High-Velocity Low-Amplitude Techniques for the Management of Discogenic Lumbosacral Radicular Syndrome: A Systematic Review

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Abstract

Objective: The purpose of this study was to investigate the effect of high-velocity low-amplitude techniques (HVLATs) on discogenic lumbosacral radicular syndrome (LSRS).

Methods: This was a systematic review of randomized controlled trials (RCTs). Cochrane Central Register of Controlled Trials (CENTRAL), Medical Literature Analysis and Retrieval System Online (MEDLINE), Excerpta Medica Database (EMBASE), Physiotherapy Evidence Database (PEDro) and Web of Science (WoS) were searched from inception until 19 November 2023. Eligible RCTs involved adults with LSRS and compared HVLATs with other nonsurgical treatments, sham HVLATs or no intervention. Data related to pain, disability, health-related quality of life (HRQoL) and adverse events were extracted. The methodological quality was assessed with the 'Cochrane Risk of Bias (RoB) Tool 2.0' and the certainty of the evidence with the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE).

Results: Three of the 415 retrieved records met the inclusion criteria. One study investigated acute LSRS, comparing HVLAT versus sham HVLAT. The second study investigated subacute and chronic LSRS, comparing the same intervention with the intervention group receiving 3 adjunctive sessions of HVLAT. The third study investigated chronic LSRS, comparing HVLATs to another manual therapy technique. Totally, 186 people were involved ($n = 95$ intervention group; $n = 91$ control group). The first study reported greater improvement in pain and disability in favor of HVLATs. The second study found no differences in pain in favor of HVLATs. The third study found greater improvement for pain, disability and HRQoL in the control group. No adverse events were reported. Two studies were at high RoB and highly heterogeneous; 1 was considered of some concern. The certainty of the evidence was "very low."

Conclusions: There is insufficient evidence to conclude whether HVLATs can be helpful in LSRS. Future high-quality RCTs are necessary. (J Manipulative Physiol Ther 2023;46;346-356)

Key Indexing Terms: *Musculoskeletal Manipulations; Radiculopathy; Physical Therapy Modalities; Physical Therapy Specialty; Pain Management*

Introduction

Lumbosacral radicular syndrome (LSRS) is an umbrella term encompassing radiculopathy or radicular pains resulting from the compression or irritation of 1 or more nerve roots in the lumbosacral region.[1-3] Radiculopathy indicates an objective loss of sensory or motor function caused by a conduction block in axons of a spinal nerve or its roots, leading to a loss of strength, changes in sensation or reduced deep tendon reflex.[4] Radicular pain indicates pain radiated in 1 or more dermatome(s), caused by ectopic activation of nociceptors of the spinal nerve or its root due to irritation, inflammation or compression.[4,5] The most frequent causes of LSRS are disc bulging or herniation, facet or ligamentous hypertrophy, spondylolisthesis, or even neoplastic and infectious processes.[6] Lumbosacral radicular syndrome has a 3%-5% prevalence in the general population, with an equal distribution between women and men.[7] The incidence of LSRS seems to increase with age, reaching a peak between 45 and 64 years of age.[8]

The diagnosis of LSRS can be formulated through patients' history, physical exam, including the neurological

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examination (evaluation of sensitivity, muscle strength, and deep tendon reflexes), neurotensive tests (e.g., Straight Leg Raising Test or Lasègue's Test, Crossed Straight Leg Raise, Slump Test, Femoral Nerve Stretch Test or Prone Knee Bend), imaging and electrodiagnostic testing.[5,6,9,10] Treatment of LSRS is mainly nonsurgical, with surgical treatments proposed only in specific cases (e.g., the presence of significant motor deficits or when nonsurgical treatments failed).[11] The most common nonsurgical interventions to treat LSRS include education, use of corsets or belts, therapeutic exercise and physical activity, electrotherapies (e.g., Transcutaneous Electrical Nerve Stimulation—TENS), ultrasound, drug therapies (e.g., acetaminophen, Non-Steroidal Anti-inflammatory Drugs—NSAIDs, corticosteroids, opiates, etc.) and manual therapy techniques, including high-velocity low-amplitude techniques (HVLATs).[11-13]

These manipulative techniques are characterized by a passive high velocity and low amplitude impulse applied to a joint complex within its anatomical limit. HVLAT can help improve movement and function or reduce pain.[14] So far, different studies have investigated the effect of HVLATs in LSRS and low back pain (LBP), bringing inconclusive and contrasting results to the forefront.[12,13,15-17] The Danish Clinical Practice Guidelines (CPG), compiled by Stochkendahl et al., reported a small effect of manual techniques on LBP and Lower Limb Pain (LLP).[12] Hahne et al. reported limited or absent evidence to support the effectiveness of HVLATs compared to other treatments.[13] The National Institute for Health and Care Excellence (NICE) CPG concluded that manual therapy might be considered for managing LBP with or without sciatica.[15] Leininger et al. reported moderate evidence that Spinal Manipulative Therapy (SMT) is superior to sham SMT for acute leg and back pain and low-quality evidence for manipulation and mobilization for chronic LBP and LLP.[16] Finally, Assendelft et al. found no evidence that spinal manipulative therapy is superior to other standard treatments for people with acute or chronic LBP.[17] Considering these heterogeneous results, it was necessary to synthesize the literature on the effectiveness of HVLATs in LSRS. Hence, this systematic review aimed to analyze the effect of HVLATs on discogenic LSRS regarding pain, disability, health-related quality of life (HRQoL) and any associated adverse events.

Methods

This systematic review aimed to analyze the effect of HVLATs on LSRS caused by disc issues (discogenic) concerning pain, disability, quality of life (QoL) and any associated adverse events. The methodology followed the Cochrane Handbook for Systematic Reviews of Interventions,[18] the reporting followed the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA), and the protocol was registered in the PROSPERO database (reference: CRD42022340216).[19,20]

Inclusion Criteria

Types of Study. Only randomized controlled trials (RCTs) assessing the impact of HVLATs on LSRS were included. Specifically, English-language RCTs on humans, without date restrictions, and consideration of data before crossover in cross-over studies were included.

Participants. Adult individuals (≥18 years) diagnosed with LSRS through history, physical examination, and confirmed by imaging (MRI or CT) were included. Exclusions were made for specific conditions such as bilateral radiculopathy, cauda equina syndrome, infection, spondylolisthesis ≥ Grade III (Meyerding classification), nerve root compression by a structure other than the intervertebral disc, spinal fracture, cancer, rheumatic diseases, Reiter syndrome, or mental disorders. Studies with participants undergoing prior back surgery or other invasive medical procedures were also excluded.

Interventions. RCTs were included in which at least 1 group received HVLAT by a practitioner (e.g., physiotherapist, chiropractor, osteopath, etc.). Other manual techniques (e.g., massage, joint mobilization, etc.) without HVLATs were not considered eligible. Nonsurgical treatments (e.g., massage, joint mobilization, exercise, electrotherapies, psychological intervention, etc.), sham HVLATs, and no treatment(s) served as a control/comparison group were included. Finally, studies with HVLATs as additional treatments in the intervention group were included if both groups received the same baseline intervention.

Outcomes

The primary outcomes included pain intensity (Numeric Rating Scale, NRS or Visual Analog Scale, VAS), disability level (e.g., Oswestry Disability Index, ODI), HRQoL (e.g., SF-36), neuropathic symptoms and signs assessment (e.g., Leeds Assessment of Neuropathic Symptoms and Signs, LANSS) and the presence of adverse events or complications. We also considered the Global Perceived Effect measured with the Global Perceived Effect Scale (GPES) as an additional outcome.

Information Sources

The search string based on the Population Intervention Comparison Outcome (PICO) acronym was adapted for the following databases: Cochrane Controlled Trial Register

(CENTRAL), MEDLINE (via PubMed), EMBASE, Web of Science, and PEDro. We adopted the "Cochrane Handbook for Systematic Reviews for Interventions" recommendations.[18] In their book, the Cochrane group suggested using MEDLINE via PubMed, EMBASE, and CENTRAL as the bare minimum requirement and other sources based on the specific topic of the review (rehabilitation). Therefore, we also adopted Web of Science and PEDro. The search covered databases from inception until June 2022, with an update until 19 November 2023. The complete search terms are listed in Supplementary File 1 (Supplementary File 1—Research Terms). Supplementary searches were conducted through cross-references from systematic reviews and clinical practice guidelines on LSRS management.

Selection Process

Articles retrieved were uploaded onto the Rayyan website (https://rayyan.qcri.org) after duplicate removal with EndNote 20.[21,22] Two researchers (FA and RS) independently and systematically reviewed titles and abstracts for eligibility, applying the inclusion and exclusion criteria. When necessary, the full texts were read. Disagreements were resolved through consensus or consultation with a third author (SB). No authors or experts were contacted to get additional studies.

Data Extraction

The following data were extracted by 2 reviewers (RS, GB) from each selected study: authors, title, study design, setting, participants characteristics (number, age, gender, assigned sex at birth), symptoms characteristics (duration, localization, and intensity), main treatment characteristics (duration, frequency, type of technique), control treatment characteristics, outcomes (tools used to record each outcome, mean and standard deviations). Disagreements in the data collection were resolved by either a consensus process or consultation with a third author (SB).

Risk of Bias Assessment

The risk of bias was assessed independently by 2 authors (RS and GB) using the "Revised Cochrane risk-of-bias tool for randomized trials" (RoB 2).[23] This tool evaluates the risk of bias in 5 domains: randomization process, deviation from intended intervention, missing outcome data, measurement of the outcome and selection of the reported result. All domains are then rated as "low risk," "high risk" or "same concern." If necessary, disagreements between the 2 investigators were resolved by discussion with a third author (SB).

Data Synthesis and Assessing Certainty in the Findings

Given the substantial heterogeneity in the population, comparison, and intervention, a meta-analysis was deemed unfeasible. Instead, mean differences (MDs) between intervention and control groups, along with their corresponding 95% confidence intervals (CIs), were calculated for each outcome at available time points. This procedure used the "ttesti" function in Stata 18 (StataCorp). The overall quality of evidence was evaluated through the Grading of Recommendation, Assessment, Development and Evaluation (GRADE) framework.[24] This framework allows for assessing and developing a summary of evidence in a systematic approach. For each outcome, the 5 GRADE domains were considered: risk of bias, imprecision, inconsistency, indirectness, and publication bias. Using the GRADE approach, the overall quality of evidence was selected between 4 possible levels: high, moderate, low, and very low.

Results

Study Selection

A total of 415 records were identified through database searching. After removing the duplicates (n = 37), we assessed the remaining records by titles and abstracts. Eventually, 52 studies were eligible for full-text reading. Among these 52 studies, only 3 met the inclusion criteria and were included in this systematic review (Fig 1).[25-27] Supplementary File 2 reports the full list of the excluded studies after full-text reading with reasons for exclusion (Supplementary File 2).

Characteristics of the Included Studies

The 3 selected studies were published in 2006, 2021, and 2023 and were conducted in Italy, Iran, and Nigeria., respectively.[25-27] A total of 186 patients with LSRS were involved (95 in the treatment and 91 in the control groups). The study by Santilli et al. was conducted on people with acute LSRS (less than 10 days) and compared HVLAT versus sham HVLAT (i.e., a soft muscle pressing similar to manipulation but not involving rapid thrusts).[26] The study by Ghasabmahaleh et al. was conducted on people with subacute and chronic LSRS (more than 4 weeks).[27] Both groups underwent the same physiotherapy intervention, with the intervention group receiving 3 sessions of HVLAT as adjunctive therapy.[27] The study by Danazumi et al. was conducted on people with chronic LSRS and compared HVLAT versus Spinal Mobilization With Leg Movement (SMWLM).[25] All the studies measured LBP and Lower Limb Pain (LLP) intensity.[25-27] Detailed characteristics of the included studies are listed in Table 1.

Effects of the Interventions

Table 2 reports the results of the studies and their calculated measures of the effect (MD and 95% CI). In the study

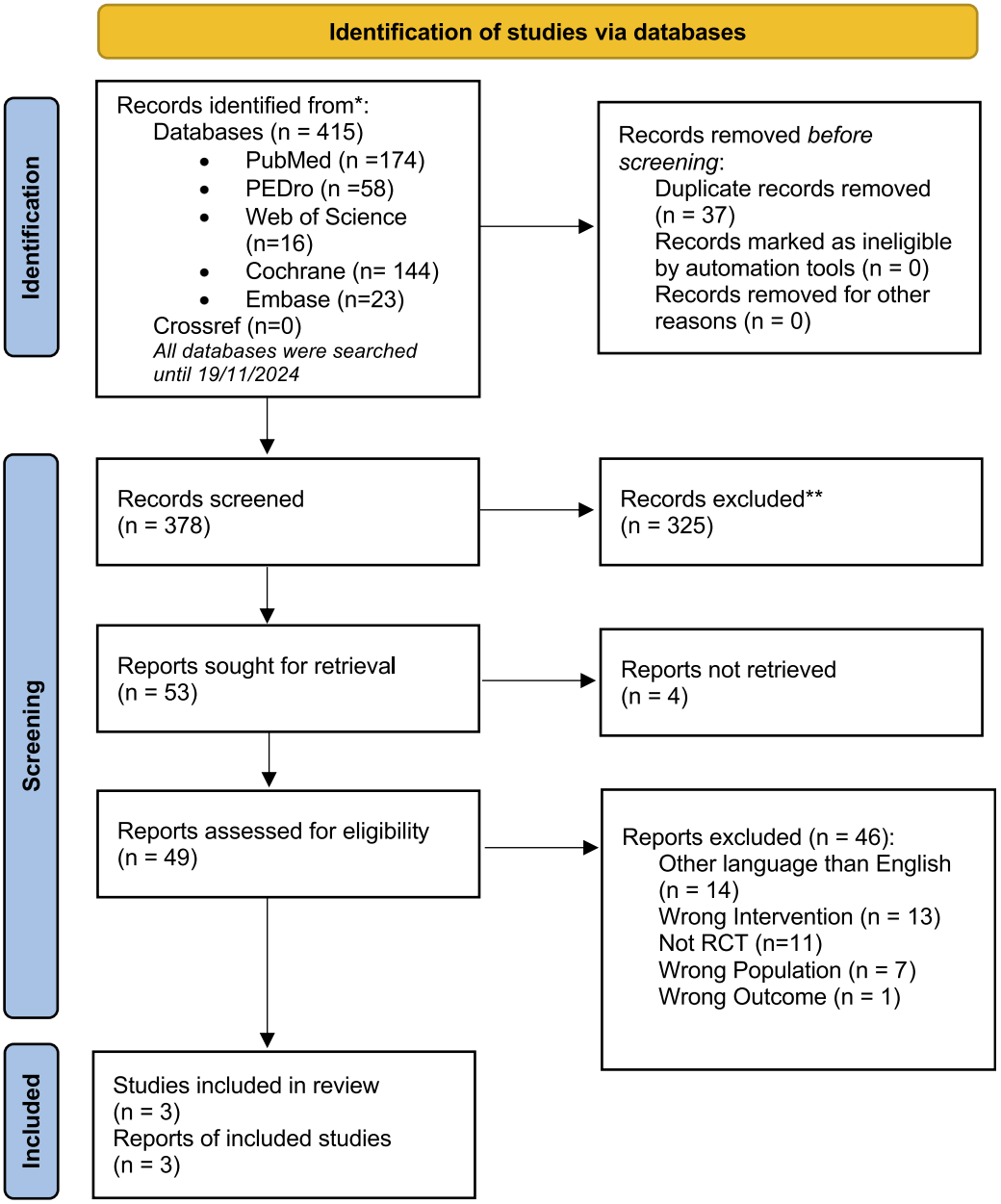

Fig 1. *PRISMA flow diagram.* n, *number.*

by Santilli et al., no differences were found at the different time points between the intervention and the control groups.[26] The authors declared no differences in patients' HRQoL with SF-36, but no raw data were displayed at the follow-ups.[26] In the study by Ghasabmahaleh et al., for the outcome LBP, the authors found lower pain levels (MD) in favor of HVLATs: -0.5 (95% CI: -1.6; 0.6) after the intervention, -1.4 (-2.5; 0.3) at 90 days. For the outcome LLP, the authors found lower pain levels in favor of HVLATs: -1.3 (95% CI: -2.3; -0.3) after the intervention and -2.3 (-3.3; -1.3) at 90 days. Lastly, for the outcome disability, the authors found lower levels in favor of HVLATs: -8.6 (95% CI: 17; 0.2) after the intervention and -16.1 (-25.0; -7.3) at 90 days.[27] In the study by Danazumi et al., for the outcome LBP, the authors found higher pain levels in the intervention group: 2.1 (95% CI: 0.8; 3.4) at 45 days, 1 (0.3; 1.7) at 90 days, 1.3 (1.0; 1.6) at 180 days and 1 (0.8; 1.2) at 1 year. For the outcome LLP, the authors found higher pain levels in the intervention group: 1.9 (95% CI: 0.2; 3.6) at 45 days, 0.8 (0.1; 1.5) at 90 days, 1.7 (0.6; 2.8) at 180 days and 1.1 (0.2; 2.0) at 1 year. For the outcome disability, the authors found higher disability levels in the intervention group: 3.8 (95% CI: 1.1; 6.5) at 45 days, 4.1 (1.8; 6.4) at 90 days, 3.3 (0.7; 5.9) at 180 days and 2.7 (1.1;

Table 1. *Study Characteristics*

Study	Setting	N° Int/Cont	Age (SD)	Type Intervention N° session)	Type Control (N° session)	Follow-Up(s)	Outcomes
Ghasabmahaleh et al. (2021) "Spinal Manipulation for Subacute and Chronic Lumbar Radiculopathy: A Randomized Controlled Trial"	Department of Physical Medicine and Rehabilitation; Imam Reza University Hospital (Tehran, Iran)	44 (22/22)	44.3 (10.1)	HVLAT (lumbar manipulation) + medication + routine physiotherapy (heat + TENS + US + exercise N session = 13 (5 sessions/week; almost 50 minutes each)	Medication + routine physiotherapy (heat + TENS + US + exercise) N session = 10 (5 sessions/ week; almost 50 minutes each)	After the intervention and 3 months	***Leg and Back pain***: VAS (10 cm) ***Disability***: Oswestry disability questionnaire score
Santilli et al. (2006) "Chiropractic manipulation in the treatment of acute back pain and sciatica with disc protrusion: a randomized double-blind clinical trial of active and simulated spinal manipulations"	Ambulatory patients in 2 medical rehabilitation centers in and near Rome (Celio Hospital and Istituto Chirurgico Ortopedico Traumatologico, Italy	102 (53/49)	43.1	Soft tissue manipulations and brisk rotational thrusting away from the greatest restriction **(HVLAT)** N session = 5 days/week up to a maximum of 20	Simulated manipulations (soft muscle pressing similar to manipulations but not following any specific patterns and not involving rapid thrusts) (SHAM HVLA) N session = 5 days/week up to a maximum of 20	On days 15, 30, 45, 90, 180	***Leg and Back pain***: VAS (10 cm) **Quality of Life:** (SF-36 score)
Danazumi et al. (2023) Chiropractic manipulation in the treatment of acute back pain and sciatica with disc protrusion: a randomized double-blind clinical trial of active and simulated spinal manipulations	General and surgical outpatient clinic departments of Federal Medical Centre Nguru and physiotherapy outpatient clinic of the same hospital.	40 (20/20)	39.09 (4.76)	HVLAT (lumbar manipulation) + NM (SLR as per guidelines of Butler and Jones) immediately after + home regimen of therapeutic exercise after 12 weeks postrandomization	Mulligan's SMWLM + NM (SLR per guidelines of Butler and Jones) immediately after + home regimen of therapeutic exercise after 12 weeks postrandomization	On Weeks 6, 12, 26, 52	***Leg and Back pain:*** VAS (10 cm) ***Disability*** **=** Roland-Morris Disability Questionnaire ***Quality of life*** **=** SF-36 score

N, number of participants; Int, intervention; Cont., control; SD, standard deviation; VAS, Visual Analog Scale; HVLA, high-velocity low amplitude; PT, physiotherapy; TENS, transcutaneous electrical nerve stimulation; US, ultrasound; NM, neurodynamic mobilization; SMWLM, spinal mobilization with leg movement; SLR, straight leg raise; SF-36, Short Form 36 Health Survey Questionnaire.

Table 2. . *Study Outcomes*

Authors	Outcome	Baseline *Mean (SD)*		After the Intervention *Mean (SD)*		Follow Up: Day 15 *Mean (SD)*		Day 30 *Mean (SD)*		Day 45 *Mean (SD)*		Day 90 *Mean (SD)*		Day 180 *Mean (SD)*		Day 365 *Mean (SD)*	
		Int *N* = 22	Cont *N* = 22	Int *N* = 22	Cont *N* = 22	-	-	-	-	-	-	Int *N* = 22	Cont *N* = 22	-	-	-	-
Ghasabmahaleh et al. (2021)	**LBP (VAS)**	5.5 (1.6)	6.0 (1.9)	4.5 (1.8)	5.0 (1.9)	-	-	-	-	-	-	3.8 (1.5)	5.2 (2.0)	-	-	-	-
				Mean difference (95% CI)								**Mean difference (95% CI)**					
				-0.5 (-1.6; 0.6)								-1.4 (-2.5; -0.3)					
	LLP (VAS)	6.9 (1.6)	7.3 (1.8)	5.0 (1.3)	6.3 (1.9)	-	-	-	-	-	-	4.3 (1.6)	6.6 (1.7)	-	-	-	-
				Mean difference (95% CI)								**Mean difference (95% CI)**					
				-1.3 (-2.3; -0.3)								-2.3 (-3.3; -1.3)					
	Disability (ODI)	41.8 (17.4)	41.1 (18.1)	25.2 (12.0)	33.8 (15.3)	-	-	-	-	-	-	22.2 (10.7)	38.3 (17.4)	-	-	-	-
				Mean difference (95% CI)								**Mean difference (95% CI)**					
				-8.6 (-17.0; -0.2)								-16.1 (-25.0; -7.3)					
Santilli et al. (2006)	**LBP (VAS)**	**Int** *N* = 53	**Cont** *N* = 49	-	**-**	**Int** ***N* = 50**	**Cont** ***N* = 48**	**Int** ***N* = 49**	**Int** *N* = 48	**Int** *N* = 48	**Cont** *N* = 48	**Int** *N* = 48	**Cont** *N* = 48	**Int** *N* = 48	**Cont** *N* = 48	**-**	**-**
		6.4 (2.2)	6.2 (2.1)	**-**	-	4.5 (5.9)	5.8 (4.9)	3.7 (7.5)	4.5 (5.6)	2.5 (6.5)	4.0 (7.0)	2.0 (7.1)	4.0 (6.7)	2.0 (7.0)	3.8 (7.1)	-	-
						Mean difference (95% CI)		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**			
						-1.3 (-3.5; 0.9)		0.8 (-3.5; 1.9)		-1.5 (4.2; 1.2)		-2.0 (-4.8; 0.8)		-1.8 (-4.6; 1.0)			
	LLP (VAS)	5.2 (4.6)	5.0 (4.1)	-	-	3.8 (7.4)	4.1 (6.3)	2.2 (6.9)	4.0 (6.7)	2.0 (7.0)	3.7 (6.2)	1.0 (6.2)	3.8 (7.4)	1.0 (6.2)	3.6 (7.6)	-	-
						Mean difference (95% CI)		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**			
						-0.3 (-3.0; 2.5)		-1.8 (-4.5; 2.9)		-1.7 (-4.4; 1.0)		-2.8 (-5.6; -0.1)		-2.6 (-5.4; 0.2)			

(*continued*)

Table 2. (*Continued*)

Authors	Outcome	Baseline *Mean (SD)*		After the Intervention *Mean (SD)*		Follow Up: Day 15 *Mean (SD)*		Day 30 *Mean (SD)*		Day 45 *Mean (SD)*		Day 90 *Mean (SD)*		Day 180 *Mean (SD)*		Day 365 *Mean (SD)*	
		Int *N* = 22	Cont *N* = 22	Int *N* = 22	Cont *N* = 22	-	-	-	-	-	-	Int *N* = 22	Cont *N* = 22	-	-	-	-
Danazumi et al. (2023)	**LBP (VAS)**	**Int** *N* = 20	**Cont** *N* = 20	**-**	**-**	**-**	**-**	**-**	**-**	**Int** *N* = 20	**Cont** *N* = 20	**Int** *N* = 20	**Cont** *N* = 20	**Int** *N* = 20	**Cont** *N* = 20	**Int** *N* = 20	**Cont** *N* = 20
		6.1 (2.5)	6.9 (3.3)	-	-	-	-	-	-	5.2 (2.0)	3.1 (2.1)	3.7 (1.2)	2.7 (1.1)	2.4 (0.5)	1.1 (0.4)	2.0 (0.3)	1.0 (0.4)
										Mean difference (95% CI)		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**	
										2.1 (0.8; 3.4)		1.0 (0.3; 1.7)		1.3 (1.0; 1.6)		1.0 (0.8; 1.2)	
	LLP (VAS)	6.0 (3.7)	6.1 (4.2)	-	-	-	-	-	-	4.1 (3.1)	2.2 (1.9)	3.2 (1.1)	2.4 (1.0)	2.7 (2.2)	1.0 (1.1)	1.8 (1.6)	0.7 (1.1)
										Mean difference (95% CI)		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**	
										1.9 (0.2; 3.6)		0.8 (0.1; 1.5)		1.7 (0.6; 2.8)		1.1 (0.2; 2.0)	
	Disability (RMDQ)	16.0 (5.7)	16.2 (5.7)	-	-	-	-	-	-	11.8 (4.3)	8.0 (4.3)	8.8 (3.1)	4.7 (4.1)	5.6 (5.0)	2.3 (2.7)	4.0 (3.4)	1.3 (1.0)
										Mean difference (95% CI)		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**	
										3.8 (1.1; 6.5)		4.1 (1.8; 6.4)		3.3 (0.7; 5.9)		2.7 (1.1; 4.3)	
	Quality of Life (SF-36)	42.5 (4.9)	39.9 (5.7)	- -	-	-	-	-	-	54.6 (4.1)	66.6 (4.9)	67.2 (3.7)	74.3 (4.3)	71.0 (4.9)	86.3 (3.7)	76.4 (3.3)	91.0 (4.8)
										Mean difference (95% CI)		**Mean difference (95% CI)**		**Mean difference (95% CI)**		**Mean difference (95% CI)**	
										-12.0 (-14.9; -9.1)		-7.1 (-9.7; -4.5)		-15.3 (-18.1; -12.5)		-14.6 (-17.2; -12.0)	

LBP, low back pain; LLP, lower limb pain; Int, intervention; Cont., control VAS, Visual Analog Scale; ODI, Oswestry Disability Index; RMDQ, Roland-Morris Disability Questionnaire; SD, standard deviation.

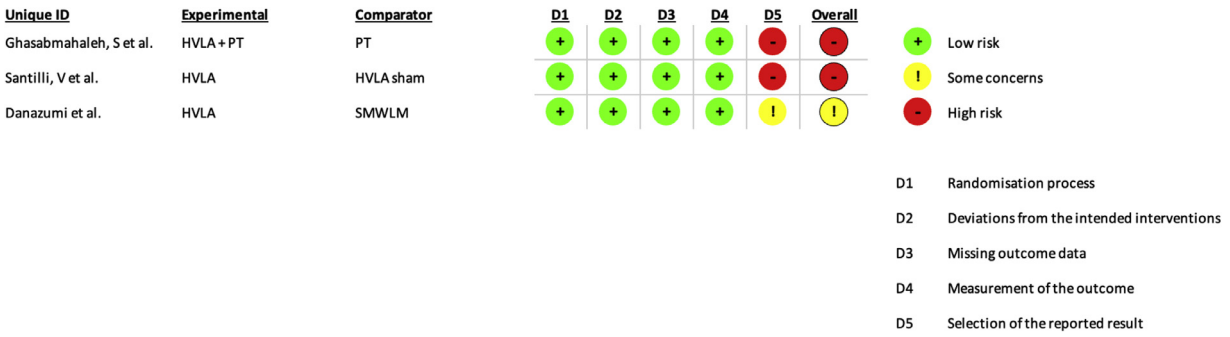

Fig 2. *Risk of bias assessment. HVLAT, high-velocity low-amplitude technique; PT, multimodal physiotherapy treatment; SMWLM, spinal mobilization with leg movement; D, domain.*

4.3) at 1 year. For the outcome HRQoL, the authors found lower HRQoL levels in the intervention group: -12 (95% CI: -14.9; -9.1) at 45 days, -7.1 (-9.7; -4.5) at 90 days, -15.3 (-18.1; -12.5) at 180 days and -14.6 (-17.2; -12.0) at 1 year.[25] In 2 studies, any adverse events were not reported any adverse events.[26,27] The same outcome was not measured in the study from Danazumi et al.[25]

Quality Assessment

The study by Ghasabmahaleh et al. was considered at high risk for the measurement of the outcome item since no blind assessors were reported for the pain outcome.[27] The same study was considered at high risk for the reported results because multiple analyses were performed on the same outcomes and some outcomes at the follow-ups were reported only as graphs, without reporting the precise means and standard deviations that we calculated manually.[27] At the same time, the study by Santilli et al. was considered at high risk for the selection of the reported result because different outcome measures were used for the same domain.[26] Moreover, the study protocol is absent.[26] For these reasons, the studies from Santilli et al. and Ghasabmahaleh et al. resulted in a high risk of bias. The study from Danazumi et al. was judged to be of some concern for the domain selection of the reported result because no statistical analysis plan was reported in the study protocol[26] (Fig 2).

Certainty of the Evidence

The certainty of evidence following GRADE criteria was very low for the 3 reported outcomes (pain, disability and quality of life), as reported in Table 3.

Table 3. *Certainty of Evidence (GRADE)*

Outcomes	Number of Studies	Impact	Certainty of Evidence (GRADE)	Comments
Pain	Three RCTs	One RCT did not show differences between interventions and controls. One RCT showed a higher effect of HVLATs compared to the control group. One RCT showed a lower effect of HVLATs compared to the control group.	⊕○○○ **Very low**	Significant heterogeneity in the population (acute in 1 study and chronic in the other), in the treatment and comparison (1 study had a sham HVLAT and the other nothing but HVLAT was as an adjunctive treatment), and in the dosage. Imprecision (the total amount of sample size is less than 400). High risk of bias.
Disability	Two RCTs	One RCT showed a higher effect of HVLATs compared to the control group. One RCT showed a lower effect of HVLATs compared to the control group.	⊕○○○ **Very low**	Imprecision (the total amount of sample size is less than 400). High risk of bias.
Quality of life	One RCT	One RCT showed a lower effect of HVLATs compared to the control group.	⊕○○○ **Very low**	Imprecision (the total amount of sample size is less than 400). Some concern in the RoB.

GRADE, Grading of Recommendation, Assessment, Development and Evaluation; RCT, randomized controlled trial; HVLAT, high-velocity low-amplitude techniques; RoB, risk of bias.

Discussion

This systematic review aimed to explore the effect of HVLATs on pain, levels of disability health-related quality of life in LSRS and possible adverse events. Only 3 studies met the eligibility criteria, exclusively including people with discogenic LSRS confirmed through imaging.[25-27] In the study by Santilli et al., we did not find any differences between interventions and controls in LBP and LLP. In the study by Ghasabmahaleh et al., we found differences in favor of HVLATs for LBP, LLP, and disability. Finally, in the study by Danazumi et al., we found differences in favor of the control group for LBP, LLP, disability, and HRQoL. However, it is noteworthy that the first 2 studies were considered at high RoB, while the 1 against HVLATs reported some concerns in the RoB. Adverse events were not reported in 2 of the included studies.[26,27] On the contrary, adverse events were not measured in the study by Danazumi et al.[25] Overall, the contrasting results, the low quality of the studies and the very low certainty of the evidence did not allow for drawing conclusions on the effectiveness of HVLATs in LSRS.[25-27]

Past evidence found controversial and conflicting results on the efficacy of HVLATs in LSRS. The NICE CPG tried to compare the effectiveness of manual therapy (i.e., HVLATs, mobilization and tractions) with other treatments (e.g., exercise, medications, laser therapy, sham manipulations, etc.).[15] It concluded that manual therapy might be considered for managing LBP, with or without sciatica, only as part of a multimodal treatment that includes exercise and psychological therapies (if needed).[15] However, this CPG included studies with a population of LBP, LSRS or a combination thereof, with only the study by Santilli et al. investigating HVLAT efficacy for LSRS.[15,26]

The Danish CPG compiled by Stochkendahl et al. included only 2 studies which investigated HVLATs in LSRS, reporting a small effect of general manual techniques (not only HVLATs) on short-term in LBP and LLP.[12,26,28] Notwithstanding, they included a paper that considered a mixed population of people with LBP and LLP with or without neurological signs.[28] Then, the review by Hahne et al. reported limited or absent evidence to support the effectiveness of HVLATs compared to other treatments.[13] However, they included papers that used inconsistent terminology in the treatment as they used the term "manipulation" to indicate different manual techniques other than HVLATs.[29] The review compiled by Leininger et al. found moderate evidence that HVLATs are more effective than sham HVLATs and low-quality evidence for HVLATs and mobilization compared to other treatments for chronic lumbar spine-related extremity symptoms.[16] Nevertheless, in this review, the term "spine-related extremity symptoms" included LSRS and nonradicular radiating pain (in a nondermatomal pattern).[16]

Therefore, the reason for this inconclusive evidence on HVLATs in LSRS can stem from different issues in the design of the studies. The term "manipulation" is used by various studies to refer to manual therapy techniques other than HVLATs.[30-33] The same scenario happens once defining LSRS, as authors adopted this term for different pain conditions with or without neurological signs (e.g., LBP).[28,34,35] Finally, some studies did not focus on LSRS but on a mixed population of people with different back-related diseases.[15-17]

Our systematic review revealed diverse and contrasting results of HVLATs on pain, disability, and HRQoL in individuals with LSRS. However, the included studies exhibited significant heterogeneity, encompassing distinct phases of LSRS pathology (acute/subacute or chronic) and variations in the administration of HVLATs —either as an adjunctive therapy or in isolation, with different dosages employed. Compounded by these differences, our analysis indicated a "very low" certainty and quality of evidence, reflecting limitations in study design, methodology, and potential biases. Consequently, the current evidence landscape impedes the establishment of a definitive conclusion regarding the effectiveness of HVLATs in treating LSRS. The observed variability underscores the imperative for more standardized and rigorous research in this domain, emphasizing caution in interpreting and applying the existing evidence until higher-quality studies become available.

Limitations

The included studies were limited to only 3, with 2 considered at high RoB and 1 showing some concerns.[25-27] Then, the studies displayed heterogeneity in the treatment modalities employed, the follow-ups and the type of LSRS (chronic, subacute, and acute).[25-27] Moreover, the search strategy for this systematic review was limited to only a few electronic databases and did not include grey literature or unpublished studies. Finally, the quality of evidence was very low, and the results of this review did not allow us to draw a definitive conclusion regarding the effectiveness of HVLATs in reducing LBP and LLP and their related disability in individuals with LSRS caused by disc issues (discogenic).

Conclusions

The findings of this systematic review identified that there is insufficient evidence for assessing the effectiveness of HVLATs in LRSR. Clinical practice guidelines for the management of LSRS should take into account these results when determining the suitability of these treatments for inclusion in their recommendations. Future studies should aim to improve the quality of RCTs by establishing consensus definitions for LSRS and HVLATs, and by using homogeneous populations and interventions.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.jmpt.2024.08.008.

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Contributorship Information

Concept development (provided idea for the research): RS, GB, FA, FM, TM, SB; Design (planned the methods to generate the results): RS, GB, FA, FM, TM, SB; Supervision (oversight, organization, and implementation): RS, GB, FA, FM, TM, SB; Data collection/processing (experiments, organization, or reporting data): RS, GB, FA, FM, TM, SB; Analysis/interpretation (analysis, evaluation, presentation of results): RS, GB, FA, FM, TM, SB; Literature search (performed the literature search): RS, FA, SB; Writing (responsible for writing a substantive part of the manuscript): RS, GB, FA, SB; Critical review (revised manuscript for intellectual content): RS, GB, FA, FM, TM, SB.

Practical Applications

- High-velocity low-amplitude techniques (HVLATs) are considered optional treatment for the management of lumbosacral radicular syndrome (LSRS) by clinical practice guidelines.
- However, we cannot conclude whether HVLATs are effective in LSRS management.
- There is a need for high-quality RCTs to understand the role of HVLATs in LSRS management.

References

1. Spijker-Huiges A, Vermeulen K, Winters JC, Van Wijhe M, Van Der Meer K. Epidural steroids for lumbosacral radicular syndrome compared to usual care: quality of life and cost utility in general practice. *Arch Phys Med Rehabil*. 2015;96(3):381-387. https://doi.org/10.1016/j.apmr.2014.10.017.
2. Luijsterburg PAJ, Verhagen AP, Ostelo RWJG, Van Os TAG, Peul WC, Koes BW. Effectiveness of conservative treatments for the lumbosacral radicular syndrome: a systematic review. *Eur Spine J*. 2007;16(7):881-899. https://doi.org/10.1007/s00586-007-0367-1.
3. Luijsterburg PAJ, Verhagen AP, Braak S, Avezaat CJJ, Koes BW. Do neurosurgeons subscribe to the guideline lumbosacral radicular syndrome? *Clin Neurol Neurosurg*. 2004;106(4):313-317. https://doi.org/10.1016/j.clineuro.2004.02.003.
4. Vining RD, Shannon ZK, Minkalis AL, Twist EJ. Current evidence for diagnosis of common conditions causing low back pain: systematic review and standardized terminology recommendations. *J Manipulative Physiol Ther*. 2019;42(9):651-664. https://doi.org/10.1016/j.jmpt.2019.08.002.
5. van Boxem K, Cheng J, Patijn J, et al. 11. Lumbosacral radicular pain. *Pain Pract*. 2010;10(4):339-358. https://doi.org/10.1111/j.1533-2500.2010.00370.x.
6. Berry JA, Elia C, Saini HS, Miulli DE. A review of lumbar radiculopathy, diagnosis, and treatment. *Cureus*. 2019;11(10):e5934. https://doi.org/10.7759/cureus.5934.
7. Tarulli AW, Raynor EM. Lumbosacral radiculopathy. *Neurol Clin*. 2007;25(2):387-405. https://doi.org/10.1016/j.ncl.2007.01.008.
8. Koes B W, van Tulder M W, Peul W C. Diagnosis and treatment of sciatica. *Br Med J*. 2007;334(7607):1317. https://doi.org/10.1136/bmj.39223.428495.BE.
9. van der Windt DA, Simons E, Riphagen II, et al. Physical examination for lumbar radiculopathy due to disc herniation in patients with low-back pain. *Cochrane Database Syst Rev*. 2010;2:CD007431. https://doi.org/10.1002/14651858.cd007431.pub2.
10. De Luigi AJ, Fitzpatrick KF. Physical examination in radiculopathy. *Phys Med Rehabil Clin N Am*. 2011;22(1):7-40. https://doi.org/10.1016/j.pmr.2010.10.003.
11. Khorami AK, Oliveira CB, Maher CG, et al. Recommendations for diagnosis and treatment of lumbosacral radicular pain: a systematic review of clinical practice guidelines. *J Clin Med*. 2021;10(11):2482. https://doi.org/10.3390/jcm10112482.
12. Stochkendahl MJ, Kjaer P, Hartvigsen J, et al. National clinical guidelines for non-surgical treatment of patients with recent onset low back pain or lumbar radiculopathy. *Eur Spine J*. 2018;27(1):60-75. https://doi.org/10.1007/s00586-017-5099-2.
13. Hahne AJ, Ford JJ, Mcmeeken JM. Conservative management of lumbar disc herniation with associated radiculopathy a systematic review. *Spine*. 2010;35(11):E488-E504. https://doi.org/10.1097/BRS.0b013e3181cc3f56.
14. Rushton A, Beeton K, Ronel D, et al. *International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) Educational Standards In Orthopaedic Manipulative Therapy*.; 2016.
15. National Guideline Centre (Great Britain). *Low Back Pain and Sciatica in Over 16s: Assessment and Management*. UK): National Institute for Health and Care Excellence; 2016.
16. Leininger B, Bronfort G, Evans R, Reiter T. Spinal manipulation or mobilization for radiculopathy: a systematic review. *Phys Med Rehabil Clin N Am*. 2011;22(1):105-125. https://doi.org/10.1016/j.pmr.2010.11.002.

17. Assendelft WJ, Morton SC, Yu EI, Suttorp MJ. Shekelle PG. Spinal manipulative therapy for low back pain. *Cochrane Database Syst Rev*. 2004;1:CD000447. https://doi.org/10.1002/14651858.CD000447.pub2.
18. Higgins JPT, Thomas J, Chandler J, et al. Cochrane handbook for systematic reviews of interventions version 6.3 2022. www.training.cochrane.org/handbook. Accessed August 31, 2023.
19. Page MJ, Shamseer L, Tricco AC. Registration of systematic reviews in PROSPERO: 30,000 records and counting. *Syst Rev*. 2018;7(1):32. https://doi.org/10.1186/s13643-018-0699-4.
20. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *PLoS Med*. 2021;18(3):e1003583. https://doi.org/10.1371/JOURNAL.PMED.1003583.
21. Harrison H, Griffin SJ, Kuhn I, Usher-Smith JA. Software tools to support title and abstract screening for systematic reviews in healthcare: an evaluation. *BMC Med Res Methodol*. 2020;20(1):7. https://doi.org/10.1186/s12874-020-0897-3.
22. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. *Syst Rev*. 2016;5(1):210. https://doi.org/10.1186/s13643-016-0384-4.
23. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898. https://doi.org/10.1136/bmj.l4898.
24. Schünemann H, Brożek J, Guyatt G, Oxman A. GRADE handbook for grading quality of evidence and strength of recommendations. 2013.
25. Danazumi MS, Nuhu JM, Ibrahim SU, et al. Effects of spinal manipulation or mobilization as an adjunct to neurodynamic mobilization for lumbar disc herniation with radiculopathy: a randomized clinical trial. *J Manual Manipulat Ther*. 2023;31(6):408-420. https://doi.org/10.1080/10669817.2023.2192975.
26. Santilli V, Beghi E, Finucci S. Chiropractic manipulation in the treatment of acute back pain and sciatica with disc protrusion: a randomized double-blind clinical trial of active and simulated spinal manipulations. *Spine J*. 2006;6(2):131-137. https://doi.org/10.1016/j.spinee.2005.08.001.
27. Ghasabmahaleh SH, Rezasoltani Z, Dadarkhah A, Hamidipanah S, Mofrad RK, Najafi S. Spinal manipulation for subacute and chronic lumbar radiculopathy: a randomized controlled trial. *Am J Med*. 2021;134(1):135-141. https://doi.org/10.1016/j.amjmed.2020.08.005.
28. Bronfort G, Hondras MA, Schulz CA, Evans RL, Long CR, Grimm R. Spinal manipulation and home exercise with advice for subacute and chronic back-related leg pain: a trial with adaptive allocation. *Ann Intern Med*. 2014;161(6):381-391. https://doi.org/10.7326/M14-0006.
29. Burton KA, Tillotson MK, Cleary J. Single-blind randomised controlled trial of chemonucleolysis and manipulation in the treatment of symptomatic lumbar disc herniation. *European Spine Journal : Official Publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society*. 2000;9(3):202-207. https://doi.org/10.1007/s005869900113.
30. Zhang Y, Xue R, Tong Z, et al. The efficacy of manipulation with distension arthrography to treat adhesive capsulitis: a multicenter, randomized, single-blind, controlled trial. *Biomed Res Int*. 2022;2022: 1562358. https://doi.org/10.1155/2022/1562358.
31. Wilczyńska D, Łysak-Radomska A, Podczarska-Głowacka M, Zajt J, Dornowski M, Skonieczny P. Evaluation of the effectiveness of relaxation in lowering the level of anxiety in young adults—a pilot study. *Int J Occup Med Environ Health*. 2019;32(6):817-824. https://doi.org/10.13075/ijomeh.1896.01457.
32. Griswold D, Gargano F, Learman KE. A randomized clinical trial comparing non-thrust manipulation with segmental and distal dry needling on pain, disability, and rate of recovery for patients with non-specific low back pain. *J Manual Manipulat Ther*. 2019;27(3):141-151. https://doi.org/10.1080/10669817.2019.1574389.
33. Cook C. How about a little love for non-thrust manipulation? *J Manual Manipulat Ther*. 2012;20(1):1-2. https://doi.org/10.1179/106698112×13243937084444.
34. Seferlis T, Nèmeth G, Carlsson AM, Gillstrom P. Conservative treatment in patients sick-listed for acute low-back pain: a prospective randomised study with 12 months' follow-up. *European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society. and the European Section of the Cervical Spine Research Society*. 1998;7(6):461-470. https://doi.org/10.1007/s005860050109.
35. Szulc P, Wendt M, Waszak M, Tomczak M, Cieślik K, Trzaska T. Impact of McKenzie method therapy enriched by muscular energy techniques on subjective and objective parameters related to spine function in patients with chronic low back pain. *Med Sci Monitor*. 2015;21:2918-2932. https://doi.org/10.12659/MSM.894261.