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# **BMJ Open**

## Nonoperative treatment for lumbar spinal stenosis with neurogenic claudication. An updated systematic review.

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#### ABSTRACT

- 2 Objectives: Neurogenic claudication due to lumbar spinal stenosis (LSS) is a growing public health problem that can significantly
- 3 impact quality of life in older adults. We aimed to update our previous Cochrane review (2013) to determine the effectiveness of
- 4 nonoperative treatment of LSS with neurogenic claudication.
- **Design:** A systematic review was conducted. We updated our search in CENTRAL, MEDLINE, EMBASE, CINAHL, and ICL
- databases from February 2012 to September 2020 for randomized controlled trials where at least 1 arm provided data on nonoperative
- 7 treatment.
- 8 Outcome measures: Outcomes included measures of pain, function, health related quality of life and adverse events.
- **Results:** Of 13,817 citations screened, 156 were assessed and 23 new trials were identified and added to the original 21 trials. A total
- of 3,792 participants with neurogenic claudication randomized to 60 different comparison groups were assessed.
- There is moderate quality evidence from 3 trials that: Manual therapy and exercise provides superior and clinically important short-
- term improvement in symptoms and function compared to medical care or community-based group exercise; Manual therapy,
- education and exercise delivered using a cognitive-behavioural approach, demonstrates superior and clinically important
- improvements in walking distance in the immediate to long-term compared to self-directed home exercises; Glucocorticoid plus
- lidocaine injection is more effective than lidocaine alone in improving statistical, but not clinically important improvements in pain
- and function in the short-term.

- 1 The remaining 20 new trials demonstrated low or very low-quality evidence for all comparisons and outcomes, similar to the findings
- 2 of our original review.
- 3 Conclusions: There is moderate quality evidence that a multimodal approach which includes manual therapy and exercise, with or
- 4 without education is an effective treatment, and that epidural steroids are not effective for the management of LSS with neurogenic
- 5 claudication. All other nonoperative interventions provided insufficient quality evidence to make conclusions on their effectiveness.
- 7 This systematic review was registered with PROSPERO registration number CRD42020191860.

#### ARTICLE SUMMARY

## 10 Strengths and limitations of this study

- This systematic review included a wide range of nonoperative interventions commonly used in clinical practice.
- This review used consistent inclusion and exclusion criteria for neurogenic claudication, which included the corroboration of a
   diagnosis of lumbar spinal stenosis with imaging.
  - This review used rigorous methods recommended by the Cochrane Back and Neck Pain Review Group including the use of
    Grading of Recommendations, Assessment, Development and Evaluation (GRADE) to synthesize and summarize the quality
    of the evidence.
- Only English studies were included in this review.

 • Most studies had small samples sizes with heterogeneity in interventions tested, limiting ability to pool data.

Key words: neurogenic claudication, lumbar spinal stenosis, systematic review, nonoperative treatment, elderly

#### INTRODUCTION

- Lumbar spinal stenosis (LSS) causing neurogenic claudication is a highly prevalent and rapidly growing public health problem among older adults (1). It is characterized by bilateral or unilateral buttock pain and/or lower extremity discomfort, pain, weakness, or heaviness precipitated by walking and prolonged standing and relieved by stooping forward and sitting (2, 3). The underlying etiology is usually age-related osteoarthritic changes to lumbar intervertebral discs, facets joints and ligaments leading to narrowing of the central and/or lateral spinal canals and compression and/or ischemia of the spinal nerves (2, 4).
- Limited walking ability is the dominant impairment in neurogenic claudication and the most common reason for seeking care (5).
- Limited walking ability due to LSS is associated with a significant decline in functional status, quality of life and independence in this
- population (2, 5).
- Although lumbar spinal stenosis is the most common reason for spine surgery in older adults, most people with neurogenic
- 17 claudication receive nonoperative care (6). A course of nonoperative care is also recommended prior to receiving surgical intervention
- 18 (7). However, what constitutes effective nonoperative care remains unknown. In 2013 we published a Cochrane review evaluating

- nonoperative treatment for LSS causing neurogenic claudication (8, 9). This review identified 21 randomized controlled trials
  assessing a variety of nonoperative treatments. However, the quality of the evidence was deemed low or very low and therefore no
  conclusions could be made on the effectiveness of nonoperative treatment for neurogenic claudication. The purpose of this study is to
  update this systematic review and the evidence for nonoperative treatments for neurogenic claudication. Our specific research question
- 5 was: What nonoperative interventions are effective in improving outcomes in patients with neurogenic claudication due to lumbar
- 6 spinal stenosis?

## **METHODS**

- 10 This systematic review was registered with PROSPERO registration number CRD42020191860 and was conducted and reported
- according to the PRISMA guidelines (10).

## **Ethics Approval Statement**

- 14 Ethics approval was not required for conducting this systematic review.
- 16 Patient and Public Involvement Statement
- Patients or the public were not involved in the conduct of this systematic review.

## Population, Interventions, Comparison and Outcomes (PICO Criteria)

- 3 The population of interest was individuals with imaging confirmed LSS (central or foraminal, with or without spondylolisthesis) and
- 4 neurogenic claudication. Neurogenic claudication is a clinical diagnosis and was defined as buttock or leg pain and/or aching,
- 5 numbness, tingling, weakness, or fatigue with or without back pain, precipitated by standing or walking. There were no age
- 6 restrictions. The interventions of interest included all nonoperative treatments and the comparison was any treatment including
- 7 surgery. Outcomes included at least one of the following measures: walking ability, pain intensity, physical function, quality of life, or
- 8 global improvement.

## Search and Study Selection

- We replicated and updated our original electronic database search (from 1966 to January 2011) to September 2020. The search was
- performed by an experienced librarian in CENTRAL (Cochrane Library 2011 issue1), Medline, EMBASE, CINAHL and Index to
- 13 Chiropractic Literature. The terms "spinal stenosis," "lumbar spinal stenosis," "neurogenic claudication," "lumbar radicular pain,"
- "cauda equina," and "spondylosis" were combined with a highly sensitive search strategy to identify randomized controlled trials
- 15 (RCTs).

- 1 Studies were included if they were RCTs published in peer reviewed English journals, at least one arm of the trial provided data on
- 2 effectiveness of a nonoperative treatment and at least 80% of subjects had neurogenic claudication with imaging confirmed LSS.
- 3 Studies evaluating subjects with radiculopathy caused by disc herniations without neurogenic claudication were excluded.
- 5 Studies with mixed populations were only included if separate data for subjects with neurogenic claudication due to lumbar spinal
- 6 stenosis were provided.
- 8 Two pairs of reviewers independently screened all titles and abstracts identified by the search strategy. Full text of articles deemed to
- 9 be potentially relevant were independently assessed by two reviewers who made the final decision for inclusion. A third reviewer was
- 10 consulted if consensus was not reached.

## Risk of Bias Assessment and Data Analysis

- 13 Two reviewers independently assessed methodological risk of bias and performed data extraction. Safety data (intervention side
- effects and/or complications) when available were also collected. Risk of bias was assessed using the 12-item criteria recommended
- by the Cochrane Back Review Group (11). Discrepancies in risk of bias scoring and data extraction were discussed during a consensus
- meeting. Reviewers who were authors of any of the included studies were recused from performing risk of bias assessment, data
- extraction, data analysis or synthesis of their own studies.

- 1 Low risk of bias was defined as fulfilling 6 or more of the 12 criteria including clearly described and appropriate randomization (Item
- 2 A), and allocation concealment (Item B), and with no severe flaws. A severe flaw was defined a priori as a serious methodological
- deficiency not captured by the 12-item criteria that significantly increases the risk of bias such as very high dropout or cross-over rates
- 4 and sample sizes less than 30 subjects per treatment arm.

- 6 For each comparison, outcomes were analyzed according to these follow-up time periods: immediate (up to one week following the
- 7 intervention); short-term (between one week and three months); intermediate (between three months and one year) and; long-term
- 8 (one year or longer). Outcome data were pooled, and meta-analyses were performed when trials were judged to be sufficiently
- 9 homogeneous, both clinically and statistically.
- Rehabilitation therapy was defined as treatment that utilized any combination of education, exercise instruction, manual therapy, heat
- and cold applications, electrotherapy, other physical therapy modalities, orthosis, and other assistive devices. Multimodal treatment
- included various combinations of rehabilitation therapy treatments, oral and other mediations, and spinal injections, but not surgery.

### **Data Synthesis**

- The quality of the evidence for each outcome and for each comparison was evaluated using GRADE (Grades of Recommendations,
- Assessment, Development and Evaluation (12, 13) Overall quality of the evidence was based on performance against five domains: 1)

- risk of bias; 2) consistency of findings; 3) directness of comparisons; 4) precision of estimates; and 5) other considerations such as selective reporting.
- 4 The quality of the evidence starts at high when there are consistent findings among at least 75% of RCTs with low risk of bias and
- 5 consistent, direct, and precise data and with no known or suspected publication bias. It downgrades a level for each domain not met.
- 6 Treatment effects between comparators (more effective, less effective or no difference) were based on statistically significant and
- 7 clinically important differences in outcomes.
- **High quality evidence -** all five domains are met; further research is very unlikely to change the confidence in the estimate of effect.
- Moderate quality evidence one of the domains is not met; further research is likely to have an important impact on the confidence
- in the estimate of effect and may change the estimate.
- 12 Low quality evidence two domains are not met; further research is very likely to have an important impact in the confidence of the
- estimate of effect and is likely to change the estimate.
- 14 Very low-quality evidence three or more domains are not met; there is great uncertainty about the estimate of effect.

- Evidence provided by a single small trial was considered inconsistent and imprecise and thus provide "low" or "very low" quality
- evidence, depending on whether it was assessed as having a low or high risk of bias, respectively, and there were no other limitations.

- 1 Studies with both low risk of bias and inappropriate or unclear randomization and/or treatment allocation techniques were downgraded
- 2 by two levels for the "risk of bias" domain.

- 4 The results below are reported based on statistically significant differences between comparators for each outcome. Differences
- 5 considered clinically important will be specified when the quality of the evidence is moderate or higher. The MCIDs used are listed in
- 6 Table 2. Adverse events for the new studies are detailed when reported by the author

9 RESULTS

**Selection and Description of Included Trials** 

- We screened 13,817 titles and abstracts and assessed 156 full-text articles. This resulted in 44 RCTs meeting the inclusion criteria,
- including 23 new trials. Figure 1 summarizes original and updated screening results. Supplemental Table 1 describes the
- characteristics of all included trials. In total, 3,792 participants (1,765 males, 1836 females and 191 participants of undisclosed gender
- 16 (14, 15) were randomized to one of 60 comparison groups. Seventeen studies evaluated rehabilitation therapy or multimodal care (14,
- 17 16-31), 11 assessed epidural injections (32-42), 7 evaluated oral medications (15, 43-48), 6 assessed calcitonin (49-54), 2 evaluated
- acupuncture (55, 56) and 1 assessed spinal manipulation (57). Thirty-eight trials were conducted at tertiary care or university affiliated
- centres and 6 at medical/rehabilitation clinics (18, 24, 35-38). The mean age of participants was 63.3 years. The duration of symptoms

- varied considerably amongst the studies with a mean ranging from 12 weeks to 15 years. Follow-up periods also varied significantly
- 2 ranging from immediately following the intervention to 10-year post intervention.

## 4 Risk of Bias of Included Studies

5 The median and mean number of criteria met was 7 of 12 (range 2-11) (Table 1).

## 6 Table 1. Risk of bias assessment for studies on non-operative treatment for lumbar spinal stenosis with neurogenic claudication

Author	Α	В	С	D	E	F	G	Н		J	K	L	Total
Calcitonin													
Eskola 1992	?	?	+	+	+	?	+	-	?	?	?	+	5
Porter 1983	?	?	-	?	?	+	+	j	-	?	+	+	4
Porter 1988	?	?	+	?	?	-	+	+	?	?	?	+	4
Podichetty 2004	?	?	+	+	+	-	+	-	+		?	+	6
Tafazal 2007	?	?	+	+	+	+	+	+		?	?	+	7
Sahin 2009	?	?	-	-	+	-	?	+	+	3	?	+	4
Oral Medications													
Prostaglandin													
Matsudaria 2009	+	+	-	-	+	+	+	?	+	?	?	+	7*
Methylcabalin													
Waikakul 2000	-	?	-	-	+	+	+	?	+	?	?	+	5
Gabapentin													
Yaksi 2007	?	?	-	-	-	?	+	+	?	?	?	+	3
Pregabalin													
Markman 2015	+	+	+	+	+	+	+	+	?	+	-	+	10 ****
Gabapentin													
Park 2017	+	?	+	+	+	+	+	+	?	?	-	+	8 ****
Oxymorphone Hydrochloride													
Markman 2015 (2)	+	+	+	+	+	-	?	+	?	+	+	+	9 **** #
					•			•					

Oral Corticoid													
Rodrigues 2014	+	+	?	?	?	T +	+	?	?	?	?	+	5
Rehabilitation Therapy or Multime	odal												
Goren 2010	+	+	-	-	+	+	-	+	+	?	?	+	7 *
Koc 2009	?	?	-	-	+	+	+	-	+	?	?	+	5
Pua 2007	+	+	-	-	+	-	+	+	+	?	-	+	7 *
Whitman 2006	+	?	-	-	+	+	+	+	+	?	?	+	7
Minetama 2019	+	?	-	-	+	+	+	+	?	+	+	+	8 ****
Schneider 2019	+	+	-	-	+	-	+	+	+	?	+	+	8 *
Ammendolia 2018	+	+	-	- ,	+	+	+	+	+	+	+	+	10 *
Oğuz 2013	?	?	-	-	?	?	+	-	?	?	?	+	2
Homayouni 2015	+	+	- 4		+	+	+	-	-	+	?	+	7 ****
Marchand 2019	+	+	-	-	+	?	+	+	?	_	+	+	7 ****
Kim 2019	+	+	+	+	+	+	+	+	?	+	+	+	11 *
Spinal Manipulation Passmore 2017	Ţ-	+	<u> </u>	-	+	+	+	1	+	+	+	+	8 ****
Acupuncture													_
Kim 2016	+	+	Τ-	l -	-	Τ-	+	+	l -	+	+	±	7 ****
Qin 2020	+	+	+	-	+	+	+	+	+	-	+	+	10 *
Epidural Injections													
Cuckler 1985	?	?	+	+	+	+	+	+	+	?	+	+	9
Fukusaki 1988	?	?	?	?	+	+	+	+	+	?	+	+	7
Zahaar 1991	?	?	+	?	+	+	+	+	+	-	?	-	6
Brown 2012	+	-	+	-	?	+	+	-	?	?	-	+	5
Friedly 2014, 2017, Makris 2016	+	+	+	+	+	+	+	+	?	+	+	+	11 *
Song 2016	?	3	3	?	?	+	+	-	?	+	+	+	5
Milburn 2014	3	3	+	-	+	-	+	-	?	-	-	+	4
Hammerich 2019	+	+	-	-	+	-	+	?	?	-	+	+	6 ****
Sencan 2020	+	?	+	-	+	+	?	+	+	+	?	+	8 ****
Wei 2020	+	+	+	-	-	+	-	+	?	+	+	+	8 *

Percutaneous Epidural Adhesiolysis	;												
Karm 2018	+	?	+	<b>-</b>	+	-	+	+	?	-	-	+	6 ****
Surgery vs Physical Therapy								•					
Zucherman 2004, 2005, 2006	3	+	-	-	+	+		+	+	?	+	+	>6 **
Weinstein 2007, 2009, Abdu 2018	+	+	-	-	+	+	+	+	?	?	-	+	>6 *** ^
Amundsen 2000	+	5	-	-	-	+	+	+	-	?	-	?	4
Malmivaara 2007	+	+	-	-	+	+	+	+	+	?	?	+	8 *
Weinstein 2008, 2010, Lurie 2015	+	+	-	-	+	-	+	+	?	?	-	+	6 ^
Delitto 2015	+	+	),	-	+	?	+	-	+	-	+	+	7 ^

1A Was the method of randomization adequate?, B Was the treatment allocation concealed?, C Was the patient blinded to the intervention?, D Was the care provider 2blinded to the intervention?, E Was the outcome assessor blinded to the intervention?, F Was the drop-out rate described and acceptable?, G Were all randomized 3participants analyzed in the group to which they were allocated?, H Are reports of the study free of suggestion of selective outcome reporting?, I Were the groups similar at 4baseline regarding the most important prognostic indicators?, J Were co-interventions avoided or similar?, K Was the compliance acceptable in all groups?, L Was the timing 5of the outcome assessment similar in all groups?, + Yes, - No, ? Unclear, \* Low risk of bias if 6 or more items met, including valid randomization and treatment allocation 6techniques and no severe flaws, \*\* 2 year follow-up drop out rate 30%, 1 year < 20%; intention to treat inconsistent at 2 year f/u, \*\*\* Drop out rate <20% at 1 year, >20% at 74 years, \*\*\*\* < 30 participants per treatment arm, \*\*\*\*\* Treatment allocation unclear, ^ Severe flaw due to high crossover rates, # Premature end of study

- Although 31 studies met 6 or more criteria, only 9 were considered to have low risk of bias (19, 20, 24, 27, 28, 31, 37, 42, 43, 56).
- Among the remaining 22 studies that met 6 or more criteria, 13 failed to explicitly describe and/or use appropriate randomization
- procedures, allocation concealment, or both (16-18, 30, 32-34, 39, 41, 48, 52, 54, 57); three had severe flaws due to high crossover
- rates (21, 22, 25), which made the intention-to-treat analyses uninterpretable and 6 had other serious flaws including premature
- stopping of the trial (47), large number of participants lost to follow-up (40) and small sample size (less than 30 participants per arm)
- 15 (26, 29, 46, 55).

## 17 Evidence of Effect of Interventions

- 1 Fifty-three of the 60 comparisons were examined in a single trial, most with small sample sizes. It was only possible to combine data
- 2 from 2 trials (assessing surgery vs. multimodal treatment) for 1 outcome in a meta-analysis (19, 22). The 5 other studies (all assessing
- 3 calcitonin) (49-52, 54) were combined qualitatively. The results of these pooled analyses were published in our previous reviews (8,
- 4 9). Heterogeneity in source population, intervention, and outcome instruments precluded pooling of data from other trials.
- 5 Supplemental Table 2, a summary of GRADE assessment and outcomes, summarizes the quality of the evidence for outcomes for
- 6 each comparison.

### Calcitonin

- 9 There were no new studies assessing calcitonin. The conclusion from our previous review was that there is very low-quality evidence
- from 6 trials (49-54) (N=231) that calcitonin is no better than placebo or paracetamol regardless of mode of administration or
- 11 outcome assessed.

## **Oral Medication**

- We identified 4 new studies assessing 5 oral medications. There is low-quality evidence based on 1 small cross-over trial (46) (N=29),
- that pregabalin does not improve pain, distance walked, function or global health status immediately following the intervention
- compared to placebo. Adverse events were reported in 64% of the pregabalin group, the most common being dizziness, compared to
- 17 35% in the placebo group.

- A small trial evaluating gabapentin plus conservative care (48) (N=45) provides very low-quality evidence demonstrating no significant improvement in back/leg pain, disability scores or global health in the short-term compared to conservative care plus botulinum toxin injection. Five patients (20.8%) reported mild to moderate pain at injection sites for a few days after botulinum toxin injections.
- 7 There is very low-quality evidence from 1 small trial (47) (N=24) that oxymorphone hydrochloride or propoxyphene and acetaminophen is no better than placebo in the immediate term for all outcomes assessed.
- 10 A single small trial provided very low-quality evidence (15) (N=61) that oral corticoids do not improve outcomes in the short-term compared to placebo.
  - The original review identified 3 studies assessing oral medications and concluded that there is low-quality evidence that prostaglandins improves walking distance and leg pain in the short-term compared with etodolac (a nonsteroidal anti-inflammatory drug) (43); very low-quality evidence that gabapentin improves walking distance and pain compared with placebo in the intermediate and long-term(45) and that methylcobalamin (vitamin B 12) plus conservative treatment improves walking distance in the intermediate and long-term compared with conservative treatment alone (44).

## Rehabilitation Therapy and Multi-modal Treatment

We identified 8 new studies evaluating 13 rehabilitation therapy and/or multimodal treatment approaches, with one study being compared to surgery.

There is moderate quality evidence from 1 trial (31) (N=259) that manual therapy and exercise provides superior and clinically important short-term improvement in symptoms and function compared to medical care or community-based group exercise and that community-based group exercise improves physical activity in the short-term compared to medical care. There were no reported serious adverse events in any group. There was a significantly greater rate of transient joint soreness associated with the manual therapy and exercise group (49%) compared with the community-based group exercise (31%) and medical care (6%) groups.

 Another trial provides moderate quality evidence (27) (N=104) that comprehensive care (manual therapy, education and exercise delivered using a cognitive-behavioural approach) demonstrates superior and clinically important improvements in walking distance in the immediate, short, intermediate, and long-term and compared to self-directed home exercise. This study also provides low-quality evidence that comprehensive care improves overall pain and function in the long-term compared to self-directed home exercises. At 12 months, none of the 43 participants in the comprehensive group and 2 of the 46 participants in the self-directed group experienced adverse events. These adverse events were mostly attributed to a temporary increase in low back and/or leg pain.

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There is low-quality evidence from 1 trial (28) (N=34) that a form of manual therapy (Mokuri Chuna), acupuncture and physician
care, with or without a herbal remedy ( Gang-Chuk Tang), improves low back pain in the intermediate term compared to oral
aceclofenac, epidural steroids and physical therapy (heat and TENS).
A single study assessing supervised physical therapy (manual therapy, exercise, and body weight-supported treadmill) (30) (N= 86

- provides low-quality evidence for improved symptoms, function and walking distance in the short-term compared to home exercises.
- There is very low-quality evidence from 1 study (14) (N=120) that heat, TENS and home exercise instruction is no better than isokinetic exercise in the immediate, short and intermediate term for all outcomes and less effective than unloaded exercises in the immediate and short-term. Unloaded exercise was also found to be superior to isokinetic exercise in the immediate and short-term.
  - One small single study (26) (N=47) provides very low-quality evidence that aquatic exercise is more effective than physical therapy (exercise, ultrasound, heat and TENS) in improving pain and walking distance in the immediate term.
  - Another small single trial (29) (N=40) provides very low-quality evidence that a pre-surgical exercise program improves post-surgical outcomes in the immediate, but not in the short or intermediate terms.

- 2 There is low-quality evidence from 1 study (25) (N=169) that a structured physical therapy program (education and exercises)
- 3 provides similar outcomes to decompression surgery in the long-term (2 years follow-up). Nine out of 82 participants receiving
- 4 physical therapy reported adverse events consisting of worsening of symptoms whereas 33 out 87 participants reported surgery related
- 5 complications, mainly attributable to reoperation, delay in wound healing and surgical site infection.
- 7 Our original review identified 9 rehabilitation therapy/multi-modal trials of which 5 were compared to surgical interventions. A meta-
- 8 analysis was conducted for 2 of the surgical trials. Two of the original surgical trials have since published 8-year follow-up results (see
- 9 below). All studies provide either low or very low-quality evidence.
- A meta-analysis (8, 9) that includes 2 trials (22) (19) shows that laminectomy improves outcomes only at the 2 year follow-up
- compared to conservative care. One of these studies shows no difference in outcomes after an 8-year follow-up (58).
- An interspinous surgical implant (17, 59, 60) was found to be superior to multi-modal treatment (epidural injections, pain medication,
- education, exercise, back brace, heat/ice, and massage). Another trial (16) provided inconclusive evidence when comparing
- laminectomy with or without fusion to lumbar orthosis and education.

- 1 Among patients with degenerative spondylolisthesis, 1 study (21) shows no difference in outcomes with laminectomy when compared
- 2 to conservative care including after an 8-year follow-up (61).
- 3 One study showed that exercise plus ultrasound is no better than exercise plus sham ultrasound but better than no treatment, and
- 4 exercise plus sham ultrasound is better than no treatment (24). Other studies demonstrated that in-patient physical therapy (ultrasound,
- 5 heat and TENS) is more effective than home exercise plus oral diclofenac (23), unweighted treadmill walking plus exercise is no
- 6 better than cycling plus exercise (20), and manual therapy, exercise and unweighted treadmill is more effective than flexion exercises,
- 7 walking and sham ultrasound (18).

## **Epidural Injections**

- We identified 6 new studies evaluating epidural injections. There is moderate quality evidence from 1 study (37, 62) (N=400) that
- glucocorticoid plus lidocaine injection is better than lidocaine alone in improving pain and function at 3 weeks (short-term) but not at
- 6-weeks (short-term), 12 weeks (intermediate-term) or 12 months (long-term). The improved outcomes at 3 weeks were statistically
- significant but not considered to be of clinical importance (63). A follow-up subgroup analysis (64) using patient-prioritized Roland-
- Morris Disability Questionnaire (RMDQ) items, did not change the results. A total 21.5% of patients in the glucocorticoid-lidocaine
- group and 15.5% in the lidocaine alone group reported one or more adverse events (p=0.08). Adverse events included headaches,
- 16 fever, infection, dizziness, cardiovascular/lung problems, leg swelling and dural puncture.

- A small study (36) (N=29) provided very low-quality evidence that an injection of lidocaine is no better than a saline injection for all outcomes in the short-term.
- 4 There is very low-quality evidence from 1 study (38) (N=57) that steroid injections at the level of maximal stenosis improve pain and
- 5 function in the immediate and short-term compared to steroid injections at 2 levels cephalad to the maximum level of stenosis.
- 7 A small trial (40) (N=54) provided very low-quality evidence that steroid injections are no better than steroid injections combined
- 8 with physical therapy (manual therapy and exercise) in improving pain or function in the short-term but are more effective in
- 9 improving pain in the intermediate and long-term.
- 11 There is very low-quality evidence from 1 study (41) (N=67) that interlaminar steroid injection improves pain and walking distance in
- the intermediate but not in the short-term compared to transforaminal steroid injection.
- A 3-arm trial (42) (N=30) provided low-quality evidence that TNF alpha inhibitor (Etanercept) injections improved pain and function
- in the immediate, short and intermediate term compared to steroid or lidocaine injections and that steroid injections were no better
- than lidocaine for all outcomes and follow-up periods.

- 1 There is very low-quality evidence from 1 small trial (35) (N=38) that minimally invasive lumbar decompression surgery (MILD) is
- 2 no better than epidural steroid injections for all outcomes in the short-term.
- 4 One small trial (39) (N=44) provided very low-quality evidence that an epidural inflatable balloon catheter (ZiNeu) improves pain and
- 5 function in the intermediate term but not the short-term compared to a balloon-less catheter (Racz). Minor and transient adverse events
- 6 were reported equally in both groups (no data provided), mostly pain and paresthesia at the injection site.
- 8 Our original review identified 4 trials evaluating 7 epidural injection approaches, all with very low-quality evidence for all outcomes.
- 9 Two trials demonstrated that translaminar (32) or caudal (33) steroid injections were no better than placebo. Two other trials showed
- that translaminar epidural steroid plus a block was better than placebo or an epidural block alone (34), that translaminar epidural block
- was better than placebo (34), and that interlaminar epidural steroid plus a block was better than home exercise plus diclofenac or in-
- patient physical therapy (ultrasound, heat and TENS) (23).

### Acupuncture

- We identified 2 new studies assessing acupuncture. There is low quality evidence from 1 trial (56) (N=80) that acupuncture improves
- back and leg pain, symptoms and function in the immediate, short, and intermediate term compared to sham acupuncture. Three out of
- 40 participants in the acupuncture group reported short-term pain at the insertion site (1 also had a hematoma) and 5 out of the 40

- 1 participants in the sham group reported non-serious back pain or fatigue. There is very low-quality evidence from a small trial (55)
- 2 (N=50) that acupuncture plus usual care is no better than usual care alone in the short-term for all outcomes.

4 Spinal Manipulation

- We identified 1 study assessing spinal manipulation. There is very low-quality evidence from a very small trial (57) (N=14) that spinal
- 6 manipulation alone is no better than a wait list control in the immediate term for all outcomes

DISCUSSION

- We updated our systematic review on nonoperative treatments for LSS causing neurogenic claudication and identified 23 new trials
- that were added to the previous 21 studies. The highest number of studies, 17/44, evaluated rehabilitation therapy/multimodal
- treatment, 11 assessed epidural interventions, 7 oral medications, 6 calcitonin, 2 evaluated acupuncture and 1 assessed spinal
- manipulation. Of the 60 comparisons that were evaluated, 5 comparisons from 3 trials (27, 31, 37) provided moderate quality
- evidence. The remaining comparisons provide either low or very low-quality evidence. In our original review, all comparisons for all
- the interventions assessed were of low or very low-quality evidence. This lack of moderate or high-quality evidence limited our ability
- to make conclusions on the effectiveness of most nonoperative treatments.

 There is now moderate evidence that a multimodal structured 6-week program consisting of manual therapy and exercise with or without education is an effective treatment approach (27, 31) for neurogenic claudication and that epidural steroid injections do not provide clinically important improvements in short or long-term outcomes compared to epidural lidocaine injections. However, given that these respective findings came from single studies, this evidence lacks consistency and therefore there is a possibility that replicating these trials in the future might result in substantially different conclusions. However, a recent clinical practice guideline for the management of LSS leading to neurogenic claudication concurred with our findings and recommended, based on moderate quality evidence, multimodal care consisting of education with home exercises and manual therapy (65). These guidelines also recommended against the use of epidural steroid injections, based on high quality evidence. A recent systematic review and meta-analysis of RCTs evaluating conservative nonpharmacological therapies for degenerative LSS also concluded, based on low to moderate evidence, that manual therapy and supervised exercises significantly improves outcomes compared to self-directed or group exercises (66). A recent clinical update published in the British Medical Journal recommended supervised exercise and manual therapy as a first line treatment for LSS and recommended against the use of epidural steroid injections (67). More dated systematic reviews did not recommend a combination of education, exercise, manual therapy as an effective treatment for LSS (7, 68, 69). However, these reviews did not include the more recent higher quality trials (27, 31) evaluating this multimodal approach.

A multimodal approach to the treatment of LSS would appear to be a rational approach given the complexity of neurogenic claudication with underlying physical, functional, and psychosocial factors impacting recovery (70). There is also a plausible rationale

- 1 for the lack of effectiveness of epidural steroid injections for neurogenic claudication since the dominant underlying
- 2 pathophysiological mechanism appears to be neuro-ischemia rather than neuro-inflammation (4).
- 4 Although we cannot make firm conclusions about the effectiveness of nonoperative treatments for neurogenic claudication, this
- 5 review is important because it provides important information regarding the state of current evidence regarding nonoperative
- 6 treatments. This can be used to inform clinical practice guidelines and aid clinicians and patients in making clinical decisions
- 7 regarding treatment options. This is particularly important with respect to interventions that have higher risks and costs such as
- 8 epidural injections and surgery. About 25% of all epidural injections are performed for LSS (71, 72) yet the evidence from our current
- 9 review and those of others (73-75) do not support their use. The number and associated costs of surgical procedures for degenerative
- LSS is growing, especially decompression surgery with complex fusion (76, 77). LSS continues to be the most common reason for
- spine surgery in older adults (6, 76). High quality evidence for the effectiveness of surgery is also lacking based on our current review
- and the findings of other systematic reviews (78, 79). Clinical trials evaluating surgery for LSS are difficult to conduct due to
- challenges in recruitment and blinding (patient and practitioner) and high costs (80). One ongoing clinical trial is comparing
- decompression surgery with sham surgery which should help to evaluate the potential role of the placebo effect of surgery for LSS
- (81).

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pain (86).

 Oral medication is often the first line treatment in primary care management of LSS (5). Pregabalin and gabapentin are commonly prescribed medications for LSS despite the growing evidence that these medications are not effective for back-related leg symptoms and may cause more harm than good (82-84).

New to this updated review are clinical trials on acupuncture and spinal manipulation, however, the quality of the evidence was insufficient to make conclusions on their effectiveness. A systematic review and meta-analysis of RCTs and controlled clinical trials published in Chinese, found no conclusive evidence for the effectiveness and safety of acupuncture for LSS (85). Passive unimodal treatments such as acupuncture and spinal manipulation are unlikely to provide long-term benefit but more likely to provide benefit when combined with a comprehensive approach to managing LSS (27), not unlike recommendations for managing chronic low back

This review is also important because it provides a comprehensive assessment and identification of significant knowledge gaps in this area to guide future research. This includes the need for higher quality studies that assess commonly used nonoperative treatments particularly in primary care settings, that are adequately powered and have low risk of bias and long-term follow-up. Future RCTs should follow the CONSORT guideline (87) when planning trials and reporting study findings in an attempt to improve transparency and reduce bias.

 The strengths of this review include the evaluation of a wide range of nonoperative interventions and the use of consistent inclusion and exclusion criteria for neurogenic claudication, which included the corroboration of a diagnosis of LSS with imaging. The use of these criteria to define the study population increases the likelihood that participants in the included studies had the diagnosis of neurogenic claudication due to narrowing of the central canal or lateral foraminae (88-90). Other strengths of this review include the use of rigorous methods recommended by The Cochrane Collaboration, the World Health Organization, and the Cochrane Back and Neck Pain Review Group.(13) This included the use of the GRADE method to synthesize and summarize the quality of the evidence. Limitations of this review include the potential for language bias because only English articles were accepted. We also included studies with small samples sizes which are more prone to high risk of bias (91). Over half of the included studies had less than 30 subjects per arm at baseline, and none of these studies could be pooled because of high heterogeneity across studies. However, the exclusion of studies with small samples sizes in this review would not have changed our conclusions. The definition of a severe flaw and the criteria used to assess risk of bias (low vs. high) were arbitrary, therefore alternative definitions and criteria could have impacted the findings and conclusions of this review. The validity of MCIDs used in this review is unknown. Although most were derived from studies with neurogenic claudication (63, 92, 93) others were based on an arbitrary improvement of at least 30% (94). There are no agreed upon MCIDs in LSS and therefore different MCIDs thresholds could have potentially altered our conclusions. The location and severity of the stenosis on imaging was not deemed important in this review. Imaging findings often do not correlate with patient symptoms or severity and therefore imaging by itself is a not reliable diagnostic tool in this population (67, 95, 96). Neurogenic claudication is the clinical entity of interest in this review and, although usually caused by LSS, the diagnosis is made

clinically without imaging (97). Neurogenic claudication symptoms, by definitions improve with flexion, due to the increased volume around the involved nerve roots irrespective of where the stenosis is located (e.g., centrally or at the lateral recess). However, it is uncertain whether the effectiveness of some interventions, such as epidural steroid injections is dependent on location of the spinal stenosis. This is a different research question requiring future research.

CONCLUSIONS

- 7 There is moderate quality evidence that a multimodal approach that includes manual therapy and exercise, with or without education is
- 8 a safe and effective treatment, and that epidural steroids are not effective for the management of LSS causing neurogenic claudication.
- 9 All other studies evaluating nonoperative interventions provided insufficient quality evidence, limiting the ability to make conclusions
- about their effectiveness. With the growing prevalence and significant personal, social, and economic burden of LSS, more high-
- quality evidence for nonoperative interventions is urgently needed to guide clinical practice.

CONTRIBUTORSHIP STATEMENT

- 15 CA was involved in the conception and design of the study, screening of articles, risk of bias assessment, Grade analysis, writing the
- 16 first draft of the manuscript, revision of the manuscript and administrative support. AB, MS, AF, CC, JO were involved in screening

- of articles, risk of bias assessment, Grade analysis and critical revision of the manuscript. CH, JP, AA, KS, JY, AA participated in
- 2 screening of articles, risk of bias assessment, data extraction and critical revision of the manuscript.

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- 11 The remaining authors CH, JP, AB, MS, AF, KS, AA, AA2 and JO declare no funding disclosures.

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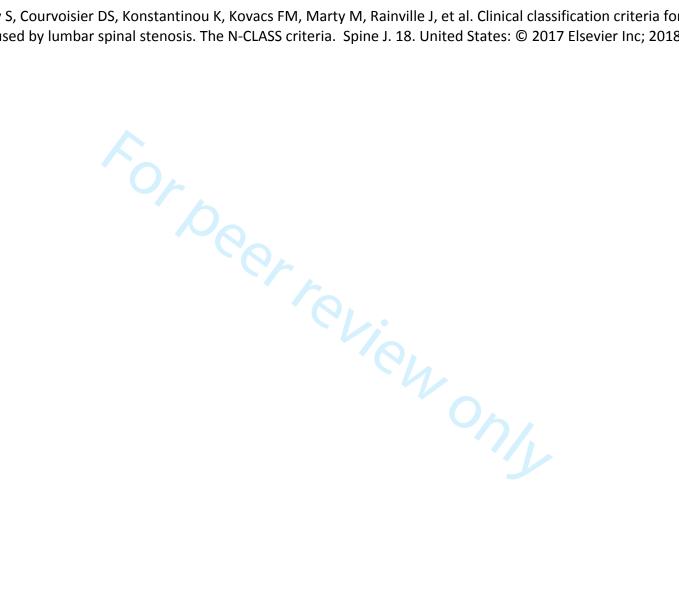
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Figure Legend

For peer teview only Figure 1. Study Flow Diagram



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- 7 Supplemental Table 1. Characteristics of Included Studies
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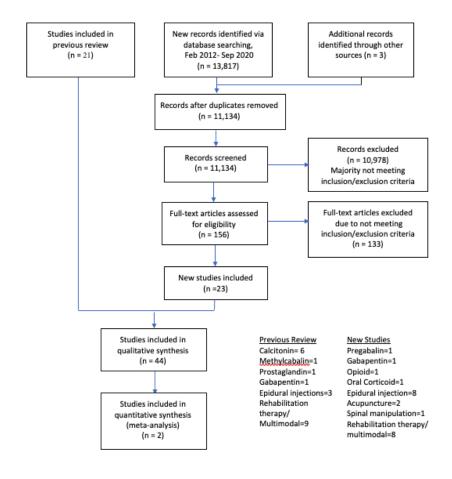


Figure 1. Study Flow Diagram

Figure 1. Study Flow Diagram

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# Supplemental Table 1. Characteristics of included studies

Study	Participants and Settings	Interventions	Outcomes/Follow-	Results (Group 1 is reference group)
	Settings		up Calcitonin	(Group 1 is reference group)
Eskola 1992	39 subjects with an average of 6 years of pain, average age of 56.6 years of age, 20 males and 19 females.  Setting: Orthopaedic hospital in Finland.	1) 100IU Calcitonin injection every other day for 4 weeks (n=20)  2) Placebo treatment (Miacalcic Sandoz 100IU) every other day for 4 weeks (n=19)	1) VAS 2) Treadmill test 3) Coping with ADLs 4) Digitest Ergojump 5) Blood tests  Follow-up: 1, 3, 4, 6 and 12 months	Between group WMD and 95% CI Pain (VAS) (mm): -0.050 (-0.053 to -0.047) Walking distance (meters): -18.5 (-240.37 to 203.37)  Adverse events: The calcitonin injection group reported minor nausea and rash in 89% of the subjects.
Podichetty 2004	55 subjects with an average age of 68.5 years and an average of 36.2 weeks of the condition in the intervention group and 29.8 weeks in the placebo group, 33 males and 22 females.  Setting: Spinal center in the United States	<ol> <li>400 IU intranasal calcitonin daily for 6 weeks followed by open label 6-week extension (n=36)</li> <li>Placebo nasal spray daily for 6 weeks, followed by open label 6-week extension, during which all patients received 400IU calcitonin (n=19)</li> </ol>	VAS     Walking     capacity     ODI     Stenosis     specific     questionnaire     Satisfaction     with pain     levels,     functional     status, and     treatment     received     SF-36     Symptom     diary  Follow-up: 12     weeks	Between group MD, 95% CI, p values 12 weeks: Pain VAS (mm): 0.5 (-0.85 to 1.93): p=0.44, Walking time (seconds): 42.2 (-86.9 to 170.4): p=0.51 Walking distance (feet): 163.3 (-311.16 to637.84); p=0. 0.49 SF-36 MCS: -4.22 (-10.41 to1.97) ; p=0.18 SF-36 PCS: 0.43 (-3.73 to 4.59); p= 0.84
Porter	41 subjects with	1) 100 IU salmon calcitonin injection	Walking chart	Insufficient data provided to calculate mean difference in

1983	10 in a double blind RCT crossover, 37 males and 4 females with mean age of 55.4 years.  Setting: Infirmary in England	four times per week, sometimes with Maxalon for nausea (n=5)  2) Matching placebo (n=5)  Only responders randomized	and ability to walk more than 1 mile 2) ODI  Follow-up: 10 weeks	walking distance or ODI among the 10 patients enrolled in RCT.  Adverse events: The calcitonin injection group reported minor nausea and rash in 40% of the subjects.
Porter 1988	42 subjects, 35 male, 7 female, average age of 53.6 years in 20 subjects and 56.7 years in 22 subjects, median duration of back pain reported was 11 years for 19 subjects, and 14 years for 22 subjects. Median duration of claudication was 1.25 years for 20 subjects and 4.5 years for 22 subjects.  Setting: Infirmary in England	1) 100 IU of salmon calcitonin injected subcutaneously 4 times per week for 8 weeks (n=20)  2) 1 ml of saline injected 4 times per week for 8 weeks (n=22)	1) VAS 2) Claudication threshold 3) 3 level mobility assessment 4) Analgesic requirements 5) 3 level sleep disturbance 6) Treatment success defined as 100% improvement in walking distance and able to walk 800 m.  Follow-up: 4 and 8 weeks	Difference in median score from baseline between groups Pain score (VAS) (mm):  4 weeks: -9  8 weeks: -5.5  Walking distance until symptoms onset (meters):  4 weeks: -14  8 weeks: 42  Walking distance until pain prevents walking (meters):  4 weeks: -41  8 weeks: -99  No significant between group differences. No p values or 95% CI provided.
Sahin 2009	45 subjects 31 males and 14 females, average	1) 200 IU intranasal calcitonin daily for 8 weeks (n=23)	1) VAS 2) Walking capacity	Percent change between groups: 8 weeks: VAS at rest: 4.7%, p>0.05

ages of 57.65 Up to 1500mg of paracetamol daily 3) **RMDI VAS with motion:** -7.9%, P>0.05 for 8 weeks (n=22) years in 4) Ranges of **Roland Morris**: 8.2%, p>0.05 calcitonin group motion Walking distance: -15.4%, p>0.05 and 54.45 years Both groups took part in a physical in paracetamol therapy and exercise program 5 times per Follow-up: 8 week for 15 sessions. weeks group. **Setting:** Physical and Rehabilitation Medicine Department in Turkey 40 subjects, 30 VAS Placebo nasal spray NaCl for 4 4 weeks: Between group MD 95% CI **Tafazal** 1) 2007 males, 10 weeks (n=20)Shuttle **ODI:** -0.7 (1.7 to -3.5) **LBOS**: -3.0 (-0.6 to -4.7) females, average walking test of 67 years in the 2) 200 IU nasal salmon calcitonin for 4 3) 4-point **VAS leg (mm):** -10 (-4.0 to -13) intervention weeks (n=20)**VAS back (mm)**: -6.0 (-6 to -12) subjective Shuttle walk distance (m): -13 (-7 to -35) group and 70.2 outcome of years in the overall placebo group, assessment 16 weeks: between group MD, p values **ODI**: 0.1, p=0.44; average of 38.7 (excellent, **LBOS**: 0.7, p=0.93; months with good, fair, **VAS leg (mm):** -4, p=0.66; symptoms in the poor) calcitonin group 4) ODI **VAS back (mm):** 16, p=0.03; Shuttle walking distance (m): -11, p=0.39 and 30.9 months 5) Modified in the placebo Somatic group. Perception Questionnaire **Setting:** 6) Modified University Zung hospital in Depression England Score Follow-up: Baseline, 4, 10, 16 weeks

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			Ora	l Me	dication	
Matsudaira	79 subjects, 24	1)	Oral prostaglandin E1 derivative (15	1)	SF-36	SF-36 subscales MD, p values
2009	males and 24		g Limaprost) 3 times daily for 8	2)	1	8 weeks: <b>physical function:</b> 9.4, p=0.01, <b>role physical:</b> 13.7,
	females, with an		weeks (n=39)		rating scales	p=0.03, bodily pain: 15.5, p<0.01: General health: 6.6,
	average age of			3)	Walking	p=0.08; vitality: 11.3, p=0.02; social functioning: 8.0, p=0.17;
	69.6 years in the	2)	400 mg of etodolac (NSAID) twice		distance	role emotional: 10.2, p=0.07; mental health: 12.2, p<0.01.
	Limaprost group		daily for 8 weeks (n=40)		LBP severity	
	and 72.2 in the			5)	Leg pain	<b>Secondary outcomes</b> not provided in a way that MD can be
	Etodolac group.	4			severity	extracted:
				6)	Leg numbness	8 weeks: low back pain: p=0.77; leg pain p=0.08; Leg
	<b>Setting:</b>				severity	numbness: p<0.01; walking distance p<0.01; patient
	Orthopaedic			7)	Treatment	subjective improvement p<0.01; patient satisfaction p<0.01
	surgery in a				satisfaction	all in favor of limaprost
	medical faculty					
	in Japan				llow-up: 8	Adverse events: 5% of subjects in both groups reported
				we	eks	gastrointestinal upset.
Waikakul	152 subjects, 68	1)	8	1)	Presence of	Walking distance
2000	males and 84		education, activity modification,		pain on spinal	Percent able to walk > 1000 meters
	females with an		exercise and physical therapy.		motion	6 mo: 71.3% vs. 88.6%, p< 0.05
	average age of		NSAIDs, muscle relaxants, and	2)	Claudication	12 mo: 81.3% vs. 97.1%, p < 0.05
	66.8 years. 44 of		analgesics as necessary. Vitamin B1,		distance	18mo: 83.8% vs. 97.1% p < 0.05
	the subjects had		B6, and B12 3 times per day (n=82)	3)	Medication	
	symptoms for				intake	
	less than one	2)	1		(NSAIDs,	Adverse events: There were no reported adverse effects in
	month, 98 had		Methlcobalin ESAI, 1.5mg per day		muscle	subjects in methylocabalin group
	symptoms for		in 3 divided doses after meals for 6		relaxants, and	
	more than one		months (n=70)		steroids)	
	month.					
					llow-up: every	
	Setting: Hospital			mo	onth for two	
	in Thailand			yea		
Yaksi	55 subjects, 22	1)		1)	VAS – low	Between group difference, p values
2007	males, 33		increased weekly by 300 mg to a		back and leg	Pain (VAS) (mm) no raw data
	females, average		maximum of 2400 mg (n=28)		pain during	$3^{\text{rd}}$ mo 3.4 vs. 1.9, p =0.039
	age of 50.8 years.				movement	4 <sup>th</sup> mo 4.1 vs.2.0, p =0.006
		2)	Placebo (n=27)	2)	Walking	
	<b>Setting:</b> Hospital				distance	Walking Ability, no raw data

	department of physical medicine and rehabilitation in Turkey	Both groups received physical therapy exercises, a lumbosacral corset with steel bracing and NSAID treatments	3) Presence or absence of motor and/or sensory deficits  Follow-up: 15 days, 1, 2, 3, 4 months	Grp 1: longer walking distance at end of 2 <sup>nd</sup> mo (p < 0.05), 3 <sup>rd</sup> mo (p <0.05) and 4 <sup>th</sup> mo (p <0.005)  Adverse events: some subjects randomized to the gabapentin group (no data specified) experienced mild to moderate drowsiness and/or dizziness.
Markman 2015	29 participants, 20 males, 9 females, Eligible subjects were older than 50 years (mean 70 .1 years) with at least one level of radiographically confirmed lumbar spinal stenosis and symptoms of neurogenic claudication for at least 3 months.  Setting: Hospital in Rochester, New York	1) Pregabalin group (n=14)  2) Active placebo (Diphenhydramine) (n=15)  Cross over study after 7 day wash out period.  Pregabalin was started at 75 mg PO twice daily or diphenhydramine, 6.25 mg) and increased on day 4 to 150 mg PO twice daily (12.5 mg diphenhydramine) for 7 days. Pregabalin was decreased to 75 mg PO twice daily (6.25 mg diphenhydramine) on day 11 for 3 days of tapering.	1) NRS - time to first moderate pain symptom during a 15-minute treadmill test (Tfirst) (NRS - greater than 4)  Follow-up: day 10 of intervention period	Between group MD, 95% CI, p values Treadmill testing pain at rest (NRS) 0.29 (0.41 to 0.98): p=0.40 Treadmill testing final pain (NRS) 0.25 (-0.44 to 0.94): p=0.46 Treadmill testing distance walked (m) -24.06 (-75.63 to 27.52): p=0.35 Treadmill testing recovery time (min) -0.79 (-1.86 to 0.28): p=0.14 Treadmill testing patient global assessment of pain -0.08 (-0.45 to 0.29): p=0.67 Treadmill testing RMDQ 1.50 (0.38 to 2.62): p=0.01  Adverse events: Complications were reported in 64% of subjects in group 1, the most common being dizziness, compared to 35% in group 2.
Park 2017	45 subjects, 21 in GPN Group (17 female, 4 males, mean age 66.1± 10.5), and 24 in BTX group (15 female and 9 males, mean age	Conservative treatments plus gabapentin (group GPN):     Gabapentin 300 to 1200mg/d - titrated to patient characteristics, comorbidities, and reported side effects (n=21)      Conservative treatments plus BTX	3) NRS - back/leg pain intensity 4) Cramp frequency (no./wk) 5) Cramp severity (0-4	No statistically significant difference between groups and lack of reporting of quantitative data  Adverse events: Five patients (20.8%) in group 2 reported mild to moderate pain at injection sites for a few days.

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	Setting: Outpatient department for interventional pain management in Korea	injection (group BTX): The BTX (botulinum toxin type A [Nabota]) dose was 100U in 5mL of 0.9% saline injected into the gastrocnemius medialis and lateralis. (n=24)  Conservative treatments: education, exercise, analgesic medication, injection therapy including epidural injections, and physical therapy	criteria) 6) Insomnia severity – (ISI 0-28) 7) ODI 8) Patient global impression of change  Follow-up: 2 weeks, 1 and 3 months.	
Markman 2015 - 2	24 participants, 12 males and 12 females, (mean age 72 years) LSS by imaging with symptoms of neurogenic claudication  Setting: Translational Pain Research Center at a University in Rochester, New York	<ol> <li>Oxymorphone hydrochloride (Opana IR, 5 mg) (n=8)</li> <li>Propoxyphene/acetaminophen (Darvocet, 100 mg/650 mg) (n=8)</li> <li>Placebo: 3 separate visits (random order with at least 3 day washout periods) (n=8)</li> </ol>	1) NRS (at rest) 2) NRS (final pain rating) 3) AUC 4) 4) Distance walked (m) 5) Recovery time (min) 6) ZCQ 7) Patient global assessment of pain 8) RMDQ 9) ODI  Follow-up: Study was prematurely terminated	Between group MD, 95% CI, p values  Treadmill testing pain at rest (NRS)  Grp 1 vs Grp 3: -0.04 (-0.72 to 0.65): p-0.89  Grp 2 vs Grp 3: -0.27 (-0.95 to 0.41): p=0.32  Grp 1 vs Grp 2: 0.23 (-0.45 to 0.92): p=0.40  Treadmill testing final pain (NRS)  Grp 1 vs Grp 3: 0.2 (-0.74 to 1.14): p=0.60  Grp 2 vs Grp 3: 0.53 (-0.40 to 1.46): p=0.16  Grp 1 vs Grp 2: -0.33 (-1.26 to 0.61): p=0.39  Treadmill testing distance walked (m)  Grp 1 vs Grp 3: -12.41 (-63.01 to 38.20): p=0.54  Grp 2 vs Grp 3: -23.41 (-73.60 to 26.79): p=0.25  Grp 1 vs Grp 2: 11 (-39.53 to 61.54): p=0.59  SSSQ symptom severity score  Grp 1 vs Grp 3: -0.03 (-0.19 to 0.13): p=0.61  Grp 2 vs Grp 3: 0.01 (-0.15 to 0.17): p=0.85  Grp 1 vs Grp 2: -0.04 (-0.20 to 0.11): p=0.49  SSSQ physical function score  Grp 1 vs Grp 3: 0.04 (-0.16 to 0.09): p=0.47  Grp 2 vs Grp 3: 0.11 (-0.01 to 0.23): p=0.03  Grp 1 vs Grp 2: -0.15 (-0.27 to -0.02): p=0.01  Patient global assessment of pain  Grp 1 vs Grp 3: -0.03 (-0.52 to 0.47): p=0.90  Grp 2 vs Grp 3: 0.13 (-0.36 to 0.61): p=0.52

Rodrigues 2014	61 patients with lumbar canal stenosis (50–75 years; canal area < 100 mm <sup>2</sup> at L3/L4, L4/L5,	1)	mg/kg of oral corticoids daily, with a dose reduction of one-third per week for 3 weeks (n=31)	1) 2) 3) 4) 5)	6-min walk test VAS	Grp 1 vs Grp 2: -0.15 (-0.64 to 0.34): p=0.44  The study was prematurely terminated because of the removal of propoxyphene/acetaminophen from the US market.  Between group comparison VAS (6 weeks) Corticoid vs Placebo: 1.53 p=0.02 (in favour of placebo)
	and/or L5/S1on MRI; and claudication within 100 m). 31 in the corticoid group (mean age 58.23 (6.38), and 30 in the placebo group (mean age 58.33 (6.19)) Setting: Hospital in São Paulo,		placebo for the same period (n=30)	Fol and	llow-up: 3, 6 112 weeks	
	Brazil		Rehabilitation The	rans	and Multimode	l Care
Goren 2010	45 subjects, 13 males, 32 females, average ages in groups of 57.4, 49.13, and 53.06. 7 subjects	1)	Stretching and strengthening exercises for lumbar, abdominal, leg muscles as well as low intensity cycling exercises were given as therapeutic exercises.  Ultrasound was applied with 1mHz, 1.5W/cm2 intensity, in continuous	1) 2)	VAS (out of 10) Treadmill test at 3 km/h for maximum of 15 minutes or	Pain (VAS) (mm) within group MD  3 weeks: Grp 1: -2.2 for back pain; -1.47 for leg pain Grp 2: -1.94 for back pain; -2.47 for leg pain Grp 3: 0.40 for back pain; 0.54 for leg pain
	with pain duration of 3-6 months, 7 with pain duration of 6-12 months, and	2)	mode on the back muscle for 10 minutes (n=17)  Same as group 1 with Ultrasound on off- mode (n=17)	4)	750m. ODI Analgesic consumption Physiatrist	Between groups differences Leg pain: Grp 1> Grp 3 (p<0.01), Grp 2> Grp 3 (p<0.01)  Walking Ability (within group MD) 3 weeks: Grp 1: 94.30 seconds

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	31 with pain		assessment	Grp 2: 114.94 seconds
	duration of	3) No exercise-no treatment (n=16)		Grp 3: -66.10 seconds
	greater than 12		Follow-up: End of	No significant change between groups
	months.		3-week treatment	
			period only	Disability (ODI) (within group MD)
	Setting:			3 weeks:
	Rehabilitation			Grp 1: -3.94
	center in Turkey			Grp 2: -7.8
				Grp 3: -3.6
				ODI between groups differences
		<b>/ /</b>		Grp 1> Grp 3 (p<0.05), Grp 2> Grp 3 (p<0.05)
Koc	29 subjects, 21	1) Conservative inpatient physical	1) VAS	No raw data provided.
2009	male, 8 female,	therapy program 5 days a week for 2	2) Treadmill	No significant between group differences for all outcomes and
2009	average ages of	weeks. PT included applications of	walk test	follow-ups except:
	62.6, 61.1, and	ultrasound 1.5 W/cm2 for 10min, hot	3) Nottingham	Tollow ups except.
	53.1 years in the	pack for 20min, and TENS for 20min	Health Profile	Pain (VAS)
	three groups,	to the lumbar region (n=13)	4) RMDI	2 weeks: Grp 2 less pain than Grp 3 p= 0.008
	average pain	to the fullibal region (n=13)	5) Functional	2 weeks. Grp 2 less pain than Grp 3 p= 0.008
	duration of 5.7	2) Lumbar epidural steroid injections,	testing	Disability (RMDI)
		10 ml of solution containing 60mg of		
	years, 5.0 years,		including	2 weeks: Grp 2 less disability than Grp 3 p= 0.007
	and 5.7 years in	triamcinolon acetonide (1.5 mL), 15	finger to floor	
	the three groups.	mg of 0.5% bupivacain hydrochloride	distance, sit-	
	0 44 34 1 1	(3 mL), and 5.5 mL of physiologic	to-stand, and a	Quality of Life (Nottingham Health Profile) (no data
	Setting: Medical	saline (0.9%NaCl) was injected in	weight	provided)
	school	3.5minutes. (n=10)	carrying test	Grp 2 had significantly higher improvement than Grp 3 at 2
	department of			weeks in mobility subgroup scores.
	physical	3) Control group (n=10)	Follow-up: 2	
	medicine and		weeks, 1, 3 and 6	Adverse events: 1 subject reported angina pectoralis and 1
	rehabilitation in	All patients included were trained to	months	reported gastric complaints (group not specified).
	Turkey	pursue a home-based therapeutic exercise		
		program performed twice daily for a		
		period of 6 months, and oral diclofenac		
		sodium 75mg was administered to all		
		patients twice daily for 2 weeks		
Pua	68 subjects, 35	1) Unweighted treadmill training:	1) VAS for pain	Pain (VAS) (mm) MD and 95% CI
2007	males, 33	Weeks 1 and 2, participants walked	over past	6 weeks: 2 (-5 to 10)

	1					T
	females, average		with a relatively pain-free gait which		week	Disability (ODI), OR, 95% CI
	age of 58 years,		translated to 30–40% of body	2)	Patient	6 weeks: OR 1.10 (0.41 to 2.98)
	12 week median		weight. In weeks 3 to 6, participants		perceived	Patient perceived benefit, OR, 95% CI
	pain duration		were encouraged to walk at a		benefit on a 6-	6 weeks: OR 0.50 (0.17 to 1.48)
			moderate intensity. The duration of		point scale	Walking ability (≥800 m), OR, 95% CI
	Setting: Hospital		each treadmill session was limited by	3)	ODI	6 weeks: OR 1.14 (0.44 to 2.94)
	in Singapore		participant tolerance or to a	4)	RMDI	`
			maximum of 30 minutes. 2x per	5)	Walking	
		4	week for 6 weeks = 12 sessions		ability	Adverse events: 1 subject in treadmill group reported increase
			(n=33)			in pain.
				Fol	llow-up: 3 and	III PWIII
		2)	Cycling on upright bicycle: During		veeks	
		2)	weeks 1 and 2, participants cycled at	0 1	CCRS	
			their comfortable pace at 50 to 60			
			rpm. Participants were instructed to			
			assume a flexed posture. In weeks 3			
			to 6, participants were encouraged to			
			exercise at a moderate intensity and			
			the duration of each cycling session			
			was limited by participant tolerance			
			or to a maximum of 30 minutes. 2x			
			per week for 6 weeks for 12 sessions			
			(n=35)			<b>&gt;</b>
Whitman	58 subjects, 31	1)	Flexion Exercise and Walking	1)	Global Rating	Patient Global Assessment (somewhat better or greater)
2006	males, 27 female,		Group: 45-60 minutes twice per		of Change	6 weeks: 41% vs. 79% p<0.01
	29 (group 1) with		week for 6 weeks. Lumbar flexion		(15-point	1 year: 21% vs. 38% p>0.05
	an average age of		exercises along with self-pace		scale)	
	70 years, 29		treadmill walking program, and sub-	2)	NPRS for	Number needed to treat for benefit for perceived recovery
	(group 2) with an		therapeutic ultrasound. The duration		lower limb	and 95% CI
	average age of		of each treadmill session was based	3)	Walking	6 weeks: 2.6 (1.8 to 7.8)
	68.9, median low		on that patient's tolerance on that		Tolerance test	1 year: 4.8 (-2.3 to 21.3)
	back pain		specific day and could extend up to	4)	ODI	long term: 4.4 (- 2.1 to 22.7)
	duration of 108		45 minutes. (n=29)	5)	Medication	
	months in Group		,		consumption	Pain (NPRS lower extremity)
	1's 29 subjects	2)	Manual Therapy, Exercise and	6)	•	Within group MD, 95% CI
	and 60 months in	-/	Walking Group: 45-60 minutes twice		subscale of the	6 weeks: 1.1 (0.2 to 2.0) vs. 1.5 (0.5 to 2.5)
1	Group 2's 29	l	per week for 6 weeks - Manual		Spinal	1 year: 1.2 (0.4 to 1.9 vs.1.0 (-0.2 to 2.2);

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	subjects, lower extremity median pain duration of 48 months in Group 1's 29 subjects and 24 months in Group 2's 29 subjects.  Setting: University in the United States	physical therapy (thrust and non thrust) to the thoracic and lumbar spine, pelvis, and lower extremities and specific exercises at discretion based on the underlying impairments. Patients received specific exercises to address impairments in mobility, strength, and/or coordination. Exercises were performed in the clinic and as part of a home exercise program. Patients also underwent a bodyweight supported treadmill ambulation program using a cable and trunk harness system to unload a specific amount of weight from the patient while the patient walks as comfortably as possible on a treadmill (n=29).	Stenosis Scale 7) Additional use of health care resources  Follow-up: 6 weeks, 1 year, long term mail survey (averaging 29 months)	Long term: 1.8 (0.6 to 3.0) vs. 2.0 (0.7 to 3.4) Between group MD not statistically significant at any follow-up period  Walking Ability (improvement in meters) within group MD, 95% CI 6 weeks: 176.5 (-9.5 to 362.4) vs. 339.7 (218.4 to 461) 1 year: 130.4 (-55.3 to 316.2) vs. 209.8 (67.5 to 352.1) Between group improvement not statistically significant at any follow-up  Disability (ODI) within group MD 6 weeks: 6.55 (1.87 to 11.23) vs. 10.48 (6.5 to 14.4) 1 year: 5.03 (1.71 to 8.35) vs. 7.14 (1.5 to 12.8) Between group differences not statistically significant at any follow-up
Minetama 2019	86 patients, 39 men and 47 women, average age 72.7 years 43 patients (20 men and 23 women, average age 72.3 years to the PT group 43 patients (19 men and 24 women, average age 73.2 years) to the HE group. Duration symptoms 20 months	<ol> <li>Physical therapy + home exercise program (n=43)</li> <li>Home exercise (HE) program alone (n=43)</li> <li>Supervised physical therapy twice a week for 6 weeks, including manual therapy, individually tailored stretching and strengthening exercises, cycling, and body weight-supported treadmill walking. The manual therapy included manipulation, stretching, and massaging of the thoracic and lumbar spine, pelvis, and lower extremities. The individually tailored muscle exercises included those for the trunk (eg, abdominal planks, side bridge, and/or back extension) and lower</li> </ol>	1) ZCQ 2) Satisfaction 3) SPWT (m) 4) NRS 5) JOABPEQ-acquired points 6) SF-36 7) HADS 8) PCS 9) PASS-20 10) TSK-11 11) Daily steps  Follow-up: 6 weeks	Between group MD, 95% CI ZCQ - Symptom severity -0.4 (-0.6 to -0.2): statistically significant ZCQ - Physical function -0.4 (-0.6 to -0.2): statistically significant SPWT (m) 455.9 (308.5 to 603.2): statistically significant NRS - Leg pain -1.4 (-2.5 to -0.3): statistically significant SF-36 - Physical functioning 9.2 (2.1 to 16.3): statistically significant SF-36 - Bodily pain 10.4 (3.3 to 17.5): statistically significant Daily steps 723.4 (199.1 to 1,283.5): statistically significant

extremities (eg, unloading hip and/or **Setting:** Spine care center at a knee exercise with ankle weight and/or university standing squats). The typical dosage for hospital in Japan strengthening exercises was a total of 2 to 3 sets with 10 repetitions, each of 6second contraction. The typical duration of stretching was three repetitions of 30 seconds. All patients in both groups were asked to take a daily walk that did not exacerbate their lower extremity symptoms using a pedometer and walking diary and to perform a HE program consisting of lumbar flexion exercises including three 30-second bouts of both single and double knee-to-chest exercises, ten 6second bouts of trunk raises and bridging in the supine position, and a 4-point kneeling exercise at least twice daily. 259 subjects, 122 1) Medical care (MC) (n=88) SSS Between group MD, 95% CI Schneider 1) 2019 **SPWT** males and 137 SSS (2 months) women with an 2) Group exercise (GE) (n=84) 3) Physical GE vs MC: 0.4 (-1.3 to 2.1) Activity MTE vs MC: -2.0 (-3.6 to -0.4) average age of 3) Manual therapy + exercise (MTE) 72.4, 68 patients MTE vs GE: -2.4 (-4.1 to -0.8) had symptoms (n=87)Follow-up: 2 and SPWT (2 months) for less than 6 6 months GE vs MC: 79.9 (-74.5 to 234.5) months, 191 had **Medical Care:** 3 visits to a physical MTE vs MC: 122.9 (-25.7 to 271.6) symptoms for medicine physician over 6 weeks. MTE vs GE: 43.0 (-111.8 to 197.9) greater than 6 Primarily prescription of oral medications Physical activity (2 months) months in any combination of nonnarcotic GE vs MC: 28.7 (2.7 to 54.7) analgesics, anticonvulsants, MTE vs MC: 20.4 (-4.5 to 45.3) antidepressants. MTE vs GE: -8.3 (-34.5 to 17.6) **Setting:** Optional referral for epidural steroid Outpatient SSS (6 months) injections if inadequate pain relief by oral research clinic in GE vs MC: -0.5 (-2.3 to 1.3) Pittsburgh medication, severe neurogenic MTE vs MC: -1.1 (-2.8 to 0.6) claudication, and/or patient preference. MTE vs GE: -0.6 (-2.4 to 1.2)

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Group Exercise: Supervised exercise classes at 2 local senior community centers. 2x 45-min classes/week, 6 weeks. Taught by senior fitness instructors. Participants self-select level of exercise based on fitness level (easy to medium)  Manual Therapy + Exercise: 2x 45-minute sessions per week, 6 weeks by either 2 chiropractors or 2 physiotherapists. Sessions included 3 interventions: 1. Warm-up procedure on stationary bicycle 2. Manual therapy procedures (lumbar distraction, hip, lumbar/sacroiliac joint and neural mobilizations 3. Individualized instruction in spinal stabilization exercises and home stretching Practitioner determined what muscles required stretch/strengthening and	Ammendolia	104 patients, 45	appropriate exercises added to program.  1) Comprehensive (n=48)	1)	SPWT	Between group MD, 95% CI, p values
gentle stretching and advice to stay  GE vs MC: 86.5 (-75.7 to 248.8)			active.  Group Exercise: Supervised exercise classes at 2 local senior community centers. 2x 45-min classes/week, 6 weeks. Taught by senior fitness instructors. Participants self-select level of exercise based on fitness level (easy to medium)  Manual Therapy + Exercise: 2x 45minute sessions per week, 6 weeks by either 2 chiropractors or 2 physiotherapists. Sessions included 3 interventions: 1. Warm-up procedure on stationary bicycle 2. Manual therapy procedures (lumbar distraction, hip, lumbar/sacroiliac joint and neural mobilizations 3. Individualized instruction in spinal stabilization exercises and home stretching Practitioner determined what muscles		l'eu	MTE vs MC: 73.8 (-84.1 to 231.7) MTE vs GE: -12.7 (-175.6 to 150.1)  Physical activity (6 months) GE vs MC: 21.3 (-6.9 to 49.4) MTE vs MC: -2.9 (-30.1 to 24.3) MTE vs GE: -24.2 (-52.5 to 4.0)  Adverse events: There were no reported serious adverse events in any group. There was a significantly greater rate of transient joint soreness associated with group 3 (49%) compared with group 2 (31%) and group 1 (6%).

(comprehensive) and 71.7 (self-directed) neurogenic claudication >3 months, imaging-confirmed canal narrowing, walk >20m and not surgical candidates in next 12 months

# **Setting:**

Academic hospital outpatient clinic in Toronto Education: Self-management strategies via cognitive behavioral approach. Body repositioning (pelvic tilt) when standing and walking. Exercises:

Standardized set of exercises demonstrated gradually over 6 weeks and was a part of structured home exercise program. Cycling, muscle stretching, strengthening, conditioning for back and lower extremity fitness and to facilitate lumbar flexion

Manual therapy: Spinal manipulation; joint, soft tissue and neural mobilization; lumbar flexion-distraction; and manual muscle stretching applied each visit. Participants received an instructional video and workbook and pedometer.

Self-directed: Instructional Video, workbook, pedometer and a single 15-to 30-minute training session with an experienced independent licensed chiropractor, independent of the comprehensive program, Training session: Describe 6-week program, review workbook, explain pedometer use and recording of weekly walking steps.

Video and workbook: Educational information and the same exercise instruction and self-management strategies received by the comprehensive

group

Significance - 50% improvement in SPWT no. (%)

- 4) ŽCO-S
- 5) ZCO-F
- 6) ZCQ-S + ZCQ-F
- 7) ODI
- 8) ODI walk
- 9) NRS Back
- 10) NRS Leg

**Follow-up:** 8 weeks, 3, 6, and 12 months

6 mo: 19 (2-35): p=0.02 12 mo: 22 (4-39): p=0.02 **50% improvement in SPWT** 

8 wks: 26 (8-42): p=0.01

3 mo: 19 (-1.0 to 36): p=0.06 6 mo: 17 (-2 to 35): p=0.09

12 mo: 24 (5-40): p=0.01

### **ZCQS**

8 wks: -0.19 (-0.37 to -0.02): p=0.03 3 mo: -0.15 (-0.37 to 0.08): p=0.19 6 mo: -0.02 (-0.22 to 0.19): p=0.87

12 mo: -0.22 (-0.47 to 0.02): p=0.07

#### **ZCOF**

8 wks: -0.02 (-0.22 to 0.17): p=0.81 3 mo: -0.18 (-0.39 to 0.03): p=0.09 6 mo: -0.11 (-0.33 to 0.11): p=0.34 12 mo: -0.27 (-0.49 to 0.04): p=0.02

#### ZCQS+ZCQF

8 wks: -0.24 (-0.56 to 0.07): p=0.13 3 mo: -0.36 (-0.75 to 0.03): p=0.07 6 mo: -0.23 (-0.58 to 0.12): p=0.20 12 mo: -0.48 (-0.90 to -0.06): p=0.03

# ODI

8 wks: -0.02 (-0.07 to 0.02): p=0.30 3 mo: -0.04 (-0.09 to 0.01): p=0.13 6 mo: -0.02 (-0.07 to 0.02): p=0.34 12 mo: -0.03 (-0.08 to 0.02): p=0.30

### **ODI Walk**

8 wks: -0.2 (-0.6 to 0.1): p=0.14 3 mo: -0.4 (-0.9 to 0.03): p=0.07 6 mo: -0.9 (-1.3 to -0.4): p<0.001 12 mo: -0.2 (-0.7 to 0.2): p=0.32

#### NRS Back

8 wks: -1.4 (-2.2 to -0.5): p=0.002 3 mo:-0.6 (-1.4 to 0.3): p=0.23 6 mo: -0.7 (-1.7 to 0.3): p=0.16 12 mo: -0.4 (-1.3 to 0.4): p=0.32

				NRS Leg 8 wks: -0.7 (-1.5 to 0.1): p=0.09 3 mo: 0.05 (-0.85 to 0.96): p=0.91 6 mo: -0.9 (-1.9 to 0.003): p=0.58 12 mo: -0.5 (-1.6 to 0.6): p=0.37 SF-36 Bodily Pain 8 wks: 2.0 (-4.9 to 8.9: p=0.57 3 mo: -4.5 (-12.4 to 3.5): p=0.27 6 mo: -3.3 (-10.2 to 3.6): p=0.35 12 mo: 10 (2.1 to 17.9): p=0.013 SF-36 Physical Function 8 wks: 4.2 (-3.9 to 12.4): p=0.31 3 mo: 9.2 (1.1 to 17.3): p=0.027 6 mo: 5.8 (-2.1 to 13.6): p=0.15 12 mo: 8.2 (0.2 to 16.2): p=0.045
			Pri-	Adverse events: At 12 months, 0 participants out of 43 in group 1 and 2 out of 46 participants in group 2 experienced adverse events that were mostly attributed to a temporary increase in low back and/or leg pain.
Oğuz 2013	120 patients, 30 in group 1 with an average age of 57.1 years old, 30 in group 2 with	<ol> <li>Standard exercise group (n=30)</li> <li>Isokinetic exercise program (n=30)</li> <li>Unloading exercise group (n=60)</li> </ol>	1) VAS 2) ODI 3) Beck Depression Inventory	Between group MD, p value VAS After treatment: Grp 1 vs Grp 2:0.37, p>0.05 Grp 1 vs Grp 3: 1.36, p<0.05
	an average age of 55.8 years old and group 3 with an average age of 57.4 years old,	All groups physician-guided (5x/week for 3 weeks) then at-home (3x/week)  Standard Exercise: 15 sessions of	Follow-up: 4, 12 and 24 weeks	Grp 2 vs Grp 3: 0.99, p<0.05 4 <sup>th</sup> week: Grp 1 vs Grp 2: 1.43, p>0.05 Grp 1 vs Grp 3: 1.17, p<0.05 Grp 2 vs Grp 3: -0.26, p>0.05
	LSS symptoms, narrowing by MRI	TENS, hot packs with home exercise instruction.  Isokinetic exercise: 20 minutes/day, 5		12 <sup>th</sup> week: Grp 1 vs Grp 2: 0.93, p>0.05 Grp 1 vs Grp 3: 0.71, p>0.05 Grp 2 vs Grp 3: -0.22, p>0.05 24 <sup>th</sup> week:
	Setting: University	sessions/week for a total of 15 sessions with a physician. Isokinetic exercises:		Grp 1 vs Grp 2: 1.08, p>0.05

department of physical medicine and rehabilitation in Turkey	rates of 60°/sec, 120°/sec, 180°/sec with 70° of body movement (50° flexion to 20° extension)  Each session had 3 sets, each set had 5 repetitions at described velocity, with 20s rest between each set.  Unloaded exercise: 5 sessions of unloading exercise per week, for a total of 15 sessions with a physician. Walking with unloading exercise devise: session 1-5 = 45% body weight, session 6-15 = 30% body weight. Treadmill walking at 1.2 km/hr for 20 minutes, or until pain due to neurogenic claudication was felt. Subjects advised to follow exercise program s at home at least 3x/week after discharge.		Grp 1 vs Grp 3: 0.46, p>0.05 Grp 2 vs Grp 3: -0.62, p>0.05 ODI  After treatment: Grp 1 vs Grp 2: -0.8, p>0.05 Grp 1 vs Grp 3: 1.8, p<0.05 Grp 1 vs Grp 3: 1.8, p<0.05 Grp 2 vs Grp 3: 2.6, p<0.05  4th week: Grp 1 vs Grp 2: 1.5, p>0.05 Grp 1 vs Grp 3: 2.6, p>0.05 Grp 1 vs Grp 3: 1.1, p<0.05 12th week: Grp 1 vs Grp 2: 1, p>0.05 Grp 1 vs Grp 3: 1.3, p>0.05 Grp 1 vs Grp 3: 0.3, p>0.05 Grp 1 vs Grp 3: 0.3, p>0.05 Grp 1 vs Grp 3: 0.4, p>0.05 Grp 1 vs Grp 3: 0.1, p>0.05 Grp 1 vs Grp 3: 0.5, p>0.05 Grp 1 vs Grp 3: -0.5, p>0.05 Grp 2 vs Grp 3: -115.1, p<0.05 Grp 1 vs Grp 3: -50.5, p>0.05 Grp 1 vs Grp 3: -45.9, p>0.05 Grp 1 vs Grp 3: -14.4, p>0.05 Grp 1 vs Grp 3: -18.4, p>0.05 Grp 1 vs Grp 3: -64.3, p<0.05 12th week: Grp 1 vs Grp 3: -64.3, p<0.05 Grp 2 vs Grp 3: -64.3, p<0.05 Grp 2 vs Grp 3: -52.9 p>0.05 Grp 1 vs Grp 2: 52.23 p>0.05 Grp 1 vs Grp 3: -52.9 p>0.05 Grp 1 vs Grp 3: -52.9 p>0.05 Grp 1 vs Grp 3: -52.9 p>0.05 Grp 1 vs Grp 3: -33.3, p>0.05 Grp 1 vs Grp 3: -33.3, p>0.05 Grp 2 vs Grp 3: -33.3, p>0.05
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Homayouni	47 subjects, 23	1) Treatment in therapeutic pools with	1) VAS	All between group comparisons
2015	male, 24 female,	water temperature of 29–30 degrees	2) Walking	Walking ability
	24 in group one,	Celsius. Every aquatic session	ability	Grp 1 > Grp 2: p=0.02
	mean age 55.56,	started with warm up and ended with		VAS
	12 male, 12	cool down, with duration of 10–15	Follow-up:	Grp 1 > Grp 2 p=0.001
	female, 23 in	min for each of them. Participants	Immediately after	
	group two, mean	should have attended aquatic	therapy, 3 months	
	age 55.68, 11	physical therapy sessions every other	inorup), o menune	
	male, 12 female	day for a total duration of 24		
	11	sessions. Each session included		
	Setting:	ambulation, side walking, chain		
	University-based	walking, forward walking with		
	pain clinics in	kickboard, stretching of each muscle		
	Iran	group including adductors,		
		abductors, flexors and extensors of		
		the hip, knee flexors and ankle		
		plantar flexors and dorsiflexors.		
		pelvic curl, pelvic tilt, and knee to		
		chest, double knee lift, and deep-	· //,	
		water exercise. (n=25)		
			(0)	
		2) Passive modalities by physical		
		therapists including continuous mode		
		ultrasound (US) 1.5W/ cm2 for 10		
		min and hot pack and trans-electrical		
		nerve stimulation (TENS) for 20 min		
		to the lumbar region. Also, the	Prich	
		therapists instructed the patients in		
		this group to perform trunk muscle		
		endurance, William's and stretching		
		exercises. The patients were treated		
		using these passive modalities and		
		were given exercises under		
		supervision of physiotherapists for		
		10 sessions. They were instructed to		
		perform the learned exercises 30 min		

Marchand 2019	40 participants, 17 females and 23 males, 20 in the intervention group with an average age of 66.7 years old and 20 in the control group with an average age of 71.5 years old, with history and diagnostic imaging of LSS  Setting: Regional hospital in Quebec	2)	a day at home in the following weeks until the end of the eighth week. (n=25)  Exercise 3x week / 6 weeks prior to surgery (n=20)  Regular hospital preoperative management with back posture education (n=20)	Fol	NRS (Pain Intensity) ROM (Active) Muscle strength (N-m) Walking capacity (seconds)  llow-up: 3 and nonths	Between group MD NRS (leg) Preoperative: -2.1, p<0.05 Postoperative: 1.1, p>0.05 3 months: 1.1, p>0.05 6 months: 0.3, p>0.05 ROM (active) Preoperative: 5, p<0.05 Postoperative: -6, p>0.05 Muscle Strength Preoperative: 45.7, p<0.001 Postoperative: 5.1, p>0.05 Walking Duration Preoperative: 90, p<0.05 Postoperative: -14.5, p>0.05
Kim 2019	34 subjects, mean age 64 (5.3), women 24 (66.7)  Setting: Hospital in Seoul, South Korea	1)	MT1 group: 110 g of Gang-Chuk Tang was administered 3 times a day (Gang-Chuk Tang is an herbal concoction consisting of Eucommiae Cortex, Achyranthis Radix, Rhizoma Cibotii, Sorbus commixta, G. thunbergii, Saposhnikovia Radix, and Acanthopanacis Cortex in equal portions) Daily Mokhuri Chuna therapy (relaxation and mobilization of lumbar joint and back muscle) Daily acupuncture treatment on LI4, ST36, LV3, BL22, BL23, BL24, BL25, and Ashi points. Consultation on precautions related to daily	<ul><li>3)</li><li>4)</li><li>Fol</li></ul>	VAS for leg pain VAS for low back pain Oxford Claudication Scoring Walking distance low-up: 3 and nonths	All between group comparisons  VAS leg pain (post treatment)  MT2 (28.82±27.46) vs CMT (51.82±25.34) groups: P=0.04  VAS leg pain (6 months)  MT1 (48.91±23.08) vs CMT (72.27±16.72) groups: P=0.01  MT2 (42.36±21.29) vs CMT groups: P=0.003  VAS low back pain (6 months):  MT2 (30.00±13.48) vs CMT (60.82±18.62) groups: P=0.001  Oxford Claudication Scoring (3 months)  MT1 (18.75±6.52) vs CMT (25.82±6.24) groups: p=0.02  Walking distance (3 months)  MT1 vs CMT: p=0.03  Walking distance (6 months)  MT1 vs CMT: p=0.01

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		(aceclofenac 100 mg twice daily and eperisione hydrochloride 50 mg three times daily for 28 days) and three interlaminar epidural steroid injections (5 mg of dexamethasone per injection) at the level of the affected spinal region over a 4-week period were administered.  Physiotherapy including heating pad, and transputeneous electrical parts.	2	101	
		simulator, and deep tissue heating therapy five times per week for 4			06.
l.		` ,	Mar	nipulation	1//.
degenerative LSS (n=14); Swiss Spinal Stenosis score of M=63.2, standard deviation [SD] = 15.9) (mean age 59.0 (10.6)), 7 in	2)	Spinal manipulation group: received bilateral high-velocity; low-amplitude spinal manipulation directed toward the lumbar region (by a licensed chiropractor with more than 10 years of clinical experience) (n=7)  Non Intervention Group: Waited 5	1) 2) 3) 4)  Following	Movement time NPS (Back) NPS (leg) ROM low-up: mediately after	There was no significant difference between groups for all outcomes.  1. Grp 1 vs. Grp 2, p=0.739  2. Grp 1 vs. Grp 2, p> 0.05  3. Grp 1 vs. Grp 2, p> 0.05  4. Grp 1 vs. Grp 2, p> 0.05
1 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	egenerative LSS n=14); Swiss pinal Stenosis core of M=63.2, andard eviation [SD] = 5.9) (mean age	egenerative LSS n=14); Swiss pinal Stenosis core of M=63.2, andard eviation [SD] = 5.9) (mean age 9.0 (10.6)), 7 in 2)	three times daily for 28 days) and three interlaminar epidural steroid injections (5 mg of dexamethasone per injection) at the level of the affected spinal region over a 4-week period were administered.  Physiotherapy including heating pad, and transcutaneous electrical nerve simulator, and deep tissue heating therapy five times per week for 4 weeks. (n=11)  Spinal  4 patients with egenerative LSS n=14); Swiss pinal Stenosis core of M=63.2, andard eviation [SD] = 5.9) (mean age 9.0 (10.6)), 7 in  three times daily for 28 days) and three interlaminar epidural steroid injections (5 mg of dexamethasone per injection) at the level of the affected spinal region over a 4-week period were administered.  Physiotherapy including heating pad, and transcutaneous electrical nerve simulator, and deep tissue heating therapy five times per week for 4 weeks. (n=11)  Spinal  1) Spinal manipulation group: received bilateral high-velocity; low-amplitude spinal manipulation directed toward the lumbar region (by a licensed chiropractor with more than 10 years of clinical experience) (n=7)  5.9) (mean age 9.0 (10.6)), 7 in  2) Non Intervention Group: Waited 5	three times daily for 28 days) and three interlaminar epidural steroid injections (5 mg of dexamethasone per injection) at the level of the affected spinal region over a 4-week period were administered.  Physiotherapy including heating pad, and transcutaneous electrical nerve simulator, and deep tissue heating therapy five times per week for 4 weeks. (n=11)  Spinal Man  4 patients with egenerative LSS in=14); Swiss pinal Stenosis pinal Stenosis core of M=63.2, and ard eviation [SD] = (by a licensed chiropractor with more than 10 years of clinical experience) (n=7)  Follow 10.6), 7 in 2) Non Intervention Group: Waited 5	three times daily for 28 days) and three interlaminar epidural steroid injections (5 mg of dexamethasone per injection) at the level of the affected spinal region over a 4-week period were administered. Physiotherapy including heating pad, and transcutaneous electrical nerve simulator, and deep tissue heating therapy five times per week for 4 weeks. (n=11)  Spinal Manipulation  4 patients with egenerative LSS 1 Spinal manipulation group: received bilateral high-velocity; low- amplitude spinal manipulation directed toward the lumbar region of M=63.2, andard eviation [SD] = 5.9) (mean age 9.0 (10.6)), 7 in  1 Non Intervention Group: Waited 5  Tellow-up: Immediately after intervention

no intervention group (n=7) female, 3 male) (mean age 59.1 (9.3)), 7 in the NI group (3 female, 4 male) (mean age 58.9 (12.6)) **Setting:** rehabilitation hospital in Winnipeg, Manitoba Acupuncture Acupuncture: 269 acupuncture Between group MD, 95% CI Kim 2016 50 participants 1) ODI sessions were administered during 2) SF-36 bodily ODI mean age of  $62.0 \pm 9.8$  years, the study. 81% (n=21) of patients 6 wk: -2.2 (-7.0 to 2.6) pain SF-36 received at least 10 acupuncture 3 mo: -2.5 (-8.9 to 3.8) acupuncture (n=26), age sessions. Electrical acupuncture was physical **SF-36 BP**  $65.0\pm8.7$ , male / applied at least once and bilaterally function 6 wk: -8.6 (-18.6 to 1.3) at back shu points (BL23, BL24, female 12/14, LBP 3 mo: 3.2 (-8.3 to 14.7) BL25 or BL26) or Jiaji points at L2control (n=24), bothersomene **SF-36 PF** L5 spinal levels. Other frequently 6 wk: 0.1 (-7.6 to 7.9) age  $58.9\pm10.2$ , 5) LBP intensity male / female used points were BL57, BL60, 3 mo: 1.3 (-8.3 to 10.9) GB39, GB34 and tender points 10/14. Mean Leg pain LBP bothersomeness duration of located in the lower extremities bothersomene 6 wk: -0.6 (-11.4 to 10.1) symptoms 33m (n=26)SS 3 mo: -7.4 (-19.6 to 4.8) 7) Leg pain LBP intensity **Setting:** Hospital 2) Control: In total, 255 physical intensity 6 wk: -5.1 (-15.5 to 5.3) in Yangsan, therapy sessions were provided to Self-reported 3 mo: -13.5 (-26.2 to -0.7) South Korea patients in the control group at their pain-free Leg pain bothersomeness request. 92% (n=22) of patients walking 6 wk: -7.4 (-18.4 to 3.7) received at least 10 physical therapy distance (m) 3 mo: -9.2 (-21.6 to 3.2) sessions (median 11, range 1-13). Leg pain intensity (n=24)Follow-up: 6 6 wk: -11.5 (-0.9 to -22.0) weeks, 3 months 3 mo: -12.6 (-24.6 to -0.6)

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				None statistically significant
Qin 2020	80 participants	1) Acupuncture: Applied by	1) RMDQ	RMDQ
	assigned with 70	acupuncturists with 5 years of	2) NRS back	4 wk: -3.6 (-5.2 to -1.9): p<0.001
	completing the 8-	Chinese medical university program	3) NRS Leg	8 wk: -2.6 (-3.7 to -1.4): p<0.001
	week treatment	and at least 2 year of clinical	4) SSS	3 mo: -2.3 (-3.9 to -0.7): p=0.005
	course (38 in acu	experience. Sterile disposable steel	Symptoms	6 mo: -1.8 (-3.6 to -0.3): p=0.086
	group and 32 in	needles (Hwato Acupuncture,	subscale	NRS Back
	sham acu group).	Suzhou, China; 0.30 £ 40 mm/0.30 £	5) SSS physical	4 wk: -1.7 (-2.4 to -0.9): p<0.001
	Mean age of	75 mm) were inserted through	function	8 wk: -2.3 (-3.0 to -1.5): p<0.001
	61.5±7.9 years	adhesive pads. Participants	subscale	3 mo: -1.7 (-2.6 to -0.8): p<0.001
	with 34 males	underwent 3 treatments weekly over	6) SSS	6 mo: -1.2 (-2.1 to -0.3): p=0.007
	and 46 females.	8 weeks, and each session persisted	satisfaction	NRS Leg
	Duration of	for 30 minutes. To maintain "De qi,	, subscale	4 wk: -2.0 (-2.6 to -1.3): p<0.001
	symptoms <3mo	a sensation of numbness and	7) Self-paced	8 wk: -2.9 (-2.6 to -1.3): p<0.001
	=14 (17.5%), 3-	soreness, acupuncture manipulation	walk test	3 mo: -2.4 (-3.3 to -1.4): p<0.001
	12  mo = 1(1.3%),	(twirling, lifting, and thrusting on		6 mo: -2.1 (-3.0 to -1.2): p<0.001
	1 to 5 y = 24	needles) was performed every 10	Follow-up: 4	SSS Symptoms Subscale
	(30%), >5 y =41	minutes during the treatment.	weeks, 8 weeks	4 wk: -0.6 (-0.8 to -0.4): p<0.001
	(51.3%)		(end of treatment),	8 wk: -0.9 (-1.2 to -0.6): p<0.001
	(31.370)	2) Sham acupuncture: Chosen	3 months, 6	3 mo: -0.9 (-1.2 to -0.6): p<0.001
	Setting:	acupoints, treatment duration, and	months	6 mo: -1.0 (-1.3 to 0.6): p<0.001
	2 Clinical Sites -	frequency of sessions were the same		SSS Physical Function Subscale
	Department of	as in the acupuncture group.	1/1	4 wk: -0.5 (-0.8 to -0.3): p<0.001
	Acupuncture and	Participants in the sham cohort were		8 wk: -0.8 (-1.1 to -0.5): p<0.001
	Neurology,	treated using a pragmatic placebo		3 mo: -0.7 (-1.0 to -0.4): p<0.001
	Guang'anmen	needle on the same acupoints, which	1	6 mo: -0.7 (-1.1 to -0.4): p<0.001
	Hospital	is similar to the Streitberger needle		Self-Paced Walk Test
	Department of	design (Supplementary Materials).		4 wk: p=0.648
	Acupuncture and	Acupuncturists pretended to		8 wk: p=0.29
	Neurology,	manipulate the needle every 10		3 mo: p=030
	Beijing Fengtai	minutes, but "De qi" was not sought		6 mo: p=0.133
	Hospital of			· · · · · · · · · · · · · · · · · · ·
	Integrated			<b>Adverse events:</b> 3 participants in group 1 reported pain after
	Traditional and			needle insertion and 1 had a hematoma. 3 participants in group
	Western			reported back pain and 2 reported fatigue. All adverse events
	Medicine.			were reported as mild or moderate, and none required medical
	Triculonic.			intervention.
	J		L	mici vention.

		Epidu	ıral injections	
Cuckler 1985	73 subjects in total, 37 with spinal stenosis, 36 with acute herniated nucleus pulposus, 37 males, 36 female, average age of 48.5 years in the experimental group and 49.5 years in the placebo group. Experimental group average 36.6 months in symptom duration, placebo group averaged 29.4 months.  Setting: Orthopaedic surgery department in the	1) Steroid group: 2ml of sterile water containing 80mg of methylprednisolone acetate combined with 5ml of 1% procaine was injected into the epidural space in the region between the 3rd and 4th lumbar vertebrae with the patient in the lateral decubitus position lying on the side of the painful limb (n=42), 20 with stenosis).  2) Placebo group: 2ml of saline combined with 5ml of 1% procaine was injected into the epidural space in the region between the 3rd and 4th lumbar vertebrae with the patient in the lateral decubitus position lying on the side of the painful limb. (n=31, 17 with stenosis)  All patients were advised to take mild analgesics (aspirin or acetaminophen) during the post-injection period. Second injection given if less than 50% improvement after 24 hours - considered	1) Subjective percentage of improvement with 75% required to be considered a treatment improvement, if less than 50% after 24 hours was considered a treatment failure  2) Re-injection rates  3) Surgery rates  Follow-up: 24 hours, every 3 months up to 30 months, averaging 20.2 months in the steroid group and 21.5 months in the	Patient Global Assessment (improved by at least 75%) 24 hours: 33% (steroid) vs. 21% (saline) p>0.05 Long term: 33% (saline) vs. 14% (saline) p>0.05
Fukusaki 1988	United States 53 subjects, 38 males and 15 female. Group 1 averaged 70 years of age and 79 days of symptoms on average, group 2 averaged 69 years of age and	treatment failure  1) Epidural injection with 8 ml of saline, repeated twice in the first week (n=16)  2) Epidural injection with 8 ml of 1% mepivacaine, repeated twice in the first week. (n=18)  3) Epidural injection with a mixture of 8 ml of 1% mepivacaine and 40 mg	control group.  1) Walking distance which was graded according to distance (excellent, good, or poor)  Follow-up: 1 week, 1 month, 3	Walking distance Percent excellent effect = mean of > 100m in walking distance 1 week: 12.5 % (saline) vs. 55% (block) vs. 63.2% (block + steroid); block or block + steroid > saline, p< 0.05; 1 mo: 6.3% (saline) vs. 16.7% (block) vs. 15.8% (block + steroid) p > 0.05 3 mo: 6.3 (saline) vs. 5.6% (block) vs. 5.3% (block +steroid) p 0.05  No significant difference between block vs. block + steroid at

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	an average of 82 days of	of methylprednisone, repeated twice in the first week. (n=19)	months	all follow-up periods, p>0.05
	symptoms, group 3 averaged 72 years of age and 94 days of symptoms on average			Adverse events: no reported complications
	Setting: Anaesthesia department in Japan	0,0		
Zahaar 1991	30 subjects, 37 male and 26 female. Steroid group averaged 46.5 years of age and 36.6 months of symptoms, control group	<ol> <li>Steroid injection: 5ml of hydrocortisone acetate suspension, 2x2ml carbocaine, 4% Volume completed with sterile saline to 30ml (n=18)</li> <li>Control: 2x2ml of carbocaine, 4% injected into epidural space. Volume</li> </ol>	1) Subjective percentage of improvement where 75% or more was deemed successful and surgery after	Patient Global Assessment (improved by at least 75%) 24 hours: 55% (steroid injection) vs. 50% (control) p> 0.05 Up to 36 mo: 38% (steroid injection) group vs. 33.3% (control) p>0.05  Failures (%) (required surgery) Up to 36 mo: 61% (steroid injection) vs. 66.6% (control) p>0.05
	averaged 49 years of age and 29.4 months of symptoms	completed with sterile saline to 30ml. (n=12)	injection was considered a failure.	Or
	Setting: Medical facility in Egypt		Follow-up: 24 hours, then every three months up to 36 mo averaging 20.2 mo in the steroid group and 21.5 mo control group.	
Friedly 2014, 2017	400 patients, 221 females and 179	1) Lidocaine + glucocorticoid (1-3 mL of 0.25-1% lidocaine followed by 1-	1) RMDQ	Between group MD, 95% CI, p values RMDQ
Makris 2016	males, 200 in the lidocaine group	3 mL triamcinolone (60-120mg), betamethasone (6-12mg),	2) NRS (Leg Pain)	3 weeks: -1.8 (-2.8 to -0.9): p<0.001 6 weeks: -1.0 (-2.1 to 0.1): p=0.07

	with an average	dexamethasone (8-10mg) or	<b>Follow-up:</b> 3, 6,	12 wk: 0.1 (-1.0 to 1.3): p=0.84
	age of 68.1 years	methylprednisone (60-120mg))	and 12 weeks, 6	6 mo -0.00 (-1.1 to 1.1): p=0.99
	old and 200	(n=200)	and 12 months	12 mo: -0.4 (-1.6 to 0.9): p=0.55
	gluocorticoid-			NRS (Leg pain)
	lidocaine group	2) Lidocaine group (0.25-1% lidocaine	Makris 2016	3 weeks: -0.6 (-1.2 to -0.1): p=0.02
	with an average	alone) (n=200)	subgroup	6 weeks: -0. (=0.8 to 0.4): p=0.48
	age of 68 years		1) RMDQ using	12 wk: 0.1 (-0.5 to 0.7): p=0.70
	old, LSS by CT	Physician option for intralaminar and/or	SIP Weights	6 mo: -0.2 (-0.8 to 0.4): p=0.47
	or MRI. 26%	transformaminal techniques	2) RMDQ	12 mo: 0.1 (-0.5 to 0.7): P=0.75
	patients		patient-	
	symptoms greater		prioritized	Subgroup Analysis
	than 5 years.		(LESSER)	RMDQ using SIP weight
				3 wks: -1.9 (-2.9 to -0.7): p<0.001
	Setting: 16		Follow-up: 3 and	6 wks: -1.1 (-2.2 to -0.1): p=0.04
	medical centers	or beer to	6 weeks	RMDQ patient prioritized (LESSER)
	across the United			3 wks: -1.8 (-2.8 to -0.8): p<0.001
	States			6 wks: -1.0 (-2.0 to 0.1): p=0.08
				0 Mills 110 ( 210 to 011). p 0100
			$\vee_i$	<b>Adverse events:</b> A total 21.5% of patients in group 1 and
			• //.	15.5% in group 2 reported one or more adverse events (p=0.08)
				that included headaches, fever, infection, dizziness,
			'N'	cardiovascular/lung problems, leg swelling and dural puncture.
				cardiovasculai, lang problems, leg swenning and datai panetare.
Song 2016	29 subjects, 14	1) Lidocaine spinal injection, 40 mg	1) VAS	No significant difference between groups.
Bong 2010	males and 15	triamcinolone mixed with 10 mL	2) FRI	VAS
	women with an	0.5% lidocaine was used under the	2) 110	1-month p= $0.696$ , 3 months p= $0.891$
	average age of	guide of fluoroscopy (n=15)	Follow-up: 1 and	FRI
	58.3 and 61.7	guide of fluoroscopy (fi-13)	3 months	1-month p=0.983, 3 months p=0.743
	between groups,	2) Saline spinal injection using same	3 monuis	1-month p=0.963, 3 months p=0.743
	history of	volume (n=14)		
	intermittent	volume (n=14)		
	claudication and			
	lower limb			
	radicular pain or			
	paresthesia			

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	Setting: Rehabilitation clinic in Korea			
Milburn 2014	57 patients met inclusion criteria, agreed to participate, and were enrolled. 20 patients were male; 37 were female. Mean patient age was 65.3 years (range, 32-88 years). Average duration of symptomatology (pain and/or disability) was 42 months. The mean degree of canal narrowing at the most stenotic level was 6.1 mm (range, 2.5-9.1 mm). The most common maximally stenotic intervertebral level was L4-L5	Fluoroscopically guided lumbar ILESI performed either at:  1) The level of maximal stenosis (n=30)  2) Two intervertebral levels cephalad, corresponding to a less stenotic level (n=27)  Injection was performed with a 20-gauge Tuohy needle using a loss of resistance technique. The injectate consisted of 2 mL of 40 mg/mL methylprednisolone (Pfizer), 2 mL of bupivacaine 0.25% (Hospira), and 2 mL of normal saline for a total injectate volume of 6 mL.	1) NRS - Pain with Ambulation 2) RMDQ  Follow-up: 1, 4 and 12 weeks	All between group comparisons NRS (pain with ambulation)  1 wk: Grp 1 lower pain compared to Grp 2, p=0.045  4 wk: Grp 1 lower pain compared to Grp 2, p=0.049  12 wk: Grp 1 lower pain compared to Grp 2, p=0.08  RMDQ  1 wk: Grp 1 lower compared to Grp 2, p=0.001  4 wk: Grp 1 lower compared to Grp 2, p=0.009  12 wk: Grp 1 lower compared to Grp 2, p=0.003

	(n½42) followed by L3-L4 (n½11) and L5-S1 (n¼4). Setting: Clinic in New Orleans, Louisiana			
Brown 2012	38 patients, 21 males and 17 females, 21 in mild group with an average age of 74.2 years and 17 in ESI group with an average age of 78.7 years, symptomatic LSS patients with painful lower limb neurogenic claudication, able to walk at least 10 feet unaided, (ODI) score > 20  Setting: Pain management clinic in Florida	<ol> <li>Epidural steroid (80 mg triamcinolone acetate) (n=17)</li> <li>Mild lumbar decompression (n=21)</li> </ol>	1) VAS 2) ODI 3) ZCQ 4) Patient Satisfaction (0-10)  Follow-up: 6 and 12 weeks	VAS 6 and 12 weeks P=0.54 ODI p=0.86 ZCQ p>0.05 Patient satisfaction p>0.05
Hammerich 2019	54 patients total, age 67.2 ± 9.7, 27 male, 27 female, 31 in ESI group, 23 in ESI plus PT. Mean duration of	<ol> <li>ESI (n=31)</li> <li>ESI + PT (n=23)</li> <li>ESI: 1.5 mL of steroid at each site injected with maximal involvement using transforaminal approach.</li> </ol>	1) ODI 2) NRS current 3) SF-36 emotional role 4) SF-36 emotional well-being	Between group MD, 95% CI, p values ODI 10 wks: -1.08 (-8.10 to 5.94) p=0.80 6 mo: -4.70 (-11.72 to 2.32) p=0.27 12 mo: -2.72 (-9.74 to 4.30) p=0.52 NRS 10 wks: -1.68 (-3.08 to -0.29) p=0.07

	symptoms 14 m  Setting: Clinics in Colorado, Texas, South Carolina and New Hampshire	PT: 8-10 sessions PT manual therapy and exercise. Walking program and/or stationary bike, stretching and strengthening exercises.	5) SF-36 general health perception  Follow-up: 10 weeks, 6 and 12 months	6 mo: -1.99 (-3.38 to -0.60) p=0.04 12 mo:-2.44 (-3.80 to -1.08) p=0.00 <b>SF-36 Emotional role</b> 10 wks: -28.53 (-49.05 to -8.01) p=0.03 6 mo: -11.25 (-31.77 to 9.27) p=0.39 12 mo: -10.67 (-31.19 to 9.85) p-0.41 <b>SF-36 Emotional well-being</b> 10 wks: -11.26 (-19.52 to -2.99) p=0.02 6 mo: 2.69 (-5.57 to 10.95) p=0.59 12 mo: -5.76 (-14.02 to 2.50) p=0.24 <b>SF-36 General Health Perception</b> 10 wks: -8.99 (-17.20 to -0.78) p=0.05 6 mo: -5.56 (-13.77 to 2.65) p=0.23 12 mo: -5.10 (-13.31 to 3.11) p=0.27
Sencan 2020	67 patients. The median age 62.5 years with 18 males and 49 females. Median duration of symptoms was 29 and 24 months in the ILESI and bilateral TFESI groups, respectively  Setting: University department Pain Medicine, Istanbul Turkey	<ol> <li>Interlaminar: ILESI, fluoroscopy guided with 1 to 2 mL contrast dye with mixture of 80 mg methylprednisolone acetate, 2 mL saline solution, and 2 mL (0.5%) bupivacaine solution</li> <li>Transforaminal: TFESI, fluoroscopy guided with 1 to 2 mL contrast dye with mixture of 80 mg methylprednisolone acetate, 2 mL saline solution, and 2 mL (0.5%) bupivacaine solution</li> </ol>	1) NPS 2) ODI 3) Beck depression scale 4) Walk distance  Follow-up: after treatment, 3 weeks and 3 months	Between Group Median Differences (data not provided), p values NPS after treatment: p=0.14 3 wks: p=0.28 3 mo: p=0.047 ODI 3 wks: p=0.93 3 mo: p=0.65 Beck Depression Scale 3wks: p=0.048 3 mo: p=0.03 Walking Distance 3 wks: p=0.23 3 mo: p=0.048
Wei 2020	90 patients. Mean age about 65 years, 45 females, 45	Epidural injection with 2.0mL of lidocaine and 10 mg of TNF-a inhibitor (etanercept) on the affected spinal nerves.	1) VAS (leg) 2) ODI Follow-up: after	Between Group Mean Differences (data not provided), p values Grp 1 vs Grp 2 VAS

	males, mean duration of symptoms about 2.8 months  Setting: University Hospital Jiangsu China	2)	Epidural administration with 2mL of lidocaine mixed with 2mL of steroid (diprospan)  Epidural injection 4.0mL of lidocaine only.		atment, 1,3, 6 onths	after treatment, 1, 3 and 6 mo, Grp 1 greater reduction, p<0.05  ODI  1, 3 and 6 mo, Grp 1 greater reduction, p<0.05  Grp 1 vs Grp 3  VAS  after treatment, 1, 3 and 6 mo, Grp 1 greater reduction, p<0.05  ODI  1, 3 and 6 mo, Grp 1 greater reduction, p<0.05  Grp 2 vs Grp 3  VAS  after treatment, 1, 3 and 6 mo, no significant difference, p>0.05  ODI  1, 3 and 6 mo, no significant difference, p>0.05
Karm 2018	44 patients total, 20 in the RACZ group (age 66.1 +-12.2, male 9 (45.0%), and 24 in the ZiNeu group (Age 65.5 +-6.4 18 females, 26 males.  Setting: Single- center, academic, outpatient interventional pain management clinic in Korea	2)	PEA Using a Balloon-less Catheter (Racz) (n = 20)  Percutaneous Epidural Decompression and Adhesiolysis Using an Inflatable Balloon Catheter (ZiNeu) (n = 24)	2) 3) Fol	pain)	Between group MD, 95% CI, p values  NRS-11 (Back pain)  1 mo:-0.38 (-1.81 to 1.06): p=0.61  3 mo: -1.13 (-2.63 to 0.38): p=0.14  6 mo: -2.02 (-3.58 to 0.45): p=0.01  NRS-11 (Leg pain)  1 mo: 0.73 (-0.40 to 1.85): p=0.21  3 mo: -0.69 (-1.89 to 0.52): p=0.26  6 mo: -1.88 (-3.15 to 0.61): p=0.00  ODI (%)  1 mo: -6.13 (-13.88 to 1.61): p=0.12  3 mo: -6.63 (-14.75 to 1.48): p=0.11  6 mo: -13.74 (-22.18 to 5.30): p=0.00  Adverse events: Minor and transient adverse events were reported equally in both groups (no data provided), mostly pain and paresthesia at the injection site.
				Surg	gery	
Zucherman 2004, 2005, 2006	191 subjects, 57% male and 43% female in the X STOP group. 52% male	1)	X STOP Interspinous Process Decompression System (n=100)  Non-operative treatment: Subjects received an epidural steroid injection	1) 2) 3)	SF-36 ZCQ Worker's compensation claims	Patient global assessment (Good result) 2 yrs: 73.1% (surgery) vs. 35.9% (control) (P< 0.001) Symptoms Severity score

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and 48% female	on enrolment and were eligible for	4) ODI	Surgery better at 6 w, 6 mo, 1 and 2 yr (graphs) (P<0.001)
			2 yrs: MPC 45.4% (surgery) vs. 7.4% (control) (P < 0.001)
		, ,	"Clinically relevant improvement (patients)":
		changes	2 yrs: 60.2% (surgery) vs. 18.5% (control) (P< 0.001)
			Symptoms Severity score††
			Surgery better at 6 w, 6 mo, 1 and 2 yr (graphs) (P<0.001)
			2 yrs: MPC 44.3% (surgery) vs0.4% (control) (P < 0.001)
		Follow-up:	"Clinically relevant improvement (as measured by
			patients)":
			2 yrs: 57% (surgery) vs. 14.8% (control) (P < 0.001)
symptom	but body jackets and chair back	Control. 19 (2 yl)	ZCQ (global success)
duration in the X	braces were not. (n=91)		6 mo: 52% (surgery) vs. 9% (control) (P value not reported)
STOP group and			1 yr: 59% vs 12% (P value not reported)
			2 yrs: 48.4% (surgery) vs. 4.9% (control) (P < 0.001)
non-operative			Quality of life (SF-36)
group.			At all post treatment time points (6 w, 6 mo, 1 yr, 2 yr), the
			mean domain scores documented in the X STOP group were
Setting: Spine			significantly greater than those in the non operative group, with
center in the			the exception of the mean General Health, Role Emotional, and
United States			Mental Component Summary scores at 2 years
		10,	Adverse events: No complications were reported in group 2. In
			group 1, complications were reported in 11% of subjects
			including spinous process fracture, coronary ischemia,
			respiratory distress, hematoma, and 1 death (pulmonary edema)
Subjects with	1) Assigned to surgery (standard	1) SF-36 hodily	All between group comparisons using Intention-to-Treat
		_ ′	analysis
			SF-36 Bodily Pain, DMC, 95% CI
$\mathcal{L}$	(1137)		2 yrs: 1.5 (-4.2 to 7.3)
	2) Assigned to non-surgical treatment:		4 yrs: -2 (-8.6 to 4.6)
		1 /	8 yrs: p=0.85
	countries operative care (ii 113)		SF-36 Bodily Function, DMC, 95% CI
			2 yrs: 1.9 (-3.7 to 7.5)
			4 yrs: -3.1 (-9.2 to 3.0)
			8 yrs: p=0.31
in the surgical		5) ODI	Disability (ODI), DMC, 95% CI
	duration in the X STOP group and 4.7 years in the non-operative group.  Setting: Spine center in the United States  Subjects with image-confirmed degenerative spondylolisthesis: 304 subjects in the RCT, 303 in the observational cohort, 31% male in the surgical group, 33% male	in the non- operative group. Average age of 70 years in the X STOP group and 69.1 years in the non-operative group. Average of 3.5 year symptom duration in the X STOP group and 4.7 years in the non-operative group.  Setting: Spine center in the United States  Subjects with image-confirmed degenerative spondylolisthesis: 304 subjects in the RCT, 303 in the observational cohort, 31% male in the surgical group, 33% male	in the non- operative group. Average age of 70 years in the X STOP group and 69.1 years in the non-operative group. Average of 3.5 year symptom duration in the X STOP group and 4.7 years in the non-operative group.  Setting: Spine center in the United States  1) Assigned to surgery (standard image-confirmed degenerative spondylolisthesis: 304 subjects in the RCT, 303 in the RCT, 303 in the observational cohort, 31% male in the surgical group, 33% male  additional injections as needed, as well as NSAIDS, analgesic agents, and physical therapy. Physical therapy consisted of education on back care and modalities such as ice packs, heat packs, massage, stabilization exercises, and pool therapy. Braces such as abdominal binders and corsets were permitted, but body jackets and chair back braces were not. (n=91)  Follow-up: Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy with or without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)  Laminectomy without fusion) (n=159) Surgery: 7 (2 yr) Control: 19 (2 yr)

				6 n	llow-up: nonths, 1, 4 and years	
	Neurology department in a hospital in Norway				Fair, Unchanged, Worse)	
	duration of sciatica was 2 years.  Setting:		the day for all activities plus instruction and back school." (n=18)		rating from evaluating physician and study team (Excellent,	Other outcomes (claudication or walking distance; level of daily activity; and neurologic deficits) were not reported separately for the randomized cohort.
	females). Median back pain duration was 14 years, median	2)	(n=13)  Conservative therapy: Lumbar orthosis use for 1 month worn during	4) 5)		1 yr: NR 4 yrs: RR 3.33 (0.77 to 14.33) 10 yrs: RR 1.59 (0.55 to 4.55)
	(males were 1.5 years higher than		osteophytes from the vertebral margins or facet joints. No fusions.	3)		10 yrs: RR 3.18 (0.97 to 10.41)  Pain (none or mild)
Amundsen 2000	100 subjects, 54 male, 46 female, median age of 59	1)	Surgery: Partial or total laminectomy, medial facetectomy, discectomy, and/or removal of	1) 2)	VAS Verbal Rating Scale	Patient global assessment (Good result)  1 yr: RR 2.07 (0.98 to 4.38)  4 yrs: RR 1.94 (1.14 to 3.31)
	orthopaedic departments in the United States		100	то 8 у	eks, 3 and 6 onths, 1, 2, 4 and rears	
	Setting: multi- centred			Fo	ndex	complication mostly and dural tears and 19% postsurgical complications including 1 death, 11% required additional surgeries at 2 years,
	symptoms for at least 12 weeks			7)	care Stenosis pothersomeness	Bothersomeness Scale) were not provided separately for the randomized cohort.  Adverse events: group 1 reported 14% intraoperative
	years in the non- surgical group. Subjects had			s	current symptoms and	Other outcomes (patient's satisfaction; Stenosis Bothersomeness Index, Leg Pain Bothersomeness Scale; and Low Back Pain
	age of 64.7 years in the surgical group and 68.2			i	eported mprovement, atisfaction with	4 yrs: 4.1 (-0.8 to 9.1) 8 yrs: p=0.039

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subjects were male, 45% of non-operative subjects were male. Nonoperative group had average age of 62.9 years, surgical group had average age of 63.9 years. Surgical group averaged 14 years since onset of symptoms, nonsurgical group average 16 years since onset of symptoms. Minimum of 6 months of symptoms for study inclusion.

Setting: Research Center in Finland 2) Non-operative treatment: NSAIDS when indicated and seen one to three times by a physiotherapist, in addition to the standard visit at each follow-up. The physiotherapist gave all patients educational brochure. The patients were encouraged to use their back in a normal way. Painrelieving body postures were taught as well as basic ergonomics related to lifting and carrying. Individually structured programs included trunk muscle endurance and stretchingtype exercises. Additional individual physiotherapy consisting of passive treatment methods (such as ultrasound and transcutaneous nerve stimulation). (n=44)

The patients in the surgical group also received the brochure and the instructions described above.

rating scale for back and leg pain Walking ability

- 2) Walking
  ability
  (distance
  without a
  break) also via
  treadmill test
- 3) General health status on a 5 point scale (very good, quite good, average, quite poor or very poor.
- 4) ODI
- 5) Ability to complete certain activities of daily
- 6) living without difficulty, some difficulty, marked difficulties or not at all
- 7) Radiographic examination

Follow-up: 6 months, 1 and 2 years

1 yr: 1.69 (0.41 to 2.96) 2 yr: 1.51(0.25 to 2.77)

Back pain, MD, 95% CI

1 yr: 2.33 (1.12 to 3.55) 2 yrs: 2.13(0.98 to 3.28)

Disability (ODI), MD, 95% CI

1yr: 11.3 (4.3to 18.8) 2 yrs: 7.8 (0.8 to 14.9)

> 10 points reduction (ODI): RR, 95% CI

1 yr: 2.16 (1.31to 3.57) 2 yrs: 1.36 (0.88 to 2.10)

Walking disability (walking distance <1.250 m), RR, 95% CI

1 yr: 0.93 (0.61 to 2.03) 2 yrs: 1.08 (0.70 to 2.42)

Walking disability (walking distance <400 m), RR, 95% CI

1 yr: 0.91 (0.51 to 4.24) 2 yrs: 1.18 (0.67 to 4.72)

Weinstein	289 in the RCT,	1)	Assigned to surgery: Standard	1)	SF-36 bodily	All between group comparisons using Intention-to-Treat
2008, 2010,	365 in the		laminectomy with or without fusion		pain	Analysis
Lurie 2015	observational		(n=138)	2)	SF-36 bodily	SF-36 Bodily Pain, DMC, 95% CI
	cohort. 62% male				function	2 yrs: 7.8 (1.5to 14.1)
	in the surgical	2)	Assigned to non-surgical treatment:	3)	Low back pain	4 yrs: 0.3 (-6.4 to 7)
	groups, 59%		Usual non-operative care -	ĺ	bothersomene	8 yrs: p=0.25
	male in the non-		recommended to include at least		ss scale	SF-36 Bodily Function, DMC, 95% CI
	surgical groups.		active physical therapy, education or	4)	Leg pain	2 yrs: 0.1 (-6.4 to 6.5)
	Average age of	4	counseling with home exercise		bothersomene	4 yrs: -3.2 (-9.9 to 3.6)
	63.8 in the		instruction, and the administration of		ss scale	8 yrs: p=0.89
	surgical group,		NSAIDs, if tolerated (n=151)	5)	ODI	Disability (ODI), DMC, 95% CI
	66.1 in the non-			6)	Subjective	2 yrs: -3.5 (-8.7 to 1.7)
	surgical group.				self-reported	4 yrs: 0.2 (-5.2 to 5.7)
	60% in the				improvement,	8 yrs: p=0.87
	surgical group				satisfaction	
	and 55% in the				with current	Other outcomes (patient's satisfaction; Stenosis Bothersomeness
	non-surgical				symptoms and	Index, Leg Pain Bothersomeness Scale; and Low Back Pain
	group had				care,	Bothersomeness Scale) were not provided separately for the
	symptoms for			7)	Stenosis	randomized cohort.
	over 6 months.				bothersomene	
					ss index	Adverse events: In group 1, 10% of patients required
	Setting: multi-					transfusions intraoperatively and 5% postoperatively.
	centred-			Fo	llow-up: 6	The most common surgical complication was dural tear, in 9%
	orthopaedic			we	eks, 3 and 6	of patients. At 2 years, reoperation had occurred in 8% of
	departments in			mo	onths, 1, 2, 4, 8	subjects.
	the United States.			yea	nrs	
Delitto 2015	169 patients, 88	1)	Surgical decompressive	1)	SF-36 physical	2 years -SF-36 Physical Function, MD and 95% CI
	males and 81		laminectomies, partial facet		ection	0.9 (7.9 to 9.6)
	females, 87		resection, and neuroforaminotomies			
	surgical group		(n=87)	Fo	llow-up: 2 years	Adverse events: 9 out of 82 participants in group 2 reported
	with an average				• •	adverse events consisting of worsening of symptoms whereas 33
	age of 66.6 years	2)	PT program: lumbar flexion			out 87 participants in group 1 reported surgery related
	old and 82 PT		exercises, exercises and education			complications, mainly attributable to reoperation, delay in
	group with an		(n=82)			wound healing and surgical site infection.
	average age of					
	69.8 years old,					
	LSS by computed					

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tomography - criteria of Wiesel and colleagues (18) or magnetic resonance imaging - criteria of Boden and colleagues (2)  Setting: Neurologic and orthopedic surgery departments and physical therapy clinics in western	Ao <sub>r</sub> o <sub>ro</sub> ee <sub>r</sub>
clinics in western	
Pennsylvania	

ADLs = Activities of Daily Living, AUC = Area under the pain-intensity curve, BTX = Botox, CI = Confidence Interval, DMC = Difference in mean change from baseline, ESI = Epidural Steroid Injection, FRI = Functional Rate Index, GRP = Group, HADS = Hospital Anxiety and Depression Scle, IU = International Units, JOABPEQ = Japanese orthopaedic association back pain evaluation questionnaire, LBOS = Low Back Outcome Score, LBP = Low Back Pain, m = Meters, MCS = Mental Component Score, MD = Mean Difference, mm = Millimeters, Mo = Months, MPC = Mean Percent Change, NRS = Numerical Pain Rating Scale, NR = Not Reported, ODI = Oswestry Disability Index, OR = Odds Ratio, PASS-20 = Pain Anxiety Symptoms Scale, PCS = Physical Component Score, RCT = Randomized Controlled Trial, RMDI = Roland Morris Disability Index, ROM = Range of Motion, RR = Relative Risk, SBI = Stenosis Bothersomeness Index, SPWT = Self-Paced Walking Test, SSS = Spinal Stenosis Questionnaire, TSK-11 = Tampa Scale-11, VAS = Visual Analogue Scale, WMD = Weighted Mean Difference, ZCQ = Zurich Claudication Questionnaire

# Supplemental Table 2. Non operative interventions for neurogenic claudication due to lumbar spinal stenosis: A summary of GRADE assessment and outcomes (60 comparisons)

						Walking	ability/pain/function	n/quality of life mea	isures	GRADE
Studies	Risk of Bias	Consistency	Directness	Precision	Selective Reporting	Immediate up to 1w	Short-term >1w - 3m	Intermediate 3m – 1yr	Long term >1yr	
						Calcitonin				
				C	alcitonin ir	jection vs. placeb	o injection			
Eskola	High	No	Yes	No	Yes	J1	= TWT	= TWT	= TWT	+000
1992		No	Yes	No			= VAS	= VAS	= VAS	+000
Porter 1983	High	No	Yes	No	Yes		? Distance walked	? Distance walked		+000
Porter	High	No	Yes	No	Yes		= Distance walked			+000
1988		No	Yes	No			= VAS			+000
				Cal	lcitonin na	sal spray vs. place	bo injection			
Podichetty	High	No	Yes	No	Yes		= Distance walked			+000
2004		No	Yes	No			= Time walked			+000
		No	Yes	No			= SF-36			+000
		No	Yes	No			= VAS			+000
Tafazal	High	No	Yes	No	No		= Shuttle walk			+000
2007		No	Yes	No			= VAS leg			+000
		No	Yes	No			= VAS back			+000
		No	Yes	No			= ODI			+000
		No	Yes	No			= Global			+000
					<del></del>	cal therapy vs. pai	racetamol plus phy	sical therapy		
Sahin	High	No	Yes	No	No		= Distance walked			+000
2009		No	Yes	No			= VAS			+000
		No	Yes	No			= RMDI			+000
					(	Oral Medication				
				O	ral prostag	glandin vs. Etodlac	(NSAID)			
Matsudaira	Low	No	Yes	No	Yes		> Distance walked #			++00
2009		No	Yes	No			? SF-36			+000
		No	Yes	No			= LBP			++00
		No	Yes	No			> Leg pain			++00
		No	Yes	No			> Global #			++00
			Methyloo	cobalami	n (vit B12)	plus conservative	care vs. conserva	tive care		
Waikakul 2000	High	No	Yes	No	No			> Distance walked #	> Distance walked #	+000

High		1 /	merapy,	COISCI &	NSAIDS vs. placeb	oo pius piiysicai u	iciapy, coisci & iv	SAIDS	
nigii	No	Yes	No	No		= VAS	> Distance walked	> Distance	+000
	No	Yes	No				> VAS	walked #	+000
	No	Yes	No					> VAS #	
				Prega		cebo			
High	No		No	No					+000
									+000
									+000
									+000
	No	Yes	No		< RMDQ				+000
		Gal	papentin	plus conse	ervative vs. conserv	ative plus botulin	ıum		
High	No	Yes	No	No		= NPS (Back/leg)			0000
	No	Yes	No			= ODI			0000
	No	Yes	No			= Global			0000
				70					
			О	xymorpho	one hydrochloride v	vs. placebo			
High	No	Yes	No	No	= NPS rest/final				0000
	No	Yes	No		= Distance walked				0000
	No	Yes	No		= Recovery Time				0000
	No	Yes	No		= ZCQ (s)				0000
	No	Yes	No		= ZCQ (f)				0000
	No	Yes	No		= Global				0000
			Pr	opoxyphe		vs. placebo			
High	No	Yes	No	No					0000
	No	Yes	No		= Distance walked				0000
	No	Yes	No		= Recovery Time				0000
	No	Yes	No		= ZCQ (s)				0000
	No	Yes	No		< ZCQ (f) #				0000
	No	Yes	No		= Global				0000
		Oxy	morphor	e hydroch	iloride vs. propoxy	phene/acetaminor	ohen	-	
High	No	Yes	No	No	= NPS rest/final				0000
5	No	Yes	No		= Distance walked				0000
	No	Yes	No						0000
	No	Yes	No						0000
	No		No						0000
	No	Yes	No		= Global				0000
				Orol		eho.			
	High High	High No	High	High	High	High	Pregabalin vs. active placebo	High	High

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Rodrigues	High	No	Yes	No	No	= SF-36			0000
2014		No	Yes	No		= RMDQ			0000
		No	Yes	No		= 6 min walk			0000
		No	Yes	No		< VAS #			0000
						Therapy and Multimodal Care			
			E	xercise p	lus ultraso	und vs. exercise plus sham ultrasoun	d		
Goren	low	No	Yes	No	No	= TWT			++00
2010		No	Yes	No		= VAS back			++00
		No	Yes	No		= VAS leg			++00
		No	Yes	No		= ODI			++00
				E	xercise plu	s ultrasound vs. no treatment			
Goren	Low	No	Yes	No	No	= TWT			++00
2010		No	Yes	No		= VAS back			++00
		No	Yes	No		> VAS leg #			++00
		No	Yes	No		> ODI			++00
				Exer	cise plus si	ham ultrasound vs. no treatment			
Goren	Low	No	Yes	No	No	= TWT			++00
2010		No	Yes	No		= VAS back			++00
		No	Yes	No		> VAS leg #			++00
		No	Yes	No		> ODI #			++00
			In-patient	physical	therapy vs	s. home exercise program plus oral d	iclofenac		
Koc	High	No	Yes	No	Yes	= TWT	= TWT		+000
2009		No	Yes	No		= VAS	= VAS		+000
		No	Yes	No		=RMDI	= RMDI		+000
		No	Yes	No		= NHP	= HNP		+000
			Unweig	ghted trea	admill wal	king plus exercise vs. cycling plus ex	kercise		
Pua	Low	No	Yes	No	No	= Distance walked			++00
2007		No	Yes	No		= ODI			++00
		No	Yes	No		= RMDI			++00
		No	Yes	No		= VAS			++00
		No	Yes	No		= Global			++00
	Ma	nual thera	apy, exercis	se and un	weighted 1	readmill vs. flexion exercise, walking	g and sham ultras	ound	
Whitman	High	No	Yes	No	No	= TWT			+000
2006		No	Yes	No		> Global #			+000
		No	Yes	No		= ODI			+000
		No	Yes	No		= NPRS			+000
		110	103		myigad phy	rsical therapy vs home exercises			. 000
				Supe	i viscu pily	sical dictapy vs hollie exercises			

Minetama	High	No	Yes	No	No		> ZCQ (F) #			+000
2019	5	No	Yes	No			>ZCQ (S) #			+000
2019		No	Yes	No			> Distance walked #			+000
		No	Yes	No			> NPS (leg)			
		No	Yes	No			> SF-36 PF			+000
		No	Yes	No			> SF-36 BP			+000
		No	Yes	No			= Daily Steps			+000
		No	Yes	No			Dully Steps			+000
				Ma	nual thera	py & exercise vs	medical care	<u>'</u>		
Schneider	Low	No	Yes	Yes	No		> ZCQ #	= ZCQ		+++0
2019		No	Yes	/Yes			= SPWT	= SPWT		+++0
		No	Yes	Yes			= PA	= PA		+++0
				Manua	l therapy &	exercise vs. con	nmunity exercise			
Schneider	Low	No	Yes	Yes	No		> ZCQ #	= ZCQ		+++0
2019		No	Yes	Yes			= SPWT	= SPWT		+++0
		No	Yes	Yes	<b>\</b> \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \		= PA	= PA		+++0
					Communi	ty exercise vs. me	dical care			
Schneider	Low	No	Yes	Yes	No		= ZCQ	= ZCQ		+++0
2019		No	Yes	Yes			= SPWT	= SPWT		+++0
		No	Yes	Yes			> PA	= PA		+++0
			Cor	nprehens	ive therap	y and exercise vs.	self-directed exerc	ise		
Ammendolia	Low	No	Yes	Yes	No	> SPWT #	> SPWT #	> SPWT #	> SPWT #	+++0
2018		No	Yes	Yes		> 30% SPWT	> 30% SPWT	> 30% SPWT	>30% SPWT	+++0
		No	Yes	Yes		> 50% SPWT	= 50% SPWT	= 50% SPWT	> 50% SPWT	+++0
		No	Yes	Yes		> ZCQ (s)	= ZCQ (s)	= ZCQ (s)	> ZCQ (f) #	++00
		No	Yes	Yes		= ZCQ (f)	= ZCQ (f)	= ZCQ (f)	> ZCQ (s) +	++00
		No	Yes	Yes		= ODI	= ODI	> ODI (walk)	ZCQ (f)	++00
		No	Yes	Yes		> NPS (back) #	= NPS (back)	= NPS (back)	= ODI	++00
		No		Yes		= NPS (leg)	= NPS (leg)	= NPS (leg)	= NPS (back)	++00
						= SF-36 BP	= SF-36 BP	= SF-36 BP	> SF-36 BP #	++00
			ļ			= SF-36 PF	> SF-36 PF #	= SF-36 PF	>SF-36 PF #	++00
				St	tandard ex	ercise vs. isokinet		<u>'</u>		
Oğuz	High	No	Yes	No	Yes	= VAS	= VAS	= VAS		0000
2013		No	Yes	No		= ODI	= ODI	= ODI		0000
		No	Yes	No		= TWT	= TWT	= TWT		0000
				S	Standard ex	kercise vs. unload	ed exercise			
Oğuz	High	No	Yes	No	Yes	< VAS	< VAS	= VAS		0000
2013		No	Yes	No		< ODI	= ODI	= ODI		0000
		No	Yes	No		= TWT	= TWT	= TWT		0000

				Iso	okinetic ex	ercises vs. unloade	d exercises			
Oğuz	High	No	Yes	No	Yes	< VAS	= VAS	= VAS		0000
2013	13.83	No	Yes	No		< ODI	< ODI	= ODI		0000
		No	Yes	No		< TWT #	< TWT	= TWT		0000
			•	Aquatic	physical tl	herapy exercise vs.	physical therapy			
Homayouni	High	No	Yes	No	Yes	> VAS #	= VAS			0000
2015		No	Yes	No		> Distance walked	= Distance walked			0000
			Pre-surgica	al exerci	se program	vs. routine preope	rative hospital ma	nagement		
Marchand	High	No	Yes	No	Yes	> NPS (leg) #	= NPS (leg)	= NPS (leg)		0000
2019	8	No	Yes	No		> Duration walked #	= Duration walked	= Duration walked		0000
Gang-C	huk Tang	(herbal co	oncoction)	daily M	lokuri Chu	na therapy, daily ac	ununcture nhysic	rian consultation v	s oral aceclofer	าลด
Garig-C	muk Tang	(IICIOai C	siicoction),	_		oid injection, physic		Ziaii Collouitation v	s. orar accerorer	iac,
***	1 -					ola injection, physic	1 2	T *** G // >		. 000
Kim	Low	No	Yes	No	Yes		= VAS (leg)	= VAS (leg)		+000
2019		No	Yes	No			= VAS (back)	> VAS (back) #		+000
		No	Yes	No			> OCS	= OCS		+000
		No	Yes	No			> Distance walked	> Distance walked		+000
Mo	okhuri Chi	ına, acupu	incture, and	d physic:	ian consult	ation vs. oral acecle	ofenac, epidural s	teroid injection, pl	nysical therapy	
Kim	Low	No	Yes	No	Yes	>VAS (low back)#	= VAS (leg)	> VAS (leg) #		+000
2019	20.11	No	Yes	No	1 65	· · · · · · · · · · · · · · · · · · ·	= VAS (back)	> VAS (back) #		+000
_019		No	Yes	No			= OCS	= OCS		+000
		No	Yes	No			= Distance walked	= Distance walked		+000
			l		Sn	inal Manipulation		1		
				I		nal manipulation v				
Passmore	High	No	Yes	No	No	= NPS (Back)				0000
2017	6	No	Yes	No		= NPS (Leg)				0000
						Agunungtura				
						Acupuncture with usual care vs.	1			
				Λ.		*************	*****			

Kim	High				No		6 weeks:			
2016	Ingii	No	Yes	No	110		= ODI			0000
2010		No	Yes	No			= SF-36 BP			0000
		No	Yes	No			= SF-36 PF			0000
		No	Yes	No			= LBP			0000
		No	Yes	No			= Leg pain			0000
		No	Yes	No			= Distance walked			0000
							3 months:			
		No	Yes	No			= ODI			0000
		No	Yes	No			= SF-36 BP			0000
		No	Yes	No			= SF-36 PF			0000
		No	Yes	No			= LBP			0000
		No	Yes	No			= Leg pain			0000
		No	Yes	No			= Distance walked			0000
					Acupunc	ture vs. sham acup	uncture			
Qin	Low	No	Yes	No	No	> RMDQ	> RMDQ	> RMDQ		++00
2020		No	Yes	No		> NRS (back) #	> NRS (back) #	> NRS (back)		++00
		No	Yes	No		> NRS (leg) #	> NRS (leg) #	> NRS (leg) #		++00
		No	Yes	No		> SSS-S #	> SSS-S #	> SSS-S #		++00
		No	Yes	No		> SSS-F #	> SSS-F #	> SSS-F #		++00
		No	Yes	No		= SPWT	= SPWT	= SPWT		++00
					E	pidural Injection				
			Tra	nslamina	r epidural	steroid injections v	s. placebo injection	ons		
Cuckler	High	No	Yes	No	No	= Global			=global	+000
1985										
			Translan	ninar epid	dural stero	ids plus epidural bl	lock vs. placebo ir	njections		
Fukusaki	High	No	Yes	No	No	> Distance walked #	= Distance walked			+000
1988										
		T	ranslamina	ar epidura	al steroids	plus epidural block	x vs. epidural bloc	k injections		
Fukusaki	High	No	Yes	No	No	= Distance walked	= Distance walked			+000
1988										
				T	ranslamin	ar epidural block v				
Fukusaki	High	No	Yes	No	No	> Distance walked #	= Distance walked			+000
1988										
		Intralamir	nar epidura	1 steroid	plus epidu	ral block vs. home	exercise program	plus oral diclofe	enac	
Koc	High	No	Yes	No	Yes		= TWT	= TWT		+000
2009		No	Yes	No	Yes		> VAS #	= VAS		+000
	1	No	Yes	No	Yes		> RMDI #	= RMDI		+000

		No	Yes	No	Yes		> NHP	= HNP		+000
		Iı	ntralamina	r epidura	l steroid pl	us epidural block	vs. in-patient physi	cal therapy		
Koc	High	No	Yes	No	Yes	_	= TWT	= TWT		+000
2009		No	Yes	No	Yes		= VAS	= VAS		+000
		No	Yes	No	Yes		= RMDI	= RMDI		+000
		No	Yes	No	Yes		= NHP	= HNP		+000
						l steroids vs. place	ebo injections			
Zahaar 1991	High	No	Yes	No	No	= Global			= Global	+000
			N	Mild luml	bar decomp	pression vs. epidu	ral steroid injection	1		
Brown	High	No	Yes	No	No		= VAS			0000
2012	_	No	Yes	No			= ODI			0000
		No	Yes	No			= ZCQ			0000
		No	Yes	No			12 weeks:			
				1			= VAS			0000
		No	Yes	No			= ODI			0000
		No	Yes	No			= ZCQ			0000
				]	Lidocaine	vs. glucocorticoid-	-lidocaine			
Friedly 2014,	Low				No	8	3 weeks:	12 weeks:	12 months:	
2017		No	Yes	Yes			< RMDQ	= RMDQ	= RMDQ	+++0
		No	Yes	Yes			< NPS (leg)	= NPS (leg)	= NPS (leg)	+++0
							6 weeks:	6 months:	( 2)	
		No	Yes	Yes			= RMDQ	= RMDQ		+++0
		No	Yes	Yes			= NPS (leg)	= NPS (leg)		+++0
							Makris 2016			
							3 weeks:			
Makris 2016	Low	No	Yes	No	Yes		< RMDQ using SIP			0000
							Weights			
		No	Yes	No	Yes		< RMDQ Patient-			0000
							Prioritized			
							(LESSER)			
							6 weeks:			
		No	Yes	No	Yes		< RMDQ using SIP			
							Weights			0000
		No	Yes	No	Yes		= RMDQ Patient-			
							Prioritized			0000
							(LESSER)			

				Lidoca	ine spinal i	njection vs. saline	spinal injection			
Song	High				No		1 month:			
2016	111811	No	Yes	No	1.0		= VAS			0000
2010		No	Yes	No			= FRI			0000
		110	1 05	110			3 months:			
		No	Yes	No			= VAS			0000
		No	Yes	No			= FRI			0000
	Fluoro				SIS at the	level of maximal s		ervertebral levels	cephalad	0000
Milburn	High				No	1 week:	4 weeks:		1	
2014	mgn	No	Yes	No	110	> NPS (walking) #	> NPS (walking) #			0000
2011		No	Yes	No		> RMDQ #	> RMDQ			
		No	Yes	No		12.12 ( "	12 weeks:			0000
		1,0	1 00				= NPS (walking)			
		No	Yes	No			> RMDQ			0000
		No	Yes	No			, IGNDQ			0000
		110	1 03		al steroid ini	ection (ESI) Vs. ESI	& physiotherapy			0000
Hammerich	High	No	Yes	No	No		= ODI	= ODI	= ODI	0000
2019	8	No	Yes	No			= NPS	> NPS #	> NPS #	0000
		No	Yes	No			> SF-36 ER #	= SF-36 ER	= SF-36 ER	0000
		No	Yes	No			> SF-36 EWB	= SF-36 EWB	= SF-36 EWB	0000
		No	Yes	No			> SF-36 GH	= SF-36 GH	= SF-36 GH	0000
			Ţ	nterlamii	ı nar vs. tran	sforaminal epidura	al steroid injection			
Sencan 2020	High		1		Yes	= NPS	3 weeks:	3 months:		
Senean 2020	riigii	No	Yes	No	103	1115	= NPS	> NPS		0000
		No	Yes	No			= ODI	= ODI		0000
		No	Yes	No			> BDS	> BDS		0000
		No	Yes	No			= Distance walked	> Distance walked #		0000
		110	103	140			Distance warked	> Distance wanted #		0000
		No	Yes	No						0000
		No	Yes	No						0000
		No	Yes	No						0000
		No	Yes	No						0000
		110	168		ha inhibita	or (Etanercept) vs.	steroid injection			0000
M : 2020	т	N.T.				` • ′	•	C 41		1 + +00
Wei 2020	Low	No	Yes	No		> VAS #	1, 3 months:	6 months:		++00
		No	Yes	No			> VAS #	> VAS #		++00
		No	Yes	No TNE	Calmba isla	hitan (Etamana ant)	> ODI #	> ODI #		++00
				INF	aipna inn	bitor (Etanercept)	vs. mocame			

Wei 2020	Low	No	Yes	No		> VAS #	1, 3 months:	6 months:		++00		
W C1 2020	Low	No	Yes	No		· VIIII	> VAS #	> VAS #		++00		
		No	Yes	No			> ODI #	> ODI #		++00		
		110	1 25	1.0	Steroi	d vs. lidocaine inje		05111	I			
*** : 2020	T .		1		1			T.c. 1	Т	++00		
Wei 2020	Low	No	Yes	No		= VAS	1, 3 months:					
		No	Yes	No			= VAS	= VAS		++00		
		No	Yes	No			= ODI	= ODI		++00		
					Percutane	ous Epidural Adl	hesiolysis					
			Ballo	on-less c	atheter (Ra	cz) vs. inflatable b	oalloon catheter (Z	iNeu)				
Karm 2018	High			4	No		1 month:	6 months:				
		No	Yes	No			= NPS (back)	< NPS (back) #		0000		
		No	Yes	No			= NPS (leg)	< NPS (leg) #		0000		
		No	Yes	No			= ODI	< ODI		0000		
							3 months:					
		No	Yes	No			= NPS (back)			0000		
		No	Yes	No			= NPS (leg)			0000		
		No	Yes	No			= ODI			0000		
	•		•		Surger	y vs. Physical Th	erapy					
				Intersp	inous spac	eer (X_Stop) vs. no	on operative care					
Zucherman	High	No	Yes	No	No		> ZCQ(S)#	> ZCQ(S)#	> ZCQ(S)#	+000		
2004, 2005,		No	Yes	No			> ZCQ(F)#	> ZCQ(F)#	> ZCQ(F)#	+000		
Hsu 2006							> SF-36 PF	> SF-36 PF	> SF-36 PF#	+000		
							> SF-36 BP	> SF-36 BP	> SF-36 BP#	+000		
							> SF-36 GH	> SF-36 GH	> SF-36 GH	+000		
							> SF-36 ER	> SF-36 ER	> SF-36 ER#	+000		
		La	minectom	y +/- fusi	on vs. non	operative care for	degenerative spor	ndylolisthesis				
			•			•						

	T				T				Ι.	,
Weinstein	High	No	Yes	No	No		= SF-36 BP, PF	= SF-36 BP, PF	2 years:	
2007, 2009		No	Yes	No			= ODI	= ODI	= SF-36 BP, PF	+000
Abdu 2018		No	Yes	No			= LBPBS	= LBPBS	= ODI	+000
		No	Yes	No			= LPBI	= LPBI	= LBPBS	+000
		No	Yes	No			= SBS	= SBS	= LPBI	+000
									= SBS	+000
		No	Yes	No					4 years:	
		No	Yes	No					= SF-36 BP, PF	+000
		No	Yes	No					= ODI	+000
		No	Yes	No					= LBPBS	+000
		No	Yes	No					= LPBI	+000
									= SBS	+000
		No	Yes	No					8 years:	
		No	Yes	No					= SF-36 BP, PF	+000
		No	Yes	No					= ODI	+000
		No	Yes	No					= LBPBS	+000
		No	Yes	No	$^{\sim}$				= LPBI	+000
									= SBS	+000
				Lam	inectomy -	-/- fusion vs. non o	perative care			
Amundsen	High	No	Yes	No	No		?* Pain severity	?* Global	?* Pain severity	+000
2000		No	Yes	No					? Global	+000
Malmivaara	Low	No	Yes	No	No			= TWT	= TWT	++00
2007		No	Yes	No				= SW	= SW	++00
N= 94		No	Yes	No				> VAS leg walk #	> VAS leg walk	++00
		No	Yes	No				> VAS LB walk #	#	++00
		No	Yes	No				> ODI	> VAS LB walk	++00
									#	
									> ODI	++00
Weinstein	High	No	Yes	No	No		= SF-36 BP	= SF-36 BP	2 years:	+000
2008, 2010,	8	No	Yes	No			= SF-36 PF	= SF-36 PF	> SF-36 BP **	+000
Lurie 2015		No	Yes	No			= LBPBS	= LBPBS	#	+000
		No	Yes	No			= LPBI	= LPBI	= SF-36 PF	+000
		No	Yes	No			= SBS	= SBS	= LBPBS	+000
		No	Yes	No			= ODI	= ODI	= LPBI	+000
									= SBS	+000
									= ODI	
									4 years:	+000
									=SF-36 BP **	+000
									= SF-36 PF	+000
									= LBPBS	+000
									= LPBI	+000
<u> </u>	1		I		<u> </u>					1000

									= SBS 8 years: = SF-36 BP = SF-36 PF	+000 +000 +000
									= ODI = Stenosis Index	+000
			Lamine	ctomy, fa	cet resecti	on, neuroforaminot	omy vs. physical t	therapy		
Delitto 2015	High	No No	Yes Yes	No No	No				2 years: = SF-36 = ODI	+000
> favours int	ervention (f	irst comparis	son), < favou	rs control	second com	parison), = no difference	ce between intervention	on and control groups	s, TWT= Treadmil	1

Walking Test, VAS= Visual Analog Scale for Pain Intensity, RMDI= Roland-Morris Back Disability Index, NHP= Nottingham Health Profile, Global= Patient Perceived Improvement, SR= Selective Reporting, ODI= Oswestry Back Disability Index, ?= insufficient data, LBP= Low back Pain Severity Scale, Leg pain= Leg Pain Severity Scale, ? SF-36=No data on overall score, improvement in some subscales, NPRS= Numeric Pain Rating Scale, SF-36 BP= SF-36 Bodily Pain Subscale, SF-36-PF= SF-36 Physical Function Subscale, SF-36 ER= SF-36 emotional role subscale, SF-36 EWB= SF-36 emotional well-being subscale, SF-36 GH= SF-36 General health subscale, LBPBS= Low Back Pain Bothersome Scale, LPBI= Leg Pain Bothersome Index, SBS= Stenosis Bothersome Scale, SW= Subjective Walking, VAS leg= Visual Analog Scale for Leg Pain, VAS LB= Visual Analog Scale for Low Back Pain, VAS leg walking= Visual Analog Scale for Leg pain while walking, SIP= sickness index profile, BDS= Beck Depression Score, LESSER= Lumbar Epidural Steroid Injection for Spinal Stenosis Extended Research, PA= Physical Activity, FRI= Functional Rating Index, TWT= Total Walking Time, SSS= Spinal Stenosis Questionnaire, ?\*= no between group statistical comparisons, \*\*= SF-36 BP significantly better at 2 years but not 4 years.
GRADE evidence; +000= Very low GRADE evidence, ++00= Low GRADE, +++0= Moderate GRADE evidence, ++++= High GRADE evidence # between group difference meeting the MCID. The MCID used were: ≥1.25 points for back pain and≥1.5 points for leg pain on 0 to 100-point Visual Analogue Scale (VAS) and 0 to 10-point Numerical Rating Scale (NRS) for back pain (58), ≥5 points on 0- to 24-point Roland-Morris Disability Questionnaire (RMDQ) (59), ≥8 points for conservative treatment and ≥12 points for back pain (58), ≥5 points for Oswestry Disability Index (ODI) (60), ≥ 0.1 points for the functional component and 0.36 points for symptom component of the Zurich Claudication Questionnaire (ZCO) (58), > 0.38 points for combined symptoms and functional

scores of the ZCQ (92), > 30% between-group difference for walking distance, global improvement and SF36 subscales (61).

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# PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE	-		
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT	1		
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 6-7
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 7
METHODS	_		
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 9
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 8-9
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 8-9
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 9
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 9
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 8 & 10
7 3 9	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 8-10 Supplemental Table 1
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 9-10
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 11-12
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 11-12
5	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 11-12
3	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Supplemental Table 2
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 10
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
3	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	NA

# **PRISMA 2020 Checklist**

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Figure 1
Study characteristics	17	Cite each included study and present its characteristics.	Supplementa Table 1
Risk of bias	18	Present assessments of risk of bias for each included study.	Table 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Supplementa Table 1 & 2
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Table 2
syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Supplementa Table 2
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Supplementa Table 2
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 25-26
	23b	Discuss any limitations of the evidence included in the review.	Page 28-29
	23c	Discuss any limitations of the review processes used.	Page 28-29
	23d	Discuss implications of the results for practice, policy, and future research.	Page 28
OTHER INFORMA			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 7
protocor	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 30
Competing interests	26	Declare any competing interests of review authors.	Page 30
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	NA

# **BMJ Open**

# Nonoperative treatment for lumbar spinal stenosis with neurogenic claudication: An updated systematic review.

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#### **ABSTRACT**

- 2 Objectives: Neurogenic claudication due to lumbar spinal stenosis (LSS) is a growing health problem in older adults. We updated our
- 3 previous Cochrane review (2013) to determine the effectiveness of nonoperative treatment of LSS with neurogenic claudication.
- **Design:** A systematic review.
- **Data Sources**: CENTRAL, MEDLINE, EMBASE, CINAHL, and ICL databases were searched and updated to July 22<sup>nd</sup>, 2020.
- 6 Eligibility criteria: We only included randomized controlled trials published in English where at least 1 arm provided data on
- 7 nonoperative treatment and included participants diagnosed with neurogenic claudication with imaging confirmed LSS.
- 8 Data Extraction and synthesis: Two independent reviewers extracted data and assessed risk of bias using the Cochrane Risk of Bias
- 9 Tool One. Grading of Recommendations Assessment, Development, and Evaluation (GRADE) was used for evidence synthesis.
- **Results:** Of 15,200 citations screened, 156 were assessed and 23 new trials were identified.
- There is moderate quality evidence from 3 trials that: Manual therapy and exercise provides superior and clinically important short-
- term improvement in symptoms and function compared to medical care or community-based group exercise; Manual therapy,
- education and exercise delivered using a cognitive-behavioural approach, demonstrates superior and clinically important
- improvements in walking distance in the immediate to long-term compared to self-directed home exercises; Glucocorticoid plus
- 15 lidocaine injection is more effective than lidocaine alone in improving statistical, but not clinically important improvements in pain
- and function in the short-term.

- 1 The remaining 20 new trials demonstrated low or very low-quality evidence for all comparisons and outcomes, like the findings of our
- 2 original review.
- 3 Conclusions: There is moderate quality evidence that a multimodal approach which includes manual therapy and exercise, with or
- 4 without education is an effective treatment, and that epidural steroids are not effective for the management of LSS with neurogenic
- 5 claudication. All other nonoperative interventions provided insufficient quality evidence to make conclusions on their effectiveness.
- 7 This systematic review was registered with PROSPERO registration number CRD42020191860.

#### ARTICLE SUMMARY

### 10 Strengths and limitations of this study

- This systematic review included a wide range of nonoperative interventions commonly used in clinical practice.
- This review used consistent inclusion and exclusion criteria for neurogenic claudication, which included the corroboration of a
   diagnosis of lumbar spinal stenosis with imaging.
  - This review used rigorous methods recommended by the Cochrane Back and Neck Pain Review Group including the use of
    Grading of Recommendations, Assessment, Development and Evaluation (GRADE) to synthesize and summarize the quality
    of the evidence.
- Only English studies were included in this review.

 • Most studies had small samples sizes with heterogeneity in interventions tested, limiting ability to pool data.

Key words: neurogenic claudication, lumbar spinal stenosis, systematic review, nonoperative treatment, elderly

#### INTRODUCTION

- Lumbar spinal stenosis (LSS) causing neurogenic claudication is a highly prevalent and rapidly growing public health problem among older adults (1). It is characterized by bilateral or unilateral buttock pain and/or lower extremity discomfort, pain, weakness, or heaviness precipitated by walking and prolonged standing and relieved by stooping forward and sitting (2, 3). The underlying etiology is usually age-related osteoarthritic changes to lumbar intervertebral discs, facets joints and ligaments leading to narrowing of the central and/or lateral spinal canals and compression and/or ischemia of the spinal nerves (2, 4).
- Limited walking ability is the dominant impairment in neurogenic claudication and the most common reason for seeking care (5).
- Limited walking ability due to LSS is associated with a significant decline in functional status, quality of life and independence in this
- population (2, 5).
- Although lumbar spinal stenosis is the most common reason for spine surgery in older adults, most people with neurogenic
- 17 claudication receive nonoperative care (6). A course of nonoperative care is also recommended prior to receiving surgical intervention
- 18 (7). However, what constitutes effective nonoperative care remains unknown. In 2013 we published a Cochrane review evaluating

- 1 nonoperative treatment for LSS causing neurogenic claudication (8, 9). This review identified 21 randomized controlled trials
- 2 assessing a variety of nonoperative treatments. However, the quality of the evidence was deemed low or very low and therefore no
- 3 conclusions could be made on the effectiveness of nonoperative treatment for neurogenic claudication. The purpose of this study is to
- 4 update this systematic review and the evidence for nonoperative treatments for neurogenic claudication. Our specific research question
- 5 was: What nonoperative interventions are effective in improving outcomes in patients with neurogenic claudication due to lumbar
- 6 spinal stenosis?

**METHODS** 

- 10 This systematic review was registered with PROSPERO registration number CRD42020191860 and was conducted and reported
- according to the PRISMA guidelines (10). We used methods recommended by the Cochrane Back Review Group (11).
- 12 Ethics Approval Statement
- 13 Ethics approval was not required for conducting this systematic review.
  - Patient and Public Involvement Statement
- Patients or the public were not involved in the conduct of this systematic review.

### Population, Interventions, Comparison and Outcomes (PICO Criteria)

- 2 The population of interest was individuals with imaging confirmed LSS (central or foraminal, with or without spondylolisthesis) and
- 3 neurogenic claudication. Neurogenic claudication is a clinical diagnosis and was defined as buttock or leg pain and/or aching,
- 4 numbness, tingling, weakness, or fatigue with or without back pain, precipitated by standing or walking. There were no age
- 5 restrictions. The interventions of interest included all nonoperative treatments and the comparison was any treatment including
- 6 surgery. Outcomes included at least one of the following measures: walking ability, pain intensity, physical function, quality of life, or
- 7 global improvement.

# Search and Study Selection

- We replicated and updated our original electronic database search (from 1966 to January 2011) to July 22<sup>nd</sup> 2020. The search was
- performed by an experienced librarian in CENTRAL (Cochrane Library 2011 issue1), Medline, EMBASE, CINAHL and Index to
- 12 Chiropractic Literature. The terms "spinal stenosis," "lumbar spinal stenosis," "neurogenic claudication," "lumbar radicular pain,"
- "cauda equina," and "spondylosis" were combined with a highly sensitive search strategy to identify randomized controlled trials
- 14 (RCTs). Reference lists of selected studies and previous reviews were also searched to identify additional articles. Supplemental file 1
- provides details on the full search strategies used for all databases.

- 1 Studies were included if they were RCTs published in peer reviewed English journals, at least one arm of the trial provided data on
- 2 effectiveness of a nonoperative treatment and at least 80% of subjects had neurogenic claudication with imaging confirmed LSS.
- 3 Studies evaluating subjects with radiculopathy caused by disc herniations without neurogenic claudication were excluded.
- 5 Studies with mixed populations were only included if separate data for subjects with neurogenic claudication due to lumbar spinal
- 6 stenosis were provided.
- 8 Two pairs of reviewers independently screened all titles and abstracts identified by the search strategy. Full text of articles deemed to
- 9 be potentially relevant were independently assessed by two reviewers who made the final decision for inclusion. A third reviewer was
- 10 consulted if consensus was not reached.

#### Risk of Bias Assessment and Data Analysis

- 13 Two reviewers independently assessed methodological risk of bias and performed data extraction. Safety data (intervention side
- effects and/or complications) when available were also collected. The Cochrane Risk of Bias Tool 1 was used that included the 12-
- item criteria recommended by the Cochrane Back Review Group (11). Discrepancies in risk of bias scoring and data extraction were
- 16 resolved with discussion and if necessary, with a third reviewer until consensus was reached. Reviewers who were authors of any of

- the included studies were recused from performing risk of bias assessment, data extraction, data analysis or synthesis of their own
- 2 studies.
- 3 Low risk of bias was defined as fulfilling 6 or more of the 12 criteria including clearly described and appropriate randomization (Item
- 4 A), and allocation concealment (Item B), and with no severe flaws. A severe flaw was defined a priori as a serious methodological
- 5 deficiency not captured by the 12-item criteria that significantly increases the risk of bias such as very high dropout or cross-over rates
- 6 and sample sizes less than 30 subjects per treatment arm.
- 8 For each comparison, outcomes were analyzed according to these follow-up time periods: immediate (up to one week following the
- 9 intervention); short-term (between one week and three months); intermediate (between three months and one year) and; long-term
- 10 (one year or longer). Outcome data were pooled, and meta-analyses were performed when trials were judged to be sufficiently
- 11 homogeneous, both clinically and statistically.
- Rehabilitation therapy was defined as treatment that utilized any combination of education, exercise instruction, manual therapy, heat
- and cold applications, electrotherapy, other physical therapy modalities, orthosis, and other assistive devices. Multimodal treatment
- included various combinations of rehabilitation therapy treatments, oral and other mediations, and spinal injections, but not surgery.
- 16 Data Synthesis

- 1 The quality of the evidence for each outcome and for each comparison was evaluated using GRADE (Grades of Recommendations,
- 2 Assessment, Development and Evaluation (12, 13) Overall quality of the evidence was based on performance against five domains: 1)
- 3 risk of bias; 2) consistency of findings; 3) directness of comparisons; 4) precision of estimates; and 5) other considerations such as
- 4 selective reporting.
- 6 The quality of the evidence starts at high when there are consistent findings among at least 75% of RCTs with low risk of bias and
- 7 consistent, direct, and precise data and with no known or suspected publication bias. It downgrades a level for each domain not met.
- 8 Treatment effects between comparators (more effective, less effective or no difference) were based on statistically significant and
- 9 clinically important differences in outcomes.
- High quality evidence all five domains are met; further research is very unlikely to change the confidence in the estimate of effect.
- Moderate quality evidence one of the domains is not met; further research is likely to have an important impact on the confidence
- in the estimate of effect and may change the estimate.
- 14 Low quality evidence two domains are not met; further research is very likely to have an important impact in the confidence of the
- estimate of effect and is likely to change the estimate.
- Very low-quality evidence three or more domains are not met; there is great uncertainty about the estimate of effect.

- 1 Evidence provided by a single small trial was considered inconsistent and imprecise and thus provide "low" or "very low" quality
- 2 evidence, depending on whether it was assessed as having a low or high risk of bias, respectively, and there were no other limitations.
- 3 Studies with both low risk of bias and inappropriate or unclear randomization and/or treatment allocation techniques were downgraded
- 4 by two levels for the "risk of bias" domain.

- 6 The results below are reported based on statistically significant differences between comparators for each outcome using data reported
- by authors. Differences considered clinically important will be specified when the quality of the evidence is moderate or higher. The
- 8 MCIDs we used are listed in Supplemental Table 2. Adverse events for the new studies are detailed when reported by the authors.

1011 RESULTS

**Selection and Description of Included Trials** 

- We screened 15,200 titles and abstracts and assessed 156 full-text articles. This resulted in 44 RCTs meeting the inclusion criteria,
- including 23 new trials. Figure 1 summarizes original and updated screening results. Supplemental Table 1 describes the
- characteristics of all included trials. In total, 3,792 participants (1,765 males, 1836 females and 191 participants of undisclosed gender
- 18 (14, 15) were randomized to one of 60 comparison groups. Seventeen studies evaluated rehabilitation therapy or multimodal care (14,
- 19 16-31), 11 assessed epidural injections (32-42), 7 evaluated oral medications (15, 43-48), 6 assessed calcitonin (49-54), 2 evaluated

- acupuncture (55, 56) and 1 assessed spinal manipulation (57). Thirty-eight trials were conducted at tertiary care or university affiliated
- 2 centres and 6 at medical/rehabilitation clinics (18, 24, 35-38). The mean age of participants was 63.3 years. The duration of symptoms
- 3 varied considerably amongst the studies with a mean ranging from 12 weeks to 15 years. Follow-up periods also varied significantly
- 4 ranging from immediately following the intervention to 10-year post intervention.

# Risk of Bias of Included Studies

7 The median and mean number of criteria met was 7 of 12 (range 2-11), see Table 1.

Table 1. Risk of bias assessment for studies on non-operative treatment for lumbar spinal stenosis with neurogenic claudication

Author	Α	В	С	D	E	F	G	Н	I	J	K	L	Total
Calcitonin													
Eskola 1992	?	?	+	+	+	?	+	-	?	3	?	+	5
Porter 1983	?	?	-	?	?	+	+	?	-	3	+	+	4
Porter 1988	?	?	+	?	?	-	+	+	?	?	?	+	4
Podichetty 2004	?	?	+	+	+	-	+	-	+	?	?	+	6
Tafazal 2007	?	?	+	+	+	+	+	+	-	?	?	+	7
Sahin 2009	?	?	-	-	+	-	?	+	+	?	?	+	4
Oral Medications													
Prostaglandin													
Matsudaria 2009	+	+	-	-	+	+	+	?	+	?	?	+	7*
Methylcabalin													
Waikakul 2000	-	?	-	-	+	+	+	?	+	?	?	+	5
Gabapentin													
Yaksi 2007	?	?	-	-	-	?	+	+	?	?	?	+	3
Pregabalin													
Markman 2015	+	+	+	+	+	+	+	+	?	+	-	+	10 ****

Gabapentin													
Park 2017	+	?	+	+	+	+	+	+	?	?	-	+	8 ****
Oxymorphone Hydrochloride		•				•							•
Markman 2015 (2)	+	+	+	+	+	-	?	+	?	+	+	+	9 **** #
Oral Corticoid							•						
Rodrigues 2014	+	+	?	?	?	+	+	?	?	?	?	+	5
Rehabilitation Therapy or Multim	odal												
Goren 2010	+	+	-	-	+	+	-	+	+	?	?	+	7 *
Koc 2009	?	?	72	-	+	+	+	-	+	?	?	+	5
Pua 2007	+	+	-	- /	+	-	+	+	+	?	-	+	7 *
Whitman 2006	+	?	-	4	+	+	+	+	+	?	?	+	7
Minetama 2019	+	?	- 1	-	+	+	+	+	?	+	+	+	8 ****
Schneider 2019	+	+	-	-	+		+	+	+	?	+	+	8 *
Ammendolia 2018	+	+	-	-	+	+	+	+	+	+	+	+	10 *
Oğuz 2013	3	?	-	-	?	?	+	-	?	?	?	+	2
Homayouni 2015	+	+	-	-	+	+	+		-	+	?	+	7 ****
Marchand 2019	+	+	-	-	+	?	+	+	?	•	+	+	7 ****
Kim 2019	+	+	+	+	+	+	+	+	?	+	+	+	11 *
Coincil Bilania ulation													
Spinal Manipulation		Ι.	Т	T T	Ι.	Τ.	Τ.	ı	Ι.	Ι.	I . //	Ι.	8 ****
Passmore 2017	-	+	-	-	+	+	+	-	+	+	+	+	8 ****
Acupuncture	_	_	_	_	_	_	_	_	_	_	_	_	
Kim 2016	+	+	Τ-	Ι-	T -	Τ-	+	+	T -	+	+	+	7 ****
Qin 2020	+	+	+	-	+	+	+	+	+	-	+	+	10 *
<b>Epidural Injections</b>													
Cuckler 1985	?	?	+	+	+	+	+	+	+	?	+	+	9
Fukusaki 1988	?	3	?	?	+	+	+	+	+	?	+	+	7
Zahaar 1991	?	?	+	?	+	+	+	+	+	-	?	-	6
Brown 2012	+	-	+	-	?	+	+	-	?	?	-	+	5
Friedly 2014, 2017, Makris 2016	+	+	+	+	+	+	+	+	?	+	+	+	11 *
Song 2016	?	?	?	?	?	+	+	-	?	+	+	+	5

					1								
Milburn 2014	?	?	+	-	+	-	+	-	3	-	-	+	4
Hammerich 2019	+	+	-	-	+	-	+	?	?	-	+	+	6 ****
Sencan 2020	+	?	+	-	+	+	?	+	+	+	?	+	8 ****
Wei 2020	+	+	+	-	-	+	-	+	?	+	+	+	8 *
Percutaneous Epidural Adhesiolysis	;												
Karm 2018	+	?	+	-	+	-	+	+	?	-	-	+	6 ****
Surgery vs Physical Therapy													
Zucherman 2004, 2005, 2006	?	+	-	-	+	+		+	+	?	+	+	>6 **
Weinstein 2007, 2009, Abdu 2018	+	+	72	-	+	+	+	+	?	?	-	+	>6 *** ^
Amundsen 2000	+	?	-	-	-	+	+	+	-	?	-	?	4
Malmivaara 2007	+	+	-	-	+	+	+	+	+	?	?	+	8 *
Weinstein 2008, 2010, Lurie 2015	+	+	- 4		+	-	+	+	?	?	-	+	6 ^
Delitto 2015	+	+	-	-	+	?	+	-	+	-	+	+	7 ^

1A Was the method of randomization adequate?, B Was the treatment allocation concealed?, C Was the patient blinded to the intervention?, D Was the care provider 2blinded to the intervention?, E Was the outcome assessor blinded to the intervention?, F Was the drop-out rate described and acceptable?, G Were all randomized 3participants analyzed in the group to which they were allocated?, H Are reports of the study free of suggestion of selective outcome reporting?, I Were the groups similar at 4baseline regarding the most important prognostic indicators?, J Were co-interventions avoided or similar?, K Was the compliance acceptable in all groups?, L Was the timing 5of the outcome assessment similar in all groups?, + Yes, - No, ? Unclear, \* Low risk of bias if 6 or more items met, including valid randomization and treatment allocation 6techniques and no severe flaws, \*\* 2 year follow-up drop out rate 30%, 1 year < 20%; intention to treat inconsistent at 2 year f/u, \*\*\* Drop out rate <20% at 1 year, >20% at 74 years, \*\*\*\* < 30 participants per treatment arm, \*\*\*\*\* Treatment allocation unclear, ^ Severe flaw due to high crossover rates, # Premature end of study

- Although 31 studies met 6 or more criteria, only 9 were considered to have low risk of bias (19, 20, 24, 27, 28, 31, 37, 42, 43, 56).
- Among the remaining 22 studies that met 6 or more criteria, 13 failed to explicitly describe and/or use appropriate randomization
- procedures, allocation concealment, or both (16-18, 30, 32-34, 39, 41, 48, 52, 54, 57); three had severe flaws due to high crossover
- rates (21, 22, 25), which made the intention-to-treat analyses uninterpretable and 6 had other serious flaws including premature

- stopping of the trial (47), large number of participants lost to follow-up (40) and small sample size (less than 30 participants per arm)
- 2 (26, 29, 46, 55).

#### **Evidence of Effect of Interventions**

- 5 Fifty-three of the 60 comparisons were examined in a single trial, most with small sample sizes. It was only possible to combine data
- 6 from 2 trials (assessing surgery vs. multimodal treatment) for 1 outcome in a meta-analysis (19, 22). The 5 other studies (all assessing
- 7 calcitonin) (49-52, 54) were combined qualitatively. The results of these pooled analyses were published in our previous reviews (8,
- 8 9). Heterogeneity in source population, intervention, and outcome instruments precluded pooling of data from other trials.
- 9 Supplemental Table 2, a summary of GRADE assessment and outcomes, summarizes the quality of the evidence for outcomes for
- 10 each comparison.

#### Calcitonin

- 13 There were no new studies assessing calcitonin. The conclusion from our previous review was that there is very low-quality evidence
- from 6 trials (49-54) (N= 231) that calcitonin is no better than placebo or paracetamol regardless of mode of administration or
- 15 outcome assessed.

### **Oral Medication**

- 1 We identified 4 new studies assessing 5 oral medications. There is low-quality evidence based on 1 small cross-over trial (46) (N=29),
- 2 that pregabalin does not improve pain, distance walked, function or global health status immediately following the intervention
- 3 compared to placebo. Adverse events were reported in 64% of the pregabalin group, the most common being dizziness, compared to
- 4 35% in the placebo group.

- 6 A small trial evaluating gabapentin plus conservative care (48) (N=45) provides very low-quality evidence demonstrating no
- 7 significant improvement in back/leg pain, disability scores or global health in the short-term compared to conservative care plus
- 8 botulinum toxin injection. Five patients (20.8%) reported mild to moderate pain at injection sites for a few days after botulinum toxin
- 9 injections.

- 11 There is very low-quality evidence from 1 small trial (47) (N=24) that oxymorphone hydrochloride or propoxyphene and
- acetaminophen is no better than placebo in the immediate term for all outcomes assessed.

- A single small trial provided very low-quality evidence (15) (N=61) that oral corticoids do not improve outcomes in the short-term
- 15 compared to placebo.

- 1 The original review identified 3 studies assessing oral medications and concluded that there is low-quality evidence that
- 2 prostaglandins improves walking distance and leg pain in the short-term compared with etodolac (a nonsteroidal anti-inflammatory
- 3 drug) (43); very low-quality evidence that gabapentin improves walking distance and pain compared with placebo in the intermediate
- 4 and long-term(45) and that methylcobalamin (vitamin B 12) plus conservative treatment improves walking distance in the
- 5 intermediate and long-term compared with conservative treatment alone (44).

7 Rehabilitation Therapy and Multi-modal Treatment

- 8 We identified 8 new studies evaluating 13 rehabilitation therapy and/or multimodal treatment approaches, with one study being
- 9 compared to surgery.
- There is moderate quality evidence from 1 trial (31) (N=259) that manual therapy and exercise provides superior and clinically
- important short-term improvement in symptoms and function compared to medical care or community-based group exercise and that
- community-based group exercise improves physical activity in the short-term compared to medical care. There were no reported
- serious adverse events in any group. There was a significantly greater rate of transient joint soreness associated with the manual
- therapy and exercise group (49%) compared with the community-based group exercise (31%) and medical care (6%) groups.

Another trial provides moderate quality evidence (27) (N=104) that comprehensive care (manual therapy, education and exercise delivered using a cognitive-behavioural approach) demonstrates superior and clinically important improvements in walking distance in the immediate, short, intermediate, and long-term and compared to self-directed home exercise. This study also provides low-quality evidence that comprehensive care improves overall pain and function in the long-term compared to self-directed home exercises. At 12 months, none of the 43 participants in the comprehensive group and 2 of the 46 participants in the self-directed group experienced

There is low-quality evidence from 1 trial (28) (N=34) that a form of manual therapy (Mokuri Chuna), acupuncture and physician care, with or without a herbal remedy (Gang-Chuk Tang), improves low back pain in the intermediate term compared to oral aceclofenac, epidural steroids and physical therapy (heat and TENS).

adverse events. These adverse events were mostly attributed to a temporary increase in low back and/or leg pain.

- A single study assessing supervised physical therapy (manual therapy, exercise, and body weight-supported treadmill) (30) (N= 86) provides low-quality evidence for improved symptoms, function and walking distance in the short-term compared to home exercises.
  - There is very low-quality evidence from 1 study (14) (N=120) that heat, TENS and home exercise instruction is no better than isokinetic exercise in the immediate, short and intermediate term for all outcomes and less effective than unloaded exercises in the immediate and short-term. Unloaded exercise was also found to be superior to isokinetic exercise in the immediate and short-term.

- 2 One small single study (26) (N=47) provides very low-quality evidence that aquatic exercise is more effective than physical therapy
- 3 (exercise, ultrasound, heat and TENS) in improving pain and walking distance in the immediate term.
- 5 Another small single trial (29) (N=40) provides very low-quality evidence that a pre-surgical exercise program improves post-surgical
- 6 outcomes in the immediate, but not in the short or intermediate terms.
- 8 There is low-quality evidence from 1 study (25) (N=169) that a structured physical therapy program (education and exercises)
- 9 provides similar outcomes to decompression surgery in the long-term (2 years follow-up). Nine out of 82 participants receiving
- physical therapy reported adverse events consisting of worsening of symptoms whereas 33 out 87 participants reported surgery related
- complications, mainly attributable to reoperation, delay in wound healing and surgical site infection.
- Our original review identified 9 rehabilitation therapy/multi-modal trials of which 5 were compared to surgical interventions. A meta-
- analysis was conducted for 2 of the surgical trials. Two of the original surgical trials have since published 8-year follow-up results (see
- below). All studies provide either low or very low-quality evidence.

- 1 A meta-analysis (8, 9) that includes 2 trials (22) (19) shows that laminectomy improves outcomes only at the 2 year follow-up
- 2 compared to conservative care. One of these studies shows no difference in outcomes after an 8-year follow-up (58).
- 4 An interspinous surgical implant (17, 59, 60) was found to be superior to multi-modal treatment (epidural injections, pain medication,
- 5 education, exercise, back brace, heat/ice, and massage). Another trial (16) provided inconclusive evidence when comparing
- 6 laminectomy with or without fusion to lumbar orthosis and education.
- 7 Among patients with degenerative spondylolisthesis, 1 study (21) shows no difference in outcomes with laminectomy when compared
- 8 to conservative care including after an 8-year follow-up (61).
- 9 One study showed that exercise plus ultrasound is no better than exercise plus sham ultrasound but better than no treatment, and
- exercise plus sham ultrasound is better than no treatment (24). Other studies demonstrated that in-patient physical therapy (ultrasound,
- heat and TENS) is more effective than home exercise plus oral diclofenac (23), unweighted treadmill walking plus exercise is no
- better than cycling plus exercise (20), and manual therapy, exercise and unweighted treadmill is more effective than flexion exercises,
- walking and sham ultrasound (18).

# **Epidural Injections**

- We identified 6 new studies evaluating epidural injections. There is moderate quality evidence from 1 study (37, 62) (N=400) that
- glucocorticoid plus lidocaine injection is better than lidocaine alone in improving pain and function at 3 weeks (short-term) but not at

- 1 6-weeks (short-term), 12 weeks (intermediate-term) or 12 months (long-term). The improved outcomes at 3 weeks were statistically
- 2 significant but not considered to be of clinical importance (63). A follow-up subgroup analysis (64) using patient-prioritized Roland-
- 3 Morris Disability Questionnaire (RMDQ) items, did not change the results. A total 21.5% of patients in the glucocorticoid-lidocaine
- 4 group and 15.5% in the lidocaine alone group reported one or more adverse events (p=0.08). Adverse events included headaches,
- 5 fever, infection, dizziness, cardiovascular/lung problems, leg swelling and dural puncture.
- A small study (36) (N=29) provided very low-quality evidence that an injection of lidocaine is no better than a saline injection for all
- 8 outcomes in the short-term.
- There is very low-quality evidence from 1 study (38) (N=57) that steroid injections at the level of maximal stenosis improve pain and
- function in the immediate and short-term compared to steroid injections at 2 levels cephalad to the maximum level of stenosis.
- A small trial (40) (N=54) provided very low-quality evidence that steroid injections are no better than steroid injections combined
- with physical therapy (manual therapy and exercise) in improving pain or function in the short-term but are more effective in
- improving pain in the intermediate and long-term.

- 1 There is very low-quality evidence from 1 study (41) (N=67) that interlaminar steroid injection improves pain and walking distance in
- 2 the intermediate but not in the short-term compared to transforaminal steroid injection.
- 4 A 3-arm trial (42) (N=30) provided low-quality evidence that TNF alpha inhibitor (Etanercept) injections improved pain and function
- 5 in the immediate, short and intermediate term compared to steroid or lidocaine injections and that steroid injections were no better
- 6 than lidocaine for all outcomes and follow-up periods.
- 8 There is very low-quality evidence from 1 small trial (35) (N=38) that minimally invasive lumbar decompression surgery (MILD) is
- 9 no better than epidural steroid injections for all outcomes in the short-term.
- One small trial (39) (N=44) provided very low-quality evidence that an epidural inflatable balloon catheter (ZiNeu) improves pain and
- function in the intermediate term but not the short-term compared to a balloon-less catheter (Racz). Minor and transient adverse events
- were reported equally in both groups (no data provided), mostly pain and paresthesia at the injection site.
- Our original review identified 4 trials evaluating 7 epidural injection approaches, all with very low-quality evidence for all outcomes.
- 16 Two trials demonstrated that translaminar (32) or caudal (33) steroid injections were no better than placebo. Two other trials showed
- that translaminar epidural steroid plus a block was better than placebo or an epidural block alone (34), that translaminar epidural block

- 1 was better than placebo (34), and that interlaminar epidural steroid plus a block was better than home exercise plus diclofenac or in-
- 2 patient physical therapy (ultrasound, heat and TENS) (23).

## 4 Acupuncture

- 5 We identified 2 new studies assessing acupuncture. There is low quality evidence from 1 trial (56) (N=80) that acupuncture improves
- 6 back and leg pain, symptoms and function in the immediate, short, and intermediate term compared to sham acupuncture. Three out of
- 7 40 participants in the acupuncture group reported short-term pain at the insertion site (1 also had a hematoma) and 5 out of the 40
- 8 participants in the sham group reported non-serious back pain or fatigue. There is very low-quality evidence from a small trial (55)
- 9 (N=50) that acupuncture plus usual care is no better than usual care alone in the short-term for all outcomes.

# **Spinal Manipulation**

- We identified 1 study assessing spinal manipulation. There is very low-quality evidence from a very small trial (57) (N=14) that spinal
- manipulation alone is no better than a wait list control in the immediate term for all outcomes

# 14 DISCUSSION

- We updated our systematic review on nonoperative treatments for LSS causing neurogenic claudication and identified 23 new trials
- that were added to the previous 21 studies. The highest number of studies, 17/44, evaluated rehabilitation therapy/multimodal
- treatment, 11 assessed epidural interventions, 7 oral medications, 6 calcitonin, 2 evaluated acupuncture and 1 assessed spinal

 manipulation. Of the 60 comparisons that were evaluated, 5 comparisons from 3 trials (27, 31, 37) provided moderate quality
evidence. The remaining comparisons provide either low or very low-quality evidence. In our original review, all comparisons for all
the interventions assessed were of low or very low-quality evidence. This lack of moderate or high-quality evidence limited our ability
to make conclusions on the effectiveness of most nonoperative treatments.

There is now moderate evidence that a multimodal structured 6-week program consisting of manual therapy and exercise with or without education is an effective treatment approach (27, 31) for neurogenic claudication and that epidural steroid injections do not provide clinically important improvements in short or long-term outcomes compared to epidural lidocaine injections. However, given that these respective findings came from single studies, this evidence lacks consistency and therefore there is a possibility that replicating these trials in the future might result in substantially different conclusions. However, a recent clinical practice guideline for the management of LSS leading to neurogenic claudication concurred with our findings and recommended, based on moderate quality evidence, multimodal care consisting of education with home exercises and manual therapy (65). These guidelines also recommended against the use of epidural steroid injections, based on high quality evidence. A recent systematic review and meta-analysis of RCTs evaluating conservative nonpharmacological therapies for degenerative LSS also concluded, based on low to moderate evidence, that manual therapy and supervised exercises significantly improves outcomes compared to self-directed or group exercises (66). A recent clinical update published in the British Medical Journal recommended supervised exercise and manual therapy as a first line treatment for LSS and recommended against the use of epidural steroid injections (67). More dated systematic reviews did not recommend a

combination of education, exercise, manual therapy as an effective treatment for LSS (7, 68, 69). However, these reviews did not include the more recent higher quality trials (27, 31) evaluating this multimodal approach.

- A multimodal approach to the treatment of LSS would appear to be a rational approach given the complexity of neurogenic
- 5 claudication with underlying physical, functional, and psychosocial factors impacting recovery (70). There is also a plausible rationale
- 6 for the lack of effectiveness of epidural steroid injections for neurogenic claudication since the dominant underlying
- 7 pathophysiological mechanism appears to be neuro-ischemia rather than neuro-inflammation (4).

- 9 Although we cannot make firm conclusions about the effectiveness of nonoperative treatments for neurogenic claudication, this
- 10 review is important because it provides important information regarding the state of current evidence regarding nonoperative
- treatments. This can be used to inform clinical practice guidelines and aid clinicians and patients in making clinical decisions
- regarding treatment options. This is particularly important with respect to interventions that have higher risks and costs such as
- epidural injections and surgery. About 25% of all epidural injections are performed for LSS (71, 72) yet the evidence from our current
- review and those of others (73-75) do not support their use. The number and associated costs of surgical procedures for degenerative
- LSS is growing, especially decompression surgery with complex fusion (76, 77). LSS continues to be the most common reason for
- spine surgery in older adults (6, 76). High quality evidence for the effectiveness of surgery is also lacking based on our current review
- and the findings of other systematic reviews (78, 79). Clinical trials evaluating surgery for LSS are difficult to conduct due to

- 1 challenges in recruitment and blinding (patient and practitioner) and high costs (80). One ongoing clinical trial is comparing
- 2 decompression surgery with sham surgery which should help to evaluate the potential role of the placebo effect of surgery for LSS
- 3 (81).

- 5 Oral medication is often the first line treatment in primary care management of LSS (5). Pregabalin and gabapentin are commonly
- 6 prescribed medications for LSS despite the growing evidence that these medications are not effective for back-related leg symptoms
- 7 and may cause more harm than good (82-84).

- 9 New to this updated review are clinical trials on acupuncture and spinal manipulation, however, the quality of the evidence was
- insufficient to make conclusions on their effectiveness. A systematic review and meta-analysis of RCTs and controlled clinical trials
- published in Chinese, found no conclusive evidence for the effectiveness and safety of acupuncture for LSS (85). Passive unimodal
- treatments such as acupuncture and spinal manipulation are unlikely to provide long-term benefit but more likely to provide benefit
- when combined with a comprehensive approach to managing LSS (27), not unlike recommendations for managing chronic low back
- 14 pain (86).

- 16 This review is also important because it provides a comprehensive assessment and identification of significant knowledge gaps in this
- area to guide future research. This includes the need for higher quality studies that assess commonly used nonoperative treatments

particularly in primary care settings, that are adequately powered and have low risk of bias and long-term follow-up. Future RCTs should follow the CONSORT guideline (87) when planning trials and reporting study findings in an attempt to improve transparency and reduce bias.

 The strengths of this review include the evaluation of a wide range of nonoperative interventions and the use of consistent inclusion and exclusion criteria for neurogenic claudication, which included the corroboration of a diagnosis of LSS with imaging. The use of these criteria to define the study population increases the likelihood that participants in the included studies had the diagnosis of neurogenic claudication due to narrowing of the central canal or lateral foraminae (88-90). Other strengths of this review include the use of rigorous methods recommended by The Cochrane Collaboration, the World Health Organization, and the Cochrane Back and Neck Pain Review Group.(13) This included the use of the GRADE method to synthesize and summarize the quality of the evidence. Limitations of this review include the potential for language bias because only English articles were accepted. We also included studies with small samples sizes which are more prone to high risk of bias (91). Over half of the included studies had less than 30 subjects per arm at baseline, and none of these studies could be pooled because of high heterogeneity across studies. However, the exclusion of studies with small samples sizes in this review would not have changed our conclusions. The definition of a severe flaw and the cut-off point of 6 or more to differentiate trials of low from high risk of bias were arbitrary, therefore alternative definitions and cut-off points or the use of other risk of bias tools could have impacted the findings and conclusions of this review. The validity of MCIDs used in this review is unknown. Although most were derived from studies with neurogenic claudication (63, 92, 93) others

were based on an arbitrary improvement of at least 30% (94). There are no agreed upon MCIDs in LSS and therefore different MCIDs thresholds could have potentially altered our conclusions. The location and severity of the stenosis on imaging was not deemed important in this review. Imaging findings often do not correlate with patient symptoms or severity and therefore imaging by itself is a not reliable diagnostic tool in this population (67, 95, 96). Neurogenic claudication is the clinical entity of interest in this review and, although usually caused by LSS, the diagnosis is made clinically without imaging (97). Neurogenic claudication symptoms, by definitions improve with flexion, due to the increased volume around the involved nerve roots irrespective of where the stenosis is located (e.g., centrally or at the lateral recess). However, it is uncertain whether the effectiveness of some interventions, such as epidural steroid injections is dependent on location of the spinal stenosis. This is a different research question requiring future research.

**CONCLUSIONS** 

There is moderate quality evidence that a multimodal approach that includes manual therapy and exercise, with or without education is a safe and effective treatment, and that epidural steroids are not effective for the management of LSS causing neurogenic claudication. All other studies evaluating nonoperative interventions provided insufficient quality evidence, limiting the ability to make conclusions about their effectiveness. With the growing prevalence and significant personal, social, and economic burden of LSS, more high-quality evidence for nonoperative interventions is urgently needed to guide clinical practice.

#### CONTRIBUTORSHIP STATEMENT

- 3 CA was involved in the conception and design of the study, screening of articles, risk of bias assessment, Grade analysis, writing the
- 4 first draft of the manuscript, revision of the manuscript and administrative support. AB, MS, AF, CC, JO were involved in screening
- of articles, risk of bias assessment, Grade analysis and critical revision of the manuscript. CH, JP, AA, KS, JY, AA participated in
- 6 screening of articles, risk of bias assessment, data extraction and critical revision of the manuscript.

## 8 COMPETING INTERESTS

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- 13 CC holds a Research Chair in Knowledge Translation in the Faculty of Health Sciences, Ontario Tech University, funded by the
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- The remaining authors CH, JP, AB, MS, AF, KS, AA, AA2 and JO declare no funding disclosures.

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#### DATA AVAILABILITY STATEMENT

4 No additional data are available.

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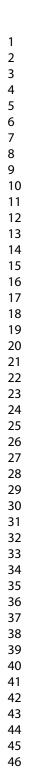
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For peer teview only Figure Legend Figure 1. Study Flow Diagram



1 Supplementals Table 2. Summary of Grade Assessment and Outcomes



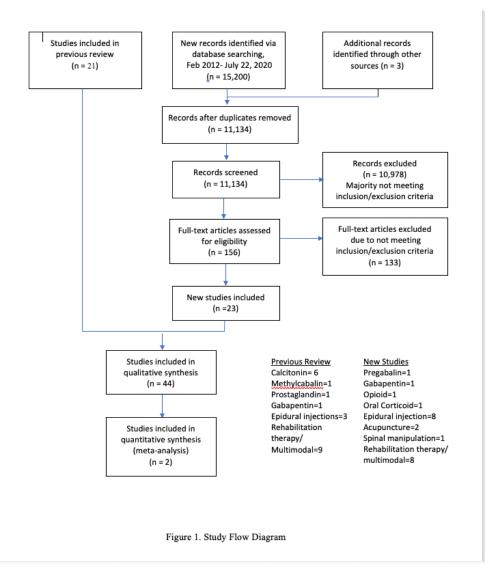


Figure 1. Study Flow Diagram 258x285mm (72 x 72 DPI)

#### Nonoperative treatment for lumbar spinal stenosis – 22 July 2020 update

Database: Ovid MEDLINE: Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE® Daily and Ovid MEDLINE® <1946-Present> Search Strategy:

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- 1 randomized controlled trial.pt. (509927)
- 2 controlled clinical trial.pt. (93770)
- 3 Pragmatic clinical trial.pt. (1444)
- 4 random\*.ti,ab. (1145458)
- 5 placebo.ab,ti. (215288)
- 6 drug therapy.fs. (2221199)
- 7 trial.ab,ti. (599425)
- 8 groups.ab,ti. (2097678)
- 9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 (5031369)
- 10 (animals not (humans and animals)).sh. (4686362)
- 11 9 not 10 (4375594)
- 12 exp Constriction, Pathologic/ (30449)
- 13 limit 12 to yr="1976 1982" (1906)
- 14 exp Lumbar Vertebrae/ (52505)
- 15 limit 14 to yr="1966 1982" (4472)
- 16 exp Spinal Canal/ (7519)
- 17 limit 16 to yr="1966 1982" (1172)
- 18 exp Spinal Diseases/ (123399)
- 19 limit 18 to yr="1966 1982" (18365)
- 20 exp Spinal Stenosis/ (6116)
- 21 spinal stenosis.ti,ab. (5088)
- 22 (lumbar adj5 stenosis).ti,ab. (4268)
- 23 (spin\* adj5 stenosis).ti,ab. (6620)
- 24 neurogenic claudication.ti,ab. (633)
- 25 exp Spinal Osteophytosis/ (4018)
- 26 exp Spondylosis/ (7484)
- 27 (lumb\* adj5 spondyl\*).ti,ab. (2886)
- 28 exp Cauda Equina/ (3250)
- 29 lumbar radicular pain.ti,ab. (218)
- 30 13 or 15 or 17 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 (44520)
- 31 9 and 30 (6508)
- 32 limit 31 to ed=20190920-20200731 (275)
- 33 limit 31 to yr=2019-2020 (545)
- 34 32 or 33 (583)

Database: Embase Classic+Embase <1947 to 2020 July 21> Search Strategy:

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- 1 Randomized Controlled Trial/ (613507)
- 2 exp Controlled clinical trial/ (800817)
- 3 Controlled Study/ (7533843)
- 4 Double Blind Procedure/ (176652)

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- Single Blind Procedure/ (39549) crossover procedure/ (64054) placebo/ (362923) Randomization/ (87513) random\*.ti,ab. (1563918) 10 placebo?.ti,ab. (314621) allocat\*.ti,ab. (155448) assign\*.ti,ab. (400691) blind\*.ti,ab. (436413) (cross-over or crossover).ti,ab. (107060) (compare or compared or comparing or comparison or comparative).ti,ab. (6802913) (controlled adj7 (study or design or trial)).ti,ab. (355549) ((singl\* or doubl\* or trebl\* or tripl\*) adj7 (blind\* or mask\*)).ti,ab. (250201) trial.ti,ab. (878032) 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 (12682849)exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/ (29761121) human/ or normal human/ or human cell/ (22533987) 20 and 21 (22470134) 20 not 22 (7290987) 19 not 23 (9386132) exp vertebral canal stenosis/ (12543) (spin\* adj5 stenosis).ti,ab. (9011) (lumbar adj5 stenosis).ti,ab. (5728) (neurogenic adj2 claudication).ti,ab. (1047) (Spin\* adj2 Osteophytosis).ti,ab. (26) exp cauda equina/ (4498) lumbar radicular pain.ti,ab. (316) (lumb\* adj5 spondyl\*).ti,ab. (4037) exp spondylosis/ (9560) spondylolisthesis/ (9419) 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 (36443) 24 and 35 (11296) limit 36 to yr=2019-2020 (1405) limit 36 to dd=20190920-20200731 (282) 37 or 38 (1426) CENTRAL via CRS Web MESH DESCRIPTOR Spinal Stenosis EXPLODE ALL AND CENTRAL: TARGET 423
- (spin\* NEAR5 stenosis) AND CENTRAL:TARGET 1189 lumb\* NEAR5 stenosis AND CENTRAL:TARGET 871 neurogenic claudication AND CENTRAL: TARGET 168 MESH DESCRIPTOR Spinal Osteophytosis EXPLODE ALL AND CENTRAL:TARGET MESH DESCRIPTOR Spondylosis EXPLODE ALL AND CENTRAL:TARGET lumb\* NEAR5 spondyl\* AND CENTRAL:TARGET 400 MESH DESCRIPTOR Cauda Equina EXPLODE ALL AND CENTRAL:TARGET 15

lumbar radicular pain AND CENTRAL:TARGET

10 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 AND CENTRAL:TARGET 1932 11 2019:YR AND CENTRAL:TARGET 105034 12 2020:YR AND CENTRAL:TARGET 30634 13 #11 OR #12 135668 14 #13 AND #10 209 CINAHL S43 S41 OR S42 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 242 S42 S40 AND EM 20190919-20200731 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 192 S41 Limiters - Published Date: 20190901-20200731 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 161 S40 S28 AND S39 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 3,036 S39 S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 Search modes -Boolean/PhraseInterface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 6.262 Search modes - Boolean/Phrase Interface - EBSCOhost Research S38 lumb\* W5 spondyl\* **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 796 S37 MH "Spondylolysis" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 486 MH "Spondylolisthesis" Search modes - Boolean/Phrase Interface - EBSCOhost Research S36 **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 1,438 **S35** "lumbar radicular pain" Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 125 Search modes - Boolean/Phrase Interface - EBSCOhost Research S34 MH "Cauda Equina" **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 368 S33 MH "Spinal Osteophytosis" Search modes - Boolean/Phrase Interface - EBSCOhost Research

Search Screen - Advanced Search

**Databases** 

Database - CINAHL Plus with Full Text S32 "neurogenic claudication" Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 243 S31 lumb\* W5 stenosis Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 1,768 spin\* W5 stenosis Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 3.656 S29 MH "Spinal Stenosis" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 2,741 S26 NOT S27 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 2,433,818 MH "Animals" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 87,894 S26 S7 OR S12 OR S19 OR S25 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 2,461,016 S25 S20 OR S21 OR S22 OR S23 OR S24 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 1,686,740 volunteer\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases S24 Search Screen - Advanced Search 52,797 Database - CINAHL Plus with Full Text prospectiv\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 525,699 S22 control\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 1,275,002 S21 followup stud\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 203 follow-up stud\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases S20 Search Screen - Advanced Search Database - CINAHL Plus with Full Text 12.011

Search modes - Boolean/Phrase Interface -

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**EBSCOhost Research Databases** 

Search Screen - Advanced Search Database - CINAHL Plus with Full Text 1,539,358 S18 MH "Prospective Studies+" Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 444,171 MH "Evaluation Research+" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 248.871 S16 MH "Comparative Studies" Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 331,705 Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases latin square Search Screen - Advanced Search Database - CINAHL Plus with Full Text 248 MH "Study Design+" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 1,351,924 S13 MH "Random Sample" Search modes - Boolean/Phrase Interface - EBSCOhost Research **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 34,389 S8 OR S9 OR S10 OR S11 Search modes - Boolean/Phrase Interface - EBSCOhost Research S12 **Databases** Search Screen - Advanced Search Database - CINAHL Plus with Full Text 431,064 S11 random\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 414,911 S10 placebo\* Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 66.332 MH "Placebos" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 12,827 **S8** MH "Placebo Effect" Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Plus with Full Text 2,282 Search modes - Boolean/Phrase Interface - EBSCOhost S1 OR S2 OR S3 OR S4 OR S5 OR S6

Research Databases

Search Screen - Advanced Search

Database - CINAHL Plus with Full Text 404.557

S6 triple-blind Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases

Search Screen - Advanced Search

Database - CINAHL Plus with Full Text 379

S5 single blind Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases

Search Screen - Advanced Search

Database - CINAHL Plus with Full Text 15,679

S4 double blind Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases

Search Screen - Advanced Search

Database - CINAHL Plus with Full Text 58,644

S3 clinical W3 trial Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases

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Search Screen - Advanced Search

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- S16 , Peer Review only, Publication Type:Clinical Trial OR , Peer Review only, Publication Type:Controlled Clinical Trial OR , Peer Review only, Publication Type:Randomized Controlled Trial OR All Fields:random\* OR All Fields:placebo\* OR All Fields:sham, Peer Review only OR All Fields:\"clinical trial\" OR All Fields:\"controlled trial\", Peer Review only OR All Fields:versus OR All Fields:vs., Peer Review only OR All Fields:double-blind OR All Fields:\"double-blind\", Peer Review only OR All Fields:single-blind OR All Fields:\"spinal stenosis\" OR All Fields:\"spinal stenosis\" OR All Fields:\"spinal stenosis\" OR Subject:\"Spondylosis\" OR Subject:\"Spondylosis\" OR Subject:\"Spondylosis\" OR Subject:\"Cauda equina\" OR All Fields:\"lumbar radicular pain\", Peer Review only AND , Year: from 2019 to 2020, Peer Review only

# Supplemental Table 1. Characteristics of included studies

Study	Participants and	Interventions	Outcomes/Follow-	Results			
	Settings		up	(Group 1 is reference group)			
Calcitonin							
Eskola 1992	39 subjects with an average of 6 years of pain, average age of 56.6 years of age, 20 males and 19 females.  Setting: Orthopaedic hospital in Finland.	1) 100IU Calcitonin injection every other day for 4 weeks (n=20)  2) Placebo treatment (Miacalcic Sandoz 100IU) every other day for 4 weeks (n=19)	<ol> <li>VAS</li> <li>Treadmill test</li> <li>Coping with         ADLs</li> <li>Digitest         Ergojump</li> <li>Blood tests</li> </ol> Follow-up: 1, 3, 4, 6 and 12 months	Between group WMD and 95% CI Pain (VAS) (mm): -0.050 (-0.053 to -0.047) Walking distance (meters): -18.5 (-240.37 to 203.37)  Adverse events: The calcitonin injection group reported minor nausea and rash in 89% of the subjects.			
Podichetty 2004	55 subjects with an average age of 68.5 years and an average of 36.2 weeks of the condition in the intervention group and 29.8 weeks in the placebo group, 33 males and 22 females.  Setting: Spinal center in the United States	<ol> <li>400 IU intranasal calcitonin daily for 6 weeks followed by open label 6-week extension (n=36)</li> <li>Placebo nasal spray daily for 6 weeks, followed by open label 6-week extension, during which all patients received 400IU calcitonin (n=19)</li> </ol>	1) VAS 2) Walking capacity 3) ODI 4) Stenosis specific questionnaire 5) Satisfaction with pain levels, functional status, and treatment received 6) SF-36 7) Symptom diary  Follow-up: 12 weeks	Between group MD, 95% CI, p values 12 weeks: Pain VAS (mm): 0.5 (-0.85 to 1.93): p=0.44, Walking time (seconds): 42.2 (-86.9 to 170.4): p=0.51 Walking distance (feet): 163.3 (-311.16 to637.84); p=0. 0.49 SF-36 MCS: -4.22 (-10.41 to1.97); p=0.18 SF-36 PCS: 0.43 (-3.73 to 4.59); p= 0.84			
Porter	41 subjects with	1) 100 IU salmon calcitonin injection		Insufficient data provided to calculate mean difference in			
Porter	41 subjects with	1) 100 10 salmon calcitonin injection	1) Walking chart	Insufficient data provided to calculate mean difference in			

1983	10 in a double blind RCT crossover, 37 males and 4 females with mean age of 55.4 years.  Setting: Infirmary in	four times per week, sometimes with Maxalon for nausea (n=5)  2) Matching placebo (n=5)  Only responders randomized	and ability to walk more than 1 mile 2) ODI  Follow-up: 10 weeks	walking distance or ODI among the 10 patients enrolled in RCT.  Adverse events: The calcitonin injection group reported minor nausea and rash in 40% of the subjects.
Porter 1988	England  42 subjects, 35 male, 7 female, average age of 53.6 years in 20 subjects and 56.7 years in 22 subjects, median duration of back pain reported was 11 years for 19 subjects, and 14 years for 22 subjects. Median duration of claudication was 1.25 years for 20 subjects and 4.5 years for 22 subjects.  Setting: Infirmary in England	1) 100 IU of salmon calcitonin injected subcutaneously 4 times per week for 8 weeks (n=20)  2) 1 ml of saline injected 4 times per week for 8 weeks (n=22)	1) VAS 2) Claudication threshold 3) 3 level mobility assessment 4) Analgesic requirements 5) 3 level sleep disturbance 6) Treatment success defined as 100% improvement in walking distance and able to walk 800 m.  Follow-up: 4 and 8 weeks	Difference in median score from baseline between groups Pain score (VAS) (mm):  4 weeks: -9  8 weeks: -5.5  Walking distance until symptoms onset (meters):  4 weeks: -14  8 weeks: 42  Walking distance until pain prevents walking (meters):  4 weeks: -41  8 weeks: -99  No significant between group differences. No p values or 95% CI provided.
Sahin 2009	45 subjects 31 males and 14 females, average	1) 200 IU intranasal calcitonin daily for 8 weeks (n=23)	VAS     Walking capacity	Percent change between groups: 8 weeks: VAS at rest: 4.7%, p>0.05

BMJ Open

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years i calcito and 54 in para group.  Setting and Rehab Medic Depart	nin group .45 years .cetamol  Both groups took part in a physical therapy and exercise program 5 tim week for 15 sessions.  g: Physical ilitation ine ment in	4) Ranges of motion	VAS with motion: -7.9%, P>0.05 Roland Morris: 8.2%, p>0.05 Walking distance: -15.4%, p>0.05
2007 males, female of 67 y interverse group years i placeb averag months symptocalcito and 30	pjects, 30 10 ss, average rears in the ention and 70.2 n the oo group, e of 38.7 s with oms in the nin group .9 months placebo  g: ssity al in	2) Shuttle walking test	4 weeks: Between group MD 95% CI ODI: -0.7 (1.7 to -3.5) LBOS: -3.0 (-0.6 to -4.7) VAS leg (mm): -10 (-4.0 to -13) VAS back (mm): -6.0 (-6 to -12) Shuttle walk distance (m): -13 (-7 to -35)  16 weeks: between group MD, p values ODI: 0.1, p=0.44; LBOS: 0.7, p=0.93; VAS leg (mm): -4, p=0.66; VAS back (mm): 16, p=0.03; Shuttle walking distance (m): -11, p=0.39

			Ora	l Me	dication	
Matsudaira	79 subjects, 24	1)	Oral prostaglandin E1 derivative (15	1)	SF-36	SF-36 subscales MD, p values
2009	males and 24		g Limaprost) 3 times daily for 8	2)	Verbal pain	8 weeks: physical function: 9.4, p=0.01, role physical: 13.7,
	females, with an		weeks (n=39)		rating scales	p=0.03, bodily pain: 15.5, p<0.01: General health: 6.6,
	average age of			3)	Walking	p=0.08; vitality: 11.3, p=0.02; social functioning: 8.0, p=0.17;
	69.6 years in the	2)	400 mg of etodolac (NSAID) twice		distance	<b>role emotional:</b> 10.2, p=0.07; <b>mental health:</b> 12.2, p<0.01.
	Limaprost group		daily for 8 weeks (n=40)	4)	LBP severity	
	and 72.2 in the			5)	Leg pain	<b>Secondary outcomes</b> not provided in a way that MD can be
	Etodolac group.	4			severity	extracted:
				6)	Leg numbness	8 weeks: low back pain: p=0.77; leg pain p=0.08; Leg
	Setting:				severity	numbness: p<0.01; walking distance p<0.01; patient
	Orthopaedic			7)	Treatment	subjective improvement p<0.01; patient satisfaction p<0.01
	surgery in a				satisfaction	all in favor of limaprost
	medical faculty					
	in Japan				llow-up: 8	Adverse events: 5% of subjects in both groups reported
					eks	gastrointestinal upset.
Waikakul	152 subjects, 68	1)	Conservative treatment consisting of	1)	Presence of	Walking distance
2000	males and 84		education, activity modification,		pain on spinal	Percent able to walk > 1000 meters
	females with an		exercise and physical therapy.		motion	6 mo: 71.3% vs. 88.6%, p< 0.05
	average age of		NSAIDs, muscle relaxants, and	2)	Claudication	12 mo: 81.3% vs. 97.1%, p < 0.05
	66.8 years. 44 of		analgesics as necessary. Vitamin B1,		distance	18mo: 83.8% vs. 97.1% p < 0.05
	the subjects had		B6, and B12 3 times per day (n=82)	3)	Medication	
	symptoms for				intake	•
	less than one	2)	Conservative treatment plus		(NSAIDs,	Adverse events: There were no reported adverse effects in
	month, 98 had		Methlcobalin ESAI, 1.5mg per day		muscle	subjects in methylocabalin group
	symptoms for		in 3 divided doses after meals for 6		relaxants, and	
	more than one		months (n=70)		steroids)	* //h
	month.					
	G 44* TT 1: 1				llow-up: every	
	Setting: Hospital				onth for two	
37.1 '	in Thailand	1\	000 0 1	yea		D 4 1100
Yaksi	55 subjects, 22	1)	900 mg of gabapentin per day	1)	VAS – low	Between group difference, p values
2007	males, 33		increased weekly by 300 mg to a		back and leg	Pain (VAS) (mm) no raw data
	females, average		maximum of 2400 mg (n=28)		pain during	3 <sup>rd</sup> mo 3.4 vs. 1.9, p =0.039
	age of 50.8 years.	2)	DI 1 ( 27)	2)	movement	4 <sup>th</sup> mo 4.1 vs.2.0, p =0.006
	G 44* TT 1: 1	2)	Placebo (n=27)	2)	Walking	XX II . A1 21/4 1 4
	<b>Setting:</b> Hospital				distance	Walking Ability, no raw data

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	department of physical medicine and rehabilitation in Turkey	Both groups received physical therapy exercises, a lumbosacral corset with steel bracing and NSAID treatments	3) Presence or absence of motor and/or sensory deficits  Follow-up: 15 days, 1, 2, 3, 4 months	Grp 1: longer walking distance at end of 2 <sup>nd</sup> mo (p < 0.05), 3 <sup>rd</sup> mo (p <0.05) and 4 <sup>th</sup> mo (p <0.005)  Adverse events: some subjects randomized to the gabapentin group (no data specified) experienced mild to moderate drowsiness and/or dizziness.
Markman 2015	29 participants, 20 males, 9 females, Eligible subjects were older than 50 years (mean 70.1 years) with at least one level of radiographically confirmed lumbar spinal stenosis and symptoms of neurogenic claudication for at least 3 months.  Setting: Hospital in Rochester, New York	1) Pregabalin group (n=14)  2) Active placebo (Diphenhydramine) (n=15)  Cross over study after 7 day wash out period.  Pregabalin was started at 75 mg PO twice daily or diphenhydramine, 6.25 mg) and increased on day 4 to 150 mg PO twice daily (12.5 mg diphenhydramine) for 7 days. Pregabalin was decreased to 75 mg PO twice daily (6.25 mg diphenhydramine) on day 11 for 3 days of tapering.	1) NRS - time to first moderate pain symptom during a 15-minute treadmill test (Tfirst) (NRS - greater than 4)  Follow-up: day 10 of intervention period	Between group MD, 95% CI, p values Treadmill testing pain at rest (NRS) 0.29 (0.41 to 0.98): p=0.40 Treadmill testing final pain (NRS) 0.25 (-0.44 to 0.94): p=0.46 Treadmill testing distance walked (m) -24.06 (-75.63 to 27.52): p=0.35 Treadmill testing recovery time (min) -0.79 (-1.86 to 0.28): p=0.14 Treadmill testing patient global assessment of pain -0.08 (-0.45 to 0.29): p=0.67 Treadmill testing RMDQ 1.50 (0.38 to 2.62): p=0.01  Adverse events: Complications were reported in 64% of subjects in group 1, the most common being dizziness, compared to 35% in group 2.
Park 2017	45 subjects, 21 in GPN Group (17 female, 4 males, mean age 66.1± 10.5), and 24 in BTX group (15 female and 9 males, mean age	Conservative treatments plus gabapentin (group GPN):     Gabapentin 300 to 1200mg/d - titrated to patient characteristics, comorbidities, and reported side effects (n=21)  2) Conservative treatments plus BTX	<ul> <li>3) NRS - back/leg pain intensity</li> <li>4) Cramp frequency (no./wk)</li> <li>5) Cramp severity (0-4</li> </ul>	No statistically significant difference between groups and lack of reporting of quantitative data  Adverse events: Five patients (20.8%) in group 2 reported mild to moderate pain at injection sites for a few days.

	Setting: Outpatient department for interventional pain management in Korea	injection (group BTX): The BTX (botulinum toxin type A [Nabota]) dose was 100U in 5mL of 0.9% saline injected into the gastrocnemius medialis and lateralis. (n=24)  Conservative treatments: education, exercise, analgesic medication, injection therapy including epidural injections, and physical therapy	criteria) 6) Insomnia severity – (ISI 0-28) 7) ODI 8) Patient global impression of change  Follow-up: 2 weeks, 1 and 3 months.	
Markman 2015 - 2	24 participants, 12 males and 12 females, (mean age 72 years) LSS by imaging with symptoms of neurogenic claudication  Setting: Translational Pain Research Center at a University in Rochester, New York	<ol> <li>Oxymorphone hydrochloride (Opana IR, 5 mg) (n=8)</li> <li>Propoxyphene/acetaminophen (Darvocet, 100 mg/650 mg) (n=8)</li> <li>Placebo: 3 separate visits (random order with at least 3 day washout periods) (n=8)</li> </ol>	1) NRS (at rest) 2) NRS (final pain rating) 3) AUC 4) 4) Distance walked (m) 5) Recovery time (min) 6) ZCQ 7) Patient global assessment of pain 8) RMDQ 9) ODI  Follow-up: Study was prematurely terminated	Treadmill testing pain at rest (NRS)  Grp 1 vs Grp 3: -0.04 (-0.72 to 0.65): p-0.89  Grp 2 vs Grp 3: -0.27 (-0.95 to 0.41): p=0.32  Grp 1 vs Grp 2: 0.23 (-0.45 to 0.92): p=0.40  Treadmill testing final pain (NRS)  Grp 1 vs Grp 3: 0.2 (-0.74 to 1.14): p=0.60  Grp 2 vs Grp 3: 0.53 (-0.40 to 1.46): p=0.16  Grp 1 vs Grp 2: -0.33 (-1.26 to 0.61): p=0.39  Treadmill testing distance walked (m)  Grp 1 vs Grp 3: -12.41 (-63.01 to 38.20): p=0.54  Grp 2 vs Grp 3: -23.41 (-73.60 to 26.79): p=0.25  Grp 1 vs Grp 2: 11 (-39.53 to 61.54): p=0.59  SSSQ symptom severity score  Grp 1 vs Grp 3: -0.03 (-0.19 to 0.13): p=0.61  Grp 2 vs Grp 3: 0.01 (-0.15 to 0.17): p=0.85  Grp 1 vs Grp 2: -0.04 (-0.20 to 0.11): p=0.49  SSSQ physical function score  Grp 1 vs Grp 3: 0.04 (-0.16 to 0.09): p=0.47  Grp 2 vs Grp 3: 0.11 (-0.01 to 0.23): p=0.03  Grp 1 vs Grp 2: -0.15 (-0.27 to -0.02): p=0.01  Patient global assessment of pain  Grp 1 vs Grp 3: -0.03 (-0.52 to 0.47): p=0.90  Grp 2 vs Grp 3: 0.13 (-0.36 to 0.61): p=0.52

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						Grp 1 vs Grp 2: -0.15 (-0.64 to 0.34): p=0.44
						The study was prematurely terminated because of the removal of propoxyphene/acetaminophen from the US market.
Rodrigues 2014	61 patients with lumbar canal stenosis (50–75 years; canal area < 100 mm² at L3/L4, L4/L5, and/or L5/S1on MRI; and claudication within 100 m). 31 in the corticoid group (mean age 58.23 (6.38), and 30 in the placebo group (mean age 58.33 (6.19))  Setting: Hospital in São Paulo, Brazil	2)	placebo for the same period (n=30)	5) Fo and	6-min walk test VAS Likert scale Illow-up: 3, 6 dd 12 weeks	Between group comparison VAS (6 weeks) Corticoid vs Placebo: 1.53 p=0.02 (in favour of placebo)
			Rehabilitation The	rapy	y and Multimoda	l Care
Goren 2010	45 subjects, 13 males, 32 females, average ages in groups of 57.4, 49.13, and 53.06. 7 subjects with pain duration of 3-6 months, 7 with pain duration of	2)	Stretching and strengthening exercises for lumbar, abdominal, leg muscles as well as low intensity cycling exercises were given as therapeutic exercises. Ultrasound was applied with 1mHz, 1.5W/cm2 intensity, in continuous mode on the back muscle for 10 minutes (n=17)  Same as group 1 with Ultrasound on	<ol> <li>1)</li> <li>2)</li> <li>3)</li> </ol>	VAS (out of 10) Treadmill test at 3 km/h for maximum of 15 minutes or 750m. ODI Analgesic consumption	Pain (VAS) (mm) within group MD  3 weeks: Grp 1: -2.2 for back pain; -1.47 for leg pain Grp 2: -1.94 for back pain; -2.47 for leg pain Grp 3: 0.40 for back pain; 0.54 for leg pain  Between groups differences Leg pain: Grp 1> Grp 3 (p<0.01), Grp 2> Grp 3 (p<0.01)  Walking Ability (within group MD)
	6-12 months, and	2)	off- mode (n=17)	5)	Physiatrist	3 weeks: Grp 1: 94.30 seconds

	31 with pain		assessment	Grp 2: 114.94 seconds
	duration of	3) No exercise-no treatment (n=16)	assessificit	Grp 3: -66.10 seconds
	greater than 12	1) No exercise-no treatment (n=10)	Follow-up: End of	No significant change between groups
	_		3-week treatment	No significant change between groups
	months.		-	D' 1714 (ODI) ( '41' MD)
	G•		period only	Disability (ODI) (within group MD)
	Setting:			3 weeks:
	Rehabilitation			Grp 1: -3.94
	center in Turkey			Grp 2: -7.8
				Grp 3: -3.6
				ODI between groups differences
				Grp 1> Grp 3 (p<0.05), Grp 2> Grp 3 (p<0.05)
Koc	29 subjects, 21	1) Conservative inpatient physical	1) VAS	No raw data provided.
2009	male, 8 female,	therapy program 5 days a week for 2	2) Treadmill	No significant between group differences for all outcomes and
	average ages of	weeks. PT included applications of	walk test	follow-ups except:
	62.6, 61.1, and	ultrasound 1.5 W/cm <sup>2</sup> for 10min, hot	3) Nottingham	1 1
	53.1 years in the	pack for 20min, and TENS for 20min	Health Profile	Pain (VAS)
	three groups,	to the lumbar region (n=13)	4) RMDI	2 weeks: Grp 2 less pain than Grp 3 p= 0.008
	average pain	to the famour region (if 15)	5) Functional	2 weeks of 2 less pain than of 5 p wood
	duration of 5.7	2) Lumbar epidural steroid injections,	testing	Disability (RMDI)
	years, 5.0 years,	10 ml of solution containing 60mg of	including	2 weeks: Grp 2 less disability than Grp 3 p= 0.007
	and 5.7 years in	triamcinolon acetonide (1.5 mL), 15	finger to floor	2 weeks. Gip 2 less disability than Gip 5 p 0.007
	the three groups.	mg of 0.5% bupivacain hydrochloride	distance, sit-	
	the three groups.	(3 mL), and 5.5 mL of physiologic	to-stand, and a	Quality of Life (Nottingham Health Profile) (no data
	Satting Madical			
	Setting: Medical	saline (0.9%NaCl) was injected in	weight	provided)
	school	3.5minutes. (n=10)	carrying test	Grp 2 had significantly higher improvement than Grp 3 at 2
	department of		F. II	weeks in mobility subgroup scores.
	physical	3) Control group (n=10)	Follow-up: 2	
	medicine and		weeks, 1, 3 and 6	Adverse events: 1 subject reported angina pectoralis and 1
	rehabilitation in	All patients included were trained to	months	reported gastric complaints (group not specified).
	Turkey	pursue a home-based therapeutic exercise		
		program performed twice daily for a		
		period of 6 months, and oral diclofenac		
		sodium 75mg was administered to all		
		patients twice daily for 2 weeks		
Pua	68 subjects, 35	1) Unweighted treadmill training:	1) VAS for pain	Pain (VAS) (mm) MD and 95% CI
2007	males, 33	Weeks 1 and 2, participants walked	over past	6 weeks: 2 (-5 to 10)

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	females, average age of 58 years, 12 week median pain duration  Setting: Hospital in Singapore	2)	with a relatively pain-free gait which translated to 30–40% of body weight. In weeks 3 to 6, participants were encouraged to walk at a moderate intensity. The duration of each treadmill session was limited by participant tolerance or to a maximum of 30 minutes. 2x per week for 6 weeks = 12 sessions (n=33)  Cycling on upright bicycle: During weeks 1 and 2, participants cycled at their comfortable pace at 50 to 60 rpm. Participants were instructed to assume a flexed posture. In weeks 3 to 6, participants were encouraged to exercise at a moderate intensity and the duration of each cycling session was limited by participant tolerance or to a maximum of 30 minutes. 2x per week for 6 weeks for 12 sessions		week Patient perceived benefit on a 6- point scale ODI RMDI Walking ability  Illow-up: 3 and weeks	Disability (ODI), OR, 95% CI 6 weeks: OR 1.10 (0.41 to 2.98) Patient perceived benefit, OR, 95% CI 6 weeks: OR 0.50 (0.17 to 1.48) Walking ability (≥800 m), OR, 95% CI 6 weeks: OR 1.14 (0.44 to 2.94)  Adverse events: 1 subject in treadmill group reported increase in pain.
Whitman 2006	58 subjects, 31 males, 27 female, 29 (group 1) with an average age of 70 years, 29 (group 2) with an average age of 68.9, median low back pain duration of 108 months in Group 1's 29 subjects and 60 months in Group 2's 29	2)	In=35)  Flexion Exercise and Walking Group: 45-60 minutes twice per week for 6 weeks. Lumbar flexion exercises along with self-pace treadmill walking program, and sub- therapeutic ultrasound. The duration of each treadmill session was based on that patient's tolerance on that specific day and could extend up to 45 minutes. (n=29)  Manual Therapy, Exercise and Walking Group: 45-60 minutes twice per week for 6 weeks - Manual	2) 3) 4) 5) 6)	Global Rating of Change (15-point scale) NPRS for lower limb Walking Tolerance test ODI Medication consumption Satisfaction subscale of the Spinal	Patient Global Assessment (somewhat better or greater) 6 weeks: 41% vs. 79% p<0.01 1 year: 21% vs. 38% p>0.05  Number needed to treat for benefit for perceived recovery and 95% CI 6 weeks: 2.6 (1.8 to 7.8) 1 year: 4.8 (-2.3 to 21.3) long term: 4.4 (- 2.1 to 22.7)  Pain (NPRS lower extremity) Within group MD, 95% CI 6 weeks: 1.1 (0.2 to 2.0) vs. 1.5 (0.5 to 2.5) 1 year: 1.2 (0.4 to 1.9 vs.1.0 (-0.2 to 2.2);

	subjects, lower	physical therapy (thrust and non	Stenosis Scale	Long term: 1.8 (0.6 to 3.0) vs. 2.0 (0.7 to 3.4)
	extremity median	thrust) to the thoracic and lumbar	7) Additional use	Between group MD not statistically significant at any follow-up
	pain duration of	spine, pelvis, and lower extremities	of health care	period
	48 months in	and specific exercises at discretion	resources	
	Group 1's 29	based on the underlying		Walking Ability (improvement in meters) within group MD,
	subjects and 24	impairments. Patients received	Follow-up: 6	95% CI
	months in Group	specific exercises to address	weeks, 1 year, long	6 weeks: 176.5 (-9.5 to 362.4) vs. 339.7 (218.4 to 461)
	2's 29 subjects.	impairments in mobility, strength,	term mail survey	1 year: 130.4 (-55.3 to 316.2) vs. 209.8 (67.5 to 352.1)
		and/or coordination. Exercises were	(averaging 29	Between group improvement not statistically significant at any
	Setting:	performed in the clinic and as part of	months)	follow-up
	University in the	a home exercise program. Patients	,	1
	United States	also underwent a bodyweight		Disability (ODI) within group MD
		supported treadmill ambulation		6 weeks: 6.55 (1.87 to 11.23) vs. 10.48 (6.5 to 14.4)
		program using a cable and trunk		1 year: 5.03 (1.71 to 8.35) vs. 7.14 (1.5 to 12.8)
		harness system to unload a specific		Between group differences not statistically significant at any
		amount of weight from the patient		follow-up
		while the patient walks as		
		comfortably as possible on a		
		treadmill (n=29).	<b>V</b>	
Minetama	86 patients, 39	1) Physical therapy + home exercise	1) ZCQ	Between group MD, 95% CI
2019	men and 47	program (n=43)	2) Satisfaction	ZCQ - Symptom severity
	women, average		3) SPWT (m)	-0.4 ( $-0.6$ to $-0.2$ ): statistically significant
	age 72.7 years	2) Home exercise (HE) program alone	4) NRS	ZCQ - Physical function
	43 patients (20	(n=43)	5) JOABPEQ-	-0.4 ( $-0.6$ to $-0.2$ ): statistically significant
	men and 23		acquired	SPWT (m)
	women, average	Supervised physical therapy twice a week	points	455.9 (308.5 to 603.2): statistically significant
	age 72.3 years to	for 6 weeks, including manual therapy,	6) SF-36	NRS - Leg pain
	the PT group	individually tailored stretching and	7) HADS	-1.4 ( $-2.5$ to $-0.3$ ): statistically significant
	43 patients (19	strengthening exercises, cycling, and	8) PCS	SF-36 - Physical functioning
	men and 24	body weight-supported treadmill	9) PASS-20	9.2 (2.1 to 16.3): statistically significant
	women, average	walking. The manual therapy included	10) TSK-11	SF-36 - Bodily pain
	age 73.2 years) to	manipulation, stretching, and massaging	11) Daily steps	10.4 (3.3 to 17.5): statistically significant
	the HE group.	of the thoracic and lumbar spine, pelvis,		Daily steps
	Duration	and lower extremities. The individually	Follow-up: 6	723.4 (199.1 to 1,283.5): statistically significant
	symptoms 20	tailored muscle exercises included those	weeks	
	months	for the trunk (eg, abdominal planks, side		
		bridge, and/or back extension) and lower		

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	Setting: Spine	extremities (eg, unloading hip and/or		
	care center at a	knee exercise with ankle weight and/or		
	university	standing squats). The typical dosage for		
	hospital in Japan	strengthening exercises was a total of 2 to		
		3 sets with 10 repetitions, each of 6-		
		second contraction. The typical duration		
		of stretching was three repetitions of 30		
		seconds.		
		A11		
		All patients in both groups were asked to		
		take a daily walk that did not exacerbate		
		their lower extremity symptoms using a		
		pedometer and walking diary and to perform a HE program consisting of		
		lumbar flexion exercises including three		
		30-second bouts of both single and		
		double knee-to-chest exercises, ten 6-		
		second bouts of trunk raises and bridging		
		in the supine position, and a 4-point		
		kneeling exercise at least twice daily.		
Schneider	259 subjects, 122	1) Medical care (MC) (n=88)	1) SSS	Between group MD, 95% CI
2019	males and 137	1) 1/12/13/14 (1/12) (1/12)	2) SPWT	SSS (2 months)
	women with an	2) Group exercise (GE) (n=84)	3) Physical	GE vs MC: 0.4 (-1.3 to 2.1)
	average age of		Activity	MTE vs MC: -2.0 (-3.6 to -0.4)
	72.4, 68 patients	3) Manual therapy + exercise (MTE)		MTE vs GE: -2.4 (-4.1 to -0.8)
	had symptoms	(n=87)	Follow-up: 2 and	SPWT (2 months)
	for less than 6		6 months	GE vs MC: 79.9 (-74.5 to 234.5)
	months, 191 had	Medical Care: 3 visits to a physical		MTE vs MC: 122.9 (-25.7 to 271.6)
	symptoms for	medicine physician over 6 weeks.		MTE vs GE: 43.0 (-111.8 to 197.9)
	greater than 6	Primarily prescription of oral medications		Physical activity (2 months)
	months	in any combination of nonnarcotic		GE vs MC: 28.7 (2.7 to 54.7)
		analgesics, anticonvulsants,		MTE vs MC: 20.4 (-4.5 to 45.3)
	Setting:	antidepressants.		MTE vs GE: -8.3 (-34.5 to 17.6)
	Outpatient	Optional referral for epidural steroid		SSS (6 months)
	research clinic in	injections if inadequate pain relief by oral		GE vs MC: -0.5 (-2.3 to 1.3)
	Pittsburgh	medication, severe neurogenic		MTE vs MC: -1.1 (-2.8 to 0.6)
		claudication, and/or patient preference.		MTE vs GE: -0.6 (-2.4 to 1.2)

45 46 47

Physician rendered general guide and on SPWT (6 months) gentle stretching and advice to stay GE vs MC: 86.5 (-75.7 to 248.8) active. MTE vs MC: 73.8 (-84.1 to 231.7) MTE vs GE: -12.7 (-175.6 to 150.1) **Group Exercise:** Supervised exercise Physical activity (6 months) classes at 2 local senior community GE vs MC: 21.3 (-6.9 to 49.4) centers. 2x 45-min classes/week, 6 MTE vs MC: -2.9 (-30.1 to 24.3) MTE vs GE: -24.2 (-52.5 to 4.0) weeks. Taught by senior fitness instructors. Participants self-select level of exercise based on fitness level (easy to medium) Adverse events: There were no reported serious adverse events in any group. There was a significantly greater rate of transient **Manual Therapy + Exercise:** joint soreness associated with group 3 (49%) compared with 2x 45minute sessions per week, 6 weeks group 2 (31%) and group 1 (6%). by either 2 chiropractors or 2 physiotherapists. Sessions included 3 interventions: 1. Warm-up procedure on stationary 2. Manual therapy procedures (lumbar distraction, hip, lumbar/sacroiliac joint and neural mobilizations 3. Individualized instruction in spinal stabilization exercises and home stretching Practitioner determined what muscles required stretch/strengthening and appropriate exercises added to program. 1) Comprehensive (n=48) 104 patients, 45 SPWT Between group MD, 95% CI, p values Ammendolia 2018 males and 59 Distance **SPWT** females, 48 in 2) Self-directed (n=51) Clinical 8 wks: 345.4 (150.0 to 540.7): p=0.00 comprehensive Significance -3 mo: 304.1 (77.9 to 530.3): p=0.01 group and 51 in **Comprehensive:** Chiropractor providing 30% 6 mo: 421.0 (181.4 to 660.6): p=0.00 self-directed 2x/week of 15-20-minute treatment improvement 12 mo: 473.2 (203.9 to 742.4): p=0.00 sessions over a 6-week period followed in SPWT no. group, with an 30% improvement in SPWT average age of by a single (booster) session, 4 weeks (%)8 wks: 24 (6-40): p=0.01 69.4 3) Clinical 3 mo: 21 (4-38): p=0.02 later.

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(comprehensive) and 71.7 (self-directed) neurogenic claudication >3 months, imaging-confirmed canal narrowing, walk >20m and not surgical candidates in next 12 months

#### **Setting:**

Academic hospital outpatient clinic in Toronto Education: Self-management strategies via cognitive behavioral approach. Body repositioning (pelvic tilt) when standing and walking. Exercises:

Standardized set of exercises demonstrated gradually over 6 weeks and was a part of structured home exercise program. Cycling, muscle stretching, strengthening, conditioning for back and lower extremity fitness and to facilitate lumbar flexion

Manual therapy: Spinal manipulation; joint, soft tissue and neural mobilization; lumbar flexion-distraction; and manual muscle stretching applied each visit. Participants received an instructional video and workbook and pedometer.

Self-directed: Instructional Video, workbook, pedometer and a single 15-to 30-minute training session with an experienced independent licensed chiropractor, independent of the comprehensive program, Training session: Describe 6-week program, review workbook, explain pedometer use and recording of weekly walking steps.

Video and workbook: Educational information and the same exercise instruction and self-management strategies received by the comprehensive group

Significance - 50% improvement in SPWT no. (%)

- 4) ZCQ-S
- 5) ZCQ-F
- 6) ZCQ-S + ZCQ-F
- 7) ODI
- 8) ODI walk
- 9) NRS Back
- 10) NRS Leg

**Follow-up:** 8 weeks, 3, 6, and 12 months

6 mo: 19 (2-35): p=0.02 12 mo: 22 (4-39): p=0.02 50% improvement in SPWT

8 wks: 26 (8-42): p=0.01 3 mo: 19 (-1.0 to 36): p=0.06 6 mo: 17 (-2 to 35): p=0.09

12 mo: 24 (5-40): p=0.01

#### **ZCQS**

8 wks: -0.19 (-0.37 to -0.02): p=0.03 3 mo: -0.15 (-0.37 to 0.08): p=0.19 6 mo: -0.02 (-0.22 to 0.19): p=0.87

12 mo: -0.22 (-0.47 to 0.02): p=0.07

#### **ZCQF**

8 wks: -0.02 (-0.22 to 0.17): p=0.81 3 mo: -0.18 (-0.39 to 0.03): p=0.09 6 mo: -0.11 (-0.33 to 0.11): p=0.34 12 mo: -0.27 (-0.49 to 0.04): p=0.02

#### ZCQS+ZCQF

8 wks: -0.24 (-0.56 to 0.07): p=0.13 3 mo: -0.36 (-0.75 to 0.03): p=0.07 6 mo: -0.23 (-0.58 to 0.12): p=0.20 12 mo: -0.48 (-0.90 to -0.06): p=0.03

#### ODI

8 wks: -0.02 (-0.07 to 0.02): p=0.30 3 mo: -0.04 (-0.09 to 0.01): p=0.13 6 mo: -0.02 (-0.07 to 0.02): p=0.34 12 mo: -0.03 (-0.08 to 0.02): p=0.30

#### **ODI Walk**

8 wks: -0.2 (-0.6 to 0.1): p=0.14 3 mo: -0.4 (-0.9 to 0.03): p=0.07 6 mo: -0.9 (-1.3 to -0.4): p<0.001 12 mo: -0.2 (-0.7 to 0.2): p=0.32

#### NRS Back

8 wks: -1.4 (-2.2 to -0.5): p=0.002 3 mo:-0.6 (-1.4 to 0.3): p=0.23 6 mo: -0.7 (-1.7 to 0.3): p=0.16 12 mo: -0.4 (-1.3 to 0.4): p=0.32

		10,000 CO.		NRS Leg  8 wks: -0.7 (-1.5 to 0.1): p=0.09  3 mo: 0.05 (-0.85 to 0.96): p=0.91  6 mo: -0.9 (-1.9 to 0.003): p=0.58  12 mo: -0.5 (-1.6 to 0.6): p=0.37  SF-36 Bodily Pain  8 wks: 2.0 (-4.9 to 8.9: p=0.57  3 mo: -4.5 (-12.4 to 3.5): p=0.27  6 mo: -3.3 (-10.2 to 3.6): p=0.35  12 mo: 10 (2.1 to 17.9): p=0.013  SF-36 Physical Function  8 wks: 4.2 (-3.9 to 12.4): p=0.31  3 mo: 9.2 (1.1 to 17.3): p=0.027  6 mo: 5.8 (-2.1 to 13.6): p=0.15  12 mo: 8.2 (0.2 to 16.2): p=0.045  Adverse events: At 12 months, 0 participants out of 43 in group 1 and 2 out of 46 participants in group 2 experienced adverse
Oğuz 2013	120 patients, 30	1) Standard exercise group (n=30)	1) VAS	events that were mostly attributed to a temporary increase in low back and/or leg pain.  Between group MD, p value VAS
	in group 1 with an average age of 57.1 years old, 30 in group 2 with	<ul><li>2) Isokinetic exercise program (n=30)</li><li>3) Unloading exercise group (n=60)</li></ul>	2) ODI 3) Beck Depression Inventory	After treatment: Grp 1 vs Grp 2:0.37, p>0.05 Grp 1 vs Grp 3: 1.36, p<0.05
	an average age of 55.8 years old and group 3 with an average age of	All groups physician-guided (5x/week for 3 weeks) then at-home (3x/week)	Follow-up: 4, 12 and 24 weeks	Grp 2 vs Grp 3: 0.99, p<0.05 4 <sup>th</sup> week: Grp 1 vs Grp 2: 1.43, p>0.05 Grp 1 vs Grp 3: 1.17, p<0.05
	57.4 years old, LSS symptoms, narrowing by MRI	<b>Standard Exercise:</b> 15 sessions of TENS, hot packs with home exercise instruction.		Grp 2 vs Grp 3: -0.26, p>0.05 12 <sup>th</sup> week: Grp 1 vs Grp 2: 0.93, p>0.05 Grp 1 vs Grp 3: 0.71, p>0.05
	Setting: University	<b>Isokinetic exercise:</b> 20 minutes/day, 5 sessions/week for a total of 15 sessions with a physician. Isokinetic exercises:		Grp 2 vs Grp 3: -0.22, p>0.05 24 <sup>th</sup> week: Grp 1 vs Grp 2: 1.08, p>0.05

department of physical medicine and rehabilitation in Turkey	rates of 60°/sec, 120°/sec, 180°/sec with 70° of body movement (50° flexion to 20° extension) Each session had 3 sets, each set had 5 repetitions at described velocity, with 20s rest between each set.  Unloaded exercise: 5 sessions of unloading exercise per week, for a total of 15 sessions with a physician. Walking with unloading exercise devise: session 1-5 = 45% body weight, session 6-15 = 30% body weight. Treadmill walking at 1.2 km/hr for 20 minutes, or until pain due to neurogenic claudication was felt.	Grp 1 vs Grp 3: 0.46, p>0.05 Grp 2 vs Grp 3: -0.62, p>0.05  ODI  After treatment: Grp 1 vs Grp 2: -0.8, p>0.05 Grp 1 vs Grp 3: 1.8, p<0.05 Grp 2 vs Grp 3: 2.6, p<0.05  4 <sup>th</sup> week: Grp 1 vs Grp 2: 1.5, p>0.05 Grp 1 vs Grp 3: 2.6, p>0.05 Grp 1 vs Grp 3: 1.1, p<0.05 Grp 2 vs Grp 3: 1.1, p<0.05 12 <sup>th</sup> week: Grp 1 vs Grp 2: 1, p>0.05 Grp 1 vs Grp 3: 1.3, p>0.05 Grp 2 vs Grp 3: 1.3, p>0.05 Grp 2 vs Grp 3: 0.3, p>0.05
	Unloaded exercise: 5 sessions of	Grp 2 vs Grp 3: 2.6, p<0.05 4 <sup>th</sup> week:
	of 15 sessions with a physician. Walking with unloading exercise devise: session	Grp 1 vs Grp 3: 2.6, p>0.05 Grp 2 vs Grp 3: 1.1, p<0.05
	30% body weight. Treadmill walking at 1.2 km/hr for 20 minutes, or until pain	Grp 1 vs Grp 2: 1, p>0.05 Grp 1 vs Grp 3: 1.3, p>0.05
	Subjects advised to follow exercise program s at home at least 3x/week after discharge.	24 <sup>th</sup> week: Grp 1 vs Grp 2: 0.4, p>0.05 Grp 1 vs Grp 3: 0.5, p>0.05
		Grp 2 vs Grp 3: 0.1, p>0.05  Total Gait Duration  After treatment:
		Grp 1 vs Grp 2: 64.6, p>0.05 Grp 1 vs Grp 3: -50.5, p>0.05 Grp 2 vs Grp 3: -115.1, P<0.05
		4 <sup>th</sup> week: Grp 1 vs Grp 2: 45.9, p>0.05
		Grp 1 vs Grp 3: -18.4, p>0.05 Grp 2 vs Grp 3: -64.3, p<0.05 12 <sup>th</sup> week:
		Grp 1 vs Grp 2: 52.23 p>0.05 Grp 1 vs Grp 3: -0.67 p>0.05 Grp 2 vs Grp 3: -52.9 p>0.05
		24 <sup>th</sup> week: Grp 1 vs Grp 2: 35.2, p>0.05 Grp 1 vs Grp 3: 1.9, p>0.05
		Grp 2 vs Grp 3: -33.3, p>0.05

Treatment in therapeutic pools with VAS Homayouni 47 subjects, 23 1) All between group comparisons 2015 male, 24 female, water temperature of 29-30 degrees 2) Walking Walking ability 24 in group one, Celsius. Every aquatic session ability Grp 1 > Grp 2: p=0.02started with warm up and ended with VAS mean age 55.56, 12 male, 12 cool down, with duration of 10-15 Grp 1 > Grp 2 p= 0.001Follow-up: min for each of them. Participants female, 23 in Immediately after should have attended aquatic therapy, 3 months group two, mean physical therapy sessions every other age 55.68, 11 male, 12 female day for a total duration of 24 sessions. Each session included **Setting:** ambulation, side walking, chain University-based walking, forward walking with kickboard, stretching of each muscle pain clinics in Iran group including adductors, abductors, flexors and extensors of the hip, knee flexors and ankle plantar flexors and dorsiflexors. Other interventions were mini-squat, pelvic curl, pelvic tilt, and knee to chest, double knee lift, and deepwater exercise. (n=25) 2) Passive modalities by physical therapists including continuous mode ultrasound (US) 1.5W/cm2 for 10 min and hot pack and trans-electrical nerve stimulation (TENS) for 20 min to the lumbar region. Also, the therapists instructed the patients in this group to perform trunk muscle endurance, William's and stretching exercises. The patients were treated using these passive modalities and were given exercises under supervision of physiotherapists for 10 sessions. They were instructed to perform the learned exercises 30 min

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			a day at home in the following weeks until the end of the eighth week. (n=25)			
Marchand 2019	40 participants, 17 females and 23 males, 20 in the intervention group with an average age of 66.7 years old and 20 in the control group with an average age of 71.5 years old, with history and diagnostic imaging of LSS  Setting: Regional hospital in Quebec	1) 2)	Exercise 3x week / 6 weeks prior to surgery (n=20)	2) 3) 4)	NRS (Pain Intensity) ROM (Active) Muscle strength (N-m) Walking capacity (seconds)  Illow-up: 3 and nonths	Between group MD NRS (leg) Preoperative: -2.1, p<0.05 Postoperative: 1.1, p>0.05 3 months: 1.1, p>0.05 6 months: 0.3, p>0.05 ROM (active) Preoperative: 5, p<0.05 Postoperative: -6, p>0.05 Muscle Strength Preoperative: 45.7, p<0.001 Postoperative: 5.1, p>0.05 Walking Duration Preoperative: 90, p<0.05 Postoperative: -14.5, p>0.05
Kim 2019	34 subjects, mean age 64 (5.3), women 24 (66.7)  Setting: Hospital in Seoul, South Korea	1)	MT1 group: 110 g of Gang-Chuk Tang was administered 3 times a day (Gang-Chuk Tang is an herbal concoction consisting of Eucommiae Cortex, Achyranthis Radix, Rhizoma Cibotii, Sorbus commixta, G. thunbergii, Saposhnikovia Radix, and Acanthopanacis Cortex in equal portions) Daily Mokhuri Chuna therapy (relaxation and mobilization of lumbar joint and back muscle) Daily acupuncture treatment on LI4, ST36, LV3, BL22, BL23, BL24, BL25, and Ashi points. Consultation on precautions related to daily	2) 3) 4) Fol	VAS for leg pain VAS for low back pain Oxford Claudication Scoring Walking distance	All between group comparisons  VAS leg pain (post treatment)  MT2 (28.82±27.46) vs CMT (51.82±25.34) groups: P=0.04  VAS leg pain (6 months)  MT1 (48.91±23.08) vs CMT (72.27±16.72) groups: P=0.01  MT2 (42.36±21.29) vs CMT groups: P=0.003  VAS low back pain (6 months):  MT2 (30.00±13.48) vs CMT (60.82±18.62) groups: P=0.001  Oxford Claudication Scoring (3 months)  MT1 (18.75±6.52) vs CMT (25.82±6.24) groups: p=0.02  Walking distance (3 months)  MT1 vs CMT: p=0.03  Walking distance (6 months)  MT1 vs CMT: p=0.01

		2)	activity and stepwise walking training for the entire 4 weeks of therapy. (n=12)  MT2 group: Mokhuri Chuna, acupuncture, and physician consultation were offered in the same manner and dosage as the MT1			The primary outcome of this pilot study was safety as measured by the type and incidence of adverse events (AEs).
			group with the exception that all herbal medications were withheld. (n=11)			
		3)	CMT group: Oral analgesic therapy (aceclofenac 100 mg twice daily and eperisione hydrochloride 50 mg three times daily for 28 days) and three interlaminar epidural steroid injections (5 mg of dexamethasone per injection) at the level of the affected spinal region over a 4-week period were administered. Physiotherapy including heating pad, and transcutaneous electrical nerve simulator, and deep tissue heating therapy five times per week for 4 weeks. (n=11)	$Q_{i}$	lich	
			` ,	Ma	nipulation	4//
Passmore 2017	14 patients with degenerative LSS (n=14); Swiss Spinal Stenosis score of M=63.2, standard deviation [SD] = 15.9) (mean age 59.0 (10.6)), 7 in	1)	Spinal manipulation group: received bilateral high-velocity; low-amplitude spinal manipulation directed toward the lumbar region (by a licensed chiropractor with more than 10 years of clinical experience) (n=7)	3) 4) Fol	Movement time NPS (Back) NPS (leg) ROM	There was no significant difference between groups for all outcomes.  1. Grp 1 vs. Grp 2, p=0.739  2. Grp 1 vs. Grp 2, p> 0.05  3. Grp 1 vs. Grp 2, p> 0.05  4. Grp 1 vs. Grp 2, p> 0.05
	59.0 (10.6)), 7 in the SM group (4	2)	Non Intervention Group: Waited 5 minutes if they were assigned to the	ınte	ervention	

female, 3 male) (mean age 59.1 (9.3)), 7 in the NI group (3 female, 4 male) (mean age 58.9 (12.6))  Setting: rehabilitation hospital in Winnipeg, Manitoba	no intervention group (n=7)		
	Ac	upuncture	
Kim 2016  50 participants mean age of 62.0±9.8 years, acupuncture (n=26), age 65.0±8.7, male / female 12/14, control (n=24), age 58.9±10.2, male / female 10/14. Mean duration of symptoms 33m  Setting: Hospital in Yangsan, South Korea	<ol> <li>Acupuncture: 269 acupuncture sessions were administered during the study. 81% (n=21) of patients received at least 10 acupuncture sessions. Electrical acupuncture was applied at least once and bilaterally at back shu points (BL23, BL24, BL25 or BL26) or Jiaji points at L2–L5 spinal levels. Other frequently used points were BL57, BL60, GB39, GB34 and tender points located in the lower extremities (n=26)</li> <li>Control: In total, 255 physical therapy sessions were provided to patients in the control group at their request. 92% (n=22) of patients received at least 10 physical therapy sessions (median 11, range 1–13). (n=24)</li> </ol>	1) ODI 2) SF-36 bodily pain 3) SF-36 physical function 4) LBP bothersomene ss 5) LBP intensity 6) Leg pain bothersomene ss 7) Leg pain intensity 8) Self-reported pain-free walking distance (m)  Follow-up: 6 weeks, 3 months	Between group MD, 95% CI ODI  6 wk: -2.2 (-7.0 to 2.6) 3 mo: -2.5 (-8.9 to 3.8) SF-36 BP  6 wk: -8.6 (-18.6 to 1.3) 3 mo: 3.2 (-8.3 to 14.7) SF-36 PF  6 wk: 0.1 (-7.6 to 7.9) 3 mo: 1.3 (-8.3 to 10.9) LBP bothersomeness 6 wk: -0.6 (-11.4 to 10.1) 3 mo: -7.4 (-19.6 to 4.8) LBP intensity 6 wk: -5.1 (-15.5 to 5.3) 3 mo: -13.5 (-26.2 to -0.7) Leg pain bothersomeness 6 wk: -7.4 (-18.4 to 3.7) 3 mo: -9.2 (-21.6 to 3.2) Leg pain intensity 6 wk: -11.5 (-0.9 to -22.0) 3 mo: -12.6 (-24.6 to -0.6)

Oin 2020 80 participants 1) Acupuncture: Applied by acupuncturists with 5 years of assigned with 70 completing the 8-Chinese medical university program and at least 2 year of clinical week treatment experience. Sterile disposable steel course (38 in acu group and 32 in needles (Hwato Acupuncture, Suzhou, China; 0.30 £ 40 mm/0.30 £ sham acu group). Mean age of 75 mm) were inserted through adhesive pads. Participants 61.5±7.9 years underwent 3 treatments weekly over with 34 males 8 weeks, and each session persisted and 46 females. Duration of for 30 minutes. To maintain "De qi," a sensation of numbness and symptoms <3mo soreness, acupuncture manipulation =14 (17.5%), 3-(twirling, lifting, and thrusting on 12 mo = 1(1.3%),needles) was performed every 10 1 to 5 y = 24minutes during the treatment. (30%), >5 y =41 (51.3%)

**Setting:** 

Hospital

Integrated

Western

Medicine.

Traditional and

Sham acupuncture: Chosen acupoints, treatment duration, and frequency of sessions were the same 2 Clinical Sites as in the acupuncture group. Department of Participants in the sham cohort were Acupuncture and treated using a pragmatic placebo Neurology, needle on the same acupoints, which Guang'anmen is similar to the Streitberger needle design (Supplementary Materials). Department of Acupuncture and Acupuncturists pretended to manipulate the needle every 10 Neurology, minutes, but "De qi" was not sought. Beijing Fengtai Hospital of

**RMDO** 1)

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- NRS back
- NRS Leg
- 4) SSS **Symptoms** subscale
- 5) SSS physical function subscale
- SSS satisfaction subscale
- 7) Self-paced walk test

Follow-up: 4 weeks, 8 weeks (end of treatment). 3 months, 6 months

None statistically significant **RMDO** 

4 wk: -3.6 (-5.2 to -1.9): p<0.001

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8 wk: -2.6 (-3.7 to -1.4): p<0.001 3 mo: -2.3 (-3.9 to -0.7): p=0.005

6 mo: -1.8 (-3.6 to -0.3): p=0.086

**NRS Back** 

4 wk: -1.7 (-2.4 to -0.9): p<0.001

8 wk: -2.3 (-3.0 to -1.5): p<0.001 3 mo: -1.7 (-2.6 to -0.8): p<0.001

6 mo: -1.2 (-2.1 to -0.3): p=0.007

NRS Leg

4 wk: -2.0 (-2.6 to -1.3): p<0.001

8 wk: -2.9 (-2.6 to -1.3): p<0.001 3 mo: -2.4 (-3.3 to -1.4): p<0.001

6 mo: -2.1 (-3.0 to -1.2): p<0.001

**SSS Symptoms Subscale** 

4 wk: -0.6 (-0.8 to -0.4): p<0.001

8 wk: -0.9 (-1.2 to -0.6): p<0.001

3 mo: -0.9 (-1.2 to -0.6): p<0.001 6 mo: -1.0 (-1.3 to 0.6): p<0.001

**SSS Physical Function Subscale** 

4 wk: -0.5 (-0.8 to -0.3): p<0.001 8 wk: -0.8 (-1.1 to -0.5): p<0.001

3 mo: -0.7 (-1.0 to -0.4): p<0.001

6 mo: -0.7 (-1.1 to -0.4): p<0.001

**Self-Paced Walk Test** 

4 wk: p=0.648

8 wk: p=0.29

3 mo: p=030

6 mo: p=0.133

**Adverse events:** 3 participants in group 1 reported pain after needle insertion and 1 had a hematoma. 3 participants in group 2 reported back pain and 2 reported fatigue. All adverse events were reported as mild or moderate, and none required medical intervention.

		Epidı	ıral injections	
Cuckler	73 subjects in	1) Steroid group: 2ml of sterile water	1) Subjective	Patient Global Assessment (improved by at least 75%)
1985	total, 37 with	containing 80mg of	percentage of	24 hours: 33% (steroid) vs. 21% (saline) p>0.05
	spinal stenosis,	methylprednisolone acetate	improvement	Long term: 33% (saline) vs. 14% (saline) p>0.05
	36 with acute	combined with 5ml of 1% procaine	with 75%	
	herniated nucleus	was injected into the epidural space	required to be	
	pulposus, 37	in the region between the 3rd and 4th	considered a	
	males, 36 female,	lumbar vertebrae with the patient in	treatment	
	average age of	the lateral decubitus position lying	improvement,	
	48.5 years in the	on the side of the painful limb	if less than	
	experimental	(n=42), 20 with stenosis).	50% after 24	
	group and 49.5		hours was	
	years in the	2) Placebo group: 2ml of saline	considered a	
	placebo group.	combined with 5ml of 1% procaine	treatment	
	Experimental	was injected into the epidural space	failure	
	group average	in the region between the 3rd and 4th	2) Re-injection	
	36.6 months in	lumbar vertebrae with the patient in	rates	
	symptom	the lateral decubitus position lying	3) Surgery rates	
	duration, placebo	on the side of the painful limb.		
	group averaged	(n=31, 17 with stenosis)	Follow-up: 24	
	29.4 months.		hours, every 3	
		All patients were advised to take mild	months up to 30	
	Setting:	analgesics (aspirin or acetaminophen)	months, averaging	
	Orthopaedic	during the post-injection period. Second	20.2 months in the	
	surgery	injection given if less than 50%	steroid group and	
	department in the	improvement after 24 hours - considered	21.5 months in the	
	United States	treatment failure	control group.	
Fukusaki	53 subjects, 38	1) Epidural injection with 8 ml of	1) Walking	Walking distance
1988	males and 15	saline, repeated twice in the first	distance which	Percent excellent effect = mean of $> 100$ m in walking distance
	female. Group 1	week (n=16)	was graded	1 week: 12.5 % (saline) vs. 55% (block) vs. 63.2% (block +
	averaged 70		according to	steroid); block or block + steroid > saline, p< 0.05;
	years of age and	2) Epidural injection with 8 ml of 1%	distance	1 mo: 6.3% (saline) vs. 16.7% (block) vs. 15.8% (block +
	79 days of	mepivacaine, repeated twice in the	(excellent,	steroid) $p > 0.05$
	symptoms on	first week. (n=18)	good, or poor)	3 mo: 6.3 (saline) vs. 5.6% (block) vs. 5.3% (block +steroid) p>
	average, group 2			0.05
	averaged 69	3) Epidural injection with a mixture of	Follow-up: 1	
	years of age and	8 ml of 1% mepivacaine and 40 mg	week, 1 month, 3	No significant difference between block vs. block + steroid at

	an average of 82 days of symptoms, group 3 averaged 72 years of age and 94 days of symptoms on average  Setting: Anaesthesia department in Japan	of methylprednisone, repeated twice in the first week. (n=19)	months	all follow-up periods, p>0.05  Adverse events: no reported complications
Zahaar 1991	30 subjects, 37 male and 26 female. Steroid group averaged 46.5 years of age and 36.6 months of symptoms, control group averaged 49 years of age and 29.4 months of symptoms  Setting: Medical facility in Egypt	<ol> <li>Steroid injection: 5ml of hydrocortisone acetate suspension, 2x2ml carbocaine, 4% Volume completed with sterile saline to 30ml (n=18)</li> <li>Control: 2x2ml of carbocaine, 4% injected into epidural space. Volume completed with sterile saline to 30ml. (n=12)</li> </ol>	1) Subjective percentage of improvement where 75% or more was deemed successful and surgery after injection was considered a failure.  Follow-up: 24 hours, then every three months up to 36 mo averaging 20.2 mo in the steroid group and 21.5 mo control group.	Patient Global Assessment (improved by at least 75%) 24 hours: 55% (steroid injection) vs. 50% (control) p> 0.05 Up to 36 mo: 38% (steroid injection) group vs. 33.3% (control) p>0.05  Failures (%) (required surgery) Up to 36 mo: 61% (steroid injection) vs. 66.6% (control) p>0.05
Friedly 2014, 2017 Makris 2016	400 patients, 221 females and 179 males, 200 in the lidocaine group	1) Lidocaine + glucocorticoid (1-3 mL of 0.25-1% lidocaine followed by 1-3 mL triamcinolone (60-120mg), betamethasone (6-12mg),	1) RMDQ 2) NRS (Leg Pain)	<b>Between group MD, 95% CI, p values RMDQ</b> 3 weeks: -1.8 (-2.8 to -0.9): p<0.001 6 weeks: -1.0 (-2.1 to 0.1): p=0.07

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	with an average age of 68.1 years old and 200 gluocorticoid-lidocaine group with an average age of 68 years old, LSS by CT or MRI. 26% patients symptoms greater than 5 years.  Setting: 16 medical centers across the United States	dexamethasone (8-10mg) or methylprednisone (60-120mg)) (n=200)  2) Lidocaine group (0.25-1% lidocaine alone) (n=200)  Physician option for intralaminar and/or transformaminal techniques	Follow-up: 3, 6, and 12 weeks, 6 and 12 months  Makris 2016 subgroup  1) RMDQ using SIP Weights  2) RMDQ patient-prioritized (LESSER)  Follow-up: 3 and 6 weeks	12 wk: 0.1 (-1.0 to 1.3): p=0.84 6 mo -0.00 (-1.1 to 1.1): p=0.99 12 mo: -0.4 (-1.6 to 0.9): p=0.55  NRS (Leg pain) 3 weeks: -0.6 (-1.2 to -0.1): p=0.02 6 weeks: -0. (=0.8 to 0.4): p=0.48 12 wk: 0.1 (-0.5 to 0.7): p=0.70 6 mo: -0.2 (-0.8 to 0.4): p=0.47 12 mo: 0.1 (-0.5 to 0.7): P=0.75  Subgroup Analysis  RMDQ using SIP weight 3 wks: -1.9 (-2.9 to -0.7): p<0.001 6 wks: -1.1 (-2.2 to -0.1): p=0.04  RMDQ patient prioritized (LESSER) 3 wks: -1.8 (-2.8 to -0.8): p<0.001 6 wks: -1.0 (-2.0 to 0.1): p=0.08  Adverse events: A total 21.5% of patients in group 1 and 15.5% in group 2 reported one or more adverse events (p=0.08) that included headaches, fever, infection, dizziness, cardiovascular/lung problems, leg swelling and dural puncture.
Song 2016	29 subjects, 14 males and 15 women with an average age of 58.3 and 61.7 between groups, history of intermittent claudication and lower limb radicular pain or paresthesia	<ol> <li>Lidocaine spinal injection, 40 mg triamcinolone mixed with 10 mL 0.5% lidocaine was used under the guide of fluoroscopy (n=15)</li> <li>Saline spinal injection using same volume (n=14)</li> </ol>	1) VAS 2) FRI  Follow-up: 1 and 3 months	No significant difference between groups.  VAS  1-month p= 0.696, 3 months p= 0.891  FRI  1-month p=0.983, 3 months p=0.743

	Setting: Rehabilitation clinic in Korea			
Milburn 2014	57 patients met inclusion criteria, agreed to participate, and were enrolled. 20 patients were male; 37 were female. Mean patient age was 65.3 years (range, 32-88 years). Average duration of symptomatology (pain and/or disability) was 42 months. The mean degree of canal narrowing at the most stenotic level was 6.1 mm (range, 2.5-9.1 mm). The most common maximally stenotic intervertebral level was L4-L5	Fluoroscopically guided lumbar ILESI performed either at:  1) The level of maximal stenosis (n=30)  2) Two intervertebral levels cephalad, corresponding to a less stenotic level (n=27)  Injection was performed with a 20-gauge Tuohy needle using a loss of resistance technique. The injectate consisted of 2 mL of 40 mg/mL methylprednisolone (Pfizer), 2 mL of bupivacaine 0.25% (Hospira), and 2 mL of normal saline for a total injectate volume of 6 mL.	1) NRS - Pain with Ambulation 2) RMDQ  Follow-up: 1, 4 and 12 weeks	All between group comparisons NRS (pain with ambulation)  1 wk: Grp 1 lower pain compared to Grp 2, p=0.045  4 wk: Grp 1 lower pain compared to Grp 2, p=0.049  12 wk: Grp 1 lower pain compared to Grp 2, p=0.08  RMDQ  1 wk: Grp 1 lower compared to Grp 2, p=0.001  4 wk: Grp 1 lower compared to Grp 2, p=0.009  12 wk: Grp 1 lower compared to Grp 2, p=0.003

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	(n <sup>1</sup> / <sub>4</sub> 42) followed by L3-L4 (n <sup>1</sup> / <sub>4</sub> 11) and L5-S1 (n <sup>1</sup> / <sub>4</sub> 4). <b>Setting:</b> Clinic in New Orleans, Louisiana			
Brown 2012	38 patients, 21 males and 17 females, 21 in mild group with an average age of 74.2 years and 17 in ESI group with an average age of 78.7 years, symptomatic LSS patients with painful lower limb neurogenic claudication, able to walk at least 10 feet unaided, (ODI) score > 20  Setting: Pain management clinic in Florida	Epidural steroid (80 mg triamcinolone acetate) (n=17)  Mild lumbar decompression (n=21)	1) VAS 2) ODI 3) ZCQ 4) Patient Satisfaction (0-10)  Follow-up: 6 and 12 weeks	VAS 6 and 12 weeks P=0.54 ODI p=0.86 ZCQ p>0.05 Patient satisfaction p>0.05
Hammerich 2019	54 patients total, age 67.2 ± 9.7, 27 male, 27 female, 31 in ESI group, 23 in ESI plus PT. Mean duration of	1) ESI (n=31) 2) ESI + PT (n=23) ESI: 1.5 mL of steroid at each site injected with maximal involvement using transforaminal approach.	1) ODI 2) NRS current 3) SF-36 emotional role 4) SF-36 emotional well-being	Between group MD, 95% CI, p values ODI 10 wks: -1.08 (-8.10 to 5.94) p=0.80 6 mo: -4.70 (-11.72 to 2.32) p=0.27 12 mo: -2.72 (-9.74 to 4.30) p=0.52 NRS 10 wks: -1.68 (-3.08 to -0.29) p=0.07

SF-36 general symptoms 14 m 6 mo: -1.99 (-3.38 to -0.60) p=0.04 PT: 8-10 sessions PT manual therapy and health 12 mo: -2.44 (-3.80 to -1.08) p=0.00 **Setting:** Clinics exercise. Walking program and/or perception SF-36 Emotional role in Colorado, stationary bike, stretching and 10 wks: -28.53 (-49.05 to -8.01) p=0.03 Texas, South strengthening exercises. 6 mo: -11.25 (-31.77 to 9.27) p=0.39 Follow-up: 10 Carolina and weeks, 6 and 12 12 mo: -10.67 (-31.19 to 9.85) p-0.41 New Hampshire months SF-36 Emotional well-being 10 wks: -11.26 (-19.52 to -2.99) p=0.02 6 mo: 2.69 (-5.57 to 10.95) p=0.59 12 mo: -5.76 (-14.02 to 2.50) p=0.24 SF-36 General Health Perception 10 wks: -8.99 (-17.20 to -0.78) p=0.05 6 mo: -5.56 (-13.77 to 2.65) p=0.23 12 mo: -5.10 (-13.31 to 3.11) p=0.27 Sencan 2020 67 patients. The 1) Interlaminar: ILESI, fluoroscopy 1) NPS Between Group Median Differences (data not provided), p median age 62.5 guided with 1 to 2 mL contrast dye 2) ODI values vears with 18 with mixture of 80 mg NPS Beck methylprednisolone acetate, 2 mL after treatment: p=0.14 males and 49 depression females. Median saline solution, and 2 mL (0.5%) scale 3 wks: p=0.28bupivacaine solution Walk distance 3 mo: p=0.047duration of ODI symptoms was 29 and 24 months in 2) Transforaminal: TFESI, fluoroscopy Follow-up: after 3 wks: p=0.93the ILESI and guided with 1 to 2 mL contrast dye treatment, 3 weeks 3 mo: p=0.65with mixture of 80 mg bilateral TFESI and 3 months **Beck Depression Scale** 3wks: p=0.048 methylprednisolone acetate, 2 mL groups, saline solution, and 2 mL (0.5%) 3 mo: p=0.03respectively Walking Distance bupivacaine solution **Setting:** 3 wks: p=0.23University 3 mo: p = 0.048department Pain Medicine, Istanbul Turkey Wei 2020 Epidural injection with 2.0mL of 90 patients. Mean 1) VAS (leg) Between Group Mean Differences (data not provided), p age about 65 lidocaine and 10 mg of TNF-a 2) ODI values Grp 1 vs Grp 2 years, 45 inhibitor (etanercept) on the affected females, 45 spinal nerves. Follow-up: after VAS

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group. 52% male		received an epidural steroid injection		claims	Symptoms Severity score
	2)			compensation	(control) (P< 0.001)
43% female in					2 yrs: 73.1% (surgery) vs. 35.9%
57% male and		Decompression System (n=100)			(Good result)
191 subjects,	1)	X STOP Interspinous Process	1)	SF-36	Patient global assessment
			Surge	ery	
clinic in Korea					and parestnesia at the injection site.
					reported equally in both groups (no data provided), mostly pair and paresthesia at the injection site.
					Adverse events: Minor and transient adverse events were
-					6 mo: -13.74 (-22.18 to 5.30): p=0.00
Setting: Single-					3 mo: -6.63 (-14.75 to 1.48): p=0.11
					1 mo: -6.13 (-13.88 to 1.61): p=0.12
males.					ODI (%)
18 females, 26					6 mo: -1.88 (-3.15 to 0.61): p=0.00
+-6.4					3 mo: -0.69 (-1.89 to 0.52): p=0.26
			Foll	ow-up: 1, 3	1 mo: 0.73 (-0.40 to 1.85): p=0.21
in the ZiNeu				7	NRS-11 (Leg pain)
	2)				6 mo: -2.02 (-3.58 to 0.45): p=0.01
	2)	Percutaneous Enidural		` •	3 mo: -1.13 (-2.63 to 0.38): p=0.14
		(Nac2) (11 – 20)			1 mo:-0.38 (-1.81 to 1.06): p=0.61
	1)				NRS-11 (Back pain)
11 notionts total	1)	DEA Using a Rolloon less Catheter	1)	NDS (back	Between group MD, 95% CI, p values
					1, 3 and 6 mo, no significant difference, p>0.05
					after treatment, 1, 3 and 6 mo, no significant difference, p>0.0 <b>ODI</b>
					VAS
China					Grp 2 vs Grp 3
					1, 3 and 6 mo, Grp 1 greater reduction, p<0.05
		lidocaine only.			ODI
Setting:	3)				after treatment, 1, 3 and 6 mo, Grp 1 greater reduction, p<0.05
					VAS
2.8 months		(diprospan)			Grp 1 vs Grp 3
symptoms about		lidocaine mixed with 2mL of steroid			1, 3 and 6 mo, Grp 1 greater reduction, p<0.05
duration of	2)	Epidural administration with 2mL of	mon	ıths	ODI
	symptoms about 2.8 months  Setting: University Hospital Jiangsu China  44 patients total, 20 in the RACZ group (age 66.1 +-12.2, male 9 (45.0%), and 24 in the ZiNeu group (Age 65.5 +-6.4 18 females, 26 males.  Setting: Single-center, academic, outpatient interventional pain management clinic in Korea	symptoms about 2.8 months  Setting: University Hospital Jiangsu China  44 patients total, 20 in the RACZ group (age 66.1 +-12.2, male 9 (45.0%), and 24 in the ZiNeu group (Age 65.5 +-6.4 18 females, 26 males.  Setting: Singlecenter, academic, outpatient interventional pain management clinic in Korea  191 subjects, 57% male and 43% female in the X STOP  2)	symptoms about 2.8 months  Setting: University Hospital Jiangsu China  1) PEA Using a Balloon-less Catheter (Racz) (n = 20)  2) Percutaneous Epidural Decompression and Adhesiolysis Using an Inflatable Balloon Catheter (ZiNeu) (n = 24)  1) Eximple Center, academic, outpatient interventional pain management clinic in Korea  1) X STOP Interspinous Process Decompression System (n=100)  1) X STOP Interspinous Process Decompression System (n=100)  2) Non-operative treatment: Subjects	Setting: University Hospital Jiangsu China   1) PEA Using a Balloon-less Catheter (Racz) (n = 20)   2) Percutaneous Epidural Decompression and Adhesiolysis Using an Inflatable Balloon Catheter (ZiNeu) (n = 24)   Foll and String and Percenter, academic, outpatient interventional pain management clinic in Korea   1) X STOP Interspinous Process Decompression System (n=100)   2) Non-operative treatment: Subjects   3) Surge	symptoms about 2.8 months  Setting: University Hospital Jiangsu China  1) PEA Using a Balloon-less Catheter (Racz) (n = 20) 2) Percutaneous Epidural pecompression and Adhesiolysis Using an Inflatable Balloon Catheter (ZiNeu) (n = 24)  Setting: 1) NRS (back pain) 2) NRS (leg pain) 3) ODI  Follow-up: 1, 3 and 6 months  Surgery  191 subjects, 57% male and 43% female in the X STOP  1) X STOP Interspinous Process Decompression System (n=100) 2) Non-operative treatment: Subjects  sometimes  Surgery  1) SF-36 2) ZCQ 3) Worker's compensation

	and 48% female	on enrolment and were eligible for	4) ODI	Surgery better at 6 w, 6 mo, 1 and 2 yr (graphs) (P<0.001)
	in the non-	additional injections as needed, as	5) Radiographic	2 yrs: MPC 45.4% (surgery) vs. 7.4% (control) (P < 0.001)
	operative group.	well as NSAIDS, analgesic agents,	changes	"Clinically relevant improvement (patients)":
	Average age of	and physical therapy. Physical		2 yrs: 60.2% (surgery) vs. 18.5% (control) (P< 0.001)
	70 years in the X	therapy consisted of education on		Symptoms Severity score††
	STOP group and	back care and modalities such as ice		Surgery better at 6 w, 6 mo, 1 and 2 yr (graphs) (P<0.001)
	69.1 years in the	packs, heat packs, massage,		2 yrs: MPC 44.3% (surgery) vs0.4% (control) (P < 0.001)
	non-operative	stabilization exercises, and pool	Follow-up:	"Clinically relevant improvement (as measured by
	group. Average	therapy. Braces such as abdominal	Surgery: 7 (2 yr)	patients)":
	of 3.5 year	binders and corsets were permitted,	Control: 19 (2 yr)	<sup>1</sup> 2 yrs: 57% (surgery) vs. 14.8% (control) (P < 0.001)
	symptom	but body jackets and chair back		ZCQ (global success)
	duration in the X			6 mo: 52% (surgery) vs. 9% (control) (P value not reported)
	STOP group and	braces were not. (n=91)		1 yr: 59% vs 12% (P value not reported)
	4.7 years in the			2 yrs: 48.4% (surgery) vs. 4.9% (control) (P < 0.001)
	non-operative			Quality of life (SF-36)
	group.			At all post treatment time points (6 w, 6 mo, 1 yr, 2 yr), the
	8 1			mean domain scores documented in the X STOP group were
	Setting: Spine			significantly greater than those in the non operative group, with
	center in the			the exception of the mean General Health, Role Emotional, and
	United States		<b>*</b> //•	Mental Component Summary scores at 2 years
			· (V)	<b>Adverse events:</b> No complications were reported in group 2. In
				group 1, complications were reported in 11% of subjects
				including spinous process fracture, coronary ischemia,
				respiratory distress, hematoma, and 1 death (pulmonary edema)
Weinstein	Subjects with	Assigned to surgery (standard	1) SF-36 bodily	All between group comparisons using Intention-to-Treat
2007, 2009,	image-confirmed	laminectomy with or without fusion		analysis
Abdu 2018	degenerative	(n=159)	2) SF-36 bodily	SF-36 Bodily Pain, DMC, 95% CI
	spondylolisthesis:		function	2 yrs: 1.5 (-4.2 to 7.3)
	304 subjects in	2) Assigned to non-surgical treatment:	3) low back pain	4 yrs: -2 (-8.6 to 4.6)
	the RCT, 303 in	Usual non-operative care (n=145)	bothersomeness	8 yrs: p=0.85
	the observational	1	scale	SF-36 Bodily Function, DMC, 95% CI
	cohort, 31% male		4) Leg pain	2 yrs: 1.9 (-3.7 to 7.5)
	in the surgical		bothersomeness	4 yrs: -3.1 (-9.2 to 3.0)
	group, 33% male		scale	8 yrs: p=0.31
	in the surgical		5) ODI	Disability (ODI), DMC, 95% CI
	group. Average		6) Subjective self-	2 yrs: 2.2 (-2.3 to 6.8)

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	age of 64.7 years				eported	4 yrs: 4.1 (-0.8 to 9.1)
	in the surgical				mprovement,	8 yrs: p=0.039
	group and 68.2				atisfaction with	8 yis. p=0.039
	years in the non-				urrent	Other outcomes (patient's satisfaction; Stenosis Bothersomeness
	surgical group.				ymptoms and	Index, Leg Pain Bothersomeness Scale; and Low Back Pain
	Subjects had				are	Bothersomeness Scale) were not provided separately for the
	symptoms for at				Stenosis	randomized cohort.
	least 12 weeks			/	othersomeness	Adverse events: group 1 reported 14% intraoperative
		4		iı	ndex	complication mostly and dural tears and 19% postsurgical
	Setting: multi-					complications including 1 death, 11% required additional
	centred			Fol	llow-up: 6	surgeries at 2 years,
	orthopaedic			we	eks, 3 and 6	
	departments in			mo	nths, 1, 2, 4 and	
	the United States		700	8 y	ears	
Amundsen	100 subjects, 54	1)		1)	VAS	Patient global assessment (Good result)
2000	male, 46 female,		laminectomy, medial facetectomy,	2)	Verbal Rating	1 yr: RR 2.07 (0.98 to 4.38)
	median age of 59		discectomy, and/or removal of		Scale	4 yrs: RR 1.94 (1.14 to 3.31)
	(males were 1.5		osteophytes from the vertebral	3)	3	10 yrs: RR 3.18 (0.97 to 10.41)
	years higher than		margins or facet joints. No fusions.		change	Pain (none or mild)
	females).		(n=13)		(better, worse,	1 yr: NR
	Median back pain				or unchanged)	4 yrs: RR 3.33 (0.77 to 14.33)
	duration was 14	2)	Conservative therapy: Lumbar	4)	Work status	10 yrs: RR 1.59 (0.55 to 4.55)
	years, median		orthosis use for 1 month worn during	5)	3	
	duration of		the day for all activities plus		rating from	Other outcomes (claudication or walking distance; level of daily
	sciatica was 2		instruction and back school." (n=18)		evaluating	activity; and neurologic deficits) were not reported separately
	years.				physician and	for the randomized cohort.
	G•				study team	* //h
	Setting:				(Excellent,	
	Neurology				Fair,	
	department in a				Unchanged,	
	hospital in				Worse)	
	Norway			Ec.	llow-up:	
					now-up: nonths, 1, 4 and	
					years	
Malmivaara	94 subjects, 22%	1)	Segmental decompressive surgery	1)	•	All between group comparisons
2007	of surgical	1)	with facetectomy (n=50)	1)	numerical pain	Leg pain, MD, 95% CI
2007	or surgicar	I	with facticetomy (ii 50)	l	numericai pain	Leg pain, 1712, 75 /0 CI

subjects were male, 45% of non-operative subjects were male. Nonoperative group had average age of 62.9 years, surgical group had average age of 63.9 years. Surgical group averaged 14 years since onset of symptoms, nonsurgical group average 16 years since onset of symptoms. Minimum of 6 months of symptoms for study inclusion.

Setting: Research Center in Finland 2) Non-operative treatment: NSAIDS when indicated and seen one to three times by a physiotherapist, in addition to the standard visit at each follow-up. The physiotherapist gave all patients educational brochure. The patients were encouraged to use their back in a normal way. Painrelieving body postures were taught as well as basic ergonomics related to lifting and carrying. Individually structured programs included trunk muscle endurance and stretchingtype exercises. Additional individual physiotherapy consisting of passive treatment methods (such as ultrasound and transcutaneous nerve stimulation). (n=44)

The patients in the surgical group also received the brochure and the instructions described above.

rating scale for back and leg pain

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- 2) Walking ability (distance without a break) also via treadmill test
- 3) General health status on a 5 point scale (very good, quite good, average, quite poor or very poor.
- 4) ODI
- 5) Ability to complete certain activities of daily
- 6) living without difficulty, some difficulty, marked difficulties or not at all
- 7) Radiographic examination

Follow-up: 6 months, 1 and 2 years

1 yr: 1.69 (0.41 to 2.96) 2 yr: 1.51(0.25 to 2.77)

Back pain, MD, 95% CI

1 yr: 2.33 (1.12 to 3.55) 2 yrs: 2.13(0.98 to 3.28)

Disability (ODI), MD, 95% CI

1yr: 11.3 (4.3to 18.8) 2 yrs: 7.8 (0.8 to 14.9)

> 10 points reduction (ODI): RR, 95% CI

1 yr: 2.16 (1.31to 3.57) 2 yrs: 1.36 (0.88 to 2.10)

Walking disability (walking distance <1.250 m), RR, 95% CI

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1 yr: 0.93 (0.61 to 2.03) 2 yrs: 1.08 (0.70 to 2.42)

Walking disability (walking distance <400 m), RR, 95% CI

1 yr: 0.91 (0.51 to 4.24) 2 yrs: 1.18 (0.67 to 4.72)

Weinstein	289 in the RCT,	1)	Assigned to surgery: Standard	1)	SF-36 bodily	All between group comparisons using Intention-to-Treat
2008, 2010,	365 in the		laminectomy with or without fusion		pain	Analysis
Lurie 2015	observational		(n=138)	2)	SF-36 bodily	SF-36 Bodily Pain, DMC, 95% CI
	cohort. 62% male		,		function	2 yrs: 7.8 (1.5to 14.1)
	in the surgical	2)	Assigned to non-surgical treatment:	3)	Low back pain	4 yrs: 0.3 (-6.4 to 7)
	groups, 59%		Usual non-operative care -		bothersomene	8 yrs: p=0.25
	male in the non-		recommended to include at least		ss scale	SF-36 Bodily Function, DMC, 95% CI
	surgical groups.		active physical therapy, education or	4)	Leg pain	2 yrs: 0.1 (-6.4 to 6.5)
	Average age of		counseling with home exercise		bothersomene	4 yrs: -3.2 (-9.9 to 3.6)
	63.8 in the		instruction, and the administration of		ss scale	8 yrs: p=0.89
	surgical group,		NSAIDs, if tolerated (n=151)	5)	ODI	Disability (ODI), DMC, 95% CI
	66.1 in the non-			6)	Subjective	2 yrs: -3.5 (-8.7 to 1.7)
	surgical group.			- /	self-reported	4 yrs: 0.2 (-5.2 to 5.7)
	60% in the				improvement,	8 yrs: p=0.87
	surgical group				satisfaction	o yish p over
	and 55% in the				with current	Other outcomes (patient's satisfaction; Stenosis Bothersomeness
	non-surgical				symptoms and	Index, Leg Pain Bothersomeness Scale; and Low Back Pain
	group had				care,	Bothersomeness Scale) were not provided separately for the
	symptoms for			7)	Stenosis	randomized cohort.
	over 6 months.			"	bothersomene	Turido mileta vonoru
				4	ss index	<b>Adverse events:</b> In group 1, 10% of patients required
	Setting: multi-				bb index	transfusions intraoperatively and 5% postoperatively.
	centred-			Fo	llow-up: 6	The most common surgical complication was dural tear, in 9%
	orthopaedic				eks, 3 and 6	of patients. At 2 years, reoperation had occurred in 8% of
	departments in				onths, 1, 2, 4, 8	subjects.
	the United States.			yea		subjects.
Delitto 2015	169 patients, 88	1)	Surgical decompressive	•	SF-36 physical	2 years -SF-36 Physical Function, MD and 95% CI
Denitio 2013	males and 81	1)	laminectomies, partial facet		ection	0.9 (7.9 to 9.6)
	females, 87		resection, and neuroforaminotomies	ıul	10t1011	0.7 (1.7 10 7.0)
	surgical group		(n=87)	Fo	llow-up: 2 years	<b>Adverse events:</b> 9 out of 82 participants in group 2 reported
	with an average		(11-87)	T U	now-up. 2 years	adverse events consisting of worsening of symptoms whereas 33
	age of 66.6 years	2)	PT program: lumbar flexion			out 87 participants in group 1 reported surgery related
	old and 82 PT	2)	exercises, exercises and education			complications, mainly attributable to reoperation, delay in
	group with an		(n=82)			wound healing and surgical site infection.
	average age of		(11-02)			would hearing and surgical site infection.
	69.8 years old,					
	LSS by computed					

tomography - criteria of Wiesel and colleagues (18) or magnetic resonance imaging - criteria of Boden and colleagues (2)  Setting: Neurologic and orthopedic surgery departments and physical therapy clinics in western Pennsylvania	For Deer
	ALIC = Area under the pain-intensity curve BTX = Botox CI = Confidence Interval DMC = Difference in mean change

ADLs = Activities of Daily Living, AUC = Area under the pain-intensity curve, BTX = Botox, CI = Confidence Interval, DMC = Difference in mean change from baseline, ESI = Epidural Steroid Injection, FRI = Functional Rate Index, GRP = Group, HADS = Hospital Anxiety and Depression Scle, IU = International Units, JOABPEQ = Japanese orthopaedic association back pain evaluation questionnaire, LBOS = Low Back Outcome Score, LBP = Low Back Pain, m = Meters, MCS = Mental Component Score, MD = Mean Difference, mm = Millimeters, Mo = Months, MPC = Mean Percent Change, NRS = Numerical Pain Rating Scale, NR = Not Reported, ODI = Oswestry Disability Index, OR = Odds Ratio, PASS-20 = Pain Anxiety Symptoms Scale, PCS = Physical Component Score, RCT = Randomized Controlled Trial, RMDI = Roland Morris Disability Index, ROM = Range of Motion, RR = Relative Risk, SBI = Stenosis Bothersomeness Index, SPWT = Self-Paced Walking Test, SSS = Spinal Stenosis Questionnaire, TSK-11 = Tampa Scale-11, VAS = Visual Analogue Scale, WMD = Weighted Mean Difference, ZCQ = Zurich Claudication Questionnaire

# Supplemental Table 2. Non operative interventions for neurogenic claudication due to lumbar spinal stenosis: A summary of GRADE assessment and outcomes (60 comparisons)

						Walking	Walking ability/pain/function/quality of life measures					
Studies	Risk of Bias	Consistency	Directness	Precision	Selective Reporting	Immediate up to 1w	Short-term >1w - 3m	Intermediate 3m – 1yr	Long term >1yr			
	•					Calcitonin	•					
				C	alcitonin in	jection vs. placel	oo injection					
Eskola	High	No	Yes	No	Yes	,	= TWT	= TWT	= TWT	+000		
1992		No	Yes	No			= VAS	= VAS	= VAS	+000		
Porter 1983	High	No	Yes	No	Yes		? Distance walked	? Distance walked		+000		
Porter	High	No	Yes	No	Yes		= Distance walked			+000		
1988		No	Yes	No			= VAS			+000		
				Cal	lcitonin nas	sal spray vs. place	ebo injection					
Podichetty	High	No	Yes	No	Yes		= Distance walked			+000		
2004		No	Yes	No			= Time walked			+000		
		No	Yes	No			= SF-36			+000		
		No	Yes	No			= VAS			+000		
Tafazal	High	No	Yes	No	No		= Shuttle walk			+000		
2007		No	Yes	No			= VAS leg			+000		
		No	Yes	No			= VAS back			+000		
		No	Yes	No			= ODI			+000		
		No	Yes	No			= Global			+000		
			citonin na		1 1 7	cal therapy vs. pa	racetamol plus phy	sical therapy				
Sahin	High	No	Yes	No	No		= Distance walked			+000		
2009		No	Yes	No			= VAS			+000		
		No	Yes	No			= RMDI			+000		
					(	<b>Oral Medication</b>						
				O	ral prostag	landin vs. Etodla	c (NSAID)					
Matsudaira	Low	No	Yes	No	Yes		> Distance walked #			++00		
2009		No	Yes	No			? SF-36			+000		
		No	Yes	No			= LBP			++00		
		No	Yes	No			> Leg pain			++00		
		No	Yes	No			> Global #			++00		
			Methylo	cobalami	n (vit B12)	plus conservative	e care vs. conservat	tive care				
Waikakul 2000	High	No	Yes	No	No			> Distance walked #	> Distance walked #	+000		

	Gaba	pentin pl	us physical	therapy,	corset &	NSAIDS vs. placeb	oo plus physical th	nerapy, corset & N	ISAIDS	
Yaksi 2007	High	No No No	Yes Yes Yes	No No No	No		= VAS	> Distance walked > VAS	> Distance walked # > VAS #	+000
					Prega	balin vs. active pla	cebo			
Markman 2015	High	No No No No	Yes Yes Yes Yes Yes	No No No No No	No	= NPS rest/final = Distance walked = Recovery time = Global < RMDQ				+000 +000 +000 +000 +000
			Gab	papentin	plus conse	ervative vs. conserv	ative plus botuling	num		
Park 2017	High	No No No	Yes Yes Yes	No No No	No		= NPS (Back/leg) = ODI = Global			0000 0000 0000
				O	xymorpho	one hydrochloride v	vs. placebo			
Markman 2015 - 2	High	No No No No No	Yes Yes Yes Yes Yes	No No No No No	No	= NPS rest/final = Distance walked = Recovery Time = ZCQ (s) = ZCQ (f) = Global				0000 0000 0000 0000 0000
				Pr	opoxyphe	ne/acetaminophen	vs. placebo			
Markham 2015 – 2	High	No No No No No	Yes Yes Yes Yes Yes Yes	No No No No No No	No	= NPS rest/final = Distance walked = Recovery Time = ZCQ (s) < ZCQ (f) # = Global				0000 0000 0000 0000 0000 0000
			Oxy	morphor	ne hydroch	loride vs. propoxy	phene/acetaminor	hen	<u>'</u>	
Markham 2015 - 2	High	No No No No No	Yes Yes Yes Yes Yes Yes	No No No No No	No	= NPS rest/final = Distance walked = Recovery Time = ZCQ (s) > ZCQ (f) # = Global				0000 0000 0000 0000 0000
					Ora	corticoid vs. place	ebo			

Rodrigues	High	No	Yes	No	No	= SF-36		0000
2014		No	Yes	No		= RMDQ		0000
		No	Yes	No		= 6 min walk		0000
		No	Yes	No		< VAS #		0000
						Therapy and Multimodal Care		
			E	xercise p	lus ultraso	und vs. exercise plus sham ultrasound		
Goren	low	No	Yes	No	No	= TWT		++00
2010		No	Yes	No		= VAS back		++00
		No	Yes	No		= VAS leg		++00
		No	Yes	No		= ODI		++00
				Ez	xercise plu	s ultrasound vs. no treatment		
Goren	Low	No	Yes	No	No	= TWT		++00
2010		No	Yes	No		= VAS back		++00
		No	Yes	No		> VAS leg #		++00
		No	Yes	No		> ODI		++00
				Exer	cise plus s	nam ultrasound vs. no treatment		
Goren	Low	No	Yes	No	No	= TWT		++00
2010		No	Yes	No		= VAS back		++00
		No	Yes	No		> VAS leg #		++00
		No	Yes	No		> ODI #		++00
			In-patient	physical	therapy va	s. home exercise program plus oral di	clofenac	
Koc	High	No	Yes	No	Yes	= TWT	= TWT	+000
2009		No	Yes	No		= VAS	= VAS	+000
		No	Yes	No		= RMDI	= RMDI	+000
		No	Yes	No		= NHP	= HNP	+000
			Unwei	ghted trea	admill wal	king plus exercise vs. cycling plus ex	ercise	
Pua	Low	No	Yes	No	No	= Distance walked		++00
2007		No	Yes	No		= ODI		++00
		No	Yes	No		= RMDI		++00
		No	Yes	No		= VAS		++00
		No	Yes	No		= Global		++00
	Ma	inual thera	apy, exercis	se and un	weighted	readmill vs. flexion exercise, walking	g and sham ultraso	ound
Whitman	High	No	Yes	No	No	= TWT		+000
2006		No	Yes	No		> Global #		+000
		No	Yes	No		= ODI		+000
		No	Yes	No		= NPRS		+000
	<u> </u>	110	1 1 05					1000
				Supe	rvisea phy	sical therapy vs home exercises		

Minetama	High	No	Yes	No	No		> ZCQ (F) #			+000
2019	8	No	Yes	No			>ZCQ (S) #			+000
		No	Yes	No			> Distance walked #			+000
		No	Yes	No			> NPS (leg)			
		No	Yes	No			> SF-36 PF			+000
		No	Yes	No			> SF-36 BP			+000
		No	Yes	No			= Daily Steps			+000
		No	Yes	No			Buily Steps			+000
		110			nual thera	py & exercise vs	medical care		_	
Schneider	Low	No	Yes	Yes	No		> ZCQ #	= ZCQ		+++0
2019	20	No	Yes	Yes	1,0		= SPWT	= SPWT		+++0
2019		No	Yes	Yes			= PA	= PA		+++0
		110	145		1 therapy &	k exercise vs. cor	nmunity exercise			
Schneider	Low	No	Yes	Yes	No		> ZCQ #	= ZCQ		+++0
2019	Low	No	Yes	Yes	110		= SPWT	= SPWT		+++0
2019		No	Yes	Yes			= PA	= PA		+++0
		110	1 45		Communit	ty exercise vs. me		111	l .	
Schneider	Low	No	Yes	Yes	No		= ZCQ	= ZCQ		+++0
2019	2011	No	Yes	Yes	110		= SPWT	= SPWT		+++0
2019		No	Yes	Yes			> PA	= PA		+++0
		110			sive therap	v and exercise vs	. self-directed exerc			
Ammendolia	Low	No	Yes	Yes	No	> SPWT #	> SPWT #	> SPWT #	> SPWT #	+++0
2018		No	Yes	Yes		> 30% SPWT	> 30% SPWT	> 30% SPWT	>30% SPWT	+++0
		No	Yes	Yes		> 50% SPWT	= 50% SPWT	= 50% SPWT	> 50% SPWT	+++0
		No	Yes	Yes		> ZCQ (s)	= ZCQ (s)	= ZCQ (s)	> ZCQ (f) #	++00
		No	Yes	Yes		= ZCQ (f)	= ZCQ (f)	= ZCQ (f)	> ZCQ (s) +	++00
		No	Yes	Yes		= ODI	= ODI	> ODI (walk)	ZCQ (f)	++00
		No	Yes	Yes		> NPS (back) #	= NPS (back)	= NPS (back)	= ODI	++00
		No		Yes		= NPS (leg)	= NPS (leg)	= NPS (leg)	= NPS (back)	++00
		1.0		1 05		= SF-36 BP	= SF-36 BP	= SF-36 BP	> SF-36 BP #	++00
						= SF-36 PF	> SF-36 PF #	= SF-36 PF	>SF-36 PF #	++00
				S	tandard ex	ercise vs. isokine		51 50 11	51 50 11 "	
Oğuz	High	No	Yes	No	Yes	= VAS	= VAS	= VAS		0000
2013	111.511	No	Yes	No	1 25	= ODI	= ODI	= ODI		0000
	1	No	Yes	No		= TWT	= TWT	= TWT		0000
_010	l		1							
		110		5	Standard ex	kercise vs. unioac	led exercise			
	High	No	Yes	No		xercise vs. unload	led exercise   < VAS	= VAS		0000
Oğuz 2013	High		Yes Yes		Standard ex Yes			= VAS = ODI		0000

				Iso	okinetic ex	ercises vs. unloade	d exercises			
Oğuz	High	No	Yes	No	Yes	< VAS	= VAS	= VAS		0000
2013		No	Yes	No		< ODI	< ODI	= ODI		0000
		No	Yes	No		< TWT #	< TWT	=TWT		0000
				Aquatic	physical tl	nerapy exercise vs.	physical therapy			
Homayouni	High	No	Yes	No	Yes	> VAS #	= VAS			0000
2015		No	Yes	No		> Distance walked	= Distance walked			0000
			Pre-surgica	al exerci	se program	vs. routine preope	rative hospital ma	nagement		
Marchand	High	No	Yes	No	Yes	> NPS (leg) #	= NPS (leg)	= NPS (leg)		0000
2019		No	Yes	No		> Duration walked #	= Duration walked	= Duration walked		0000
Gang-C	huk Tang	(herbal co	oncoction).	daily M	lokuri Chu	na therapy, daily ac	upuncture, physic	cian consultation v	s. oral aceclofer	nac,
C	Č		,	-		oid injection, physi				•
Kim	Low	No	Yes	No	Yes	, , , , , , , , , , , , , , , , , , ,	= VAS (leg)	= VAS (leg)		+000
2019		No	Yes	No			= VAS (back)	> VAS (back) #		+000
		No	Yes	No			> OCS \	= OCS		+000
		No	Yes	No			> Distance walked	> Distance walked		+000
Mo	khuri Chi	una, acupi	ıncture, and	d physic	ian consult	lation vs. oral acecle	l ofenac, epidural s	teroid injection, pl	vsical therapy	
Kim	Low	No	Yes	No	Yes	>VAS (low back)#	= VAS (leg)	> VAS (leg) #		+000
2019	Low	No	Yes	No	103	7 7715 (low buck)	= VAS (back)	> VAS (leg) #		+000
2019		No	Yes	No			= OCS	= OCS		+000
		No	Yes	No			= Distance walked	= Distance walked		+000
			-I	I.	Sp	inal Manipulation		1		
				I		nal manipulation v				
Passmore	High	No	Yes	No	No	= NPS (Back)				0000
2017	5	No	Yes	No		= NPS (Leg)				0000
						Acupuncture				
						Acupuncture	1			
				A	cupuncture	with usual care vs.	usual care			

Kim High No 6 weeks: 2016 = ODI0000 No Yes No No Yes No = SF-36 BP 0000 No Yes No = SF-36 PF 0000 No Yes No = LBP0000 No Yes No = Leg pain 0000 = Distance walked No Yes No 0000 3 months: No Yes No = ODI0000 No = SF-36 BP0000 Yes No No = SF-36 PF 0000 Yes No No Yes No =LBP0000 No Yes No = Leg pain 0000 = Distance walked 0000 No Yes No Acupuncture vs. sham acupuncture > RMDQ > RMDQ > RMDQ Qin Low No Yes No ++002020 > NRS (back) # > NRS (back) # > NRS (back) ++00 No Yes No No Yes No > NRS (leg) # > NRS (leg) # > NRS (leg) # ++00 > SSS-S # > SSS-S # No Yes No > SSS-S # ++00> SSS-F # > SSS-F # No Yes No > SSS-F # ++00No Yes No = SPWT= SPWT = SPWT ++00 **Epidural Injection** Translaminar epidural steroid injections vs. placebo injections Cuckler High No Yes No No = Global =global +0001985 Translaminar epidural steroids plus epidural block vs. placebo injections Fukusaki High No Yes No No > Distance walked # = Distance walked +0001988 Translaminar epidural steroids plus epidural block vs. epidural block injections = Distance walked No = Distance walked Fukusaki High No Yes +0001988 Translaminar epidural block vs. placebo Fukusaki High No Yes No No > Distance walked # = Distance walked +0001988 Intralaminar epidural steroid plus epidural block vs. home exercise program plus oral diclofenac = TWT Koc High No Yes No Yes = TWT+0002009 No Yes No Yes > VAS # = VAS+000No Yes No Yes > RMDI # = RMDI+000

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		No	Yes	No	Yes		> NHP	= HNP		+000
		Iı	ntralaminaı	r epidura	l steroid pl	us epidural block v	s. in-patient physi	cal therapy		
Koc	High	No	Yes	No	Yes	•	= TWT	= TWT		+000
2009		No	Yes	No	Yes		= VAS	= VAS		+000
		No	Yes	No	Yes		= RMDI	= RMDI		+000
		No	Yes	No	Yes		= NHP	= HNP		+000
				Cau	dal epidura	l steroids vs. place	bo injections			
Zahaar 1991	High	No	Yes	No	No	= Global			= Global	+000
			N	Aild luml	bar decomp	oression vs. epidura	al steroid injection	l		
Brown	High	No	Yes	No	No	_	= VAS			0000
2012		No	Yes	No			= ODI			0000
I		No	Yes	No			= ZCQ			0000
		No	Yes	No			12 weeks:			
				\ \			= VAS			0000
		No	Yes	No			= ODI			0000
		No	Yes	No			= ZCQ			0000
				I	Lidocaine v	vs. glucocorticoid–	lidocaine	l .		
Friedly 2014,	Low				No	6	3 weeks:	12 weeks:	12 months:	
2017	20	No	Yes	Yes	1,0		< RMDQ	= RMDQ	= RMDQ	+++0
1		No	Yes	Yes			< NPS (leg)	= NPS (leg)	= NPS (leg)	+++0
		1.0	1 55	1 55			6 weeks:	6 months:	1112 (105)	
		No	Yes	Yes			= RMDQ	= RMDQ		+++0
1		No	Yes	Yes			= NPS (leg)	= NPS (leg)		+++0
							Makris 2016			
M-1:- 2016	T	NI-	V	NI-	V		3 weeks: < RMDQ using SIP			0000
Makris 2016	Low	No	Yes	No	Yes		Weights			0000
		No	Yes	No	Yes		Weights   < RMDQ Patient-			0000
		NO	Yes	NO	Y es		Prioritized			0000
							(LESSER)			
							6 weeks:			
		No	Yes	No	Yes		< RMDQ using SIP			
		INU	1 68	INO	1 68		Weights			0000
		No	Vac	No	Yes		= RMDQ Patient-			0000
		INO	Yes	INO	r es		Prioritized			0000
										0000
							(LESSER)			

				Lidoca	ine spinal i	njection vs. saline	spinal injection			
Song	High				No		1 month:			
2016	8	No	Yes	No			= VAS			0000
		No	Yes	No			= FRI			0000
							3 months:			
		No	Yes	No			= VAS			0000
		No	Yes	No			= FRI			0000
	Fluoro		_		SIS at the	level of maximal s		ervertebral levels	cephalad	
Milburn	High				No	1 week:	4 weeks:			
2014	J	No	Yes	No		> NPS (walking) #	> NPS (walking) #			0000
		No	Yes	No		> RMDQ #	> RMDQ			
		No	Yes	No		,	12 weeks:			0000
							= NPS (walking)			
		No	Yes	No			> RMDQ			0000
		No	Yes	No						0000
				Epidura	al steroid inj	ection (ESI) Vs. ESI	& physiotherapy	<u>'</u>		
Hammerich	High	No	Yes	No	No		= ODI	= ODI	= ODI	0000
2019		No	Yes	No			= NPS	> NPS #	> NPS #	0000
		No	Yes	No			> SF-36 ER #	= SF-36 ER	= SF-36 ER	0000
		No	Yes	No			> SF-36 EWB	= SF-36 EWB	= SF-36 EWB	0000
		No	Yes	No			> SF-36 GH	= SF-36 GH	= SF-36 GH	0000
			I	nterlamii	nar vs. tran	sforaminal epidura	al steroid injection			
Sencan 2020	High				Yes	= NPS	3 weeks:	3 months:		
	C	No	Yes	No			= NPS	> NPS		0000
		No	Yes	No			= ODI	= ODI		0000
		No	Yes	No			> BDS	>BDS		0000
		No	Yes	No			= Distance walked	> Distance walked #		0000
		No	Yes	No						0000
		No	Yes	No						0000
		No	Yes	No						0000
		No	Yes	No						0000
				TNF alp	ha inhibito	or (Etanercept) vs.	steroid injection			
Wei 2020	Low	No	Yes	No		> VAS #	1, 3 months:	6 months:		++00
		No	Yes	No			> VAS #	> VAS #		++00
		No	Yes	No			> ODI #	> ODI #		++00
				TNF	alpha inh	ibitor (Etanercept)	vs. lidocaine			

Wei 2020	Low	No	Yes	No		> VAS #	1, 3 months:	6 months:		++00
		No	Yes	No			> VAS#	> VAS #		++00
		No	Yes	No			> ODI #	> ODI #		++00
	·			•	Steroic	d vs. lidocaine	<u> </u>		<u> </u>	
Wei 2020	Low	No	Yes	No		= VAS	1, 3 months:	6 months:		++00
		No	Yes	No			= VAS	= VAS		++00
		No	Yes	No			= ODI	= ODI		++00
				-	Percutane	ous Epidural	Adhesiolysis			
			Ballo	on-less ca	atheter (Ra	cz) vs. inflatab	ole balloon catheter (	ZiNeu)		
Karm 2018	High				No		1 month:	6 months:		
		No	Yes	No			= NPS (back)	< NPS (back) #		0000
		No	Yes	No			= NPS (leg)	< NPS (leg) #		0000
		No	Yes	No			= ODI	< ODI		0000
							3 months:			
		No	Yes	No			= NPS (back)			0000
		No	Yes	No			= NPS (leg)			0000
		No	Yes	No			= ODI			0000
				•		y vs. Physical		•	·	
				Intersp	inous spac	er (X_Stop) vs	. non operative care			
Zucherman	High	No	Yes	No	No		> ZCQ(S)#	> ZCQ(S)#	> ZCQ(S)#	+000
2004, 2005,		No	Yes	No			> ZCQ(F)#	> ZCQ(F)#	> ZCQ(F)#	+000
Hsu 2006							> SF-36 PF	> SF-36 PF	> SF-36 PF#	+000
							> SF-36 BP	> SF-36 BP	> SF-36 BP#	+000
							> SF-36 GH	> SF-36 GH	> SF-36 GH	+000
							> SF-36 ER	> SF-36 ER	> SF-36 ER#	+000
		La	minectom	y +/- fusi	on vs. non	operative care	for degenerative spe	ondylolisthesis		

High	No	Yes	No	No	= SF-36 BP, PF	= SF-36 BP, PF	2 years:	
								+000
		Yes	No		= LBPBS		= ODI	+000
	No	Yes	No		= LPBI		= LBPBS	+000
	No	Yes	No		= SBS	= SBS		+000
							= SBS	+000
		Yes	No				4 years:	
	No	Yes	No				= SF-36 BP, PF	+000
	No		No					+000
	No	Yes	No					+000
	No	Yes	No					+000
							= SBS	+000
	No	Yes	No				8 years:	
	No							+000
	No							+000
	No		No					+000
	No	Yes	No	~ (V)				+000
							= SBS	+000
			Lam	inectomy -	fusion vs. non operative care			
High	No	Yes	No	No	?* Pain severity	?* Global	?* Pain severity	+000
C	No	Yes	No				? Global	+000
Low	No	Yes	No	No		= TWT	= TWT	++00
	No	Yes	No			= SW	= SW	++00
	No	Yes	No			> VAS leg walk #	> VAS leg walk	++00
	No	Yes	No			> VAS LB walk #	#	++00
	No	Yes	No			> ODI	> VAS LB walk	++00
							#	
							> ODI	++00
High	No	Yes	No	No	= SF-36 BP	= SF-36 BP		+000
	No	Yes	No		= SF-36 PF	= SF-36 PF	> SF-36 BP **	+000
	No	Yes	No		= LBPBS	= LBPBS	#	+000
			No				= SF-36 PF	+000
			No					+000
	No	Yes	No		= ODI	= ODI	= LPBI	+000
							= SBS	+000
							= ODI	
								+000
							=SF-36 BP **	+000
			1	1			= SF-36 PF	+000
							= SF-30 PF	+000
							= SF-36 PF = LBPBS	+000
	High	High No	No	No	No	No	No	No

									= SBS	
									8 years:	+000
									= SF-36 BP	+000
									= SF-36 PF	+000
									= ODI	+000
									= Stenosis	
									Index	
			Lamineo	ctomy, fa	cet resection	on, neuroforaminot	omy vs. physical t	herapy		
Delitto	High			<b>J</b> )	No	,	, ,	1,7	2 years:	
2015	8	No	Yes	No					= SF-36	+000
2010		No	Yes	No					= ODI	+000

> favours intervention (first comparison), < favours control (second comparison), = no difference between intervention and control groups, TWT= Treadmill Walking Test, VAS= Visual Analog Scale for Pain Intensity, RMDI= Roland-Morris Back Disability Index, NHP= Nottingham Health Profile, Global= Patient Perceived Improvement, SR= Selective Reporting, ODI= Oswestry Back Disability Index, ?= insufficient data, LBP= Low back Pain Severity Scale, Leg pain= Leg Pain Severity Scale, ? SF-36=No data on overall score, improvement in some subscales, NPRS= Numeric Pain Rating Scale, SF-36 BP= SF-36 Bodily Pain Subscale, SF-36- PF= SF-36 Physical Function Subscale, SF-36 ER= SF-36 emotional role subscale, SF-36 EWB= SF-36 emotional well-being subscale, SF-36 GH= SF-36 General health subscale, LBPBS= Low Back Pain Bothersome Scale, LPBI= Leg Pain Bothersome Index, SBS= Stenosis Bothersome Scale, SW= Subjective Walking, VAS leg= Visual Analog Scale for Leg Pain, VAS LB= Visual Analog Scale for Low Back Pain, VAS leg walking= Visual Analog Scale for Leg pain while walking, SIP= sickness index profile, BDS= Beck Depression Score, LESSER= Lumbar Epidural Steroid Injection for Spinal Stenosis Extended Research, PA= Physical Activity, FRI= Functional Rating Index, TWT= Total Walking Time, SSS= Spinal Stenosis Questionnaire, ?\*= no between group statistical comparisons, \*\*= SF-36 BP significantly better at 2 years but not 4 years.

GRADE evidence; +000= Very low GRADE evidence, ++00= Low GRADE, +++0= Moderate GRADE evidence, ++++= High GRADE evidence #between group difference meeting the MCID. The MCID used were: ≥1.25 points for back pain and ≥1.5 points for leg pain on 0 to 100-point Visual Analogue Scale (VAS) and 0 to 10-point Numerical Rating Scale (NRS) for back pain (58), ≥5 points on 0- to 24-point Roland-Morris Disability Questionnaire (RMDQ) (59), ≥8 points for conservative treatment and ≥12 points for surgery on 0- to 100-points for Oswestry Disability Index (ODI) (60), ≥ 0.1 points for the functional component and 0.36

scores of the ZCQ (92), > 30% between-group difference for walking distance, global improvement and SF36 subscales (61).

## PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 6-7
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 7
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 9
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 8-9
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 8-9 & Supplemental File 1
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 9
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 9
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 8 & 10
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 8-10 Supplemental Table 1
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 9-10
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 11-12
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 11-12
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 11-12
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Supplementa Table 2
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 10
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess trobustness of the synthesized (esuits lines.xhtml	NA

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### **PRISMA 2020 Checklist**

Section and Topic	Item #	Checklist item	Location where item is reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	NA
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Figure 1
Study characteristics	17	Cite each included study and present its characteristics.	Supplement Table 1
Risk of bias	18	Present assessments of risk of bias for each included study.	Table 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Supplement Table 1 & 2
Results of	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Table 2
syntheses	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Supplemen Table 2
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Supplement Table 2
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 25-26
	23b	Discuss any limitations of the evidence included in the review.	Page 28-29
	23c	Discuss any limitations of the review processes used.	Page 28-29
	23d	Discuss implications of the results for practice, policy, and future research.	Page 28
OTHER INFORMA	TION		
Registration and	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 7
protocol	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 30
Competing interests	26	Declare any competing interests of review authors.	Page 30
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.  For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml	NA

 PRISMA 2020 Checklist

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