Effectiveness of Multimodal Chiropractic Care

Featuring Spinal Manipulation for Persistent

Spinal Pain Syndrome Following Lumbar Spine

Surgery: Retrospective Chart Review of

31 Adults in Hong Kong

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 OPEN ACCESS

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BACKGROUND The term "persistent spinal pain syndrome type 2" (PSPS-2) has been proposed by the International Association for the Study of Pain to replace the term "failed back surgery syndrome". This retrospective study aimed to evaluate effectiveness of multimodal care featuring chiropractic spinal manipulation (CSMT) in 31 adults in Hong Kong with PSPS-2.

MATERIAL AND METHODS We identified new adult patients with PSPS-2 receiving CSMT from 2016 to 2018. Demographic and clinical data and baseline/follow-up numeric pain rating scale (NPRS) and Oswestry Disability Index (ODI) scores were extracted. Multiple linear regression was used to examine posttreatment NPRS and ODI reduction, with clinical variables as covariates.

RESULTS Of 6,589 patients with low back pain, 31 met criteria (mean age 52.2 ± 13.7 years). Surgeries included laminectomy (81%), discectomy (13%), and fusion (6%). Mean baseline NRPS was 6.6 ± 1.9; ODI was 43.8 ± 15.1%. Patients received CSMT (100%), drop technique (81%), passive modalities (65%), soft tissue manipulation (13%), flexion-distraction (13%), and mechanical traction (13%). Mean posttreatment NPRS was 0.6 ± 1.0; ODI was 2.4 ± 3.3%. All patients had a minimum clinically important difference for NPRS (≥2/10) and ODI (≥30%). One year after treatment, 48% maintained improvement, 42% experienced recurrence; in 10%, follow-up was unavailable. Regression analysis identified younger age, shorter symptom duration, and greater baseline NPRS as predictors of NPRS reduction; and greater baseline ODI as a predictor of ODI reduction (all P<0.05).

CONCLUSIONS Patients with PSPS-2 improved with multimodal care featuring CSMT, which was more effective in patients with younger age, shorter symptom duration, and higher baseline pain or disability levels.

KEYWORDS: Chiropractic, Failed Back Surgery Syndrome, Low Back Pain, Manipulation, Spinal, Musculoskeletal Manipulations

From the FULL TEXT Article:

Background

Persistent spinal pain syndrome (PSPS) is a new term proposed by the International Association for the Study of Pain to define chronic or recurrent pain of spinal origin and replaces older, potentially pejorative terms such as “failed back surgery”. [1–3] PSPS is divided into type 1 (no previous surgery) and type 2 (relevant previous surgery; PSPS-2), which affects 20% to 40% of patients who have had spine surgery. [1] Despite the growing, aging population with PSPS-2, there is no consensus regarding the optimal treatment for this condition. [4] While conservative therapies such as physical therapy, medication, and injections are often recommended instead of revision surgery [4, 5], little research has examined the utility of chiro­practic spinal manipulative therapy (CSMT) for PSPS-2. [6, 7]

Chiropractors are portal-of-entry providers that most often treat low back pain (LBP). [8] The most common treatment that chiropractors utilize is spinal manipulation [8], a form of manual therapy directed at the spinal joints. [9] Spinal ma­nipulation is an evidence-based therapy and is recommended by several practice guidelines for LBP. [10–12] However, few large-scale studies have explored the effectiveness of CSMT for PSPS-2, with the majority of evidence derived from case reports and series. [6, 7, 13]

Patients may seek chiropractic care for PSPS-2 because they are often advised to exhaust all conservative options before re­sorting to a revision spinal surgery, which has a low likelihood of providing relief in many cases. [4, 5] Further, one study found that patients may seek chiropractic care because they prefer to avoid taking prescription medications. [14] Patients also seek chiropractic care because they have a high trust or con­fidence in the chiropractor’s ability to manage back pain. [14]

Several mechanisms of action for CSMT have been pro­posed. [15] Historically, chiropractors provided CSMT with the intention of correcting vertebral misalignment. [16] While investigations have not demonstrated significant changes in bony position after CSMT, newer research suggests that pain relief instead relates to biomechanical and neurological chang­es. [16, 17] Specifically, CSMT may improve intervertebral mo­bility in areas where mobility is reduced, or inhibit nocicep­tive (pain) signaling. [15, 16]

CSMT has several contraindications, including manipulation of the spine in the presence of spinal infection or malignan­cy. [18, 19] Currently, less is known about precautions to CSMT in patients with previous spinal surgery. [7] However, limited evidence suggests that CSMT can be safely administered in this patient population. [6] In addition, while there is limited understanding of the types of CSMT approaches used in PSPS- 2 [7], there is some evidence that chiropractors modify their approach for patients with more complex surgeries, such as fusions. [20] In one survey, chiropractors reported often avoid­ing CSMT in the region of previous lumbar fusion. [20]

The chiropractic examination for patients with PSPS-2 includes taking a medical history and performing a physical examina­tion. [20] This includes conducting orthopedic and neurologic assessments and reviewing available previous imaging. [6, 21] Chiropractors typically examine patients’ range of motion, sen­sory and motor function, and muscle stretch reflexes. [6, 22] Positional or neurodynamic maneuvers, such as the straight leg raise, are also tested. [6, 22] Further, chiropractors typical­ly palpate the spine to assess for intervertebral mobility and/ or tenderness. [23] In the present study, the above procedures were conducted for included patients.

Of the prior research examining the effectiveness of CSMT for PSPS-2, we are aware of 2 studies similar to our present study. These included 54 and 32 patients, respectively. [24, 25] Both studies were limited to patients receiving lumbar flexion-dis­traction (a type of CSMT) alongside other conservative modali­ties, such as exercise. [24, 25] While these studies each reported improvements in patients’ pain severity, changes in low-back related disability were not examined. [24, 25] Accordingly, the present study aims to add to this research by including a more diverse array of CSMT techniques, as well as examining mea­sures of disability in addition to pain.

Therefore, this retrospective study aimed to investigate the effectiveness of CSMT for PSPS-2 in adult patients in Hong Kong, with the hypothesis that those receiving multimodal chiropractic care featuring CSMT would have clinically impor­tant reductions in pain and disability.

Material and Methods

 Study Design

The Ethics Committee of the Chiropractic Doctors Association of Hong Kong approved this study and granted a waiver of informed patient consent (Causeway Bay, Hong Kong; IRB ID: CDA20220611). The study is a retrospective chart review of routinely collected clinical data, and the data query and ab­straction occurred in June 2022.

Convenience sampling was used, which is a strategy that in­volves selecting all available cases within a given time period. [26] This method of sampling was most appropriate for this study, considering it is most applicable in instances of rare con­ditions and smaller expected sample sizes. [27]

 Setting

Patients were evaluated and treated in any of 20 affiliated multidisciplinary chiropractic clinics (New York Chiropractic & Physiotherapy Center, EC Healthcare, Hong Kong) by licensed, for­mally trained chiropractic providers from 2016 through 2018. These clinics are part of a larger healthcare organization (EC Healthcare) that also has neurosurgery and orthopedic departments, which can act as a referral source to the chiropractic clinics. However, patients can also present to chiropractors without an internal or external referral. Chiropractors at these clinics accept insurance, yet many patients ultimately pay out of pocket for treatment.

Although the treating chiropractors in the current study obtained their professional degrees from various institutions, the affili­ated clinics (New York Chiropractic & Physiotherapy Center) re­quire an intensive 3–month training and adherence to a clinical handbook for newly hired chiropractors. As part of this onboard­ing process, each of the chiropractors underwent one-on-one supervised training with the lead investigator of the present study. This fostered some degree of standardization of treat­ments and clinical protocols among the treating chiropractors.

 Data Source

Data was sourced from a customized electronic health records system that encompasses these clinics (CSP, EC Healthcare, Hong Kong) and is searchable by free text query. Data abstrac­tion was conducted by information technology personnel who were blinded to the study hypothesis. Queries of the medi­cal records data was conducted by searching for instances of “spine surgery”, “back surgery”, “fusion”, “laminectomy”, “dis­cectomy”, “lumbar surgery”, and grammatical variants of these terms (eg, discectomies, spinal surgery). Data were abstracted into a Microsoft Excel spreadsheet with pre-defined columns for each data item. Abstracted data were subsequently veri­fied by EC. Free text data extraction was further checked for errors and missing data and was harmonized by RT to a com­mon terminology to enable statistical analysis.

Data regarding potential adverse events was taken from mul­tiple sources, including long-term follow-up data, the larger health records system, which encompasses other medical de­partments’ documentation, including that of neurosurgery, as well as a feedback/questionnaire sent to patients after their visits, which asks about any symptoms they may have had. Recurrence of symptoms was not considered an adverse event.

 Participants

All patients were required to be at least 18 years old and to meet the definition for PSPS-2, having recurrent or persistent chronic LBP and a history of previous lumbar spine surgery. [1] For the purposes of this study, and as defined elsewhere, a minimum symptom duration of 3 months was required for symptoms following lumbar spine surgery. [28]

Patients were required to have treatment with CSMT of any type, including high-velocity, low-amplitude (HVLA), or mobi­lization techniques, such as flexion-distraction. Patients were also required to have initial and follow-up outcome assess­ment forms (Oswestry disability index; ODI).

For the purposes of this study, spinal cord stimulator implan­tation, sacroiliac joint fusion, and ablative procedures, such as radiofrequency ablation, were not considered lumbar spine sur­geries. In addition, patients having only a surgery of the cervi­cal or thoracic spine were excluded. Patients with unavailable surgical details were also excluded. In addition, patients with signs and symptoms of cauda equina syndrome (eg, bowel, bladder dysfunction), spinal metastasis, or acute spinal frac­ture were excluded, as these patients would not be candidates for CSMT and would be referred elsewhere for care.

Figure 1

The electronic health records system was searched during June 2022, and a total of 6,589 patients who presented with LBP at the affiliated clinics during the study time window (January 1, 2016, to December 31, 2018) were identified. Among these patients, 53 reported a history of spine surgery. Thirty-one pa­tients met the inclusion criteria and 22 were excluded (Figure 1).

 Variables

Basic patient information was recorded in a de-identified manner. The patient’s sex and age in years, upon presenta­tion to the chiropractor, was recorded. The patient’s chief con­cerns in addition to LBP were written in free text. In this sys­tem, sciatica was used to denote pain radiating from the low back into the leg, distal to the knee. Comorbidities that met the criteria for the Centers for Medicare and Medicaid defini­tion for Chronic Conditions were extracted from the electron­ic health record. [29]

The primary outcome variable of pain severity was recorded at the initial and final presentation to the chiropractor on an 11–point numeric pain rating scale from 0 to 10, in which 10 is the most severe pain. [30] This value was obtained from a written questionnaire rather than from a verbal assessment of pain. Pain severity was used as a continuous variable in the regression models. A 30% reduction in pain severity, or differ­ence of 2 points, was considered the minimal clinically impor­tant difference (MCID), when comparing to follow-up baseline data, according to a previous standard. [31]

The primary outcome variable of the ODI has been validat­ed for use in patients with back pain and is widely used in research. [32] The ODI was used as a primary outcome in the current study and was obtained at the initial and final chiro­practic visit. [32] ODI is based on the patient’s response to a 10–item written questionnaire, with each question scored from 0 to 5, and is reported as a percentage. [32] In this in­dex a score of 0% to 20% indicates minimal disability; 21% to 40%, moderate disability; 41% to 60%, severe disability; 61% to 80%, crippled; and 81% to 100% is bed-bound or exag­gerating symptoms (range, 0% to 100%). A 30% reduction in ODI was considered the MCID when comparing with baseline data. [31] The ODI raw score was used as a continuous vari­able within the regression models rather than the percentage.

Figures

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The year of the patient’s surgery was rounded to the nearest year to obfuscate exact dates, which can be a patient identifi­er. If the patient had 2 surgeries, the most recent surgery year was utilized for this variable. Surgeries were categorized as a laminectomy (Figure 2), discectomy, fusion, or other descrip­tor, which was extracted from the medical record.

The patient’s duration of LBP was rounded to the nearest year to obfuscate patient identifiers. This variable did not equal the time since surgery, as certain patients had a pain-free interval for years following their surgery. This was used as a continu­ous variable in the regression models.

Chiropractic treatment sessions were typically rendered 2 times per week. While all treatments included CSMT, patients also variously received passive modalities (ultrasound thermo­therapy, electrotherapy, and cryotherapy/thermotherapy), me­chanical spinal traction, or lumbosacral orthotics. Treatment was continued either until the maximum improvement was reached or the patient’s improvement plateaued.

According to a clinic protocol, side posture rotational spinal manipulation for the lumbopelvic region was avoided in pa­tients with PSPS-2 with signs of potential lumbar disc hernia­tion, such as radicular symptoms or imaging evidence of disc displacement. This was a precaution against aggravating dis­cogenic radicular symptoms. In these cases, HVLA CSMT was performed via the aid of a prone drop table technique at the lumbar spine or sacroiliac joint. The drop tables used (vari­ous brands) involve a release mechanism that allows part of the cushioned table to release to a lower position during ma­nipulation and have been suggested to reduce the necessary force used in manipulations (Figure 3). [33] HVLA manipula­tion was avoided altogether in the lumbar region in patients with previous fusion. However, patients with PSPS-2 did have HVLA manipulations in the thoracic and/or cervical spine, away from the site of surgery.

Flexion-distraction is a non-thrust rhythmic mobilization/trac­tion CSMT technique [34], which was applied to the lumbar spine using an automatic table that flexes and extends accord­ing to parameters set by the supervising chiropractor (Chirobot®, Chirotech Innovation Co., Ltd, Taiwan; Figure 4). Mechanical traction is a passive technique, not considered CSMT in the present study, that involves an axial distractive force applied to the spine. [35] In the present study, intermittent mechanical traction was performed with the same equipment for each pa­tient (MID Spine Decompression Device, WIZ Medical, Korea), using a traction force ranging from 30% to 60% of the pa­tient’s body weight according to the patient’s tolerance level and clinician’s judgement (Figure 5). [36] Instrument-assisted soft tissue manipulation was applied with a thin layer of emol­lient on the patient’s lower back and gentle repeated strokes of a massage tool (Strig, Korea; Figure 6).

The duration of CSMT was rounded to the nearest whole number of months. According to a standard clinic procedure, long-term fol­low-up was assessed when a patient was contacted by a person­al health manager employed by the clinic system (EC Healthcare, Hong Kong) at 1 year after the final chiropractic visit. The health manager determined if the patient had maintained their level of improvement or if their symptoms had returned. An adverse event was defined as a serious undesirable outcome beyond transient soreness related to treatment, including exacerbation of neuro­logic deficits or need for urgent surgery following CSMT.

All patients were recommended a set of home exercises; how­ever, the treating chiropractor may have adapted these to each patient’s specific condition. Further, compliance with home ex­ercises was not tracked during care, and therefore, this vari­able was not included as a covariate in the regression models. Typical exercises that were recommended to patients included the quadruped cat-camel, bird-dog exercises, and supine dy­ing bug. [37] These are all considered safe, low-load exercises that focus on spine stability and motor control. [37]

 Statistical Analysis

All statistical analyses were conducted using GNU PSPP Statistical Analysis Software (V.1.0.1). A P value of less than 0.05 was considered statistically significant. Multiple linear regression was utilized, as it allows examination of the rela­tionship between multiple independent variables and a contin­uous treatment outcome. [38] This method was ideal for the current study as NPRS and ODI were continuous variables, and treatment response could depend on several clinical factors.

According to recent research, the minimum required sample size for a multiple linear regression is at least 2 subjects per variable. [39, 40] In designing the regression model, a select number of key covariates were chosen from the available da­taset. This process was guided by previous research on this topic. [7] Our present study included 7 covariates in each re­gression model, which accordingly required at least 14 sub­jects for this method of analysis.

Prior to linear regression, bivariate correlation testing was per­formed using a 2–tailed Pearson correlation matrix to test for multicollinearity between patient age, sex, surgery type, symp­tom duration, baseline NPRS, baseline ODI, and duration of visits. Two pairs of variables had a statistically significant correlation coefficient >0.7, with 1 being the baseline NPRS and baseline ODI raw score (coefficient 0.95, P<0.001). Because the ODI in­corporates other questions about activity of daily living in ad­dition to pain as measured in NPRS, it was not considered to represent unnecessary redundancy and was kept in the regres­sion model. [41] For treatment duration measured in months and number of visits (coefficient 1.00, P<0.001), the months of treatment was excluded from the regression model as this rep­resented unnecessary redundancy. This high correlation was ex­plained as being due to rounding to the nearest month and a relatively uniform treatment frequency among included patients.

Results

 Participants

Table 1

Thirty-one patients, (age 52.2 ± 13.7 years, 17/31 male [55%]), were included in the retrospective analysis (Table 1). All pa­tients had surgery at least 3 months previously, and therefore, no patients were excluded based on this criterion. Although lumbar spine imaging was not a selection criterion, all includ­ed patients either presented having previous post-surgery im­aging or obtained new lumbar spine imaging, including radio­graphs and/or magnetic resonance imaging after presentation.

Four patients did not receive CSMT and were accordingly ex­cluded (mean age 41.0 ± 4.6, 50% male). In each of these 4 cas­es, patients presented to the chiropractor only once, and 1 pa­tient was referred for imaging tests which were not obtained, and 3 patients were referred to a medical specialist for consul­tation for possible epidural spinal injection. Surgeries includ­ed laminectomy (n = 3) and facetectomy (n = 1). These patients had a mean baseline NPRS rating of 9.5 ± 0.5, and mean ODI of 62.5 ± 3.0.

Three patients initially received CSMT but did not have avail­able follow-up NPRS and ODI data and were therefore exclud­ed (mean age 47.7 ± 2.1, 67% male). In 1 case, the chiroprac­tor ordered imaging, which was not obtained, and the patient discontinued care after 2 visits. In the other 2 cases, the rea­son for lack of follow-up was less clear and the patients had only 1 visit each. The surgeries in these 3 excluded patients who initially received CSMT were laminectomy (n = 2) and dis­cectomy (n = 1). The mean NPRS rating was 8.0 ± 0.0, and the mean ODI was 50.7 ± 1.9.

Among the 31 included patients, in addition to LBP, patients often had a chief concern of lower extremity symptoms, includ­ing pain, numbness, weakness, and cramping (28/31, 90%). A minority of patients had LBP as the only symptom (3/31, 10%). The mean duration of symptoms was 3.3 ± 4.4 years. Patients had a mean baseline NRPS of 6.6 ± 1.9, and mean baseline ODI of 43.8 ± 15.1%. The mean interval between lumbar spine sur­gery to chiropractic evaluation was 3.3 ± 4.4 years. The mean symptom duration was 2.6 ± 2.0 years. The most common sur­gery was laminectomy (25/31, 81%; Figure 2), followed by discectomy (4/31, 13%) and fusion (2/31, 6%). Most patients had only 1 surgery (29/31, 94%), while 2 patients had 2 sur­geries each, which in each case was a second laminectomy (2/31, 6%). Twelve patients (38.7%) had comorbid conditions including diabetes, cardiovascular disease, hyperlipidemia, thy­roid disease, and depression.

While all patients received CSMT per the selection criteria, the type of CSMT was further characterized among the oth­er forms of therapy. All patients received HVLA CSMT (31/31, 100%) and home exercise recommendations (31/31, 100%), followed by drop technique CSMT (25/31, 81%), and passive modalities, including ultrasound thermotherapy, electrothera­py, cryotherapy, and thermotherapy (20/31, 65%), instrument-assisted soft tissue manipulation (4/31, 13%), flexion-distrac­tion CSMT (4/31, 13%), and mechanical traction (4/31, 13%). The mean number of chiropractic visits was 21.5 ± 8.7, which occurred over a mean duration of 2.5 ± 1.5 months.

 Outcome Data

All patients experienced improvements in the NPRS and ODI from baseline to the final CSMT visit, and no patients report­ed any serious adverse events. The mean posttreatment NPRS was 0.6 ± 1.0, and ODI was 2.4 ± 3.3%. All patients had a MCID for NPRS (≥2 points) and ODI (≥30%). Seventeen patients (55%) reported posttreatment NPRS and ODI scores of 0, indicating no pain or low back-related disability.

Long-term follow-up analysis at 1 year after treatment iden­tified that 15 of 31 (48%) patients maintained the improve­ments that they attained during care, while 13 of 31 (42%) experienced recurrence symptoms, with a return of their orig­inal symptoms. In 3 of 31 (10%) of patients, 1–year follow-up data was unavailable. Eight of the 17 patients (26% of total pa­tients) who reported complete symptom resolution with CSMT reported continued relief at the 1–year follow-up.

Tables

2 + 3

Multiple linear regression with NPRS as the dependent variable identified that younger age, shorter symptom duration, and greater baseline NPRS were significant predictors of posttreat­ment NPRS reduction with CSMT (Table 2). For every 1 year de­crease in age, the posttreatment NPRS was reduced by b (0.20) with CSMT, so a 10–year reduction in age would correspond with an expected reduction in NPRS of 2 points. For every 1–year de­crease in symptom duration, the follow-up NPRS was reduced by b (0.34) with CSMT (eg, a 10–year reduction in age would corre­spond with 3.4 points reduction in NPRS). Last, for every 1–point increase in baseline NPRS, the posttreatment NPRS was reduced by b (0.67) with CSMT (eg, a 10–point increase or maximum NPRS would correspond with a 6.7–point reduction in NPRS).

Our regression model with ODI raw score as the dependent variable showed that a higher baseline ODI raw score predict­ed a greater improvement in posttreatment ODI after CSMT (Table 3). For every 1–point increase in baseline ODI raw score (which translates to 2% in ODI interpretation), the posttreat­ment ODI raw score was found to be reduced by b (1.12) with CSMT. Effectively, a 10–point increase in baseline ODI would correspond with an 11.2–point reduction in posttreatment ODI. The other predictors did not reach significance in this model.

The adjusted R2value can be used to determine how well the regression models fit the study observations and can range from 0 to 1 (or 0% to 100%). [40] In both of our regression models, the adjusted R2values were high (0.85 for the NPRS outcome, 0.96 for the ODI outcome). This suggests that the regression models were adequately designed and sufficient to examine the main outcomes in our study.

Discussion

In this retrospective chart review, 31 adult patients were iden­tified from chiropractic clinics in Hong Kong who had PSPS-2 and LBP and received multimodal chiropractic care featur­ing CSMT. These patients were typically middle- to older-aged adults and most often had lumbar laminectomy. Patients typ­ically presented with moderate to severe low back and lower extremity symptoms and had a moderate to severe low back-related disability measured by ODI. With several sessions of CSMT, all patients showed improvements in pain and ODI, exceeding MCID for each. At the 1–year follow-up, nearly half maintained their improvement, while the others had recur­rent symptoms or no available follow-up data. Further anal­ysis showed that younger patients and those with a shorter duration of symptoms and higher baseline pain or ODI were more likely to respond positively to CSMT.

The present study represents one of the largest series of pa­tients with PSPS-2 treated with CSMT. From a recent system­atic review and search of PubMed for other studies on June 16, 2022, we found 2 studies of a similar size which were also retrospective in design and examined patients receiving multi­modal care featuring flexion-distraction CSMT for PSPS-2. One of these studies, including 54 patients, found similar results to our chart review, as the majority of patients (81%) experienced MCID for pain relief. [24] The other similar study, including 32 patients, also found an MCID in pain relief, yet also noted that patients with combined types of surgery, such as discectomy-laminectomy, had greater improvements in pain. [25]

There are several differences between the present study and these 2 previously published large studies on CSMT and PSPS-2. [24, 25] One major difference is the high prevalence of lam­inectomy in the present study, whereas the previous studies reported that discectomy was the most common type of sur­gery. [24, 25] Another difference is that the previous studies mostly or exclusively used flexion-distraction CSMT [24, 25], whereas in the present study, patients typically received drop table lumbopelvic manipulation and HVLA manipulation else­where in the spine, and flexion-distraction was used less fre­quently. However, it is possible that the difference in surgery types accounted for the different CSMT approaches. Another difference is that the present study identified a mean MCID for both pain and low back-related disability, whereas previ­ous studies examined the main outcome of pain only. [24, 25]

The results of the present study add to the understanding that patients are more likely to improve with multimodal conservative care featuring CSMT. Two previous studies that included patients without previous surgery found that a shorter duration of LBP increased the odds of recovery with CSMT. [42, 43] However, in 1 of the studies, baseline NPRS and ODI were not significantly associated with odds of improvement with CSMT. [42] Although this differs from the results of the present study, this may be explained by differences in patient population, since our study included only patients with PSPS-2.

Future research should expand on the present study. A ran­domized controlled trial is needed to account for many of the confounding sources in the present retrospective study. Several designs could be used in which other therapies, such as phys­ical therapy or medication, could be used in a control group. In addition, health services research designs could enable an examination of the long-term associations of CSMT for PSPS-2, with regards to the likelihood of revision surgery, utilization of pain medications, and cost-effectiveness of CSMT compared with that other treatment pathways.

 Limitations

The present study had several limitations. First, as it was ret­rospective in nature, data identified from the medical record could be inaccurate, missing, or subject to patients’ recall bias. Second, without a control group to account for the natural his­tory and progression of PSPS-2, we cannot conclude that the positive treatment response was caused by CSMT. Third, we did not examine several other important outcomes, such as cost effectiveness, medication utilization, and quality of life, which could provide broader measures of effectiveness. Fourth, the results may not be generalizable as our study population had a high rate of laminectomy, differing from the study popula­tions of other studies of CSMT for PSPS-2 [24, 25], which could be explained by a difference in preferences among surgeons in Asia versus those in other regions. [44] Laminectomies are less complex surgeries than fusions [45]; therefore, this dif­ference could account for some of the observed positive treat­ment response. Fifth, there were 2 patients that dropped out of care for unknown reasons after a single visit. It is possible that these patients dropped out of care because of financial or other reasons; however, had they not responded to CSMT, their results could have slightly influenced our overall results. Sixth, the sample size of this study was sufficient to conduct a basic descriptive analysis and utilize regression models with a select number of key covariates. However, a larger sample would allow us to explore the effect of additional variables on treatment outcome. These might include comorbidities, pain distribution, time interval since lumbar surgery, imaging find­ings, and the specific treatments patients received. [7] Further, additional predictor variables could reach statistical signifi­cance with a larger population.

Seventh, given patients received a variety of treatments in ad­dition to CSMT, it is unclear if the observed results were relat­ed to CSMT alone or to other added therapies. A larger sam­ple and/or prospective design would allow us to either control for these additional therapies or standardize the treatment ap­proach. Finally, although the chiropractors in this study had similar training and similar equipment and adhered to the same clinic protocols, there was likely some variation between the CSMT and other care administered by each chiropractor. Previous studies have shown that forces delivered with manip­ulation can vary according to practitioner body mass or patient positioning. [46] Therefore, it is unclear if provider or treatment-related differences played a role in the observed outcomes. The treatment protocols could be more standardized in a pro­spective trial on this topic to reduce this confounding source.

Conclusions

We found that adult patients with PSPS-2 showed improve­ment with multimodal chiropractic care featuring CSMT, which was more effective in patients who were younger, had a short­er duration of symptoms, and/or had a higher level of pain or disability before treatment.

Declaration of Figures’ Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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