Literature review

Chiropractic treatment of lumbar spinal stenosis: a review of the literature[☆]

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Abstract

Objective: The objective of this article was to review the literature on the use of chiropractic for the treatment of lumbar spinal stenosis.

Methods: A literature search was conducted on 4 electronic databases (Medline, Index to Chiropractic Literature, Cumulative Index to Nursing and Allied Health Literature, and Allied and Complementary Medicine Database) for clinical research pertaining to chiropractic treatment of lumbar spinal stenosis. Retrieved articles were hand searched for relevant references. Inclusion criteria consisted of any clinical study design (including case reports) using chiropractic care on patients with lumbar spinal stenosis published in English in the past 25 years.

Results: Six articles on a total of 70 patients met the inclusion criteria for the review. These articles included 4 case studies, a case series, and an observational cohort study. Treatments included spinal manipulation and, most often, flexion-distraction manipulation. Numerous other interventions including exercise, activity of daily living modifications, and various passive care modalities were selectively used in the included studies.

Conclusions: There is a paucity of evidence available with respect to chiropractic treatment of spinal stenosis. The limited evidence that is available points toward chiropractic care being potentially beneficial in the treatment of patients with lumbar spinal stenosis, but further clinical investigations are necessary.

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Introduction

Lower back pain can be a disabling condition and has become the second most common reason that patients visit a physician.¹ Recent research has attempted to segregate the lower back pain population into specific subcategories in an attempt to match the

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Fig 1 Potential causes of LSS⁶⁻⁸

Developmental or Congenital
Idiopathic
Achondroplasia
Morquio Syndrome
Hypophosphatemic Vitamin D–Resistant Rickets
Spinal Dysraphism (Lipoma, Myelomeningocele)
Acquired
Degenerative
Spondylosis
Spondylolisthesis
Scoliosis
Ossification of the Ligamentum Flavum
Ossification of the Posterior Longitudinal Ligament
Intraspinal Synovial Cysts
Metabolic or Endocrine
Osteoporosis
Acromegaly
Pseudogout (Calcium Pyrophosphate Dehydrate Deposition)
Renal Osteodystrophy
Hypoparathyroidism
Epidural Lipomatosis (Cushing Disease)
Skeletal
Paget Disease
Ankylosing Spondylitis
Diffuse Idiopathic Skeletal Hyperostosis
Rheumatoid Arthritis
Traumatic
Burst Fracture
Laminectomy
Kyphosis/Scoliosis
Postoperative
Laminectomy
Fusion
Fibrosis

most appropriate treatments with conditions and improve outcomes.² Lumbar spinal stenosis (LSS) is a clinical pathology categorized as a lower back pain condition and is often encountered in older adults. An increased capability of clinicians to diagnose this condition over the past decade has been brought about by improvements in imaging technology.³ The first definition of this disorder can be attributed to Verbiest⁴; and that has since evolved into what the Spinal Stenosis Work Group of the North American Spine Society Clinical Guidelines Committee defines as a “clinical syndrome of buttock or lower extremity pain, which may occur with or without back pain, associated with diminished space available for the neural and vascular elements in the lumbar spine.”⁵

Lumbar spinal stenosis can be classified in several ways based on the specific etiology or on the anatomical location and tissues involved in the narrowing. The etiology can be divided into developmental (or congenital) and acquired types, although both can occur in the same patient (Fig 1 for a list of potential causes).⁶⁻⁸ With respect to the anatomical location and tissues involved in the narrowing, LSS can be classified as either central or lateral stenosis. Central LSS involves the narrowing of the spinal canal around the nerve roots of the cauda equina within the dural sac due to facet joint arthrosis and hypertrophy, thickening and bulging of the ligamentum flavum into the spinal canal, encroachment or bulging of a intervertebral disk herniation, or spondylolisthesis.⁹⁻¹¹ Lateral LSS typically occurs when the nerve root becomes encroached upon in the nerve root canal and/or the intervertebral foramen as a result of an intervertebral disk herniation, hypertrophy of the facet joints, loss of intervertebral disk height, or spondylolisthesis.^{6,12,13} Several of the aforementioned causes of stenosis are degenerative processes that may lead to the most common type of LSS: degenerative LSS. It is important for clinicians to understand the pathogenesis of LSS so that they can correlate this with patient symptoms, physical examination findings, and advanced imaging when considering this diagnosis for their patients.

Although the incidence and prevalence of LSS have not been well established, Fraser et al¹⁰ suggested that the prevalence was between 1.7% and 8% in the general population, whereas a report from the United States Agency for Healthcare Research and Quality suggested that 13% to 14% of patients who sought out a spinal specialist for a lower back complaint may have had severe bony stenosis.¹⁴ The incidence of lateral root entrapment has been reported at 8% to 11%.¹⁵ In the Spine Patient Outcomes Research Trial (SPORT), among 368 patients with spinal stenosis, 40% were female, the average age was 63.9 years, 20% had college degrees, and 8% were receiving workers’ compensation for their condition.¹⁶

Amundsen et al¹² determined through a prospective randomized study that the clinical symptoms of LSS, besides usually being insidious in nature, include leg pain (present in 100% of their subjects; bilateral in 42%, unilateral in 58%), lower back pain (95%), sensory disturbances in the leg (70%), and weakness (33%). In addition, this group observed that claudication was present in approximately 91% of their subjects.¹² Patients can describe the leg symptoms as pain, paresthesia, numbness, and/or weakness. These

symptoms are due to the entrapment of lumbosacral nerve roots in the constricted neural canal and foramina. Experimental studies have postulated that the pathogenesis of radiculopathy during neurogenic claudication could be due to the reduction of blood flow and impulse conduction in the compressed nerve roots, but this theory remains speculative. In the SPORT study, the duration of symptoms for patients with LSS at the time of enrollment was 7 to 12 weeks for 3% of the subjects, 3 to 6 months for 39%, 7 to 12 months for 25%, and greater than 1 year for 33% of the subjects.¹⁶

One of the hallmark signs or symptoms of LSS is the appearance of the leg pain with standing; this leg pain is exacerbated by prolonged walking (more specifically, lumbar extension) and relieved by resting in a flexed lumbar spine position.^{17,18} Katz et al¹⁸ assessed the value of the history and physical examination findings in the diagnosis of 93 symptomatic degenerative LSS subjects. The most important history and physical findings were age (>65 years), reporting no pain when seated, exhibiting a wide-based gait, and thigh pain within 30 seconds of performing lumbar extension.¹⁸ Other authors have suggested that tension signs such as a positive Straight Leg Raise test result are not typical, but that sensory findings may follow specific dermatomal distributions in the L5 (91%), S1 (63%), and L1 through L4 areas (28%).¹² More recently, Adamova et al¹⁹ investigated the contributions and limits of the exercise treadmill test and electrophysiologic examination in 92 patients with mild LSS. These authors concluded that the electrophysiologic examination may aid with discriminating between mild LSS and diabetic polyneuropathy, but that its contribution in the verification of neurogenic claudication in LSS patients is limited.¹⁹ The authors also reported that the exercise treadmill test was useful in the confirmation of neurogenic claudication and walking capacity verification, but that caution should be used with restriction of walking capacity due to other medical reasons (dyspnea, vascular claudication, joint complaints, etc).¹⁹

It is important when conducting the history and physical examination of patients with low back pain that chiropractors recognize certain symptoms or patient characteristics that could be indicative of a serious underlying spinal condition or are considered “red flags.” These include, but are not limited to, the following²⁰⁻²⁴:

1. Cancer (risk factors include age >50 years, a previous history of cancer, unexplained weight loss, no relief of pain with bedrest, pain at rest, and pain that is worse at night)
2. Infection (risk factors include immunocompromised states, persistent fever, intravenous drug use, urinary tract infection, skin infections, and increasing age)
3. Cauda equina syndrome (risk factors include progressive neurologic deficit, urinary incontinence or retention, saddle anesthesia, anal sphincter tone decreased or fecal incontinence, and bilateral lower extremity weakness or numbness)
4. Compression fractures (risk factors include increased age, history of trauma, prolonged corticosteroid use, and a history of osteoporosis)
5. Abdominal aortic aneurysm (risk factors include atherosclerotic vascular disease, abdominal pulsating mass, pain at rest, and age >60 years)

For many patients with LSS, particularly atypical or nonclassic cases, diagnosis from history and physical examination alone may prove difficult; so clinicians will often turn to advanced imaging to determine and confirm diagnosis and to help establish prognosis. Radiographic studies may provide useful information that can aid in the diagnosis of complex LSS, in addition to demonstrating the presence of degenerative changes and spondylolisthesis; but in uncomplicated cases, radiographic findings are highly unspecific.²⁵ Radiographs provide health practitioners with a means to assess or visualize the bony elements of the spine.²⁶ Specifically, radiographs may show osteophytes (associated with disk and joint space narrowing) that can produce spinal canal and intervertebral foraminal stenosis, a decreased interpedicular diameter (which can increase the diagnostic sensitivity for intervertebral foraminal stenosis), and spondylolisthesis that can be a common predisposing lesion.²⁶ However, the ability to determine the degree of LSS from radiographs has not been well established; and therefore, clinical guidelines have not been formulated to aid the clinician.²⁶

It is often suggested that, for best neural foramina visualization, a sagittal magnetic resonance imaging (MRI) should be used and that both axial computed tomography (CT) and MRI images are sufficient to visualize the central canal. Bony findings such as facet arthropathy are better visualized on CT, whereas soft tissue pathologies that can cause LSS such as a disk bulge/herniation, ligamentum flavum buckling and/or hypertrophy, and cysts of the facet capsule and ligamentum flavum are best seen on MRI.²⁷ Both CT and MRI can provide information that can be

Table 1 Summary of included articles

Author(s), Year, Study Design	Outcome Measures	Subject(s)	Interventions	Results
DuPriest, 1993, Case Report	VAS, Subjective Symptom Reporting, Ranges of Motion, and Orthopedic Testing.	76-y-old Man With Moderate to Severe Stenosis Confirmed by MRI	Flexion-Distraction MT, Passive Stretching, Massage, Ultrasound, Exercises Including Stretching, Stability and Cardiovascular Exercise, Heel Lift, and ADL Modifications. 12 Treatments Over 3 wk.	VAS Was 7.4/10 Initially and 0/10 After 3 wk of Treatment. 9-y Follow-up Found Patient Still Pain Free.
Snow, 2001, Case Report	10-Point VRS, Subjective Improvement	78-y-old Man With Severe Stenosis on MRI. Baseline Low Back Pain Was Rated 4-5/10, and Leg Pain Was 9/10.	Flexion-Distraction MT of the Lumbar Spine. 4 Treatments in 8 d, Followed by a 22-d Lapse Before the 5th Treatment and Then Weekly Until 5 mo.	After 5 Visits, the Patient No Longer Had Back Pain; and the Leg Pain Was 6-7/10. After 5 mo, the Leg Pain Was 6-7/10; and No Back Pain Was Noted. 80% Improvement Was Reported Subjectively.
Pederick, 2001, Case Report	Subjective Improvement and Clinical Testing (Straight Leg Raise and Palpatory Findings).	45-y-old Man With Moderate to Severe Stenosis Confirmed on MRI.	Therapeutic Ultrasound, Active and Passive Stretching, Spinal MT (Unspecified Technique), Prone Blocking With Manual Traction and Voluntary Sideways Leg Motions. 15 Treatments Over a 22-mo Period.	After 1 Treatment, the Patient Reported No Radiating Leg Pain and Only 1 Instance of Such Pain From the 1st Through 15th Treatments.
Snow and Doobay, 2003, Case Report	VAS, RMDQ, Subjective Reporting of ADL.	58-y-old Woman With Severe Central Canal Stenosis and Bilateral Neural Foramina Stenosis at L3-4	Flexion-Distraction MT of the Lumbar Spine With Decreasing Frequency Over the Course of 9 mo.	All Outcome Measures Showed Improvements; at 9-mo Follow-up, the Patient Reported a Full Resolution of Low Back and Leg Symptoms.
Kirkaldy-Willis and Cassidy, 1985, Case Series	Subjective Change in Pain and Disability Was Independently Assessed Using a 4-Point Scale. 1-and 3-mo Reevaluations Were Performed With Regular 3-mo Examinations Thereafter.	11 Patients With Spinal Stenosis for an Average of 16.9 y	Spinal MT (Likely Diversified Technique). 2 to 3 wk of Daily Treatments.	None of the Patients Had Symptoms Exacerbated by Manipulation. 36% of the Subjects Experienced Clinically Significant Improvements. 46% Saw No Improvement.

Table 1 (continued)

Author(s), Year, Study Design	Outcome Measures	Subject(s)	Interventions	Results
Murphy et al, 2006, Observational Cohort Study	RMDQ, 3-Level NRS, Perceived Improvement. All Outcomes Were Measured at Baseline and Each Reevaluation.	55 Patients; 19 Male and 36 Female. Average Age of 65.2 y Ranging From 32-80. Average Pain Duration of 134.2 wk. 33 Had Lateral Canal or Lateral Recess Stenosis; 28 Had Central Canal Stenosis.	Distraction MT and Neural Mobilization Exercises, Complementary Exercises. 29 Patients Were Taking Medication. Treatment Numbers Ranged From 2-50 (Mean, 13.3).	Both Statistically and Clinically Significant Improvements Were Noted. Average RMDQ Improvement was 5.1 Points. 2/3 Patients Showed Clinically Significant Improvement on the RMDQ, and the Improvement Was Maintained for an Average of 16.5 mo After Treatment Cessation. 2 Patients Required Surgery.

MT, Manipulative therapy; VRS, verbal reporting scale; ADL, activities of daily living; VAS, visual analog scale; RMDQ, Roland-Morris Disability Questionnaire; NRS, numerical rating scale.

indicative of LSS such as a measurement of the midsagittal canal diameter of less than 10 mm, a transverse area of the dural sac of less than 100 mm, a height of the lateral recess not exceeding 3 mm, and a foraminal height not exceeding 15 mm.²⁶ Recently, it has been suggested that the sensitivities of CT and MRI for lumbar stenosis exceed 70%; but this can be misleading considering that more than 20% of asymptomatic and limitation-free individuals older than 60 years may have findings of spinal stenosis on these diagnostic modalities.^{7,28}

The natural history of spinal stenosis generally indicates that, once symptoms have developed, they rarely ameliorate or deteriorate.²⁹ However, symptoms may progress as the etiologic process advances, be that degenerative change or iatrogenic or endogenous causes. Johnsson et al³⁰ followed the course of 32 untreated patients with LSS over an average of 49 months and found that 70% of the patients reported no change in their symptoms, 15% showed improvement, and the remaining 15% reported that their symptoms worsened.

Spinal stenosis is a condition commonly seen by chiropractors. In a large multicenter observational cohort study, as part of the SPORT study, 33% of the 368 subjects with spinal stenosis indicated having chiropractic treatment in the past.¹⁶ The National Board of Chiropractic Examiners reported in their 2005 Job Analysis that, among 2167 American chiropractors surveyed, spinal stenosis/neurogenic claudication was seen at a calculated average rate of 1.6 of 4.³¹ This meant that the average chiropractor surveyed reportedly sees a patient with this condition

“sometimes,” equivalent to 1 to 3 patients with this condition per month. Of the respondents, 7.0% indicated that, in most such cases, they do not treat spinal stenosis patients, whereas 19.2% treat most patients with this condition by themselves, and 73.8% of the respondents manage such patients most of the time.³¹ Among these chiropractors, 49.3% indicated providing a referral for most patients with this diagnosis.³¹ The objective of this review was to review the literature on the use of chiropractic in the treatment of LSS.

Methods

A literature search was conducted on 4 electronic databases (Medline, Index to Chiropractic Literature, Cumulative Index to Nursing and Allied Health Literature, and Allied and Complementary Medicine Database) for clinical research pertaining to chiropractic treatment of LSS. Medical Subject Headings terms were used in the search, consisting of the term *spinal stenosis* in combination with each of the following: *chiropractic*, *spinal manipulation*, *chiropractic manipulation*, and *musculoskeletal manipulations*. To expand the search to include some of the causative agents of spinal stenosis, similar searches were conducted using *degenerative arthritis*, *osteoarthritis*, and *spondylosis* in place of *spinal stenosis*. Inclusion criteria consisted of any clinical study design (including case reports) using chiropractic care (meaning that treatment was rendered by a chiropractor but did not necessarily involve spinal

manipulation) on patients with LSS published in English in the past 25 years (1983 to the third week of June, 2008). Retrieved articles were hand searched for relevant references. Exclusion criteria consisted of articles published in languages other than English that were older than 25 years or that did not involve chiropractic treatment of patients with LSS.

Results

Four single case studies³²⁻³⁵ met the inclusion criteria for this review, as did 1 case series³⁶ and an observational cohort study³⁷ (details on the included studies in Table 1). Two articles deemed eligible for inclusion^{33,38} appeared to pertain to the same case report; and as such, only one³³ was included in the analysis because it represented a complete article, whereas the other³⁸ was an abstract from a platform presentation. There were no randomized controlled trials identified for inclusion in this review, nor were any studies that used other study designs (such as case control studies, etc).

Of the 6 studies included in this analysis, 3 were identified by the Medline search,^{32,33,37} 4 were identified by searching the Index to Chiropractic Literature (as was the additional conference abstract by Snow),^{32-35,38} 2 were identified by searching the Allied and Complementary Medicine Database,^{33,34} and 2 were identified by searching the Cumulative Index to Nursing and Allied Health Literature.^{33,34} An additional article was identified by hand searching,³⁶ as it was mentioned by other included articles.^{33,34} One additional article³⁹ was identified using the expanded search parameters on the Index to Chiropractic Literature; however, it could not be obtained. This was deemed acceptable because it was not referenced by any of the other articles and was an older article from a relatively obscure source.

A total of 70 LSS patients from the 6 studies were treated using some form of chiropractic treatment. Spinal manipulation was used in each, and 4 of the studies^{32,33,35,37} used flexion-distraction manipulation in particular. Other treatments used included neural mobilization, exercise (including stability exercises and cardiovascular exercise), stretching, heel lifts, activity of daily living modifications, prone blocking with manual traction and voluntary sideways leg motions, massage, and therapeutic ultrasound (in 2 studies^{32,34}).

Discussion

Dupriest³² reported on a 76-year-old man with low back and leg pain with moderate to severe lumbar stenosis. Twelve treatments consisting of flexion-distraction manipulation; manual stretching of the thoracolumbar fascia; exercises for the low back, pelvis, and lower extremities; bicycling; progressive ambulation; ultrasound; and a 9-mm heel lift were provided over a 3-week period. Visual analog scale results were reduced from 7.4 of 10 initially to 0. Ranges of motion also demonstrated improvement. Follow-up 9 years after the initial treatments indicated no reoccurrence since discharge.

Snow³³ treated a patient with low back pain and leg pain with severe stenotic changes using modified manual flexion-distraction technique over a 5-month period. The treatments consisted of 15 flexion repetitions at each affected segment at a rate of approximately 4 to 6 seconds per repetition, while limiting flexion of the table to a depth of 10 cm. With improving patient response, the amount of flexion and traction was eventually increased at subsequent visits. On initial assessment, the patient rated his low back pain a 4 to 5 of 10 and his leg pain at 9 of 10. At the fifth visit, the patient no longer experienced any back pain; and his leg pain had subsided to 6 to 7 of 10. At a 5-month follow-up, the patient still had no low back pain and only experienced leg pain rated at 6 to 7 of 10 for short periods of time in the morning. Subjectively, the patient reported an 80% improvement.

Pederick³⁴ reported on a 45-year-old man with moderate to severe stenosis and severe low back pain and leg pain. This patient underwent a series of 15 treatments over a 20-month period. The treatments included ultrasound and stretching, along with adjustments using an unspecified technique. The patient noted no pain in his leg after the first treatment and at the conclusion of the study. There were also improvements on objective tests including postural evaluation, straight leg raise testing, and ambulation.

Snow and Doobay³⁵ reported on a 58-year-old woman with low back pain and MRI-confirmed severe central stenosis and bilateral neural foramina stenosis. Her initial visual analog scale score was 7 of 10, and her initial Roland-Morris Disability Questionnaire score was 11 of 24. The patient was treated with a decreasing frequency over a 9-month period. Continuous improvements in subjective, objective, and functional outcome measures were noted. At a 5-month follow-up, the patient's Roland-Morris score had improved to 1 of 24. At 9 months, there were no

functional restrictions and a complete cessation of low back pain and leg symptoms.

Kirkaldy-Willis and Cassidy³⁶ conducted a case series that reported the results of chiropractic manipulation on 283 patients with a variety of low back pain conditions. Eleven of those patients had central spinal canal stenosis. These 11 patients had an average pain duration of 16.9 years. Each patient was treated daily for 2 to 3 weeks using side posture manipulation to the lumbar spine by an experienced chiropractor. Results were assessed at 1 month and at every 3 months thereafter, with the average length of follow-up being 7 months. Response to treatment was assessed by an independent observer and based on the patient's impression of pain relief and decreased disability via a 4-point graded scale where grade 1 meant that the patient was symptom free with no restrictions for work or other activities; grade 2 meant that the patient demonstrated mild intermittent pain with no restrictions for work or other activities; grade 3 noted that the patient was improved, but restricted in activities by pain; and grade 4 meant that the patient continued to demonstrate constant severe pain and that the disability was unaffected by the treatment. Results were considered clinically significant with a graded response scored as a 1 or 2. After the series of manipulation treatments, 18% of the subjects were rated grade 1, 18% were grade 2, 18% were grade 3, and 46% were grade 4. Thus, 36% of these 11 patients demonstrated clinically significant improvements. No patients' conditions were exacerbated by manipulation.

An observational cohort study performed by Murphy et al³⁷ consisted of 57 patients, although 2 were excluded: one lacked baseline information, and the other did not continue with the study protocol.³⁸ Thus, there were 36 female and 19 male subjects. The mean age of the patients was 65.2 years, the mean duration of symptoms was 134.2 weeks, and the mean number of treatments was 13.3. Imaging was performed on 43 patients, and 44 reached long-term follow-up at an average of 16.5 months. Inclusion criteria consisted of leg pain with or without low back pain; MRI/CT confirmation of lateral canal, lateral recess, or central canal stenosis; clear neurogenic claudication determined from history; treatment being continued until at least 1 reexamination and patient completing the prescribed treatment plan; and the ability to speak English. Exclusion criteria consisted of radiculopathy caused by other factors, symptoms of vascular claudication, systemic illness, contraindications to study treatment, patient being unable to communicate well in English, and workers' compen-

sation injuries/personal injury cases. Treatments for all patients consisted of distraction manipulation, neural mobilization, and exercises for the lumbar spine. Some patients had additional modalities and stabilization exercises incorporated into their treatment plans. Patients were generally seen 2 to 3 times per week for the initial 3 weeks followed by reevaluation, at which time treatment frequency was reduced. Statistically significant and clinically meaningful changes were noted in the mean patient-rated improvements, disability, and pain intensity from baseline to both the end of treatment and long-term follow-up. No major complications were noted by any of the patients, although 2 patients eventually required surgery.

The systematic approach to the literature search and the use of multiple electronic databases were beneficial to the validity of the review, as was the use of hand searching of references. However, the findings of this review are limited by the narrative design used; as such, there was no systematic rating of the retrieved literature. Only 1 language was included in the review, and a 25-year publication limit was imposed. The findings are also limited by the literature itself, as the study designs used were of lower quality (only case series, case reports, and a single group observational cohort study).

Case report, case series, and observational cohort designs as found in this review do not allow for conclusions to be drawn as to the effectiveness of chiropractic treatment of LSS because there are numerous limitations to these designs. The lack of control groups, lack of randomization, and small sample sizes preclude generalizing findings to the spinal stenosis patient population. As such, the placebo effect or the effects of natural history cannot be ruled out. Several of the included studies used nonsystematic subjective outcome measures (such as perceived improvement), which demonstrate lower validity because they can be subject to reporting bias (particularly in case reports where the presence of the treating doctor and author could bias the patient response).

Outcome measure use was inconsistent between the studies, with each study having a unique set of outcome measures. Although there was some overlap in those used, they were never identical between 2 studies. Reporting of additional outcomes and interventions, such as medication use, would have been appropriate in all of the studies. There was also inconsistent timing of reevaluations and follow-ups between the included studies, making it difficult to compare their results.

Only 1 study³² had long-term follow-up after more than 24 months, whereas 2 others^{34,37} had either an average follow-up period or treatment and evaluation period of greater than 1 year. Given the potential chronicity of LSS, long-term follow-up should be used in all future studies to ensure that treatment effects are not merely transient but more long lasting. Three of the studies^{32,34,37} used multimodal treatment plans, making it impossible to determine the effect of any of the included modalities (ie, did one or all of those treatments provide benefit to the patients?); the remaining 3 studies each used only 1 form of manipulative therapy as their treatment (flexion-distraction in the Snow case reports^{33,35} and likely diversified technique in the study by Kirkaldy-Willis and Cassidy³⁶).

The most recently published of the included studies³⁷ had the strongest study design (observational cohort) and the most included subjects to date. In addition, a recent randomized controlled trial using manual physical therapy as one of the interventions by Whitman et al⁴⁰ had a strong study design and showed promising results. However, there is a tremendous need for further clinical research on this topic given the advancing age of the population in the Western world and the likelihood of some members of this population to be affected by LSS. The use of better study designs, ideally with some form of control group and randomization, with increased power will be necessary in future chiropractic clinical research on LSS. Devising a clinical prediction rule for those with LSS who may benefit from chiropractic care is certainly desirable.

Conclusions

To date, only 6 studies—4 case reports, a case series, and an observational cohort study—could be identified pertaining to chiropractic treatment of LSS. These preliminary studies all demonstrated positive results, but the low quality of the designs used precludes definitive conclusions from being made. Further clinical trials using improved research methods are much needed at this point in time.

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