97), with Kaplan-Meier estimates of the curves ***estimating median time to first perceived recovery of 8 weeks (95% CI, 3.2 to 12.8 weeks) vs. 6 weeks (95% CI, 5.2 to 6.9 weeks)*** (considered statistically-significant)
- Reoperation
    - within 1 year, 44% vs. 16%
        - 5 patients (9%) assigned to PLDD did not undergo PLDD due to laser malfunction (n = 1) or inability to reach the disc space (n = 4); 1 of these patients was free of complaints and was thus followed via ITT without surgical intervention, 4 received surgery, and 3 of these 4 needed another surgery within a year. 21 patients (38%) who had a technically-successful PLDD also underwent additional surgery in the following year, leading to a

total of 24 patients (44%) assigned to PLDD needing reoperation in the first year.
        - 9 patients (16%) in surgery group who underwent reoperation
            - was noted to exceed published averages of 7% from the Hakkinen 2007 5-year follow-up report and the Arts 2009 1-year follow-up report
    - within 2 years, 51% vs. 21%
        - an additional 4 patients who had previously received a technically-successful PLDD treatment underwent surgery by year two (amounting to a 2-year total of 25 patients [45%] who had previously had a successful PLDD treatment and 28 patients [51%] who had been assigned to PLDD)
        - an additional 3 patients assigned to the surgery group underwent reoperation (amounting to a 2-year total of 12 patients [12%])
- complications (Brouwer 2015; not reported in Brouwer 2017): 5% vs. 11%
    - transient nerve root injury, 5% vs. 2%
    - dural tear/spinal fluid leak, 0% vs. 5%
    - micturition requiring catheter, 0% vs. 2%
    - surgery at the wrong spinal level, 0% vs. 2%
    - technical failure in PLDD, 9%

CHEN 2018

Chen BL, Guo JB, Zhang HW, et al. Surgical versus non-operative treatment for lumbar disc herniation: a systematic review and meta-analysis. Clin Rehabil. 2018 Feb;32(2):146-160**.** PubMed

Relevant to FAQ2

- **Study design:** systematic review and meta-analysis
- **Population:** 19 randomized trials of 2,272 adults with lumbar disk herniation
- **Intervention:** surgical interventions varied: diskectomy (5 trials), laminectomy (3 trials), plasma disk decompression (2 trials), percutaneous disk decompression (1 trial), minimally-invasive surgery (4 trials), ozone ablation (2 trials), nucleoplasty (1 trial), chemonucleolysis (1 trial)
- **Comparison**: nonsurgical treatments varied, and may have been offered alone or as part of a composite regimen involving other nonsurgical modalities: physical therapy (8 trials), manipulation (8 trials), conventional medications (7 trials), acupuncture (3 trials), bed rest (3 trials), Chinese medicine (2 trials), epidural steroid injection (1 trial), ultrasound (1 trial)
    - **Certainty: Unusable** This systematic review and meta-analysis is not useable in its published form. Brief reasons for this judgment include:
        - Overly-broad inclusiveness of what they counted as “surgery” (e.g., including ozone ablation, nucleoplasty, and minimally-invasive methods along with open/conventional methods, and also including a trial that used chemonucleolysis, which is uncommonly used due to the risk for anaphylactic reactions and neurologic complications with inadvertent injection of chymopapain into subarachnoid space)
        - Including trials with a nonsurgical comparator group that does not meet inclusion criteria (e.g., 3 trials included bed rest, which is an inappropriate intervention; 2 trials used only Chinese medicine and manipulation therapy; 1 trial used only epidural corticosteroid injections).

- However, the search strategy utilized by this systematic review and meta-analysis is judged to be robust, with a search date extending to May 23, 2017. Therefore, each of the trials was appraised for appropriateness for inclusion in this evidence review.
    - Trials were excluded if they had an inappropriate surgical (e.g., nucleoplasty, ozone ablation) or control (e.g., bed rest; not including some element of physical therapy/physiotherapy, even a home-based exercise regimen) group intervention.
    - One trial (Chen 2015) was published in an obscure Chinese journal (Clinical Medical Engineering [lin chuang yi xue gong cheng]) and it is unclear if this trial is published in English. The appropriateness of including this trial could not be verified due to is obscurity and inability to obtain full text, so it was dropped from further consideration based on consensus after considering these factors.
        - Based on data available in Chen 2018, this trial randomized 100 people and only provided 4-week follow-up data for the Japanese Orthopedic Association scores, but forest plots suggest favoring nonoperative treatment.
    - One trial (Österman 2006) was misclassified as having a minimally-invasive surgical intervention, likely due to the surgical intervention being microdiscectomy/microdiscectomy. However, the microdiscectomy/microdiscectomy was performed in an open way (further corroborating this is the fact that the citation for further description of the procedure comes from 1978).
    - Two other trials (Peul 2008, Weinstein 2006) also clearly met inclusion criteria.
    - Therefore, three trials (Österman 2006, Peul 2008, Weinstein 2006) met criteria for consideration for the question of open/conventional surgery versus conservative/noninvasive care as defined in Part 1 Scoping. (Lurie 2014 was found when searching for follow-up reports for Weinstein 2006, and Peul 2007 is an earlier report of Peul 2008.)

CHOU 2015

Chou R, Hashimoto R, Friedly J, et al. Epidural corticosteroid injections for radiculopathy and spinal stenosis: a systematic review and meta-analysis. Ann Intern Med. 2015 Sep 1;163(5):373-381. PubMed
Relevant to FAQ2, FAQ3, FAQ4, FAQ6

- **Study design:** systematic review of randomized trials; large observational studies summarized for evaluation of serious adverse events
- **Population:** 2,912 adults with radicular low back pain (30 trials) in placebo-controlled comparisons
    - Trials primarily evaluated patients with chronic symptoms; 6 trials had majority of patients with symptom duration < 6 weeks
- **Intervention:** epidural corticosteroid injection
- **Comparison(s):** placebo (epidural local anesthetic, epidural saline, or soft-tissue injection)
    - absolute event rates with placebo not reported here because they varied by placebo
- **Outcomes:** pain, function, composite outcomes, subsequent surgery, adverse events
- **Duration of follow-up:** range from 1 week to 3 years
- **Results and Certainty for efficacy:**
-

Outcome[1]	Sample Size (no. of trials)	Results[2]	Certainty[3]
At 5 days to ≤ 2 weeks			
Improvement in pain (WMD on 0-100 scale)	701 (6)	**-7.55 (95% CI -11.4 to -3.74) favoring intervention**	Moderate (due to moderate risk of bias)
Improvement in function (SMD)	374 (3)	**-0.33 (95% CI -0.56 to -0.09)[4] favoring intervention**	Low (due to moderate risk of bias, inconsistency, and imprecision)
Successful composite outcome (RR)	168 (2)	1.05 (95% CI 0.87 to 1.27)	Not rated by Chou 2015
At 2 weeks to ≤ 3 months			
Improvement in pain (WMD)	1,657 (15)	-3.61 (95% CI -8.45 to 1.23)	Low (due to moderate risk of bias and inconsistency)
Successful pain outcome (RR)	897 (8)	1.21 (95% CI 0.98 to 1.49)	Low (due to moderate risk of bias and inconsistency)
Improvement in function (SMD)	1346 (13)[5]	−0.14 (95% CI −0.43 to 0.15)	Moderate (due to moderate risk of bias and inconsistency)
Successful functional outcome (RR)	993 (7)	0.98 (95% CI 0.77 to 1.26)	Low (due to moderate risk of bias, inconsistency and imprecision)
Risk of surgery (RR)	845 (5)[6]	**0.62 (95% CI 0.41 to 0.92) favoring intervention**	Low (due to moderate risk of bias and imprecision)
Successful composite outcome (RR)	604 (9)	1.13 (95% CI 0.98 to 1.32)	Moderate (due to moderate risk of bias)
At 3 months to < 1 year			
Improvement in pain (WMD)	556 (5)	0.71 (95% CI -5.5 to 6.92)	Low (due to moderate risk of bias, inconsistency, and imprecision)
Successful pain outcome (RR)	298 (3)	1.12 (95% CI 0.93 to 1.36)	Low (due to moderate risk of bias and inconsistency)
Improvement in function (SMD)	739 (6)	−0.22 (95% CI −0.61 to 0.18)	Low (due to moderate risk of bias, inconsistency, and imprecision)
Successful functional outcome (RR)	360 (3)	1.09 (95% CI 0.86 to 1.38)	Low (due to moderate risk of bias, inconsistency and

			imprecision)
Risk of surgery (RR)	36 (1)	0.56 (95% CI 0.12 to 2.68)	Low (due to moderate risk of bias, imprecision, and consistency could not be assessed with 1 trial)
Successful composite outcome (RR)	58 (1)	0.71 (95% CI 0.34 to 1.48)	Low (due to moderate risk of bias, imprecision, and consistency could not be assessed with 1 trial)
At > 1 year			
Improvement in pain (WMD)	887 (7)	0.13 (95% CI -2.39 to 2.65)	Moderate (due to moderate risk of bias)
Successful pain outcome (RR)	504 (4)	1.10 (95% CI 0.94 to 1.28)	Moderate (due to moderate risk of bias)
Improvement in function (SMD)	1070 (8)[7]	−0.17 (95% −0.47 to 0.12)	Low (due to moderate risk of bias and inconsistency)
Successful functional outcome (RR)	588 (4)	1.07 (95% CI 0.93 to 1.24)	Low (due to moderate risk of bias)
Risk of surgery (RR)	1208 (14)	0.97 (95% CI 0.75 to 1.25)	Moderate (due to moderate risk of bias)
Successful composite outcome (RR)	153 (2)	1.04 (95% CI 0.81 to 1.34)	Low (due to moderate risk of bias, and imprecision)

[1] WMD = Weighted Mean Difference, SMD = Standardized Mean Difference, where negative values indicate favorable outcome for intervention, RR = Risk Ratio

[2] Statistically significant results are in **bold**

[3] As rated by the authors (Chou 2015)

[4] After excluding one outlier study that reported a much stronger effect than other trials; including this trial resulted in substantial heterogeneity and no significant pooled effect (SMD −0.75, 95% CI −1.62 to 0.11, in 4 trials with 464 patients).

[5] Appendix Table 2 and online Figure 6 report 13 trials but online Table 2 reports 12 trials

[6] Online Data Supplement Table 2 and Figure 18 indicate 8 trials, but Table 2 indicates "5 trials n=845".

[7] Appendix Table 2 and online Figure 8 report 8 trials, but online Table 2 reports 9 trials

- **Additional comments:** This systematic review did not report whether included trials used 1 injection or more than 1 injection

- **Results and Certainty for harms:**
  - **Results**
    - only 1 serious adverse event reported among 38 placebo-controlled trials with 3,733 patients, which was a retroperitoneal hematoma in patient getting anticoagulation
      - methods for assessing harms not well-reported
      - data on harms were sparse

        - 18 trials did not report on harms or reported no harms; 2 did not report harms by treatment group
    - 4 large observational studies of epidural and other spinal injections found serious adverse events to be rare, although some minor adverse events were recorded, such as local hematoma, bleeding, and dural puncture
    - **Certainty – Low** due to imprecision

EL ABD 2015

El Abd O, Amadera J, Pimentel DC, Gomba L. Immediate and acute adverse effects following transforaminal epidural steroid injections with dexamethasone. Pain Physician. 2015 May-Jun;18(3):277-86. PubMed

Relevant to FAQ3, FAQ4

- **Study design:** prospective observational study
- **Population:** 150 consecutive patients having transforaminal epidural steroid injections with dexamethasone for managing radicular and axial spinal pain at the cervical, lumbar, and sacral levels; 122 had lumbar injections
- **Intervention:** fluoroscopically guided transforaminal epidural steroid injections with dexamethasone
- **Outcomes:** adverse events
- **Duration of follow-up:** 2-week time period after injection
- **Certainty: Low** because results not reported specific to lumbar injections
- **Results**:
    - proportion with side effects
        - 20.7% immediately after injection, with most common being
            - numbness in 10%
            - tingling in 2.7%
            - pruritus (genital, perineal, groin area) in 4.7%
        - 47.3% at 1 day after injection - most commonly injection site pain (17%), headaches (14%), insomnia (14%), increased radicular pain (9%), rash/flush (4%)
        - 13.3% at 3 days after injection – mostly increased radicular pain
        - 1.3% at 2 weeks after injection
    - all side effects were transient and minor, and no major complications were reported

ERSAYLI 2006

Ersayli DT, Gurbet A, Bekar A, Uckunkaya N, Bilgin H. Effects of perioperatively administered bupivacaine and bupivacaine-methylprednisolone on pain after lumbar discectomy. Spine. 2006 Sep;31(19):2221-2226. PubMed

Relevant to FAQ3

- **Study design:** randomized trial
- **Population:** 75 patients (15 per group)
    - in control group: mean age 43 years, 60% female
- **Intervention:** preemptive infiltration with 4 different approaches
        - 30 mL 0.25% bupivacaine and 40 mg methylprednisolone before wound closure
        - 30 mL 0.25% bupivacaine alone before closure
        - 30 mL 0.25% bupivacaine and 40 mg methylprednisolone before incision
        - 30 mL 0.25% bupivacaine alone before incision
    - after surgery, patient controlled analgesia (morphine) was used for 24 hours

- **Comparison:** 30 mL saline (0.9% NaCl) before wound closure (control group)
    - after surgery, patient controlled analgesia (morphine) was used for 24 hours
- **Outcomes:** pain at rest, pain with movement, morphine consumption for 24 hours after surgery, adverse events
- **Duration of follow-up:** 24 hours
- **Results:**
    - among 15 patients having diskectomy and receiving saline before wound closure
        - total morphine consumption in first 24 hours after surgery 26.4 mg (including 12.2 mg in 12-24 hours)
        - 60% had postoperative nausea and vomiting
    - mean pain score (VAS 0-10) during first 24 hours after surgery
        - at rest
            - At 1 hour, score = 2.6
            - At 4 hours, score = 0.8
            - At 8-24 hours, score = 0
        - with movement
            - At 1 hour, score = 4.6
            - At 4 hours, score = 2.6
            - At 8 hours, score = 1.3
            - At 16 hours, score = 0.6
            - At 20 hours score = 0.1
            - At 24 hours, score = 0

GHAI ***2015***

Ghai B, Kumar K, Bansal D, Dhatt SS, Kanukula R, Batra YK. Effectiveness of Parasagittal Interlaminar Epidural Local Anesthetic with or without Steroid in Chronic Lumbosacral Pain: A Randomized, Double-Blind Clinical Trial. Pain Physician. 2015 May-Jun;18(3):237-48. PubMed

Relevant to FAQ2, FAQ3, FAQ4

- **Study design:** randomized trial
- **Population:** 69 patients with chronic low back pain with lumbosacral radicular pain having 1 or more fluoroscopic guided epidural injections of steroid or placebo using parasaggital interlaminar approach
    - aged 18 to 60 years
    - radicular pain of ≥ 12 weeks duration not responding to medications and physical therapies
    - pain score of ≥ 5 on 0-10 numerical rating scale at time of enrollment
- **Intervention:** injections contained 6 mL of 0.5% lidocaine plus 80 mg (2 mL) of methylprednisolone acetate
- **Comparison:** injections contained 8 mL of 0.5% lidocaine alone
- **Outcomes:**
    - proportion of patients achieving effective pain relief (≥ 50% reduction from baseline on numerical rating scale) at various time points, with 3 months data used as primary outcome of trial
    - pain intensity using 0 – 10 numerical rating scale (at various time points)
    - Modified Oswestry Disability Questionnaire (at various time points)
    - ventral and perineural spread

    - number of injections required (patients with no efficacy on initial injection or deterioration in response received additional injection of same injectate/dose)
    - treatment emergent adverse events
    - complications
- **Duration of follow-up:** 1 year
- **Certainty: Moderate**
    - **Risk of bias:**
        - **risk of selective outcome reporting** - Abstract and Methods indicate patients were evaluated for outcomes at 2 weeks, and 1, 2, 3, 6, 9, and 12 months after injection but no results were reported for 2-week or 1-month time points
        - **differential withdrawal -** 7 withdrawals in comparison group and 2 in intervention group (all due to failure, in both groups)
    - **Precision:** no serious concerns
    - **Directness:** no serious concerns
    - **Consistency:** no serious concerns
- **Results:**
    - comparing intervention vs. control
        - proportion of patients achieving effective pain relief
            - 86% vs. 50% at 3 months (p = 0.002)
            - 86% vs. 56% at 6 months (p = 0.008)
            - 89% vs. 53% at 9 months (p = 0.001)
            - 89% vs. 59% at 12 months (p = 0.001)
        - intervention associated with significant reduction in numerical rating scale and improvement in Modified Oswestry Disability Questionnaire compared to baseline at 3, 6, 9, and 12 months
        - number of epidural injections over 52 weeks
            - mean 1.7 vs. 2 (p =0.07)
            - > 1 injection in 57% vs. 67% (not significant)
            - 3 injections in 14% vs. 34% (p = 0.03)
        - levels of injections, ventral epidural and perineural spread, and fluoroscopy time were comparable between groups
        - no patient reported any swelling, redness, or persisting pain at injection site
        - no withdrawals due to treatment emergent adverse events
        - no major complications were reported in either group

HAHNE 2011

Hahne AJ, Ford JJ, Hinman RS, et al. Outcomes and adverse events from physiotherapy functional restoration for lumbar disc herniation with associated radiculopathy. Disabil Rehabil. 2011;33(17-18):1537-1547. PubMed

Relevant to FAQ3

- **Study design:** case series
- **Population:** 95 patients (mean age 40 years, 31% female) with pain referring predominantly into 1 leg and lumbar disk herniation confirmed on computed tomography (CT) or magnetic resonance imaging (MRI)
    - 89 patients (94%) completed first formal reassessment at mean 2.5 months
    - 53 patients (56%) had at least 1 more reassessment prior to discharge

- **Intervention:** physical therapy using a functional restoration approach
    - mean 30 sessions over 8.7 months
    - most common components of therapy included:
        - core stabilization exercises: all patients
        - functional exercises 98%
        - education with a cognitive-behavioral element 96%
        - lumbar strapping 61%
        - manual therapy/massage 33%
        - repeated movements (McKenzie method) 27%
        - neurodynamic exercises 10%
- **Comparison:** none
- **Duration of follow-up:** mean 8.7 months
- **Certainty: Low**
    - **Risk of bias:** Case series. No control group.
    - **Precision:** No serious concerns.
    - **Directness:** Treatment was not standardized.
    - **Consistency:** No serious concerns.
- **Results:** Adverse events
    - temporary increase in back or leg symptoms after exercise in 6 patients (6%)
        - resolved in < 2 hours in 5 patients, in 1 day in 1 patient
    - temporary shoulder pain during exercise in 2 patients (2%)
        - resolved in < 30 minutes
    - shoulder pain after exercise that led to adhesive capsulitis in 1 patient (1%)

KARAMAN 2011

Karaman H, Kavak GO, Tüfek A, Yldrm ZB. The complications of transforaminal lumbar epidural steroid injections. Spine (Phila Pa 1976). 2011 Jun;36(13):E819-24. PubMed

Relevant to FAQ3, FAQ4

- **Study design:** prospective cohort study
- **Population:** 562 with lumbar disc hernia accompanied by radiculopathy
- **Intervention:** transforaminal lumbar epidural steroid injections (1,305 injections in 562 patients) performed under fluoroscopic guidance by same physician using standardized approach
- **Comparison(s):** Not applicable
- **Outcomes:** complications during procedure and at 3 weeks follow-up
- **Duration of follow-up:** 3 weeks
- **Certainty**: Low
- **Results:**
    - no major complications observed
    - minor complications
        - overall incidence 11.5%
        - frequency of specific minor complications
            - vasovagal reaction characterized by hypotension, nausea, and dizziness in 8.7% of patients
            - transient erectile dysfunction in 1.9% of male patients
            - facial flushing in 0.9% of patients
    - vascular penetration
        - total rate of 7.4% (97 times in 1,305 procedures)
        - most commonly seen at levels of L2-L3 and L1-L2

KIM 2010

Kim CH, Issa MA, Vaglienti RM. Flushing following interlaminar lumbar epidural steroid injection with dexamethasone. Pain Physician. 2010 Sep-Oct;13(5):481-4. PubMed

Relevant to FAQ3

- **Study design:** retrospective cohort study
- **Population:** 150 patients with low back pain with radiculopathy who received epidural steroid injection
- **Intervention:** fluoroscopically guided interlaminar lumbar epidural steroid injection using dexamethasone 16 mg (4 mg/mL)
- **Comparison(s):** Not applicable
- **Outcomes:** frequency of flushing (yes/no), assessed following procedure on day of injection and at follow-up ≤ 48 hours after injection
- **Duration of follow-up:** 48 hours
- **Certainty**: Low
- **Results**: overall incidence of flushing 28%, all resolved within 48 hours

KRANZ 2015

Kranz PG, Amrhein TJ, Gray L. Incidence of Inadvertent Intravascular Injection during CT Fluoroscopy-Guided Epidural Steroid Injections. AJNR Am J Neuroradiol. 2015 May;36(5):1000-7. PubMed

Relevant to FAQ3, FAQ4

- **Study design:** retrospective cohort study
- **Population:** 575 consecutive CT fluoroscopy-guided epidural steroid injections
- **Intervention:** CT fluoroscopy-guided epidural steroid injections performed by single proceduralist
- **Outcomes:** intravascular injection based on double-reading of CT fluoroscopy images
- **Certainty**: Moderate
- **Results:** risk of intravascular injection
    - 8% for lumbar transforaminal epidural steroid injections (22/275)
    - 2% for lumbar interlaminar epidural steroid injections (4/222)

LEE 2018

Lee JH, Kim DH, Kim DH, et al. Comparison of clinical efficacy of epidural injection with or without steroid in lumbosacral disc herniation: a systematic review and meta-analysis. Pain Physician. 2018 Sep;21(5):449-468. PubMed

Relevant to FAQ2

- **Study design:** systematic review of randomized trials
- **Population:** 1,539 adults with radicular low back pain with radiologic confirmation of lumbosacral disk herniation (14 trials) in placebo-controlled comparisons
- **Intervention:** epidural steroid injection (with or without local anesthetic and/or saline)
- **Comparison:** placebo injection (saline alone, anesthetic alone, or both)
- **Outcomes:** pain, disability
- **Duration of follow-up:** 2 weeks to 1 year
- **Certainty: Unusable**

- Because of concerns about its methods, we did not use this systematic review for outcome data extraction or for assessing the quality and strength of the underlying trial evidence:
    - trials published before 1996 were excluded without providing reason, which results in exclusion of 12 of the 30 trials included in Chou 2015
    - unclear and inappropriate methods for trial quality assessment
        - Results text and Discussion states that all included trials were evaluated as overall high quality but this statement was not supported
            - several included trials were reported to have high or unclear risk of bias on $\geq$ 1 risk of bias domains
            - method for assessing overall trial quality not reported
        - Methods section described that risk of bias for each non-RCT was assessed using the Risk of Bias Assessment tool for Non-randomized Study (RoBANs), but review was restricted to randomized trials
        - Figure 2 reports standard Cochrane risk of bias figure and Table 2 reports alternative methodological quality assessment criteria (12 domains) yet the title of the table states it is "Cochrane review criteria"
        - nonstandard methodology for evaluating review "overall risk of bias" which involved determining proportion of total number of risk of bias domains (all domains for all trials combined) that were assessed as low risk
    - unclear how outcome data were parsed into follow-up time points
        - follow-up time points reported to be "One month, 3 months, 6 months, and 1 year);
        - if follow-up of trial was 2 months, for example, it is not clear whether it would be included as "one month" or "3 months";
- **Additional comments:** This systematic review was useful for identification of 2 recent randomized trials published after Chou 2015, both of which reported more positive outcomes than pooled outcomes from Chou 2015, and both of which are summarized in this Evidence Report (Ghai 2015; Nandy 2017).

NANDI ***2017***

Nandi J, Chowdhery A. A Randomized Controlled Clinical Trial to Determine the Effectiveness of Caudal Epidural Steroid Injection in Lumbosacral Sciatica. J Clin Diagn Res. 2017 Feb;11(2):RC04-RC08. PubMed

Relevant to FAQ2

- **Study design:** randomized trial
- **Population:** 93 adults with sciatica caused by lumbar disc prolapse confirmed by MRI and lasting 1-6 months having single epidural injection
- **Intervention:** lumbar caudal epidural injection of 20 mL steroid solution (80 mg methyl prednisolone in 18 mL of isotonic saline)
- **Comparison:** lumbar caudal epidural injection of 20 mL of isotonic saline
- **Outcomes:**
    - treatment success (degree of overall improvement self-reported as "recovery" or "marked improvement") at 4 and 12 weeks
    - pain and function score changes from baseline at 4 and 12 weeks

- **Duration of follow-up:** 12 weeks
- **Certainty: High**
    - **Risk of bias:** no serious concerns
    - **Precision:** no serious concerns
    - **Directness:** no serious concerns
    - **Consistency:** no serious concerns
- **Results:**
    - comparing intervention vs. control
        - treatment success in
            - 68% vs. 17% at 4 weeks ($p < 0.001$)
            - 60% vs. 48% at 12 weeks (not significant)
        - intervention associated with significant reductions in pain (measured using visual analogue scale) and significant improvements in function (as measured by Oswestry Disability Index and Roland Morris index) compared to baseline at 4 and 12 weeks

ÖSTERMAN 2006

Österman H, Seitsalo S, Karppinen J, Malmivaara A. Effectiveness of microdiscectomy for lumbar disc herniation: a randomized controlled trial with 2 years of follow-up. Spine. 2006 Oct;31(21):2409-2414. PubMed

Relevant to FAQ2, FAQ6

- **Study design:** randomized trial
- **Population:** 56 patients
    - surgery group: 28 patients randomized (mean age 37 years, 46% female)
    - control group: 28 patients randomized (mean age 38 years, 32% female)
- **Intervention:** microdiskectomy under general anesthesia with fluoroscopic control of spinal level before draping
    - patients were advised to continue isometric exercises while waiting for surgery and after discharge
    - patients were usually discharged on the second or third postoperative day
    - follow-up visits included active physiotherapeutic instruction
- **Comparison:** isometric exercises and active physiotherapeutic instruction comparable to what the surgery group received
    - 11 patients (39%) crossed over to surgery
- **Outcomes assessed:** leg pain (primary), back pain, treatment satisfaction, full recovery, Oswestry Low Back Disability Score, 15D Health-Related Quality of Life, subjective work ability, DEPS risk of depression, forward bending ability, lateral bending ability, straight leg raise positivity, muscle weakness
- **Duration of follow-up:** 2 years (outcome assessment at 6 weeks, 3 and 6 months, and 1 and 2 years)
- **Certainty: Low**
    - **Risk of bias:** Lack of blinding. Use of last observation carried forward for missing data. Rate of loss to follow-up/unavailability of data high at some time points (i.e., 21% at 6 months for conservative therapy group; 29% and 25% at 1 year for conservative therapy and surgery groups, respectively; 14% at 2 years for conservative therapy group; 7% at all other points for both groups). Crossover from conservative care group to surgical group confounds the

question of “surgery versus conservative care”, but not the question of “surgery now versus conservative care now plus option for surgery later if needed or desired”.

- **Precision:** Small sample size. The 95% CIs were wide and included results that would likely be both clinically-meaningful and clinically-questionable.
- **Directness:** No serious concerns, but may question applicability to older patients given age of population studied
- **Consistency:** Some of the outcomes suggest possible benefit favoring surgery in a statistically-significant manner at certain time points (e.g., 6 weeks), but any such effects appear short-lived and include the possibility for both clinically-meaningful and clinically-questionable benefit (see notes on precision):
    - leg pain (0-100 scale) favors surgery at 6 weeks, but no other point
    - proportion reporting full recovery favors surgery at 6 weeks, but no other point
    - satisfaction with treatment (0-100 scale) favors surgery at 6 weeks and 6 months, but not at 3 months and 1 year; there is conflicting information for the 2-year point
    - the remaining 9 outcomes assessed all failed to show a clear difference for all time points
    - all differences in group means (expressed as surgery minus control) indicating the difference in mean improvement from baseline during the follow-up and analyzed with repeated-measures model and adjusted for baseline values failed to show clear difference between surgery and conservative care
    - additionally, for the continuous measures, none reached the suggested minimal clinically important difference as discussed immediately below
- **Other considerations:** Between-group differences in pain were less than suggested minimal clinically important difference (20 points on 100-point scale) for lumbar surgery patients. However, this by itself does not rule out the possibility that a certain proportion of patients (even if very small) might achieve meaningful improvement.

- **Results:**
    - Both groups showed substantial improvement over time
    - 11 patients (39%) in conservative group crossed over to surgery
    - As-treated analysis found no significant differences between groups
    - ITT analysis for selected outcomes (statistically significant between-group differences in **bold**)
        - mean leg pain (SD) on 0-100 scale, surgical group vs. control group
            - baseline: 61 (20) vs. 57 (21)
            - ***6 weeks***: 12 (20) vs. 25 (27) – flagged by authors as statistically significant
                - CI not reported, but calculated as: 95% CI, 0.3 points to 25.7 points (assuming homoscedasticity; if assuming heteroscedasticity, 95% CI changes to 0.2 points to 25.8 points)
            - 3 months: 9 (16) vs. 16 (25)
            - 1 year: 6 (11) vs. 9 (19)
            - 2 years: 6 (11) vs. 15 (24)
            - Difference in group means, expressed as surgery minus control and indicates the difference in mean improvement from baseline during the follow-up analyzed with repeated-measures model and adjusted for baseline values: 9 (95% CI, -1 to 20)
        - mean back pain (SD) on 0-100 scale, surgical group vs. control group
            - baseline: 53 (25) vs. 47 (28)

- 6 weeks: 21 (25) vs. 28 (24)
- 3 months: 15 (20) vs. 22 (23)
- 1 year: 19 (25) vs. 17 (23)
- 2 years: 11 (18) vs. 21 (27)
- Difference in group means, expressed as surgery minus control and indicates the difference in mean improvement from baseline during the follow-up analyzed with repeated-measures model and adjusted for baseline values: 7 (95% CI, -3 to 17)

- percentage of patients reporting full recovery, surgical group vs. control group
  - ***6 weeks***: 17.9% vs. 0% – flagged by authors as statistically significant
    - CI not reported, but calculated as: 95% CI, 2.2% to 35.6%
  - 3 months: 17.8% vs. 14.3%
  - 1 year: 25% vs. 17.8%
- mean satisfaction with treatment (SD) on 0-100 scale, surgical group vs. control group
  - ***6 weeks***: 93 (10) vs. 79 (23) – flagged by authors as statistically significant
    - CI not reported, but calculated as: 95% CI, 4.5 points to 23.5 points (assuming homoscedasticity; if assuming heteroscedasticity, 95% CI changes to 4.3 points to 23.6 points)
  - 3 months: 93 (11) vs. 88 (17)
  - ***6 months***: 88 (22) vs. 74 (28) – flagged by authors as statistically significant
    - CI not reported, but calculated as: 95% CI, 0.5 points to 27.5 points (same whether assuming homo- or heteroscedasticity)
  - 1 year: 89 (20) vs. 85 (20)
  - 2 years: 89 (19) vs. 79 (28) – flagged by authors as statistically significant, but calculation of CI and p value suggests:
    - 95% CI, 2.8 points worse to 22.8 points better (assuming homoscedasticity; if assuming heteroscedasticity, 95% CI changes to 2.9 points worse to 22.9 points better; p value in both instances 0.12)

OVERDEVEST 2017

Overdevest GM, Peul WC, Brand R, Koes BW, Bartels RH, Tan WF, Arts MP; Leiden-The Hague Spine Intervention Prognostic Study Group. Tubular discectomy versus conventional microdiscectomy for the treatment of lumbar disc herniation: long-term results of a randomised controlled trial. J Neurol Neurosurg Psychiatry. 2017 Dec;88(12):1008-1016. PubMed

Relevant to FAQ2

- **Study design:** randomized trial
- **Population:** 325 patients with a symptomatic lumbar disc herniation were randomly allocated to tubular discectomy (166 patients) or conventional microdiscectomy (159 patients)
- **Intervention:** minimally-invasive surgery (tubular discectomy); 166 patients
- **Comparison:** conventional microdiscectomy; 159 patients
- **Duration of follow-up:** original report (Arts 2009) presented 1-year follow-up data, first follow-up report (Arts 2011) presented 2-year follow-up data, and most recent follow-up (Overdevest 2017) presented 5-year follow-up data, but included data from earlier follow-up points

- **Brief considerations regarding this trial:**
    - The RMDQ data from Arts/Overdevest 2009/2011/2017 were not included in Alvi 2018 based on Alvi 2018 specifying a focus on ODI. Alvi 2018 also only captures pain outcomes for this trial up to Arts 2011, because Overdevest 2017 was published after the search cutoff for Alvi 2018. RMDQ and VAS leg and back pain results for Overdevest 2017 are briefly summarized below, as Overdevest 2017 also includes data from earlier follow-up points. These results do not materially impact the conclusions regarding how minimally-invasive methods compare to open/conventional methods, as there were no clear differences between the conventional/open surgical group and the minimally-invasive group at any time point over the 5-year follow-up period for these measures *except for* the 52-week point, where RMDQ scores suggested a statistically-significant but clinically-questionable or -irrelevant difference favoring conservative/open surgery.
        - Both groups improved considerably over time
        - 5-year results should be interpreted with caution compared to the 2-year or 1-year results due to considerable loss to follow-up by the 5-year point (only 63% and 61% in the minimally-invasive and open/conventional surgery group followed up at 5-year point, compared to 92% and 89% and 93% and 94% at the 2-year and 1-year follow-up points, respectively)
        - RMDQ (0-23 scale): There were no clear differences between the groups (conventional microdiscectomy vs. tubular discectomy) at any time point up to 5 years of follow-up aside from the 52-week time point, where there was a statistically-significant but clinically-questionable or -irrelevant difference (mean difference: 1.3 points *worse* for tubular discectomy vs. conventional microdiscectomy; 95% CI, 0.1 point to 2.5 points).
        - VAS leg pain (0-100 scale): There were no clear differences between the groups (conventional microdiscectomy vs. tubular discectomy) at any time point up to 5 years of follow-up.
        - VAS back pain (0-100 scale): There were no clear differences between the groups (conventional microdiscectomy vs. tubular discectomy) at any time point up to 5 years of follow-up.

PEUL 2007

Peul WC, van Howelingen HC, van den Hout WB, et al. Surgery versus prolonged conservative treatment for sciatica. *N Engl J Med*. 2007 May 31;356(22):2245-2256. PubMed

Peul WC, van den Hout WB, Brand R, Thomeer RT, Koes BW. Prolonged conservative care versus early surgery in patients with sciatica caused by lumbar disk herniation: two-year results of a randomized controlled trial. *BMJ*. 2008 Jun;336(7657):1355-1358. PubMed

Relevant to FAQ2, FAQ3, FAQ4, FAQ6

- **Study design:** randomized trial
- **Population:** 283 patients with severe sciatica for 6-12 weeks and radiologically confirmed disk herniation
    - 141 patients randomized to early surgery (mean age 41.7 years, 37% female)
        - 89% had surgery within first year (median time to surgery was 1.9 weeks)

        - 11% did not receive surgery because they recovered spontaneously (they did not receive/cross over to conservative care); no change in these rates at 2-year follow-up point
    - 142 patients randomized to conservative treatment (mean age 43.4 years, 32% female)
        - 39% had surgery within first year (after median of 14.6 weeks), increasing to 44% by 2-year follow-up
- **Intervention:** early surgery (i.e., scheduled within 2 weeks, canceled only if spontaneous recovery) with microdiscectomy
    - Under general or spinal anesthesia, symptomatic disk herniation removed by minimal unilateral transflaval approach with magnification (bilateral exploration on occasion at discretion of surgeon); following annular fenestration and decompression of the nerve root, the potential but unsubstantiated high risk of a recurrent disc herniation was reduced by removal of loose degenerated disc material from the disc space using curette and rongeur without striving for a subtotal discectomy
    - Postoperative rehabilitation at home was supervised by physiotherapists using a standardized exercise protocol
- **Comparison:** prolonged conservative treatment for 6 months
    - conservative treatment aimed to enable patients to resume daily activities and included advice (including "expectation of successful recovery" regardless of initial pain severity), pain medication, and referral to physiotherapy if needed
    - Offered microdiskectomy at 6 months if no improvement; offered earlier if increasing leg pain unresponsive to conservative treatment or progressive neurologic deficits
- **Outcomes assessed:**
    - Primary: functional disability (Roland Disability Questionnaire for Sciatica, 0-23 scale, higher is worse); intensity of pain (100-point visual analog scale, higher is worse); global perceived recovery (7-point Likert scale, higher is worse)
    - Secondary: neurologic examinations, functional and economic observational assessments, scores on the SF-36 scale (0-100 scale, higher is better), the Sciatica Frequency and Bothersomeness Index (0-24 scale, higher is worse), health perception (100-point visual analog scale, higher is better)
- **Results at duration of follow-up:** up to 1 year of follow-up [Peul 2007] and at 2 years of follow-up [Peul 2008]
    - **Certainty: Moderate**
        - **Risk of bias**: Lack of blinding. High rate of crossover from conservative care to surgery (39% within first year after a median of 14.6 weeks, increasing to 44% by 2-year follow-up) confounds the question of "surgery versus conservative care", but not the question of "surgery now versus conservative care now plus option for surgery later if needed or desired". Loss to follow-up was kept to a minimum at 1 year (2.8% and 2.1% in in early-surgery group and conservative-treatment group, respectively), and increased somewhat by year 2, but still under 10% in both groups (7.8% and 8.5%, respectively).
        - **Precision**: Some CIs for continuous outcome measures that were technically statistically significant included differences that would likely be clinically-meaningful and clinically-irrelevant or -questionable; dichotomized "satisfactory recovery" outcome included possibility of early surgery compared to conservative therapy being associated with both harm or benefit for all time points except the earliest time period for which it is reported (8 weeks)

        - **Directness**: No serious concerns, but may question applicability to older patients given population studied
        - **Consistency**: No serious concerns
        - **Other considerations**: Both groups showed substantial improvement over time. There is some evidence of the surgical group experiencing faster improvement in some measures compared to the conservative therapy group, but this difference is short-lived, with the groups eventually having comparable outcomes. Additionally, the clinical relevance of some of the aforementioned measures is doubtful or unclear and including likely-irrelevant differences (e.g., leg pain at 26 weeks, back pain at 8 weeks), whereas for others, the data suggest a substantial possible effect (e.g., satisfactory recovery at 8 weeks).
- **Results**:
    - Both groups showed substantial improvement over time
    - Satisfactory recovery comparing early surgery vs. conservative care
        - Defined as "complete" or "nearly complete" recovery on 7-point Likert scale of global perceived recovery
        - ***at 8 weeks***, 81.2% vs. 36.5% (ARD 44.7%; 95% CI, 34.2% to 55.0%)
        - at 26 weeks, 77.4% vs. 70.8% (ARD 6.6%; 95% CI, -3.7% to 17.0%)
        - at 52 weeks, 85.7% vs. 82.5% (ARD 3.2%; 95% CI, -5.4% to 11.9%)
        - at 104 weeks, 81.3% vs. 78.9% (ARD 2.4%; 95% CI, -7.2% to 12.0%)
    - Repeated measurement analysis of variance for primary continuous outcomes
        - ***In first 12 weeks***, mean disability and pain scores improved faster in early-surgery group compared to conservative-treatment group, but then converged over next 3-6 months. After 12-week outcome assessment, no significant differences between the groups for any of the primary outcomes for any of the time points of assessment.
    - Mean pain scores comparing early surgery vs. conservative care
        - leg pain (on 0-100 scale with higher score indicating worse pain)
            - at baseline, 67.2 vs. 64.4
            - ***at 2 weeks***, 28.5 vs. 44.2 (15.7 points better; 95% CI, 11.7 to 19.7 points)
            - ***at 8 weeks***, 10.2 vs. 27.9 (17.7 points better; 95% CI, 12.3 to 23.1 points)
            - ***at 26 weeks***, 8.4 vs. 14.5 (6.1 points better; 95% CI, 2.2 to 10.0 points)
            - at 52 weeks, 11.0 vs. 11.0 (0-point difference; 95% CI, 4 points worse to 4 points better)
            - at 104 weeks, 11.0 vs. 9.0 (2 points worse; 95% CI, 2 points better to 6 points worse)
        - back pain (on 0-100 scale with higher score indicating worse pain)
            - at baseline, 33.8 vs. 30.8
            - at 2 weeks, 33.3 vs. 34.9 (1.5 points better; 95% CI, 4.5 points worse to 7.4 points better)
            - ***at 8 weeks***, 14.4 vs. 25.7 (11.3 points better; 95% CI, 5.6 points to 17.4 points)
            - at 26 weeks, 15.5 vs. 17.8 (2.3 points better; 95% CI, 3.6 points worse to 8.2 points better)
            - at 52 weeks, 14.2 vs. 16.5 (2.3 points better; 95% CI, 3.6 points worse to 8.2 points better)

        - at 104 weeks, 15.9 vs. 17.3 (1.4 points better; 95% CI, 4.5 points worse to 6.3 points better)
- Mean disability scores (on 0-23 scale with higher score indicating worse disability) comparing early surgery vs. conservative care
    - at baseline, 16.5 vs. 16.3
    - ***at 2 weeks***, 14.4 vs. 13 (1.6 points *worse*; 95% CI, 0.3 points to 2.8 points)
    - ***at 8 weeks***, 6.1 vs. 9.2 (3.1 points better; 95% CI, 1.7 points to 4.3 points)
    - at 26 weeks, 4 vs. 4.8 (0.8 points better; 95% CI, 0.5 points worse to 2.1 points better)
    - at 52 weeks, 3.3 vs. 3.7 (0.4 points better; 95% CI, 0.9 points worse to 1.7 points better)
    - at 104 weeks, 3.1 vs. 2.6 (0.5 points *worse*; 95% CI, 0.8 points better to 1.8 points worse)
- Global perception of recovery (7-point Likert scale, higher score indicating worse status) comparing early surgery vs. conservative care
    - ***at 2 weeks***, 3.1 vs. 3.5 (0.4 points *worse*; 95% CI, 0.1 points to 0.6 points)
    - ***at 8 weeks***, 2.2 vs. 3.1 (0.9 points better; 95% CI, 0.6 points to 1.2 points)
    - at 26 weeks, 2.1 vs. 2.3 (0.2 points better; 95% CI, 0.1 points worse to 0.5 points better)
    - at 52 weeks, 1.9 vs. 2.1 (0.2 points better; 95% CI, 0.1 points worse to 0.4 points better)
- Surgical outcomes
    - First surgical intervention
        - 89% of patients randomized to early surgery had surgery within first year (median time to surgery was 1.9 weeks); 11% did not receive surgery because they recovered spontaneously (they did not receive/cross over to conservative care); no change in these rates at 2-year follow-up point
        - 39% of patients randomized to conservative treatment had surgery within first year (after median of 14.6 weeks), increasing to 44% by 2-year follow-up
    - Second surgical intervention (due to recurrent sciatica):
        - Year 1
            - 3% of patients who received surgery in early-surgery group
            - 2% of patients who received surgery in conservative-treatment group
            - 3% of patients who received surgery, irrespective of group assignment
        - Year 2
            - 5% of patients who received surgery in early-surgery group
            - 3% of patients who received surgery in conservative-treatment group
            - 6% of patients who received surgery, irrespective of group assignment
    - Complications in 1.7% overall at 1 year (2 dural tears, 1 hematoma, all resolved spontaneously); no change at 2 years
    - The median time to recovery was 4.0 weeks (95% CI, 3.7 to 4.4 weeks) for the early surgery group and 12.1 weeks (95% CI, 9.5 to 14.9 weeks) for prolonged conservative treatment group

PLASTARAS 2015

Plastaras C, McCormick ZL, Garvan C, Macron D, Joshi A, Chimes G, Smeal W, Rittenberg J, Kennedy DJ. Adverse events associated with fluoroscopically guided lumbosacral transforaminal epidural steroid injections. Spine J. 2015 Oct 1;15(10):2157-65. PubMed

Relevant to FAQ3, FAQ4

- **Study design:** retrospective cohort study
- **Population:** patients with lumbosacral radicular pain who had fluoroscopically guided transforaminal epidural steroid injection
- **Intervention:** fluoroscopically guided transforaminal epidural steroid injection (2,025 injections in 1,295 consecutive patients)
- **Comparison(s):** not applicable
- **Outcomes:** adverse events immediately and 24-72 hours after procedure
- **Duration of follow-up:** 74 hours after procedure
- **Certainty**: Low
- **Results**:
    - immediate adverse events
        - overall in 9.2% of injections
        - most common
            - vasovagal reaction in 4.2%
            - interrupted procedure from intravascular flow in 1.7%
    - delayed adverse events
        - overall in 20% of injections
        - most common
            - pain exacerbation in 5.0%
            - injection site soreness in 3.9%
            - headache in 3.9%
            - facial flushing/sweating in 1.8%
            - insomnia in 1.6%

QUAGLIETTA 2005

Quaglietta P, Cassitto D, Corriero AS, Corriero G. Paraspinal approach to the far lateral disc herniations: retrospective study on 42 cases. Acta Neurochir Suppl. 2005;92:115-119. PubMed

Relevant to FAQ3

- **Study design:** prospective cohort study
- **Population:** 42 patients (mean age 45 years, 65% male) with far-lateral lumbar herniated disk
- **Intervention:** diskectomy using paramedian muscle-splitting intertransverse approach (minimally invasive procedure)
- **Comparison:** none
- **Duration of follow-up:** mean 32.5 months (range 1-5 years)
- **Certainty: Very low**
    - **Risk of bias:** Cohort study. No control or comparison group.
    - **Precision:** Small sample size
    - **Directness:** Unclear if specific procedure is representative of minimally invasive surgery in general
    - **Consistency:** No serious concerns.
- **Results:**
    - in immediate postoperative period

        - 28.6% patients had transient radicular pain that disappeared in 15–21 days after analgesic therapy with indomethacin
        - 7.1% had transient burning dysesthesia in zone of nerve root involved that never persisted longer than 2 months

RASOULI 2014

Rasouli MR, Rahimi-Movaghar V, Shokraneh F, Moradi-Lakeh M, Chou R. Minimally invasive discectomy versus microdiscectomy/open discectomy for symptomatic lumbar disc herniation. Cochrane Database Syst Rev. 2014 Sep;(9):CD010328. PubMed

Relevant to FAQ2, FAQ5, FAQ6

- **Study design:** systematic review
- **Population:** 11 studies (1,172 patients)
- **Intervention:** minimally-invasive surgery
- **Comparison:** open/conventional surgery
- **Brief considerations regarding this systematic review**
    - This systematic review was consulted after initial review of Alvi 2018 (a more current systematic review of the same population-intervention-comparison question). Alvi 2018 specified a focus on Oswestry Disability Index (ODI) for assessing function/disability, and that initially led us to consider that other function/disability data might have been missed (e.g., data from trials measuring function/disability on the Roland Morris Disability Questionnaire [RMDQ])
    - Rasouli 2014 did not restrict its consideration of measures of function/disability.
    - Of the 11 trials included in Rasouli 2014 (all of which are also included in Alvi 2018), only 6 trials reported on measures of function/disability, and only 1 trial reported on a scale different than the ODI.
        - This trial was Arts 2011 (original trial publication is Arts 2009 and follow-up publication is Overdevest 2017), which measured function/disability on the RMDQ. This trial is summarized above briefly under Overdevest 2017, as that follow-up publication also included data for earlier follow-up periods for RMDQ as well as VAS leg pain and VAS back pain. We adopted an abbreviated summary for this trial, as the findings for all three outcomes showed no clear differences between the minimally-invasive and open/conventional surgery groups at any time point aside from the 52-week follow-up point, where there was a statistically-significant but clinically-questionable or -irrelevant finding in favor of conventional/open surgery (mean difference of 1.3 points on a 0-23 scale; 95% CI, 0.1 point to 2.5 points)
    - Considering the summary of findings table from this review, all outcome measures either showed no clear difference between the groups or a small difference that was judged to be clinically-insignificant/clinically-irrelevant. All outcomes were also judged as low certainty (aside from mean low back pain intensity at 1 year of follow-up, which was judged as very low certainty, and surgical site and other infections, which was judged as moderate certainty)
    - Considering the outcome of return to work, 2 trials (503 participants) reported inconsistent results at 2 years of follow-up (certainty very low due to high risk of bias in trials, small number of trials reporting, and inconsistent results):
        - 2 weeks (95% CI, 1.6 to 2.4 weeks) for minimally-invasive (tubular discectomy) versus 2.1 weeks (95% CI, 1.8 to 2.5 weeks) for open/conventional microdiscectomy 1 trial with 325 patients

        - 24 days for percutaneous endoscopic discectomy versus 49 days for open/conventional microdiscectomy (no SD reported in trial) in 1 trial with 178 patients
    - Considering the outcome of surgical re-intervention: "Based on three studies (425 participants), there was low-quality evidence of no statistically significant difference between MID and MD/OD for surgical re-intervention after at least six months' follow-up (RR 1.46, 95% CI 0.68 to 3.14) (Arts 2011; Mayer 1993; Ryang 2008). Statistically heterogeneity was low (I^2 = 15%). We rated the quality of evidence as low due to the high risk of bias and the small number of events, resulting in imprecise estimates."
        - However, 4 trials with 637 patients reported in Analysis 5.4 with these statistics, adding Teli 2010.

RHYNE 2012

Rhyne AL, Blumenthal SL, Frank EH, et al. Oxiplex reduces leg pain, back pain, and associated symptoms after lumbar discectomy. Spine. 2012 Apr;37(8):631-641. PubMed

Relevant to FAQ3

- **Study design:** randomized trial
- **Population:** 352 patients (mean age 42 years, 49%-56% male, 86%-87% white, mean BMI 28 kg/m^2) undergoing diskectomy for unilateral lumbar disk herniation, refractory to at least 2 weeks of conservative care
- **Intervention:** 177 patients had surgery (diskectomy via laminectomy or laminotomy) with application of Oxiplex intraoperative gel just prior to closure
- **Comparison:** 175 patients had surgery alone
- **Duration of follow-up:** 6 months
- **Results:**
    - adverse events in 175 patients randomized to surgery alone (timing of adverse events not reported)
        - gastrointestinal disorders
            - nausea in 20.6%
            - vomiting in 5.1%
            - constipation in 3.4%
        - general disorders
            - pyrexia in 6.3%
            - chills in 4.6%
        - injury and procedural complication
            - incision site complication in 39.4%
            - procedural pain in 30.9%
        - musculoskeletal disorders
            - back pain in 22.3%
            - pain in extremity in 21.7%
            - muscle spasm in 17.7%
            - buttock pain in 7.4%
            - myalgia in 7.4%
            - arthralgia in 6.9%
            - intervertebral disk protrusion in 5.1%
            - muscular weakness in 5.1%
            - musculoskeletal stiffness in 2.9%

        - nervous system disorder
            - hypoesthesia in 14.9%
            - headache in 6.9%
            - sensory loss in 4.6%
            - dizziness in 4.6%
            - hyporeflexia in 2.3%
        - insomnia in 4%
        - pruritus in 3.4%

SHRIVER 2015

Shriver MF, Xie JJ, Tye EY, et al. Lumbar microdiskectomy complication rates: a systematic review and meta-analysis. Neurosurg Focus. 2015 Oct;39(4):E6. PubMed

Relevant to FAQ4

- **Study design:** systematic review of randomized trials and prospective cohort studies
- **Population:** systematic review of 42 randomized trials and prospective cohort studies evaluating complication rates among lumbar diskectomy procedures
- **Intervention:** open or microdiskectomy (24 studies)
- **Comparisons:** minimally invasive surgeries (24 studies)
    - microendoscopic diskectomy in 16 studies
    - percutaneous microdiskectomy in 8 studies
- **Outcome: complication rates**
- **Duration of follow-up:** 2-120 months
- **Certainty: Low**
    - **Risk of bias:** Some randomized trials were assessed by study authors as Low risk of bias in all domains, but unclear how multiple studies were considered Low risk for "Blinding of Participants, Personnel and Outcome Assessors". Details of risk of bias assessment methodology not reported.
    - **Precision:** No serious concerns.
    - **Directness:** Unclear how similarly outcomes were reported across studies.
    - **Consistency:** Heterogeneity assessment described in methods but not reported in results.
- **Results:**
    - complication rates for open surgery vs. minimally invasive surgery
        - any complication in 12.9% vs. 24.1% (no p value reported)
            - nerve root injury (intraoperative nerve root puncture/direct nerve root injury or displacement without neurologic displacement) in 2.6% vs. 2% (not significant)
            - new or worsening neurological deficit (increased motor or sensory deficit or new postop radiculopathy) in 1.3% vs. 4.6% (not significant)
            - medical complications (included deep vein thrombosis, pulmonary embolism, myocardial infarction, urinary tract infection, acute kidney or lung disorders, and respiratory distress or failure) in 2.6% vs. 2.6% (not significant)
            - surgical errors (exploration at wrong vertebral level and surgical instrument breakage) in 3.1% vs. 1% (not significant)
            - durotomy (any intraoperative injury to dura or postop cerebrospinal fluid leak) in 3.9% vs. 4.5% (not significant)

- wound complications (included cellulitis, discitis, spondylodiscitis, skin infection, superficial wound infection, suture granuloma, dehiscence, and seroma) in 2.1% vs. 1.7% (not significant)
- hematoma (included wound and perineural hematoma) in 0.5% vs. 1.8% (not significant)
- recurrent disk complications at primary surgical site (included any persistent or relapsing disk herniation or prolapse) in 4.4% vs. 7% (not significant)
- reoperation (any reoperation during postoperative period regardless of indication) in 7.1% vs. 13.9% (not significant)

THALER 2012

Thaler M, Lechner R, Foedinger B, et al. Driving reaction time before and after surgery for lumbar disc herniation in patients with radiculopathy. Eur Spine J. 2012 Nov;21(11):2259-2264. PubMed

Relevant to FAQ5

- **Study design:** cohort study
- **Population:** 46 surgical patients in Austria with lumbar disk herniation who failed to respond to nonsurgical therapy and had radicular pain lasting > 6-8 weeks
    - right-side radiculopathy: 23 patients (mean age 48 years, 65% male)
    - left-side radiculopathy: 23 patients (mean age 50 years, 61% male)
- **Intervention:** sequesterectomy or subtotal diskectomy
- **Comparison:** 31 healthy controls (mean age 52 years, 61% female)
- **Outcome:** driving reaction time (DRT)
    - assessed using custom-built car simulator that assessed time from appearance of a red light to the foot moving from the gas pedal to the brake pedal and pushing down on the brake
    - there is no universally accepted threshold or range for safe driving
        - multiple road authorities recommend DRT values ranging from 700 to 1,500 milliseconds
        - the Royal Automobile Club of Victoria assumes a safety threshold of 750 milliseconds
        - the Department of Transport in Britain assumes a safety threshold of 700 milliseconds
- **Duration of follow-up:** mean of 3.1 days (immediate postoperative) and 34.82 days (follow-up)
- **Certainty: Very low**
    - **Risk of bias:** Patient and control groups were not matched; controls were required to have at least 10 years of driving experience while patients simply needed a valid driving license.
    - **Precision:** No serious concerns
    - **Directness:** DRT is a surrogate outcome for safe driving.
    - **Consistency:** No serious concerns.
    - **Other considerations:** The act of braking in response to a perturbation is more complicated than reaction time alone, and safe driving is more complicated than braking response alone. Pain medication use and cognitive function should also be considered when making return-to-driving recommendations.
- **Results:**
    - mean DRT for right side radiculopathy
        - preoperative 664 milliseconds
        - immediately postoperative 605 milliseconds (p = 0.018 vs. baseline)
        - 5 weeks 593 milliseconds

            - improvement at follow-up vs. baseline translates to a difference in stopping distance of 1.97 mile at a speed of 100 km/hour
    - mean DRT for left side radiculopathy
        - preoperative 675 milliseconds
        - immediately postoperative 638 milliseconds
        - 5 weeks 619 milliseconds (p = 0.09 vs. immediately post-op)
            - improvement at follow-up vs. baseline translates to a difference in stopping distance of 1.56 mile at a speed of 100 km/hour
    - mean DRT for controls: 487 milliseconds

THAN 2016

Than KD, Curran JN, Resnick DK, Shaffrey CI, Ghogawala Z, Mummaneni PV. How to predict return to work after lumbar discectomy: answers from the NeuroPoint-SD registry. J Neurosurg Spine. 2016 Aug;25(2):181-186. PubMed

Relevant to FAQ5

- **Study design:** prospective cohort study
- **Population:** 148 patients (median age 45 years, 71% employed preoperatively, median baseline VAS 7) with symptomatic lumbar disk herniation refractory to noninvasive treatment for at least 6 weeks
    - 127 patients available for 3-month analysis
    - sample sizes for 6-month and 1-year analyses not provided
- **Intervention:** lumbar discectomy; authors did not consider different surgical techniques (i.e., minimally-invasive vs. open/conventional methods) as part of their analysis
- **Comparison:** none
- **Outcome:** return to work
- **Duration of follow-up:** 1 year
- **Certainty: Low**
    - **Risk of bias:** Questionnaire response rates were variable (25% to 97%), particularly at later time points.
    - **Precision:** Potentially low sample sizes at 6 months and 1 year
    - **Directness:** No serious concerns
    - **Consistency:** No serious concerns
    - **Other considerations:** Return to work questionnaire did not differentiate between working full time vs. part time. Information on duration of symptoms, presence of ongoing symptoms, characteristics of disk herniations on imaging, and use of nonoperative treatments were not available. Retirement as an employment outcome was not assessed.
- **Results:**
    - average work time missed: 67 days (no confidence interval or standard deviation reported)
    - of 89 patients working preoperatively, return to work
        - at 3 months after surgery in 87.6%
        - at 6 months after surgery in 89.3%
        - at 12 months after surgery in 93.8%
    - of 38 patients not working preoperatively, return to work
        - at 3 months after surgery in 18.4%
        - at 6 months after surgery in 22.9%
        - at 12 months after surgery in 45.5%

WEINSTEIN 2006

Weinstein JN, Tosteson TD, Lurie JD, Tosteson AN, Hanscom B, Skinner JS, Abdu WA, Hilibrand AS, Boden SD, Deyo RA. Surgical vs nonoperative treatment for lumbar disk herniation: the Spine Patient Outcomes Research Trial (SPORT): a randomized trial. JAMA. 2006 Nov 22;296(20):2441-50. PubMed [Up to 2 years of follow-up]

Lurie JD, Tosteson TD, Tosteson AN, et al. Surgical versus nonoperative treatment for lumbar disc herniation: eight-year results for the Spine Patient Outcomes Research Trial. Spine. 2014 Jan;39(1):3-16. PubMed [8-year follow-up]

Relevant to FAQ2, FAQ3, FAQ4, FAQ6

- **Study design:** randomized trial
- **Population:** 501 patients
    - surgery group: 245 patients randomized, 232 included in primary analysis (no follow-up data at any point for 13); mean age 42 years, 56% male, 85% Caucasian
    - control group: 256 patients randomized; 240 included in primary analysis (no follow-up data at any point for 16); mean age 43 years, 61% male, 84% Caucasian
    - baseline variables were balanced between groups at baseline
- **Intervention:** standard open discectomy with examination of the involved nerve root
    - surgeons were encouraged to use loupe magnification or a microscope to assist
    - midline incision to reflect the paraspinous muscles, then entered the interlaminar space (in some cases the medial border of the superior facet was removed to provide a clear view of the involved root); small annular incision made to permit removal of the fragment of disk, canal was inspected and the foramen probed for residual disk or bony pathology, nerve root was decompressed, leaving it freely mobile
    - 50% underwent surgery by 3 months, 60% underwent surgery by 2 years
- **Comparison:** "usual care", with the study protocol specifying that the minimum nonsurgical treatment should include at least active physical therapy, education/counseling with home exercise instruction, and nonsteroidal anti-inflammatory drugs if tolerated
    - Other conservative/nonsurgical treatments were allowed at the discretion of the practitioner and patient as desired/deemed appropriate
    - 30% underwent surgery by 3 months, 45% underwent surgery by 2 years
- **Outcomes assessed:** Primary measures were the Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) bodily pain and physical function scales and the American Academy of Orthopaedic Surgeons MODEMS version of the Oswestry Disability Index (changes from baseline in these scales at 6 weeks, 3 months, 6 months, and 1 and 2 years). Secondary measures included patient self-reported improvement, work status, and satisfaction with current symptoms and with care, with Symptom severity measured by the Sciatica Bothersomeness Index
- **Results at duration of follow-up:** up to 2 years of follow-up [Weinstein 2006]
    - **Certainty: Very low for efficacy outcomes; moderate for surgical outcomes**
        - **Risk of bias:**
            - Lack of blinding
            - Prominent crossover from both sides (50% in surgery group had not undergone surgery by 3 months, 40% had not undergone surgery by 2 years; 30% of conservative group underwent surgery by 3 months, 45% underwent surgery by 2 years) confounds question of "surgery versus conservative care" and question of "surgery now versus conservative care now plus option for surgery later if needed or desired" (which would not be confounded if

crossover had only occurred from the conservative to the surgical group).
        - Data were available for between 73% and 86% of patients at each of the designated follow-up times.
        - Although trial specified “bare minimum” conservative/nonoperative treatment for conservative/nonoperative group, it also allowed for a wide array of other nonoperative treatments, and other nonsurgical treatments were permitted in both groups as evidenced by the 1-year follow-up data regarding nonoperative treatment modalities utilized. Although the broad allowance of nonoperative treatments increases external validity/generalizability (in a “pragmatic trial” sense), this also introduces some inferential difficulty, because among the 323 patients who either had no surgery in the first year of enrollment or had at least 1 regularly-scheduled follow-up visit prior to surgery at which nonoperative treatment information could be assessed, 180 (56%) had received epidural corticosteroid injections.
    - **Precision:** Even for secondary outcome measures that showed some degree of benefit at select follow-up points, the associated CIs frequently included magnitudes of effect that would likely be clinically-meaningful and likely be clinically-insignificant or -questionable
    - **Directness:** No serious concerns, but may question applicability to older populations
    - **Consistency assessment:** No serious concerns
- **Results**:
    - A global assessment is that there is not a consistent difference between the groups in terms of meaningful improvement in pain or function. A few measures showed some degree of benefit at certain time points, but these effects were unstable and inconsistent. Additionally, even for those outcomes where benefit was demonstrated at a certain time point but not others, the associated CI includes both clinically-meaningful and clinically-questionable effects
    - Primary outcomes: Both groups showed substantial improvements at each follow-up period, but in ITT analyses, the point estimates for the differences between groups were small, with no clear difference between the groups at any of the time points.
    - Secondary outcomes: Both groups showed substantial improvements at each follow-up period, and in ITT analyses:
        - No clear difference in work status at any time point
        - ***The Sciatica Bothersomeness Index*** scores (0-24) showed benefit at all time points, being 1.6 to 2.1 points better in the surgical group (with CIs spanning anywhere from 0.3 points to 3.4 points better depending on the time point assessed). The smaller point estimate and smaller lower bound of the CI occurred at later time points.
        - ***Being somewhat or very satisfied with symptoms showed benefit at 3 months*** (ARD 11.3%; 95% CI, 1.6% to 20.9%), but no clear difference at other time points

        - No clear difference in rate of being somewhat or very satisfied with care at any time point
        - ***Self-rated "major improvement" since enrollment showed benefit at 1 year*** (ARD 9.0%; 95% CI, 0.3% to 17.6%), but no clear difference at other time points
    - As-treated analyses based on treatment received were performed, and the authors report adjusting for time of surgery and factors affecting treatment crossover and missing data. They report these results were considerably different from the above results (i.e., showing results consistently favoring surgery), but they do not provide the same degree of data for these analyses as they do for the ITT analyses.
    - Surgical outcomes (treatment details, complications, etc.):
        - 50% randomized to surgery underwent surgery by 3 months, 60% underwent surgery by 2 years
        - 30% randomized to conservative group underwent surgery by 3 months, 45% underwent surgery by 2 years
        - Median surgical time was 75 minutes (IQR 58-90)
        - Discharge: same-day in 27%, postop day 1 in 57%, postop day 2 or more in 15% (numbers do not add to 100% due to rounding to whole numbers)
        - No perioperative deaths; only 2% had blood loss leading to transfusion
            - Transfusion was not considered a complication
        - Intraoperative complications in 5%, mostly due to dural tear (4%)
        - Postoperative complications in 7%, mostly due to "other" (unclear catchall) in 4%, but also due to superficial wound infection in 2%
            - Published report says 5%, but data show no postoperative complications in 226 out of 243 (93%) for whom data were available
            - None of the following were reported: cerebrospinal fluid leak, deep wound infection, nerve root injury, paralysis, cauda equina injury, wound dehiscence, wound hematoma
        - Reoperation in 4% within 1 year of initial surgery; reoperation in 5% within 2 years
- **Results at duration of follow-up:** 8-year follow-up [Lurie 2014]
    - **Population:**
        - Of 245 randomized to surgery, 157 (64%) were available, and 148 (60%) had undergone surgery
        - Of 256 randomized to conservative treatment, 152 (59%) were available, and 122 (48%) had undergone surgery
    - **Certainty: Very low for efficacy outcomes; low for surgical outcomes**
        - **Risk of bias**: (in addition to concerns noted above) Considerable loss to follow-up. Minor additional crossover from conservative care to surgery (absolute 3%).
    - **Results:**
        - Primary outcomes: No primary outcome measures showed clear difference between the two groups at the 8-year point
            - Oswestry Disability Index (0-100 scale) might be viewed by some as suggestive (4.2 points better; 95% CI, 0.7 points worse to 9 points better), but interpreting "trends" is problematic. The CI still includes the possibility

of no difference or even what would likely be an indistinguishable degree of worsening. But even if assuming the upper bound of the CI as the "truth", whether a 9-point improvement on a 100-point scale is clinically-meaningful is unclear.

- Secondary outcomes: ***Sciatica Bothersomeness Index (0-24 scale) continued to show benefit at 8 years*** (1.5 points better; 95% CI, 0.2 points to 2.9 points). No other secondary outcomes showed clear difference at the 8-year point.
  - Authors also report on the added analysis of AUC over time for some of the secondary outcome measures. Some of these are reported to suggest benefit over time for surgery group compared to conservative care group (Sciatica Bothersomeness Index, satisfaction with symptoms, and self-rated improvement). However, in addition to considering the appropriateness/usefulness of AUC, the *post hoc* nature of this measure must be considered.
- Authors combined randomized and observational cohorts for as-treated analyses in the 8-year follow-up report (observational cohort was previously reported on in a different publication than Weinstein 2006 summarized above). These analyses suggested benefit for surgery for all outcomes at each time point (other than work status). Other than considering return to work rates for those who received surgery, however, these data are not considered in detail here due to the additional confounding introduced by pooling the observational cohort with the randomized cohort and performing as-treated analyses.
- Return to work (surgery vs. conservative care):
  - intent to treat
    - 2 years (n = 187 vs. n = 191): 75.4% vs. 75.2%
    - 8 years (n = 157 vs. n = 151): 74.1% vs. 69.6%
  - as treated
    - 2 years (n = 675 vs. n = 344): 84.8% vs. 84.7%
    - 8 years (n = 498 vs. n = 259): 78.3% vs. 74.9%
- Surgical outcomes:
  - By 8 years, 60% of those randomized to surgery had undergone surgery (but only 64% of those randomized were available at 8-year follow-up)
  - By 8 years, 48% of those randomized to conservative treatment had undergone surgery (but only 59% of those randomized were available at 8-year follow-up)
  - Additional surgery (8-year rate) in 13%
    - Recurrent herniation in 17 patients (6.5%)
    - "Complication or other" in 9 patients (3.4%)
    - "New condition" in 3 patients (1.1%)
    - Unclear/no data in 6 patients (2.3%)
  - No perioperative deaths
  - Intraoperative complications in 6%:
    - Dural tear/CSF leak in 12 patients (4.6%)
    - Nerve root injury in 1 patients (0.4%)
    - "Other" complications in 2 patients (0.8%)
  - Postoperative complications in 7%:

        - Report says 5% had postoperative complications, but data show 244 out of 262 (93%) for whom data were available had no postoperative complications
        - Wound infection in 4 patients (1.5%)
        - "Other" in 9 patients (3.4%)
        - None of the following were reported: bone graft complication, CSF leak, paralysis, cauda equina injury, wound dehiscence, and pseudarthrosis

XIE 2017

Xie TH, Zeng JC, Li ZH, et al. Complications of lumbar disc herniation following full-endoscopic interlaminar lumbar discectomy: a large, single-center, retrospective study. Pain Physician. 2017 Mar;20(3):E379-E387. PubMed

Relevant to FAQ3

- **Study design:** retrospective cohort study
- **Population:** 479 patients (mean age 48 years, 47% female) with lumbar disk herniation; mean history 3.3 years
- **Intervention:** full-endoscopic interlaminar lumbar diskectomy (FILD)
    - all patients treated for 1-3 days with mecobalamin and nonsteroidal anti-inflammatory drugs
    - patients were instructed to do back exercises and use a lumbar brace
- **Comparison:** none
- **Outcome:** complications
- **Duration of follow-up:** mean 38 months
- **Certainty: Very low**
    - **Risk of bias:** Retrospective cohort study. Complications were reported via outpatient clinic visits, medical records, telephone or email.
    - **Precision:** No serious concerns
    - **Directness:** A single surgeon performed all procedures.
    - **Consistency:** Complication rate much higher in first 100 cases
- **Results:**
    - 6% rate of complications
    - types of complications
        - overall
            - residual radicular symptoms due to incomplete decompression in 3 patients (<1%)
                - symptoms gradually decreased after 3-6 weeks of conservative treatment with medication and exercise
            - nerve root injury during surgery in 2 patients (< 1%)
                - recovered after 1-3 months of neurotropic drug and functional exercise
            - perioperative paresthesia in 15 patients (3.1%)
                - symptoms gradually improved after 1-8 weeks of rehabilitation therapy plus mecobalamin and pregabalin
            - recurrent herniations in 9 patients (1.9%)
                - 5 reoperations
                - 4 managed conservatively
        - first 100 cases vs. later cases

- total complications 18% vs. 2.9%
- incomplete decompression 3% vs. 0%
- never root injury 2% vs. 0%
- paresthesia 9% vs. 1.6%
- recurrent herniation 6% vs. 1.3%

Evidence report for herniated disc in the lower back: Part 4 - Evidence Review Tables

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Methods

For each FAQ the key concepts (results and factors affecting certainty of the results) from the critically appraised evidence reports that are most relevant to evidence synthesis will be summarized in Evidence Review Tables. Where evidence is very limited, or the FAQ is for descriptive summary, summary text will be provided.

Results

FAQ 1: What does the treatment involve?

Conservative/noninvasive therapy

Descriptive Evidence Details

Conservative/noninvasive therapy for herniated disc in the lower back generally consists of some combination of activity modification (but strict bed rest is discouraged), targeted exercises with or without visits to a physical therapist, and medication therapy as needed (e.g., non-steroidal anti-inflammatory medication).

The DynaMed Plus Overview & Recommendations for lumbar disk herniation includes:

Conservative management alone will improve symptoms of lumbar disk herniation in most patients.

- Pain and disability 2 years after prolonged conservative management may be indistinguishable from the pain and disability 2 years after surgery.
- Advise patients to stay active over bed rest.
- Consider having the patient perform lumbar stabilization exercises.
- Nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids may be used but evidence for efficacy is lacking.
- Consider chiropractic spinal manipulation as an option to reduce the pain attributed to a herniated disk.

The chiropractic evidence is limited to a single randomized trial with 102 patients (Santilli V, Beghi E, Finucci S. Chiropractic manipulation in the treatment of acute back pain and sciatica with disc protrusion: a randomized double-blind clinical trial of active and simulated spinal manipulations. Spine J. 2006 Mar-Apr;6(2):131-7. Epub 2006 Feb 3. PubMed).

Epidural injections

Descriptive Evidence Details

EBSCO Health Library information on spinal corticosteroid injection includes:

Corticosteroids, typically along with an anesthetic, are injected into the epidural space around the spinal nerve roots of the lumbar portion of the spine to relieve pain or inflammation. The procedure can be performed in a hospital or outpatient facility and takes less than an hour. Recovery will be monitored after the injection. The entire visit takes about 2 to 3 hours. Local anesthesia or a sedative may be used. Temporary pain at the site of injection may occur and is usually treated by applying an ice pack. You should rest on the day of the procedure, but you should be able to resume your normal activities the day after the procedure and resume exercising within one week.

Open/conventional surgery

Descriptive Evidence Details

Surgery of any kind is generally considered only after a patient has had inadequate relief after trying conservative/noninvasive therapy (and possibly also epidural corticosteroid injections) for a period of at least 6 weeks.

Open/conventional surgery for herniated disc in the lower back consists of what is called a “discectomy” or “microdiscectomy”. When a disc in the lower back herniates, it can place pressure on one or more nerves in the spine. These surgeries are performed to remove the damaged portion of the herniated disc in an attempt to relieve that pressure. You may have to stop certain medications up to 1 week before the procedure (e.g., blood thinners), you should arrange for transportation to and from the hospital, and you should generally eat a light meal the night before the surgery with nothing else to eat or drink after midnight on the night before the surgery (unless directed otherwise by your surgeon).

You will be put to sleep during the surgery. The surgeon will make a cut about 1-1.5 inch in your skin on your lower back near the affected area. Your back muscles will be moved out of the way to allow the surgeon to see the area and perform the operation. A small part of bone may need to be removed to allow access to the affected area. The surgeon will remove the disc or fragments of disc.

The length of the procedure depends on how complicated your case is and what specific methods are used for the surgery. Some patients are able to go home the same day, but some have to stay an extra day or so depending on their specific case.

There are 2 main types of this surgery: open diskectomy and microdiscectomy (Rasouli 2014):

- Standard microdiskectomy can be performed with the aid of microscope magnification or headlight loupe.
- Open diskectomy does not involve the use of a microscope or loupe. However, all steps of the operations are similar.

Microdiskectomy procedure (Elowitz E. How microdiscectomy surgery is performed. Spine-health website. Available at: https://www.spine-health.com/treatment/back-surgery/how-microdiscectomy-surgery-performed):

- Performed in a surgery center or hospital and takes about 1 to 2 hours.
- General anesthesia is used during surgery.
- Patients typically stay in the surgery center or hospital for a few hours after surgery before returning home. One overnight stay in the hospital may be recommended depending on the patient's condition.

Minimally-invasive surgery

Descriptive Evidence Details

There are different types of minimally-invasive surgeries, such as tubular discectomy, percutaneous discectomy, and percutaneous endoscopic discectomy. Some methods use lasers, such as plasma laser disc decompression.

As noted with open/conventional surgery, surgery of any kind is generally considered only after a patient has had inadequate relief after trying conservative/noninvasive therapy (and possibly also epidural corticosteroid injections) for a period of at least 6 weeks.

The goal of these surgeries is the same as for open/conventional surgery, but as the name suggests, minimally-invasive surgeries are less invasive than the open/conventional surgery methods. They use smaller incisions and special tools to allow the surgeon to do the procedure with less disruption of surrounding tissue (like your back muscles). This may allow you to receive only local numbing instead of being put to sleep, often leads to a shorter duration of procedure, and often leads to a shorter duration of stay (some of these procedures are even performed on an outpatient basis).

Rasouli 2014 describes minimally-invasive surgery for herniated disk as:

- surgery is done to remove the disk in your back compressing the nerve root or spinal cord
- minimally-invasive spine surgeries use technologies to reduce incision size and the area of tissue dissection further compared to microdiskectomy
- minimally-invasive surgeries include percutaneous nucleotomy, percutaneous endoscopic lumbar diskectomy, and transmuscular tubular microdiscectomy

Overdevest 2017 noted the mean operation time was 47±22 minutes with tubular diskectomy compared to 36±16 minutes with conventional microdiscectomy. Note this is operative time only, not the total procedural duration, and thus excludes things like preoperative preparation.

FAQ 2: Will it help my pain or function?

In general, regardless of what treatment a person might pursue, most patients improve considerably with time.

Open/conventional surgery vs. conservative/noninvasive therapy

Evidence Review Table for FAQ2 – Systematic Reviews

Citation	Sample size	Intervention	Comparator	Quality of evidence	Notes
Chen 2018	2,272 (19 trials)	Any surgery (including open surgery, minimally-invasive surgery, ozone ablation, and others)	Any conservative care (including epidural injections, bed rest, and others)	Unusable	Not used due to inappropriately-broad allowance of interventions and comparators, but systematic review strategy was robust, and was thus usable to identify original trials

Evidence Review Table for FAQ2 – Randomized Trials

In all trials both groups improved substantially compared to baseline at most times, usually with difference from baseline considerably larger than any differences between groups.

Citation	Sample size	Intervention ("surgical group")	Comparator ("conservative therapy group")	Follow-up time	Key findings	Quality of evidence	Notes
Österman 2006	56	Microdiscectomy plus isometric exercises and active physical therapy before and after surgery (n =28)	Isometric exercises and active physical therapy (n=28)	6 weeks	Leg pain (0-100 scale): MD 13 points (95% CI, 0.3 to 25.7) favors surgery Treatment satisfaction (0-100 scale): MD 14 points (95% CI, 4.5 to 23.5) favors surgery Full recovery: ARD 17.9% (95% CI, 2.2% to 35.6%) favors surgery	Low	Lack of blinding, missing data, small sample size
				3 months, 6 months, 1 year, 2 years	Nearly all outcomes failed to show statistically significant differences between groups		
Weinstein 2006/Lurie 2014	501 (309 at 8 years)	Standard open discectomy (n =245)	"Usual care", including active physical therapy, education/counseling with home exercise instruction, and NSAIDs if tolerated (n=256)	3 months, 1 years, 2 years, 8 years	Pain and function results not interpretable due to extensive crossover (40%-50% of surgery group did not have surgery)	Very low	Lack of blinding; extensive crossover rates; high loss to follow-up by 8 years

Peul 2007/2008	283	Microdiscectomy within 2 weeks plus supervised postoperative rehabilitation (n = 141)	Conservative therapy for 6 months, including counseling/education on expectation for improvement, pain medication, and referral to physical therapy as needed (n = 142)	2 weeks, 8 weeks	Treatment satisfaction: ARD 44.7% (95% CI, 34.2% to 55.0%) favors surgery at 8 weeks (not assessed at 2 weeks) Leg pain (0-100 scale): favors surgery at 2 weeks (MD 15.7 points; 95% CI, 11.7 to 19.7) and 8 weeks (MD 17.7 points; 95% CI, 12.3 to 23.1 points) Back pain (0-100 scale): favors surgery at 8 weeks (MD 11.3 points; 95% CI, 5.6 to 17.4) but not 2 weeks Disability (0-23 scale): *favors conservative therapy at 2 weeks* (MD 1.6 points; 95% CI, 0.3 to 2.8) and *surgery at 8 weeks* (MD 3.1 points; 95% CI, 1.7 to 4.3) Global perception of recovery (7-point Likert scale) *favors conservative therapy at 2 weeks* (MD 0.4 points; 95% CI, 0.1 to 0.6) and *surgery at 8 weeks*	Moderate	Lack of blinding, imprecision for some outcomes
				26 weeks, 1 year, 2 years	Nearly all outcomes failed to show statistically significant differences between groups.		

					Treatment satisfaction rates: • at 26 weeks, 77.4% vs. 70.8% (ARD 6.6%; 95% CI, -3.7% to 17.0%) • at 52 weeks, 85.7% vs. 82.5% (ARD 3.2%; 95% CI, -5.4% to 11.9%) • at 104 weeks, 81.3% vs. 78.9% (ARD 2.4%; 95% CI, -7.2% to 12.0%)		

ARD, absolute risk difference; CI, confidence interval; MD, mean difference.

Minimally-invasive surgery vs. open/conventional surgery

Evidence Review Description for FAQ2 – Systematic Review

Alvi 2018 reviewed 14 trials with 1,707 patients comparing minimally-invasive surgery (percutaneous discectomy, percutaneous endoscopic discectomy, or tubular discectomy) to open discectomy/microdiscectomy

- Efficacy outcomes (meta-analysis) were reported at 1 year of follow-up and at last follow-up (which ranged from 12 to 36 months)
- Efficacy outcomes reported were leg pain, back pain (not reported at 1 year), Oswestry Disability Index scores.
- Minimally-invasive surgery was associated with slightly better Oswestry Disability Index (on 0-100 scale) at last follow-up in in analysis of 5 trials with 491 patients (mean difference 2.61 points; 95% CI 0.88, 4.35).
- No significant differences between groups in the other 4 efficacy outcomes (with analyses up to 9 trials with 553 patients).
- All efficacy outcomes were rated Very low certainty by Alvi 2018 based on serious risk of bias and serious inconsistency.

The Rasouli 2014 systematic review included 11 trials with 1,172 patients, but all were included in Alvi 2018 and do not provide efficacy data beyond that reported for Alvi 2018.

Additional data from randomized trials either not considered by Alvi 2018 or published subsequent to Alvi 2018's search cutoff (Brouwer 2015/2017 and Overdevest 2017) were summarized separately in this evidence review (see Part 3 for details), but they do not materially impact the results reported by Alvi 2018.

Epidural steroid injections vs. placebo injections

Evidence Review Table for FAQ2 – Systematic Reviews (Placebo-controlled randomized trials)

Citation	Sample size	Follow-up time	Key findings*	Quality of evidence	Notes
Bhatia 2016				Unusable	See Critical Appraisal report
Chou 2015	2,912 (30 trials)**	5 days to < 2 weeks	**Pain scores (0-100 scale) favor surgery in 6 trials with 701 patients (mean difference -7.55, 95% CI -11.4 to -3.74)** **Function scores favor surgery in 3 trials with 374 patients (standardized mean difference -0.33, 95% CI -0.56 to -0.09)** Successful composite outcome did not find significant difference in analysis of 2 trials (risk ratio 1.05; 95% CI 0.87 to 1.27)	Moderate Low Not reported	Risk of bias Risk of bias and inconsistency
		2 weeks to up to 3 months	No significant differences in pain or function, each pooled separately using binary and continuous outcome data, in analyses including up to 15 trials with 1,657 patients.	Low to Moderate	See Critical Appraisal report
		3 months to up to 1 year	No significant differences in pain or function, both pooled separately using binary and continuous outcome data, in analyses including up to 6 trials with 739 patients.	Low to Moderate	See Critical Appraisal report
		> 1 year	No significant differences in pain or function, both pooled separately using binary and continuous outcome data, in analyses including up to 8 trials with 1,070 patients.	Low to Moderate	See Critical Appraisal report
Lee 2018				Unusable	See Critical Appraisal report

*Statistically significant findings noted in **bold**. MD = mean difference.

**For efficacy analysis, which restricted to 30 placebo-controlled trials in 2,912 patients with radicular low back pain. Analysis on harms included 8 additional placebo-controlled trials in patients with spinal stenosis plus 4 large observational studies on epidural and other spinal injections.

Evidence Review Table for FAQ2 – Randomized Trials (Placebo-controlled)

Citation	Sample size	Intervention	Follow-up time	Key findings*	Quality of evidence	Notes
Ghai 2015	69	1 or more epidural steroid injections	3, 6, 9, and 12 months	**Proportion of patients achieving effective pain relief with steroid injection vs. placebo injection:** • **86% vs. 50% at 3 months (p = 0.002)** • **86% vs. 56% at 6 months (p = 0.008)** • **89% vs. 53% at 9 months (p = 0.001)** • **89% vs. 59% at 12 months (p = 0.001)** **Steroid injection associated with significant improvements from baseline in pain and function (as measured using continuous outcomes) vs. placebo injection at 3, 6, 9, and 12 months.**	Moderate	Selective outcome reporting and differential withdrawals
Nandi 2017	93	Single epidural steroid injection	4 and 12 weeks	**Treatment success with steroid injection vs. placebo injection:** • **68% vs. 17% at 4 weeks (p < 0.001)** • 60% vs. 48% at 12 weeks (not significant) **Steroid injection associated with significant improvements from baseline in pain and function (as measured using continuous outcomes) vs. placebo injection at 4 and 12 weeks**	High (4 weeks) Moderate (12 weeks)	Imprecision (inconsistency in statistical significance) at 12 weeks across continuous and dichotomous outcomes

*Statistically significant findings noted in **bold**. ITT = intention-to-treat.

FAQ 3: What are the side effects?

Conservative/noninvasive therapy

Evidence Review Description for FAQ3 – Conservative/noninvasive therapy

The potential side effects of conservative therapy will depend on the therapy used. This was not systematically reported on in the available data for this review, but there are few side effects from exercise or physical therapy aside from the possibility of short-lived muscle soreness. Side effects from medication therapy will depend on the medication. Gastrointestinal side effects are the most common side effects with non-steroidal anti-inflammatory medications. Gabapentinoids (e.g., gabapentin, pregabalin) can cause drowsiness and mental clouding. Opioids can cause constipation and fatigue.

Hahne 2011 followed 95 patients treated with physical therapy and found increased musculoskeletal pain in about 6% of patients, resolving in 2 hours in most cases (Low certainty).

Epidural injections

Evidence Review Table for FAQ3 – Epidural steroid injections

Citation	Study Type	Sample Size	Key Findings – Incidence of side effects	Certainty
Bhat 2005	Prospective controlled	100 patients	12% dysphonia or throat symptoms (for < 1 week) with epidural steroid (vs. 0% with diagnostic injection)	High
Botwin 2000	Retrospective	165 patients	8.8% side effects per epidural injection (2.7% non-positional headache for up to 24 hours, 1.9% injection site pain for up to 24 hours, 1.2% facial flushing)	Low
Botwin 2001	Retrospective	139 patients	15.6% side effects per epidural injection (4.7% insomnia, 3.5% non-positional headache for up to 24 hours, 3.1% injection site pain for up to 24 hours, 2.3% facial flushing)	Low
Chou 2015	Systematic review of observational studies	4 studies (total sample size not reported)	Observational studies reported some minor adverse events, such as local hematoma, bleeding, and dural puncture. Frequency not reported.	Low
El Abd 2015	Prospective	150 patients	21% side effects within first 30 minutes (13% numbness and tingling in limb, 5% perineal pruritus) 47% side effects within 1 day: mostly injection site pain (17%), headaches (14%), insomnia (14%), increased radicular pain (9%), rash/flush (4%) 13% side effects at 1-3 days (mostly increased radicular pain)	Low
Karaman 2011	Prospective	1305 injections (562 patients)	11.5% minor complications, most frequently vasovagal reaction (8.7%)	Low
Kim 2010	Retrospective	150 patients	28% flushing, all resolved within 48 hours	Low
Kranz 2015	Retrospective	497 injections	2% interlaminar and 8% transforaminal injections had inadvertent intravascular injection during review of CT fluoroscopy images	Moderate
Plastaras 2015	Retrospective	2025 injections (1295 patients)	9.2% immediate side effects – most common vasovagal reaction (4.2%); 20% delayed side effects – most common pain exacerbation (5%), site pain (4%), headache (4%), facial flushing/sweating (1.8%), insomnia (1.6%)	Low

Open/conventional surgery

Evidence Review Description for FAQ3 – Open/conventional surgery

In the absence of nonserious adverse event reporting in randomized trials of surgery, searches were done for randomized trials of analgesic strategies for postoperative pain courses. Control arms of such trials were to be considered.

In the control arm of a randomized trial of an experimental analgesic (Rhyne 2012, 175 patients) found adverse events may occur in up to 39% of after lumbar diskectomy. The most common adverse events reported were incision site complications (39%), procedural pain (31%), extremity pain (22%), back pain (22%), nausea (21%), muscle spasm (18%), and hypoesthesia (15%).

In the placebo arm of a randomized trial of preemptive wound infiltration with local anesthetic (Ersayli 2006, 15 patients) postoperative pain was reported to resolve within 24 hours after lumbar diskectomy using postoperative patient-controlled morphine analgesia, but up to 60% of patients may have nausea and vomiting.

We consider the above-noted evidence to be of Very low certainty. Despite coming from randomized trials, we have very little certainty in these estimates due to inconsistent reporting.

Minimally-invasive surgery

Evidence Review Description for FAQ3 – Minimally-invasive surgery

In the absence of nonserious adverse event reporting in randomized trials of surgery, searches were done for randomized trials of analgesic strategies for postoperative pain courses. Control arms of such trials were to be considered. In the absence of such trials, searches were done for cohort studies.

In one prospective cohort study of 42 patients having a minimally invasive surgery (Quaglietta 2005), 29% had radicular pain for 2-3 weeks and 7% had burning dysesthesia for up to 2 months (Very low certainty).

In a retrospective series of 479 minimally invasive surgeries by one surgeon (Xie 2017), complications were reported in 6% patients, most commonly perioperative paresthesia (3%) and recurrent herniations (2%) (Very low certainty).

FAQ 4: What are the risks?

Conservative/noninvasive therapy

Evidence Review Description for FAQ4 – Conservative therapy

Complications with conservative/noninvasive therapy depend on the specific therapy. Risks are too rare with exercise therapy to be noted in the evidence reviewed.

Epidural injections

Evidence Review Description for FAQ4 – Epidural injections

No major complications reported in numerous studies reporting side effects (see FAQ 3).

Open/conventional surgery vs. conservative/noninvasive therapy

Evidence Review Description for FAQ4 – Open/conventional surgery vs. conservative/noninvasive therapy

Among the randomized trials summarized for efficacy:

- Österman 2006 (56 patients) did not provide data on risks/complications.
- Peul 2007/Peul 2008 (283 patients) reported an overall 1.7% complication rate at 1 year due to 2 dural tears and 1 hematoma, all of which resolved spontaneously (Moderate certainty).
- Weinstein 2006/Lurie 2014 (501 patients) reported intraoperative complications in 5% at the 2-year follow-up (mainly due to dural tear/cerebrospinal fluid leak in 4%). This increased modestly by the 8-year follow-up (309 patient) to 6% (due to 2 additional dural tear/cerebrospinal fluid leak events). Postoperative complications occurred in 7% at both follow-up points (wound infection in 2%, “other” in 4%, and no reports of cerebrospinal fluid leak, paralysis, cauda equina injury, or wound dehiscence, and Weinstein 2006 also specifies the wound infections were not deep wound infections). Blood loss leading to a transfusion occurred in 2% at both follow-up points, but this was considered separately from intraoperative complications. There were no postoperative deaths (i.e., death within 3 months of surgery) at either follow-up point (Moderate certainty at 2-year point and Low certainty at 8-year point).

Complication rates vary across these trials so overall certainty is reduced to Low certainty.

Minimally-invasive surgery vs. open/conventional surgery

Evidence Review Description for FAQ4 – Minimally-invasive surgery vs. open/conventional surgery

Alvi 2018 reviewed 14 trials with 1,707 patients comparing minimally-invasive surgery (percutaneous discectomy, percutaneous endoscopic discectomy, or tubular discectomy) to open/conventional surgery (open discectomy/microdiscectomy) and reported on the following risks:

Outcome	Rates with minimally invasive surgery	Rates with open/conventional surgery	Comparative statistics	Certainty*
Total complications	Pooled rate: 17.4% (139/800) Range: 3.0% (Ruetten 2008) to 22.8% (Belykh 2016)	Pooled rate: 17.3% (201/1161) Range: 8.3% (Huang 2005) to 20.6% (Belykh 2016)	OR 0.96 (95% CI, 0.75 to 1.22) for comparison of open vs. minimally-invasive	Very low (downgraded for serious risk of bias and serious inconsistency)
Recurrent hernias	Pooled rate: 8.3% (63/760) Range: 3.3% (Ryang 2008) to 16.9% (Arts 2011)	Pooled rate: 4.6% (52/1,119) Range: 3.2% (Belykh 2016) to 10.7% (Arts 2011)	OR 0.61 (95% CI 0.42 to 0.90) favors open	Low (downgraded for serious risk of bias)
Dural tears	Pooled rate: 4.2% (29/690)	Pooled rate: 2.9% (30/1,049)	OR 0.74 (95% CI, 0.44 to 1.25) for comparison of open vs. minimally-invasive	Low (downgraded for serious risk of bias)
Blood loss	Range: 8.4 mL (Pan 2014) to 202.5 mL (Righesso 2007) (data from 241 patients)	Range: 34 mL (Shin 2008) to 190 mL (Huang 2005) (data from 274 patients)	MD 30.5 mL (95% CI, 16.6 to 44.5 mL) favors minimally-invasive	Very low (downgraded for serious risk of bias and inconsistency)

CI, confidence interval; MD, mean difference; mL, milliliters; OR, odds ratio
*Certainty ratings are based on Alvi 2018's ratings using GRADE.

Consistent findings were found in an additional systematic review (Shriver 2015) of 42 studies (including randomized, controlled trials and prospective cohort studies), which reported overall complications in 24.1% and 12.9% of patients treated with minimally-invasive vs. open/conventional surgery, respectively. Individual complications included nerve root injury (2% vs. 2.6%), new or worsening neurological deficit (4.6% vs. 1.3%), recurrent disk herniation (7% vs. 4.4%), dural tear/spinal fluid leak (4.5% vs. 3.9%), and wound complication (1.7% vs. 2.1%). (Low certainty)

Brouwer 2015/2017 (115 patients) was not included in either of the above systematic reviews, and this randomized trial reported complications in 5% of the minimally-invasive surgery group (all were transient nerve root injury) and 11% in the open/conventional surgery group (dural tear/spinal leak in 5%, transient nerve root injury in 2%, and micturition requiring catheter in 2%). (Low certainty)

FAQ 5: How long does it take to recover?

Open/conventional surgery vs. conservative/noninvasive therapy

Evidence Review Table for FAQ5 – Randomized Trials

Citation	Sample size	Outcome	Result with open surgery	Result with conservative therapy	Quality of evidence	Notes
Peul 2007/2008	283	Median time to recovery	4.0 weeks (95% CI, 3.7 to 4.4 weeks) (n = 141)	12.1 weeks (95% CI, 9.5 to 14.9 weeks) (n = 142)	Low	Very serious indirectness: Recovery was defined as complete or nearly complete disappearance of symptoms (not the intention of recovery from the procedure)
Lurie 2014	1019 at 2 years	Return to work at 2 years	84.8% (as-treated analysis) (n = 675)	84.7% (as-treated analysis) (n = 344)	Low (2 years); Very low (8 years)	Lack of blinding; extensive crossover rates; high loss to follow-up by 8 years
	757 at 8 years	Return to work at 8 years	78.3% (as-treated analysis) (n = 498)	74.9% (as-treated analysis) (n = 259)		

CI, confidence interval

As-treated data reported for Lurie 2014 (also reported 2-year data for as-treated analysis) due to the extensive crossover in both directions impeding meaningful analysis of intention-to-treat data for return to work

Descriptive Evidence Review for FAQ5 – Observational studies

Than 2016 is a prospective cohort study of 148 patients specifically investigating return to work after lumbar discectomy, and it provides Low certainty evidence that average work time missed was 67 days, with 88% of patients returning to work within 3 months (127 patients) and 94% returning within a year (number of patients not reported). They did not consider different techniques (i.e., minimally-invasive vs. open/conventional) as part of their analysis.

Thaler 2012 is a prospective cohort study of 46 patients having lumbar discectomy with sequestrectomy or subtotal discectomy (compared to 31 healthy controls). Although driving reaction times in the healthy controls were lower than the driving reaction times among those having lumbar discectomy in either the preoperative or postoperative time points, driving reaction times in those receiving surgery improved from baseline after surgery and did not exceed various thresholds considered unsafe by different authorities. Other factors may contribute to unsafe driving, but this surgery did not appear to worsen driving reaction times (Very low certainty).

Minimally-invasive surgery vs. open/conventional surgery

Evidence Review Description for FAQ5 – Systematic Reviews

Citation	Sample size	Outcome	Result with minimally invasive surgery	Result with open surgery	Quality of evidence	Notes
Alvi 2018	579 (6 trials)	Length of stay (mean)	Range 1 to 4 days. Mean difference 2.96 days (95% CI, 0.2 to 5.72 days) favoring minimally invasive surgery	Range 3.3 to 12 days.	Low	Risk of bias, inconsistent data reporting
Rasouli 2014 (Arts 2011)	325 (1 trial)	Length of postoperative work disability	2 weeks (95% CI, 1.6 to 2.4 weeks)	2.1 weeks (95% CI, 1.8 to 2.5 weeks)	Very low	High risk of bias, small number of trials, inconsistency
Rasouli 2014 (Ruetten 2008)	178 (1 trial)	Mean postoperative work disability days	24 days (SD not reported in trial)	49 days (SD not reported in trial)		

CI, confidence interval; SD, standard deviation.

Evidence Review Table for FAQ5 – Randomized Trials

Citation	Sample size	Outcome	Result with minimally invasive surgery	Result with open surgery	Quality of evidence	Notes
Brouwer 2015/2017	115	Estimated time to first perceived recovery	8 weeks (95% CI, 3.2 to 12.8 weeks)	6 weeks (95% CI, 5.2 to 6.9 weeks); favors open surgery (HR 0.64; 95% CI, 0.42 to 0.97)	Low	Lack of blinding, baseline differences, indirectness (recovery not clearly recovery from surgery)

CI, confidence interval; HR, hazard ratio.

Descriptive Evidence Review for FAQ5 – Observational studies

Than 2016 is a prospective cohort study of 148 patients specifically investigating return to work after lumbar discectomy, and it provides Low certainty evidence that average work time missed was 67 days, with 88% of patients returning to work within 3 months (127 patients) and 94% returning within a year (number of patients not reported). They did not consider different techniques (i.e., minimally-invasive vs. open/conventional) as part of their analysis.

FAQ 6: Might I get surgery later?

Epidural injections

Evidence Review Description for FAQ6 – Epidural injections

For risk of surgery, Chou 2015 found:

- Low certainty evidence that epidural corticosteroid injection was associated with a decrease in risk compared to placebo injection at the time period of 2 weeks to ≤3 months (5 trials, 845 patients)
    - pooled rates: 8.1% (37/459) versus 12.7% (49/386); relative risk 0.62 (95% CI, 0.41 to 0.92)
- Moderate certainty evidence of no significant difference in risk between epidural corticosteroid injection and placebo injection at >1 year (14 trials, 1,208 patients)
    - pooled rates: 21.9% (120/548) versus 22.7% (150/660); relative risk 0.97 (95% CI, 0.75 to 1.25)
- Insufficient or no evidence was found to evaluate risk of surgery at other follow-up times. See Critical Appraisal report for additional details, including reasons for downgrading the quality of evidence.

Open/conventional surgery vs. conservative/noninvasive therapy

Evidence Review Table for FAQ6 – Randomized Trials

Citation	Sample size	Outcome	Result with open surgery	Result with conservative therapy	Quality of evidence	Notes
Österman 2006	56	Surgery received	No crossover reported, so presumed to be 100%. Reoperation rates not reported.	39% (reoperation rates not reported)	Low	Lack of blinding, missing data, small sample size
Peul 2007/2008	283	First surgery received	89%	39% by 1 year, 44% by 2 years	Moderate	Lack of blinding
		Second surgery received (due to recurrent sciatica)	3% by 1 year, 6% by 2 years			
Weinstein 2006/Lurie 2014	501 at 2 years 309 at 8 years	First surgery received	50% by 3 months, 60% by 2 years, 60% by 8 years	30% by 3 months, 45% by 2 years, 48% by 8 years	Moderate up to 2-year point; Low for 8-year point	Lack of blinding; high loss to follow-up by 8 years
		Reoperation	4% by 1 year, 5% by 2 years, 13% by 8 years			

Minimally-invasive surgery vs. open/conventional surgery

Evidence Review Description for FAQ6 – Systematic Reviews

Citation	Sample size	Outcome	Result with minimally invasive surgery	Result with open surgery	Quality of evidence	Notes
Alvi 2018	1,080 (8 trials)	Reoperations	Pooled rate 16.1% (81/502) Range of 0% to 64.5%	Pooled rate 8.7% (50/578); OR 0.53 (95% CI, 0.36 to 0.76) favors open surgery Range of 0% to 17.6%	Very low	Risk of bias, inconsistency
Rasouli 2014	637 (4 trials)	Surgical reintervention after at least 6 months follow-up	Pooled rate 9.8% (28/286). No significant difference between groups (RR 1.46, 95% CI 0.68 to 3.14) Range not reported since Alvi 2018 includes all trials included in Rasouli 2014	Pooled rate 5.1% (18/351) Range not reported since Alvi 2018 includes all trials included in Rasouli 2014	Low	High risk of bias, rates vary across trials, imprecision. All trials included in Alvi 2018

CI, confidence interval; OR, odds ratio; RR, risk ratio.

Evidence Review Table for FAQ6 – Randomized Trials

Citation	Sample size	Outcome	Result with minimally invasive surgery	Result with open surgery	Quality of evidence	Notes
Brouwer 2015/2017	115	Reoperation rate	44% at 1 year, 51% at 2 years	16% at 1 year, 21% at 2 years	Low	Lack of blinding, baseline differences

Evidence report for herniated disk in the lower back: Part 5 - Evidence Synthesis

Prepared by EBSCO Information Services

January 16, 2019

Revised January 23, 2019 (FAQ6 adjusted for comparative frame)

Prepared by EBSCO Health Innovations and EBM Development Department:

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Methods

Evidence synthesis process

Synthesis methods will be based on the most appropriate methods matching the available evidence. We will systematically consider synthesis methods with the following questions:

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

State "Yes" or "No". Provide justification if "No".

If "Yes", what method is the best approach?

Pick one of the following and justify:

(1) meta-analysis already done

(2) meta-analysis created from the evidence results

(3) median of sufficiently-valid results, stating cutoff for validity

(4) median of all results

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

(2) range of sufficiently valid results

(3) descriptive summary without quantitative representation (e.g., consistency in direction, but inconsistency in magnitude)

(4) statement of inconsistency too limiting for single synthesized conclusion

Where evidence is very limited or the FAQ is for descriptive summary, such that summary text was provided instead of Evidence Review Tables, the Descriptive Evidence Summary will be noted.

Results

FAQ 1: What does the treatment involve?

FAQ 1a: Conservative/noninvasive therapy

Descriptive Evidence Summary

Conservative/noninvasive therapy for herniated disc in the lower back generally consists of some combination of activity modification (but strict bed rest is discouraged), targeted exercises with or without visits to a physical therapist, and medication therapy as needed (e.g., non-steroidal anti-inflammatory medication).

FAQ 1b: Epidural injections

Descriptive Evidence Summary

Corticosteroids, typically along with an anesthetic, are injected into the epidural space around the spinal nerve roots of the lumbar portion of the spine to relieve pain or inflammation. The procedure can be performed in a hospital or outpatient facility and takes less than an hour. The entire visit will last about 2 to 3 hours.

FAQ 1c: Open/conventional surgery

Descriptive Evidence Summary

Surgery is done to remove part of the cushion between the bones in your back (diskectomy). In this surgery, an opening is made in your back (open surgery). In microdiskectomy, a microscope or operating glasses is used to see details more closely. The surgery is done in a hospital and takes 1-2 hours. Most patients can return home on the same day of surgery.

FAQ 1d: Minimally-invasive surgery

Descriptive Evidence Summary

Surgery is done to remove the disk in your back compressing the nerve root or spinal cord. In minimally-invasive surgery, a small cut is made in your back with little tissue dissection. Examples of minimally-invasive surgeries include percutaneous nucleotomy, percutaneous endoscopic lumbar diskectomy, and transmuscular tubular microdiskectomy. The surgery takes about an hour.

FAQ 2: Will it help my pain or function?

FAQ 2a: Conservative/noninvasive therapy

In general, regardless of what treatment a person might pursue, most patients improve considerably with time.

FAQ 2b: Epidural steroid injections vs. placebo injections

Evidence Synthesis Process for FAQ2

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No. The evidence results from a systematic review (Chou 2015) did not separate single-injection trials from repeated-injection trials. In 2 subsequent trials (Ghai 2015, Nandi 2017), one evaluated use of a single injection (Nandi 2017) and one evaluated use of repeated injections (Ghai 2015).

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

This synthesis is based on results of a systematic Review (Chou 2015) and two primary studies (Ghai 2015 and Nandi 2017).

The systematic review (Chou 2015) found evidence of benefit in pain (Moderate certainty) and function (Low certainty) for epidural steroid injections within the first 2 weeks of injection. Effect sizes were modest (e.g., mean difference of 7.55 on a 0-100 scale for pain). Chou 2015 found no significant differences beyond 2 weeks. Chou 2015 did not separately report results from trials of single injections and results from trials that allowed more than 1 injection.

Nandi 2017 evaluated single injections and provided evidence of benefit in pain and function (using continuous scores) at 4 weeks and 12 weeks. Treatment success rates comparing steroid injection vs. placebo injection were 68% vs. 17% at 4 weeks ($p < 0.001$) and 60% vs. 48% at 12 weeks (not significant). (High certainty at 4 weeks, Moderate certainty at 12 weeks)

For the evaluation of pain relief at 2-4 weeks, consistent findings of benefit from Moderate certainty evidence (Chou 2015) and from High certainty evidence (Nandi 2017) provide High certainty for the body of evidence.

Ghai 2015 evaluated a regimen allowing 1-3 injections (mean 1.7 injections in steroid group and 2.0 injections in placebo group, over 1 year) and provided evidence of benefit in pain and function (using continuous scores) at 3 months, 6 months, 9 months and 12 months. Rates of effective pain relief were 86% to 89% with steroid injection at all time points vs. 50% to 59% with placebo injection at all time points ($p < 0.01$ at all timepoints). (Moderate certainty)

For the evaluation of longer-term benefit with repeated injections, the Moderate certainty evidence of effect from Ghai 2015 does not explicitly relate the effect to repeated injections, and the Low certainty

evidence of absence of effect from Chou 2015 does not provide interpretable results specific to trials that allowed repeated injections. So overall the body of evidence provides Low certainty.

Epidural steroid injections provide pain relief for up to 2 to 4 weeks following a single injection (High certainty), and repeated injections may provide continued pain relief (Low certainty).

FAQ 2c: Open/conventional surgery vs. conservative/noninvasive therapy

Evidence Synthesis Process for FAQ2

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No. The evidence results from systematic reviews (Chen 2018) were unusable because of inclusion of irrelevant interventions and comparators. The individual trials varied widely in quality (from very low to moderate certainty).

If "No", what method is best to represent the evidence synthesis?

(2) range of sufficiently valid results

From 3 identified primary Studies only one had a moderate quality of evidence (Peul 2007/2008). We refer to this study in the following section.

Both groups improved substantially compared to baseline at most times, usually with difference from baseline considerably larger than any differences between groups.

> At 2 weeks, leg pain favored surgery, while disability and global perception of recovery favored conservative therapy. Both groups had similar measures of back pain.
>
> At 8 weeks, all pain and function outcomes favored surgery. Although some had CIs with a lower bound of questionable clinical importance, treatment satisfaction rates were higher with surgery, with an absolute risk difference of 44.7% (95% CI, 34.2% to 55%).
>
> At all times from 3 months to 2 years, all pain and function outcomes failed to show statistically-significant or clinically-meaningful differences between groups. Treatment satisfaction rates were 71% to 86% from 6 months to 2 years without significant differences between groups.

Most people improve with or without surgery. Surgery may provide earlier improvement (Moderate certainty) based on findings reported at 8 weeks in one trial with no further surgery-specific improvements 3 months or later.

FAQ 2d: Minimally-invasive surgery vs. open/conventional surgery

Evidence Synthesis Process for FAQ2

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

Yes.

If "Yes", what method is the best approach?

Pick one of the following and justify:

(1) meta-analysis already done

This section is based on the meta-analysis of Alvi 2018. Two more RCTs identified do not materially impact the results reported by Alvi 2018.

Alvi 2018 reviewed 14 trials with 1,707 patients comparing minimally-invasive surgery to open/conventional surgery (open discectomy/microdiscectomy) and found

- Minimally-invasive surgery was associated with slightly better Oswestry Disability Index (on 0-100 scale) at last follow-up in in analysis of 5 trials with 491 patients (mean difference 2.61 points; 95% CI 0.88, 4.35).
- All other efficacy outcomes (leg pain at 1 year, leg pain at last follow-up, back pain at last follow-up, Oswestry Disability Index at 1 year) did not find significant differences comparing minimally-invasive surgery to open surgery.
- All efficacy outcomes were rated Very low certainty by Alvi 2018 based on serious risk of bias and serious inconsistency.

Minimally-invasive surgery might be as effective as open surgery (Very low certainty).

FAQ 3: What are the side effects?

FAQ 3a: Conservative/noninvasive therapy

Descriptive Evidence Summary

Side effects with conservative/noninvasive therapy depend on the specific therapy. Side effects are rarely reported with exercise therapy. Side effects are more commonly reported with medications, such gastrointestinal upset when using NSAIDs.

FAQ 3b: Epidural injections

Evidence Synthesis Process for FAQ3 – Epidural steroid injections

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No, the evidence results are inconsistent in outcomes reported and incidence rates.

If "No", what method is best to represent the evidence synthesis?

(1) range of all results

This synthesis is based on a systematic review (Chou 2015), 3 prospective and 5 retrospective studies.

The rate of side effects with epidural steroid injections has been reported to be as low as 9% and as high as 47%. Most of them were minor and lasted only a few hours up to one day.

Numbness and tingling in the limb, occurring within the first 30 minutes, is reported in one study with 13%.

Side effects resolving within 24 hours have also included injection site pain (up to 17%), headache (up to 14%), and insomnia (up to 14%).

Flushing has been reported in up to 28% injections, all resolving within 48 hours.

Increased radicular pain has been reported in up to 9% or more and may persist for a few days.

Dysphonia or throat symptoms have been reported in 12%, mostly resolving within 1 week.

(High certainty for dysphonia; Low certainty for all others)

FAQ 3c: Open/conventional surgery

Descriptive Evidence Summary

In the absence of nonserious adverse event reporting in randomized trials of surgery, searches were done for randomized trials of analgesic strategies for postoperative pain courses. Control arms of such trials were to be considered.

Adverse events reported after lumbar discectomy in 175 patients include incision site complications (about 40%), procedural pain (about 30%), back or extremity pain (about 20%), nausea (about 20%), muscle spasm (about 20%), and hypoesthesia (about 15%). One small trial (15 patients) suggests procedural pain might be resolved within 24 hours, but nausea and vomiting occurred in 60% patients with a substantial use of morphine. (Rhyne 2012, Very low certainty) The duration of pain in extremities as a side effect was not reported clearly with the studies of patients having open surgery, but the duration was up to 3 weeks in a study of patients having minimally-invasive surgery (Quaglietta 2005, 42 patients). **(Very low certainty)**

FAQ 3d: Minimally-invasive surgery

Descriptive Evidence Summary

In the absence of nonserious adverse event reporting in randomized trials of surgery, searches were done for randomized trials of analgesic strategies for postoperative pain courses. Control arms of such trials were to be considered. In the absence of such trials, searches were done for cohort studies. Adverse events reported after minimally-invasive procedures are limited to cohort studies with small samples or single surgeon experience. Pain in the extremities lasting 2 to 3 weeks was reported in 29% of one cohort (Quaglietta 2005, 42 patients) but <1% of another (Xie 2017, 479 patients). Paresthesias were reported in 7% and 3% of patients of these cohorts, respectively. (Very low certainty)

FAQ 4: What are the risks?

FAQ4a: Conservative/noninvasive therapy

Descriptive Evidence Summary

Complications with conservative/noninvasive therapy depend on the specific therapy.

FAQ 4b: Epidural steroid injections

Descriptive Evidence Summary

This synthesis is based on a systematic review (Chou 2015), 3 prospective and 5 retrospective studies.

No major complications clearly rated to the treatment have been reported among thousands of patients receiving epidural steroid injections.

FAQ 4c: Open/conventional surgery

Descriptive Evidence Summary

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No. Data on rates of complications varied too much for a combined, single result to best represent the overall body of evidence.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

We identified 1 SR and 3 primary studies. Peul 2007/2008 (283 patients) reported an overall complication rate of about 2% at 1 year (2 dural tears, 1 hematoma, all resolved spontaneously) (Moderate certainty)

Weinstein 2006 (2-year follow-up; 501 patients)/Lurie 2014 (8-year follow-up; 309 patients) reported:

- intraoperative complications in 5% and 8% at 2 years and 8 years (primarily dural tear/cerebrospinal fluid leak)
- postoperative complications in 7% at both follow-up points
  - primarily "other" (4%) and non-deep wound infection (2%)
  - no instances of cerebrospinal fluid leak, paralysis, cauda equina injury, or wound dehiscence
- blood loss requiring transfusion occurred in 2% at both follow-up points (considered separately from intraoperative complications)
- no deaths within 3 months of surgery at either follow-up point
- certainty for these outcomes is Moderate at the 2-year point and Low at the 8-year point

Alvi 2018 reported overall complication rates ranging from 8% to 21% (pooled rate 17%) among data from 1,161 patients (Very low certainty):

- recurrent hernias ranged from 3% to 11% (pooled rate 5%) among data from 1,119 patients (Low certainty)
- dural tears occurred in 3% (consistent enough results to report single estimate) among data from 1,049 patients (Low certainty)

Findings consistent with Alvi 2018 were found in Shriver 2015, which reported overall complications in 13% of patients treated with open/conventional surgery. Individual complications included nerve root

injury (3%), new or worsening neurological deficit (1%), recurrent disk herniation (4%), dural tear/spinal fluid leak (4%), and wound complication (2%). (Low certainty)

Brouwer 2015/2017 (115 patients) was not included in either of the above systematic reviews, and it reported complications in 11% of the open/conventional surgery group (dural tear/spinal leak in 5%, transient nerve root injury in 2%, and micturition requiring catheter in 2%). (Low certainty)

Overall complication rates with open surgery range from 2% to 21%. Most commonly reported complications include dural tear/spinal leak (up to 5%), transient nerve root injury (up to 3%), wound complications (up to 2%), and micturition requiring catheter (up to 2%) (Low certainty)

FAQ 4d: Minimally-invasive surgery

Descriptive Evidence Summary

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No. Data on rates of complications varied too much for a combined, single result to best represent the overall body of evidence.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

We included 2 systematic reviews (Alvi 2018 and Shriver 2015) and one additional primary study (Brouwer 2015/2017) in this section.

Alvi 2018 reported overall complication rates ranging from 3% to 23% (pooled rate 17%) among data from 800 patients (Very low certainty):

- recurrent hernias ranged from 3% to 17% (pooled rate 8%) among data from 760 patients (Low certainty)
- dural tears occurred in 4% (consistent enough results to report single estimate) among data from 690 patients (Low certainty)

Findings consistent with Alvi 2018 were found in Shriver 2015, which reported overall complications in 24% of patients treated with minimally-invasive surgery. Individual complications included nerve root injury (2%), new or worsening neurological deficit (5%), recurrent disk herniation (7%), dural tear/spinal fluid leak (5%), and wound complication (2%). (Low certainty)

Brouwer 2015/2017 (115 patients) was not included in either of the above systematic reviews, and it reported complications in 5% of the minimally-invasive surgery group (all were transient nerve root injury). (Low certainty)

Overall complication rates with minimally-invasive surgery range from 3% to 24%. Most commonly reported complications include dural tear/spinal leak (up to 5%), new or worsening neurological deficit (up to 5%), transient nerve root injury (up to 5%), wound complications (up to 2%) (Low certainty)

FAQ 5: How long does it take to recover from the intervention?

FAQ 5a: Conservative/noninvasive therapy

Descriptive Summary

Not applicable/there is generally no recovery time associated with conservative therapy.

FAQ 5b: Epidural injections

Descriptive Summary

You may be advised to rest on the day of the procedure. However, you should be able to return to normal activities the following day.

(EBSCO Health Library 2018)

FAQ 5c: Open/conventional surgery

Evidence Synthesis Process for FAQ5

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No, each outcome is reported by one or two studies only.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

Results from 1 systematic review (Rasouli 2014) and 2 primary studies (Thaler 2012, Than 2016) provide evidence for this question.

Mean length of postoperative work disability was 2 weeks with open surgery or with minimally-invasive surgery in 1 trial with 325 patients (Arts 2011 in Rasouli 2014, Very low certainty)

Mean work time missed was 67 days in 1 cohort study with 148 patients having surgery (Than 2016, Low certainty) and 24 days in the open surgery arm of 1 trial with 178 patients (Ruetten 2008 in Rasouli 2014, Very low certainty).

Return to driving may be possible the day after surgery, based on no adverse effects on simulated reaction time tests in 46 patients (Thaler 2012, Very low certainty).

Average time to return to work might be 2 to 10 weeks. (Low to Very low certainty) Driving ability may not be affected by this surgery. (Very low certainty)

FAQ 5d: Minimally-invasive surgery

Evidence Synthesis Process for FAQ5

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No, each outcome is reported by one or two studies only.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

Results from 1 systematic review (Rasouli 2014) and 2 primary studies (Thaler 2012, Than 2016) provide evidence for this question.

Mean length of postoperative work disability was 2 weeks with open surgery or with minimally-invasive surgery in 1 trial with 325 patients (Arts 2011 in Rasouli 2014, Very low certainty)

Mean work time missed was 67 days in 1 cohort study with 148 patients having surgery (Than 2016, Low certainty) and 49 days in the minimally-invasive surgery arm of 1 trial with 178 patients (Ruetten 2008 in Rasouli 2014, Very low certainty).

Return to driving may be possible the day after surgery, based on no adverse effects on simulated reaction time tests in 46 patients (Thaler 2012, Very low certainty)

Average time to return to work might be 2 to 10 weeks. (Low to Very low certainty) Driving ability may not be affected by this surgery. (Very low certainty)

FAQ 6: Might I get surgery later?

FAQ 6a: Conservative/noninvasive therapy

You may choose to get surgery later if desired for pain relief. There does not appear to be a risk of worse outcomes for pain relief by delaying surgery.

Evidence Synthesis Process for FAQ6

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No, each timepoint is reported by one or two studies only.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

Results of 3 RCTs are the basis of the analysis, here.

Rates of later decision to have surgery in patients treated with conservative therapy in randomized trials were:

- 39% in 1 trial (Osterman 2006, Low certainty)
- 39% by 1 year and 44% by 2 years in 1 trial (Peul 2007/2008, Moderate certainty)
- 30% by 3 months, 45% by 2 years, and 48% by 8 years (Weinstein 2006/Lurie 2014, Moderate certainty)

Overall these rates are consistently between 30% to 45% over two years (Moderate certainty), and may be 48% at 8 years (Low certainty)

Among people considering surgery for low back pain due to herniated disk who decide to delay surgery, 30% to 45% may choose to have surgery over the next 2 years (Moderate certainty).

FAQ 6b: Epidural steroid injections

Evidence Synthesis Process for FAQ6

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

Yes.

If "Yes", what method is the best approach?

Pick one of the following and justify:

(1) meta-analysis already done

Basis of this analysis is the meta-analysis of Chou 2015.

Among patients choosing epidural steroid injections, about 8% may choose surgery within 3 months (Low certainty) and 22% may choose surgery after > 1 year (Moderate certainty). (Chou 2015)

FAQ 6c: Open/conventional surgery

Evidence Synthesis Process for FAQ6

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No, results are not consistent across evidence reports and timepoints and comparators may be dissimilar.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

(2) range of sufficiently valid results

Of 3 RCTs investigating open/conventional surgery versus conservative therapy, 2 reported on reoperation (Peul 2007/2008, Moderate certainty; Weinstein 2006/Lurie 2014, Moderate and Low

certainty at 2 and 8 years, respectively). Two SRs of minimally-invasive versus open/conventional surgery gave reoperation estimates with either Very low (Alvi 2018) or Low (Rasouli 2014) certainty. All RCTs included by Rasouli 2014 were included by Alvi 2018, with Alvi 2018 also including additional RCTs. The difference in certainty ratings between the two SRs is due to the severity of downgrades (Alvi 2018 downgraded three times due to risk of bias and inconsistency, and Rasouli 2014 downgraded twice due to risk of bias and imprecision). One additional RCT of minimally-invasive surgery versus open/conventional surgery (Brouwer 2015/2017) provides Low certainty reoperation estimates.

Rates of repeat surgery in patients treated with open surgery in RCTs with conservative therapy controls (in as-treated analyses) were:

- 3% by 1 year and 6% by 2 years in 1 trial (Peul 2007/2008, Moderate certainty)
- 4% by 3 months, 5% by 2 years, and 13% by 8 years (Weinstein 2006/Lurie 2014, Moderate certainty at 2 years, Low certainty at 8 years)

Rates of repeat surgery with open surgery in SRs of open vs. minimally-invasive surgery were:

- Pooled rate of 8.7% among 578 patients; range 0% to 17.6% (Alvi 2018, Very low certainty)
- Pooled rate of 5.1% among 351 patients (Rasouli 2014, Low certainty); range from individual RCTs included in Rasouli 2014 not assessed due to all RCTs also being included in Alvi 2018

In one RCT comparing open surgery and minimally-invasive surgery in 115 patients, reoperation rates in the open surgery group were 16% at 1 year and 21% at 2 years (Brouwer 2015/2017, Low certainty).

Reoperation rates with open surgery are between 3% and 6% over 3 months to 2 years in Moderate certainty evidence.

Reoperation rates with open surgery are between 0% and 21% over 2 to 3 years based on a range of all results, possibly related to different procedures and surgeon experience (Low certainty).

FAQ 6d: Minimally-invasive surgery

Evidence Synthesis Process for FAQ6

Is it useful and appropriate to present the synthesis of evidence results as a combined, single result as the best representation of the body of evidence?

No, results are not consistent across evidence reports and timepoints and comparators may be dissimilar.

If "No", what method is best to represent the evidence synthesis?

Pick one of the following and justify:

(1) range of all results

Two SRs (Alvi 2018, Very low certainty; Rasouli 2014, Low certainty) and one RCT (Brouwer 2015/2017, Low certainty) provide evidence for this question. All RCTs included by Rasouli 2014 were included by Alvi 2018, with Alvi 2018 also including additional RCTs. The difference in certainty ratings between the

two SRs is due to the severity of downgrades (Alvi 2018 downgraded three times due to risk of bias and inconsistency, and Rasouli 2014 downgraded twice due to risk of bias and imprecision).

Rates of repeat surgery with minimally-invasive surgery in SRs of open vs. minimally-invasive surgery were:

- Pooled rate of 16.1% among 502 patients, significantly higher than with open surgery; range 0% to 64.5% (Alvi 2018, Very low certainty)
- Pooled rate of 9.8% among 286 patients, not significantly different than with open surgery (Rasouli, Low certainty); range from individual RCTs included in Rasouli 2014 not assessed due to all RCTs also being included in Alvi 2018

In one RCT comparing open surgery and minimally-invasive surgery in 115 patients, reoperation rates in the minimally-invasive surgery group were 44% at 1 year and 51% at 2 years, much higher than with open surgery (Brouwer 2015/2017, Low certainty).

Reoperation rates with minimally-invasive surgery may be higher than reoperation rates with open surgery. (Very low certainty) Reoperation rates with minimally-invasive surgery have ranged from 0% to 64.5% over 2 to 3 years, possibly related to different procedures and surgeon experience (Low certainty).