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The effect of mechanical traction on low back pain in patients with herniated intervertebral disks: a systemic review and meta-analysis

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Abstract

Objective: To evaluate the effectiveness of traction in improving low back pain, functional outcome, and disk morphology in patients with herniated intervertebral disks.

Data Source: PubMed, Scopus, Embase, and the Cochrane Library were searched from the earliest record to July 2019.

Review methods: We included randomized control trials which (1) involved adult patients with low back pain associated with herniated disk confirmed by magnetic resonance imaging or computed tomography, (2) compared lumbar traction to sham or no traction, and (3) provided quantitative measurements of pain and function before and after intervention. Methodological quality was assessed using the physiotherapy evidence database (PEDro) scale and Cochrane risk of bias assessment.

Results: Initial searches for literature yielded 3015 non-duplicated records. After exclusion based on the title, abstract, and full-text review, 7 articles involving 403 participants were included for quantitative analysis. Compared with the control group, the participants in the traction group showed significantly greater improvements in pain and function in the short term, with standard mean differences of 0.44 (95% confidence interval (CI): 0.11–0.77) and 0.42 (95% CI: 0.08–0.76), respectively. The standard mean differences were not significant to support the long-term effects on pain and function, nor the effects on herniated disk size.

Conclusion: Compared with sham or no traction, lumbar traction exhibited significantly more pain reduction and functional improvements in the short term, but not in the long term. There is insufficient evidence to support the effect of lumbar traction on herniated disk size reduction.

Keywords

Lumbar traction, intervertebral disk displacement, herniated disks, nerve root compressions, physical therapy modality

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Introduction

Low back pain is a common medical condition that affects 60%–80% of the adult population at some point in their lives,[1,2] and the lumbar disk is probably the most common origin of low back pain.[3] Despite the unclear mechanism of pain generation, structural changes in annulus fibrosus, nucleus pulposus, and vertebral end plates are thought to be associated with disk-related pain.[4,5] Many conservative treatment options for general low back pain, including oral or injective medications, bracing, chiropractic, acupuncture, and lumbar traction, are applicable to manage low back pain associated with disk pathologies.[6]

Lumbar traction, which can be delivered via different methods (e.g. mechanical, motorized, gravity), is commonly used in managing various lumbar conditions. Although the mechanisms of action are so far unclear, it has been proposed that lumbar traction separates vertebral bodies and reduces compressive forces on the disks, decreases nerve root compression by enlarging the intervertebral foramen, and helps return herniated disks to its original position by producing tension on spinal ligaments.[4,7] Despite its frequent application in clinical practice, the clinical effects of lumbar traction for low back pain associated with intervertebral disks herniation are unclear.

Previous review studies regarding lumbar traction have usually focused on low back pain not specifically disk-related and reported non-supportive evidence.[8–10] However, considering that the mechanism of disk-related low back pain can differ from other types of pain, and the decompression forces provided by traction can be particularly beneficial in disk-related conditions, further investigation of lumbar traction in such conditions is reasonable. Moreover, there is new evidence that traction may reduce herniated disk size,[4,11] and several relevant trials have been published recently.[12–16] Therefore, we believe a review with updated evidence will help guide clinical practice. Under the hypothesis that the traction is beneficial through disk decompression, the present study aims to investigate the benefits of traction in managing low back pain associated with intervertebral disks herniation and answer two questions: (1) "Does traction reduce pain and improve function in patients with lumbar intervertebral disks herniation and associated low back pain?" and (2) "Does traction reduce the herniated disk size?"

Method

This study was reported in accordance with the PRISMA guidelines. The authors searched for all relevant articles in the PubMed, Scopus, and Embase from their earliest record to 1 July 2019. The Cochrane library and Google Scholar were scrutinized for additional references. Main search terms were ((lumbar OR back), (pain OR radiculopathy OR sciatica), (disc OR disk OR discogenic), and (traction OR physiotherapy OR decompression)) (see Supplemental Appendix for search plan). Additional studies were obtained from the references of relevant review articles.

We included randomized control trials which (1) involved adult patients with low back pain with or without sciatica, (2) included patients with herniated disk(s) confirmed by magnetic resonance imaging or computed tomography, (3) compared lumbar traction with sham or no traction regardless of the traction type, and (4) provided quantitative measurements of pain and function before and after intervention. Additional interventions, such as physiotherapy, were allowed but should be conducted in the same conditions between treatment arms. If several studies involved the same study sample, only one of them was included for the analysis.

Three authors (YHC, CYH, and YNL) searched and evaluated the literature for inclusion of studies based on their titles and abstracts. After pooling studies obtained from different sources and removing duplicates, the full texts of potentially relevant articles were retrieved, and each article was independently evaluated by YHC, CYH, and YNL for eligibility.

YHC and CYH assessed the quality of included studies using the physiotherapy evidence database (PEDro) scale and Cochrane risk of bias tool. In PEDro scale, the methodological quality was assessed by eight items regarding random allocation, blinding procedures, and the drop-out rate.

Two items related to statistical reporting. Aggregate scores ranged from 0 to 10 points with a higher score indicating better quality. Quality was classified as high (6–10), fair (4 or 5), and poor ($\leqslant$3). Using the Cochrane risk of bias tool, we assessed seven domains of bias and stratified the risk of bias into low, high, and unclear risk. Discrepancies between reviewers at any stage were resolved through discussion and consensus. Publication bias was also evaluated.

We extracted relevant data from each study with a standard data recording form which included the number of participants, inclusion and exclusion criteria, intervention protocol (i.e. intervention duration, comparators, number of sessions, additional interventions, and outcome measures), information regarding the study quality, and final results. The goal was to evaluate the effects of the experimented interventions at the end of intervention and at the end of follow-up. We extracted the corresponding mean and standard deviation (SD) of outcomes of interest at postintervention or follow-up. If a study did not provide analyzable data, we searched through other review articles or contacted the authors to obtain relevant data.

We explored the effects on pain, function, straight leg raise test, and morphologic changes of disks. If pain was assessed under various conditions (e.g. at rest and during activities) or in various locations (e.g. back and leg), the pain experienced in the back and at rest were our outcomes of choice for the meta-analysis. If various questionnaires were used to assess functional performance, we prioritized the Oswestry disability index score[17] for the meta-analysis. Changes in disk morphology were assessed by measurements of intervertebral disk height or protruded disk size on magnetic resonance imaging or computed tomography.

The meta-analysis focused on the comparison "lumbar traction versus sham or no lumbar traction." Only one outcome measure from each outcome category in a given study was used in the analysis. We collected data from the traction arm of included studies and calculated the weighted mean difference of within group changes on the visual or numerical analog scales. A within-group change of 2.5 on a 0–10 analog pain scale was considered the minimum clinically important difference for low back pain.[18] The standardized mean difference was obtained to assess the effect size. The standardized mean difference ranging 0.2–0.5, 0.5–0.8, and >0.8 were considered to be small, moderate, and large effect sizes, respectively.[19] A random-effect model was used, and a point estimate with a 95% confidence interval (CI) was presented. Heterogeneity across studies was tested using the I^2 test. I^2 values of 25%, 50%, and 75% were considered low, moderate, and high, respectively.[20] The meta-analysis was performed using Review Manager Software 5.3.

Results

Searches yielded 3015 non-duplicated records. After exclusion based on the title, abstract, and full-text review, eight articles[12–16,21–23] were included in this review, and 7 studies with 403 participants contributed to the meta-analysis[12–16,21,22] (Figure 1). Five studies compared lumbar traction with no lumbar traction.[12,13,15,21,22] Two studies compared lumbar traction with sham traction (10%–20% body weight).[14,16] All of the included studies provided posttreatment data except for one, for which we synthesized the posttreatment data based on the information provided.[14] Three studies provided long-term follow-up results.[14,16,21]

Table 1 shows the main characteristics of the participants of included studies. Studies varied in study population regarding pain duration and traction methods. Five studies applied maximal traction force reaching 50% body weight. Two studies did not mention the force of lumbar traction.[15,21] Three studies applied continued traction,[14,21,22] and three studies applied intermittent traction.[12,13,16] Studies using self-suspension[15] and inversion traction[23] did not specify if they applied continued or intermittent traction. The intervention programs also differed among the included studies in terms of number of sessions (10–60 sessions), intervention duration (2–10 weeks), and follow-up period (up to six months).

All studies reported pain measurements using either the visual analog scale or numeric analog scale. Functional performance was reported in five

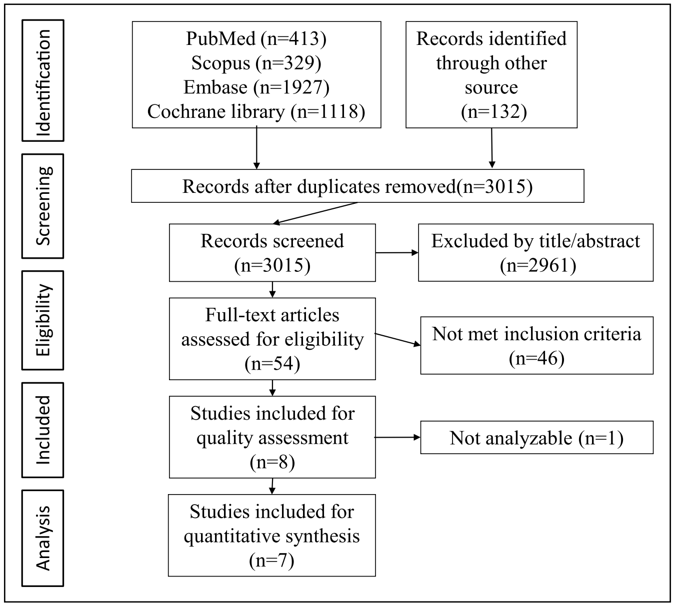

Figure 1. Flowchart of study selection process.

studies, all of which used the Oswestry disability index questionnaire[17] for assessment except for one study which used the French version of Roland-Morris disability questionnaire.[24] Three studies measured straight leg raise test angle. For herniated disk size measurement, two studies measured the herniated disk height by magnetic resonance imaging[12,15] and one study measured the herniated disk ratio by computed tomography[22] (Table 1).

PEDro scores for the included studies are shown in Table 1. All of the studies had PEDro score ⩾6 (also see Supplemental file for details). During the Cochrane risk of bias assessment, the majority of studies had significant bias in the participants and personnel blinding process due to the nature of traction studies except two studies in which lumbar traction was compared with sham traction. One of the included studies also had risks of bias in the processes of random sequence generation, allocation concealment, and selective reporting.[16] Two studies provided incomplete data regarding outcome measures.[12,13] There was no obvious publication bias (see Supplemental file).

At the end of intervention, our meta-analysis demonstrated a significant standardized mean difference of 0.44 (95% CI = 0.11–0.77, I^2 = 56%) regarding pain reduction (Figure 2(a)), and a significant standardized mean difference of 0.42 (95% CI: 0.08–0.76, I^2 = 42%) regarding functional improvements (Figure 2(b)). The within-group analysis exhibited a clinically important weighted mean difference of 3.26 (points or cm of analog scale) (95% CI = 2.24–4.29) regarding pain improvement (see Supplemental file). There were no significant standardized mean differences regarding SLRT (Figure 3) or disk morphology (Figure 4) at posttreatment. At the end of follow-up, the meta-analysis generated a non-significant standardized mean difference regarding pain reduction (Figure 5(a)) and functional improvement (Figure 5(b)).

Discussion

The results of our meta-analysis showed that lumbar traction was effective in reducing low back pain and improving low back pain–related physical functions in patients with lumbar herniated disk in the short term. The mean difference regarding within-group pain reduction by traction was 3.26

Table 1. Summary of studies included for the review.

Study	PEDro	Participants		Pain duration	Sessions	Therapy		Outcome measures	Assessment timing
		Control group	Study group			Control group	Study group		
Demirel et al.[12] (Turkey)	7	n = 10 Age: 41.3 ± 12.8 (mean ± SD)	n = 10 Age: 50.1 ± 11.8 (mean ± SD)	>8 weeks	15 sessions Frequency: Not mention	PT: Hot packing: 20 minutes Ultrasound 1.5 W/cm^2 TENS 20 minutes deep friction massage, stabilization exercise	PT[a] + traction: Type: 18 intermittent traction cycles lasting 28 minutes Target force: 50% BW plus 5 pounds	NAS SLRT ODI MRI (disk height and herniation thickness)	Before treatment, After treatment, 3 months after treatment
Gulsen et al.[13] (Turkey)	6	n = 70 Age: not mention	n = 75 Age: not mention	>6 months	20 sessions Frequency: 5 times per week for 4 weeks	PT: Hot packing 20 minutes TENS: 20 minutes Ultrasound 1.5 watt/cm^2	PT[a] + traction: Target force: 50% BW Intermittent, 30-seconds hold and 10-seconds rest	VAS ODI RMDQ	Before treatment, After treatment
Isner-Horobeti et al.[14] (France)	9	n = 9 Age: 33 ± 8	n = 8 Age: 33 ± 11	<6 weeks	10 sessions Frequency: 5 times per week for 2 weeks	Sham traction: Continuous: 20 minutes Traction: 10% BW	Traction: Continuous: 20 minutes Target force 50% BW	VAS Finger to toe test Schober-Macrae test SLRT Disability (EIEFL) Drug consumption Global satisfaction index	Pretreatment, During treatment, Post treatment, 2 weeks after treatment
Khani and Jahanbin[15] (Iran)	6	n = 25 Age: 19–52	n = 25 Age: 25–45	<6 months	60 sessions Frequency: every day	Only medication without traction	Traction: Suspension pull-up bar: Total of 10 minutes per day	VAS MRI (Herniation index)	Before treatment, After treatment

(Continued)

Table 1. (Continued)

Study	PEDro	Participants		Pain duration	Sessions	Therapy		Outcome measures	Assessment timing
		Control group	Study group			Control group	Study group		
Moustafa and Diab[21] (Egypt)	7	$n = 32$ Age: 43.2 ± 2.4 (mean ± SD)	$n = 32$ Age: 43.2 ± 1.7 (mean ± SD)	>3 months	30 sessions Frequency: 3 times per week, 10 weeks	PT: Hot packing 15 minutes Electrotherapy: 20 minutes	PT[a] + extension traction: Target force: not mention Continuous traction: 20 minutes, 3× per week for 10 weeks	Lordotic angle Disability (ODI) Pain (NAS) Lumbar flexion	Before treatment, After treatment, 6 months after treatment
Murat et al.[16] (Turkey)	8	$n = 31$ Age: 39.19 ± 10.18 (mean ± SD)	$n = 30$ Age:37.13 ± 8.81 (mean ± SD)	From 2 weeks to 3 months.	10 sessions Frequency: Not mention	PT: Infrared and exercise program, once a day and 5 times a week. Intermittent lumbar + sham traction: Intermittent 20 minutes Target force: 10%–20% BW	PT[a] + intermittent lumbar Traction: Intermittent 20 minutes Target force: 35%–50% BW	VAS Percentage of ODI RMDQ SF-36	Before treatment, after treatment, and 1 month after the treatment.
Ozturk et al.[22] (Turkey)	6	$n = 22$ (8 men, 14 women), Age: 52.7 ± 8.8 (35–70) group	$n = 24$ (14 men, 10 women), Age: 40.2 ± 11.4 (16–65)	<6 months	15 sessions Frequency: A session each weekday	PT: Hot packing: 15 minutes, Ultrasound: 1.5 W/cm^2 5 minutes, diadynamic currents: 10 minutes	PT[a] + traction: Continuous traction 15 minutes, Target force: 50% BW	VAS modified Schober test SLRT Motor deficit CT (Herniation index)	Before treatment, After treatment
Prasad et al.[23] (United Kingdom)	6	$n = 24$ Age: 36.55 ± 5.13	$n = 11$ Age: 34.46 ± 5.71	<6 months	12 sessions Frequency: 3 times a week for 4 weeks	PT: Exercise for movement control, and manual therapy	PT[a] + Traction: Mechanical inversion	RMDQ SF-36 ODI VAS MRI	Before treatment, After treatment

PEDro: physiotherapy evidence database; PT: physical therapy; TENS: Transcutaneous Electric Nerve Stimulation; VAS: visual analog scale; NAS: numeric analog scale; SLRT: straight leg raise test; MRI: Magnetic Resonance Imaging; ODI: Oswestry disability index; CT: Computed Tomography; BW: body weight; RMDQ: Roland-Morris disability questionnaire; SF-36: Short Form 36; *n*: number of participants; SD: standard deviation; EIEFL: échelle d'incapacité fonctionnelle pour l'évaluation des lombalgies.
[a]Physical therapy received by the study group was identical to the corresponding control group.

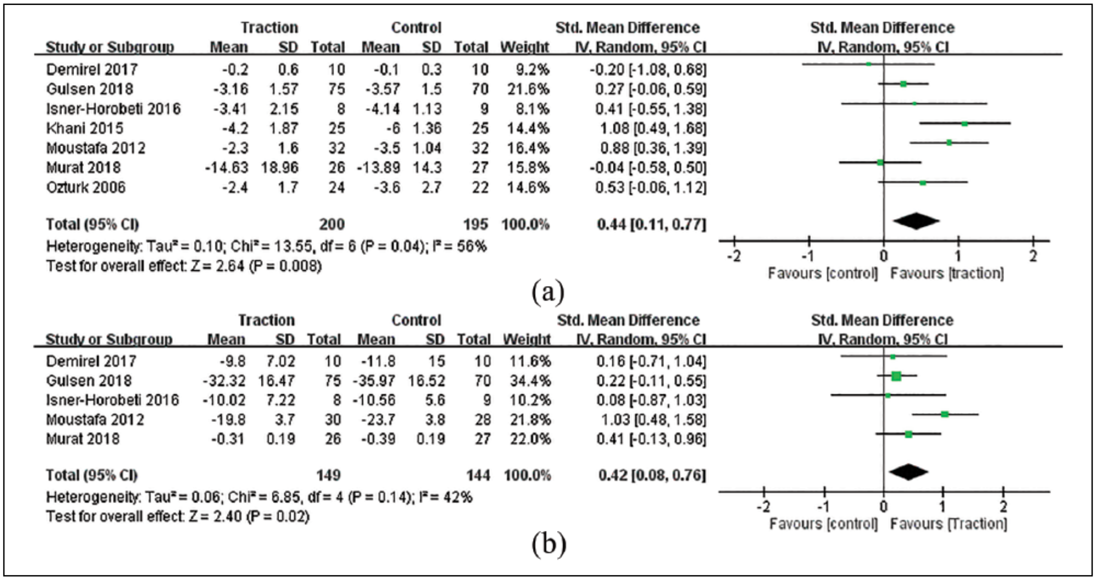

Figure 2. Forest plot: effects of traction at posttreatment: (a) pain reduction and (b) functional improvements.

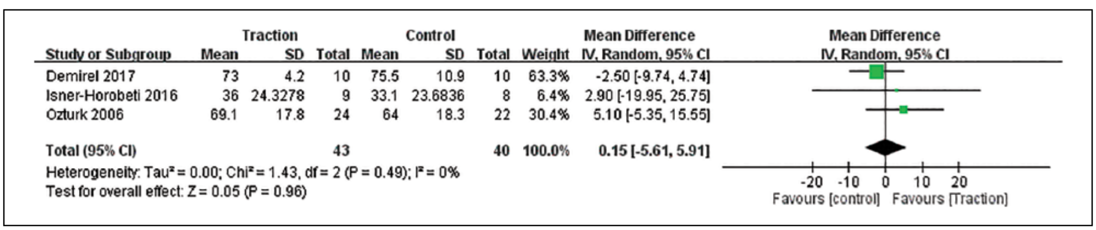

Figure 3. Forest plot: effect of traction on straight leg raise test.

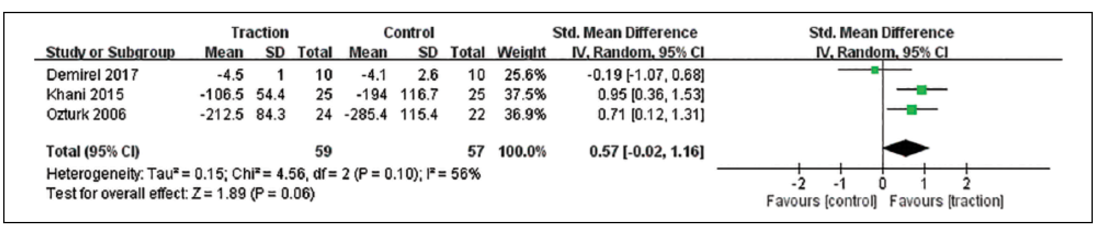

Figure 4. Forest plot: effect of traction on herniated disk.

on the analog pain scales, reaching the minimum clinically important difference (i.e. 2.5).[18] However, these effects on pain reduction and functional improvements were not shown to be long term. Considering the sample size, risk of bias, and heterogeneity of included studies, our study provided low-to-moderate evidence that lumbar traction can provide symptomatic relief in the short term.

The evidence of the effectiveness of lumbar traction has so far been inconsistent and inconclusive. Before the present study, the latest relevant

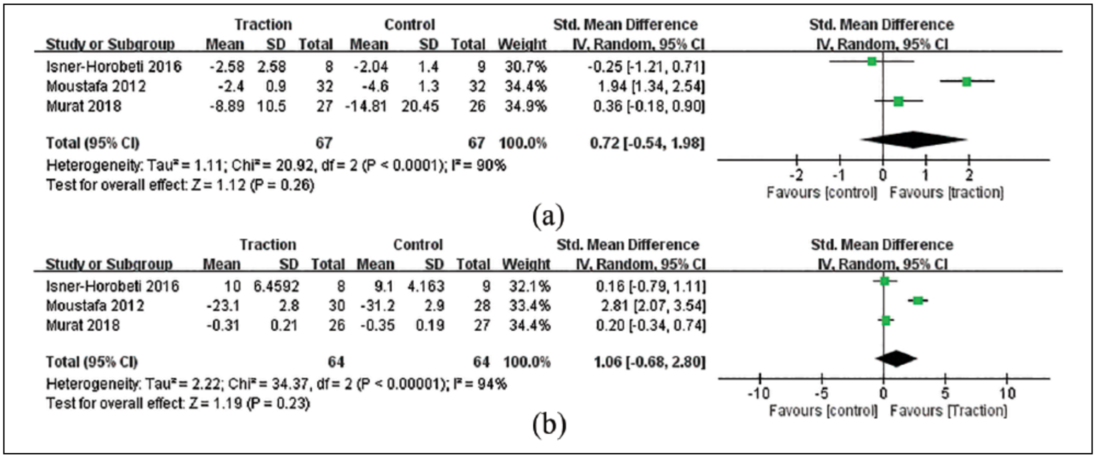

Figure 5. Forest plot: effect of traction at the end of follow-up: (a) pain reduction and (b) functional improvement.

review was a Cochrane review published in 2013 investigating the effects of lumbar traction for low back pain.[10] The authors declared that traction, either alone or in combination with other treatment, had little or no impact on pain intensity, functional status, global improvement, or returning to work among people with low back pain. However, although they included 32 articles involving 2762 patients in their review, in many cases, the results interpretation were based on the analysis of a single trial, resulting in significant selection bias. In addition, some short-term positive effects of traction were found in their study, but were not carefully interpreted. And finally, their review evaluated the effect of traction on patients with low back pain without specifying the etiology. Therefore, the effects of traction in patients with herniated disks were not specified. This prompted us to perform the present study.

In comparison to previous studies, the present study takes a disease-specific (i.e. lumbar intervertebral disks) rather than symptom-oriented (i.e. low back pain) approach. Although the relation between lumbar disk herniation and the severity of low back pain continues to be a topic of controversy,[25,26] disk pathology is believed to be pain-generating due to rich nerve innervations of the disk and structures of the surrounding spinal motion segment,[26] as well as due to the direct compression of adjacent nerve roots by disk herniation.[14] With disk degeneration, there is also a net loss of proteoglycans and water from the nucleus, leading to poor hydrodynamic transfer of axial stress to the outer annulus fibrosus, possibly resulting in further herniation and pain.[5] In this regard, traction has been shown to increase disk rehydration,[27] reduce herniated disk size,[4,11] and improve disk height.[28] These notions form the basis for the hypothesis that patients with lumbar intervertebral disks may benefit from disk decompression by lumbar traction.

There are evidences demonstrating that the herniated disk size is changeable,[29] which may imply that herniated disks can be reduced in time via mechanical means. However, although some observational image studies have shown preliminary results supporting that traction reduced the size of herniated disks,[11,30,31] these results should be interpreted with caution due to the lack of a randomized controlled design. In the present review study, we found three included randomized controlled trials that investigated the effect of traction on disk morphology.[12,15,22] Our meta-analysis on these three trials showed no significant effect at short term but revealed a trend favoring traction (P = 0.06, Figure 5), encouraging further trials to work on this issue. A possible explanation for the non-significant effect can be that the effect on reducing the size of herniated disk is temporary. In other words, the herniated disk might have returned to its original size when the mechanical traction force disappeared. However, whether temporary but repeated decompression via traction sessions provides symptomatic relief is unclear. Further studies are needed to elucidate the pathophysiology behind the treatment effects of traction.

Several limitations should be addressed. First, some of the included studies had various methodological flaws, decreasing the evidential strength of our study. Second, the included studies differed considerably in terms of the intervention settings and outcome assessments, potentially contributing to the evident heterogeneity. Third, only two trials used sham controls. Considering most pain conditions are non-biological, the lack of sham-control made determination of the contribution of the placebo effect difficult. Finally, only small sample sizes were available for analysis in certain outcome categories.

The present review provides several implications. For clinical practice, the short-term pain reduction and functional improvements provided by traction can be clinically worthy considering the potential to improve the patients' quality of life and decrease the days of sick leave. As for the treatment rationale, the lack of evidence that lumbar traction reduces herniated disk size leaves the mechanisms for pain reduction and functional improvement unclear. Perhaps the treatment mechanism can be better understood when the relation between the pathology of disk herniation and pain generation is better established in the future. For the future research, trials with large sample and sham control are needed to confirm the true benefits of traction considering the placebo effect.

Author contributions

All the authors have contributed equally to this research.

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Supplemental material

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