Spinal manual therapy interventions for pediatric patients: a systematic review

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Objective: Although much has been written about the efficacy of manual therapy interventions for adults with headaches or spinal pain, little research has focused on the use of these interventions in pediatric patients. The purpose of this systematic review was to evaluate the evidence for spinal manual therapy (SMT) interventions in patients 4–17 years old with headaches and/or mechanical spinal pain.

Methods: A search for relevant studies published in the past 15 years was conducted on MEDLINE, CINAHL, Cochrane Central Register of Randomized Control Trials, PEDro, PubMed, and Sports Discus. Only English language articles were reviewed. Studies had to include at least one outcome measure for pain, function, or quality of life. Studies evaluating post-operative interventions, or those in which the interventions were directed at influencing excessive spinal curvatures, were excluded. Case reports and studies that did not limit analysis of the results to the pediatric population were also excluded.

Results: Two randomized control trials and two studies offering lower levels of evidence were identified in the literature search. The latter studies were prospective cohort studies. The four studies were evaluated using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) criteria.

Discussion: There are very little data in the literature to support or refute the use of SMT interventions in pediatric patients. Further research is required to establish a strong evidence-based foundation for use of these interventions in children.

Keywords: Pediatrics, Systematic review, Spine, Manipulation, Headaches

Introduction

Spinal manual therapy (SMT) has been shown to have a positive, short-term influence on adult patients with spinal pain and/or headaches.^{1–3} However, it is not clear if the use of SMT in children and adolescents produces similar outcomes. This is an important consideration given the prevalence of painful spinal conditions and headaches in this population. For example, Balague and Nordin⁴ reported that one-third of young people entering adulthood have already experienced disabling back pain, while Hayden *et al.*⁵ reported that 15% of children experience frequent or continual low back pain (LBP). Laurell and Larsson⁶ reported that headaches are the most common pain complaint in children and adolescents and that the frequency of such reports is increasing. Noting that 5–10% of chiropractic patients are children and adolescents with complaints of spinal pain, Vallone *et al.*⁷ and Hestbaek and Stochkendahl⁸ called for a systematic investigation of the efficiency of manipulation for musculoskeletal pathologies in pediatric patients. Finally, Clifford and Fritz⁹ pointed out that

extrapolating the results of studies of adult patients with LBP to pediatric patients may lead to the potentially erroneous assumption that children's and adolescents' spinal pain can be managed in the same manner as that of adults.

In light of the above-noted concerns, the purpose of this systematic review was to evaluate the efficacy of SMT in children and adolescents with spinal pain and/or headaches. In this review, SMT was defined as mobilization (low-velocity joint glides or distraction), manipulation (high-velocity joint glides or distraction), massage, muscle energy technique, or soft tissue mobilization (including trigger point therapy, myofascial release, or similarly applied techniques). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)¹⁰ guidelines were used to plan and execute this systematic review.

Clinical research question

The following clinical research question was formulated using a PICO (Patient/Population, Intervention, Comparison and Outcome) model. In children and adolescents 4–17 years of age with spinal pain and/or headaches of mechanical origin (P), is the inclusion of SMT (I) superior to interventions without an SMT

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component (C) when the interventions are assessed by an objective outcome measure (O)?

Methods

Literature search strategies

Two of the authors (DV and RS) did independent searches on MEDLINE, CINAHL, Cochrane Central Register of Randomized Control Trials, PEDro, PubMed, and Sports Discus for clinical studies where manual therapy interventions were used as a component of treatment for pediatric patients with primary complaints of spinal pain and/or headaches. Systematic Reviews (SRs) and Randomized Control Trials (RCTs) were the focus of the search as such studies are considered to provide the highest level of evidence.¹¹ The search was limited to articles published in the past 15 years in order to capture the most current evidence. The literature search concluded on 31 October 2011.

Inclusion for review

The search terms used to capture relevant articles for this systematic review were: physical therapy, physiotherapy, chiropractic, osteopathy, manual therapy, mobilization, manipulation, muscle energy technique, massage, children, adolescents, back pain, neck pain, and headaches. Key words and MeSH headings were combined in multiple ways to extract as many relevant articles as possible from the literature. In addition, the authors examined relevant references in retrieved articles.

Studies included in the review were those that addressed the PICO question in terms of the age of the subjects (4–17 years), diagnosis (spinal pain and/or headaches of mechanical origin), intervention (SMT), and use of an objective outcome measure. While it was originally intended that the systematic review would be limited to RCTs, the void in the literature was greater than anticipated and necessitated the inclusion of studies offering lower levels of evidence.

Excluded studies

Studies were excluded if the intent of the manual interventions was to influence excesses in spinal curvature, unless that patient presentation was attributable to an acute or subacute mechanical dysfunction. Studies addressing pain of visceral origin or non-musculoskeletal pathologies (e.g. asthma) were also excluded. Case studies or studies that addressed post-operative management of spinal pain in pediatric patients were excluded. Studies that included any adult patients were also excluded, unless that study had a separate data analysis for the pediatric patients in the study.

Review process

Each article produced by the literature searches was evaluated by its title for potential relevance to the

review. If the title suggested that the article might meet the inclusion criteria, its abstract was reviewed. If there was any doubt concerning an article's relevance, the original article was obtained and assessed by the authors. The authors were intent on finding articles that reported specific outcome measures, notably ones that conveyed measures of pain, function, and/or disability changes.

The review team consisted of three physical therapists (DV, LK, and CS) and a second-year physical therapist student (RS). The lead author (DV) is a Fellow in the American Academy of Orthopedic Manual Physical Therapists and has more than 30 years of clinical practice and teaching experience. The other physical therapists (LK and CS) are certified clinical specialists by the American Board of Physical Therapy Specialties (ABPTS) in Pediatrics and Orthopedics, respectively. DV, LK, and CS are instructors in the entry-level doctor of physical therapy program at Grand Valley State University.

Using the GRADE (Grading of Recommendations Assessment, Development and Evaluation)¹² criteria, the four articles selected for final review were individually evaluated by three of the authors (DV, LK, and CS) to determine the quality of the methods and strength of the recommendations from each individual study. The qualitative assessments of the reviewed articles are summarized in column K (Table 1). The extent to which the reported outcomes may be used to guide decision-making in clinical practice are shown in column L (Table 1). For all four articles reviewed, the qualitative assessment rendered the strength of the recommendations to a status of 'uncertain'. Pragmatically, this means that the outcomes reported in each of these four studies should not guide clinical decision-making. As described by Brozek *et al.*,¹³ 'very low' quality makes 'any estimate of effect very uncertain.'

The potential for research bias was considered using the assessment recommended by the Cochrane Collaboration.¹⁴ In order for a study to be rated as low risk for bias, none of the six domains (randomization, allocation concealment, blinding of participants and personnel, incomplete outcome data, selective outcome reporting, 'other') of the Cochrane Collaboration¹⁴ could be rated as 'no' and no more than two of the domains could be rated as 'unclear'. Moderate-risk and high-risk classifications were established when a study had one and two, respectively, high risk of bias criterion measures as established by the Cochrane Collaboration.¹⁴

Results

The search strategy produced 870 potential articles (Fig. 1). Of these, approximately one-half (425) were duplicative. This reduced the number of potential

Table 1 GRADE analysis of studies accepted for review

Quality assessment					Summary of findings						
A	B	C	D	E	F	G	H	I	J	K ²⁴	L
1	RCT ¹⁶ Cervicogenic HA (SMT versus placebo)	Yes	Yes	Indirect	Imprecise	Low risk	28	28	Headache intensity (pre-to-post VAS mean ± SD): <i>R</i> _x group: 4.3 (1.6) to 4.0 (1.8); <i>P</i> =0.42 Sham group: 4.9 (1.8) to 5.0 (1.8); <i>P</i> =0.42	Very low ○○○○	Any estimate of effect is uncertain ¹³
1	RCT ¹⁵ LBP (Individualized PT with SMT versus group PT with no SMT) Prospective cohort ⁵	Yes	Yes	Indirect	Imprecise	Moderate risk	23	22	Roland Morris Questionnaire (pre-to-post means): <i>R</i> _x group: 6.5 to 1.9 Control group: 5.4 to 2.7; <i>P</i> =0.016	Very low ○○○○	Any estimate of effect is uncertain ¹³
1	LBP (SMT)	Yes	Yes	Indirect	Imprecise	High risk	54	0	Pediatric Visual Analogue Scale: 81.4% reported minimal detectable improvement (of 20%)	Very low ○○○○	Any estimate of effect is uncertain ¹³
1	Prospective cohort ¹⁷ Tension type HA (Myofascial trigger point therapy)	Yes	Yes	Direct	Imprecise	High risk	9	0	53.7% had an 'important improvement' Headache frequency, duration, and intensity: Reduced by 67.7, 77.3, and 74.3%, respectively	Very low ○○ + ○	Any estimate of effect is uncertain ¹³

Note: A = number of studies; B = design; C = limitations; D = inconsistency; E = directness; F = imprecision; G = publication bias; H = number of patients treated; I = number of controls; J = absolute effect and 95% CI; K = quality; L = recommendation. ○ indicates a -1 value for column C, D, E, or F; + indicates a +1 value for column C, D, E, or F.

Figure 1 Flow diagram for article identification, screening, and selection.

articles to 445. One additional study was identified in a search of the reference list of one of the articles retrieved for further analysis. Of these 446 studies, the lead author reduced the number of potentially qualified studies to 56 based on an examination of the studies' titles and/or abstracts. In the majority of cases, studies that were eliminated were found to have examined the influence of manual therapy interventions on adults only or included pediatric patients without a separate data analysis for the pediatric subgroup. The latter scenario eliminated the possibility that outcomes could be stratified to the pediatric population. The lead author retrieved these 56 potentially qualified articles to assess their individual relevance. In a vast majority of those articles, it was not possible to discern the age group studied based on the title and abstract alone. However, upon full review of the articles, most (52) were excluded by virtue of being a study on an adult population or a mixed group of adults and pediatric patients without a pediatric subgroup analysis. Others were excluded because there were surgical interventions involved or because the article was a description of medical management of pediatric patients with the relevant diagnoses. Of the four remaining articles,^{5,15–17} only two were RCTs that reflected all of the elements of the PICO question.^{15,16} Two prospective cohort studies that contained the major elements of the

PICO question were also identified.^{5,17} Table 1 presents the results of the GRADE¹² quality analysis of the four studies included in the systematic review. The authors (DV, LK, and CS) had perfect agreement ($k=1.0$) on the GRADE scoring criteria for each of the four studies included in this review.

Available evidence

The heterogeneity of the studies, in terms of design, diagnostic entities evaluated, and the outcome measures used, did not permit a meta-analysis of the outcomes from the SMT interventions. Therefore, a summary of the four individual studies is presented below.

RCTs

Of the four studies included in the final review, only the two RCTs^{15,16} attempted a direct comparison of SMT to control. The study by Borusiak *et al.*¹⁶ included 56 subjects ages 9–13 years with cervicogenic headache and compared the use of a side bending thrust directed at the cervical spine to a similarly directed sham 'manipulation' in which a high velocity, low amplitude thrust was not used. Fifty-two subjects were included in the analysis (28 sham and 24 SMT group). Neither group's intervention was described in sufficient detail to permit replication. The authors compared the two groups' mean values of the percentage of days with headaches, total duration of the headaches (hours), percentage of days missing school with headaches, percentage of days where analgesics were required, and intensity of headaches. A comparison of the means and standard deviations of the intensity and frequency data produced the following:

1. intensity (VAS score):
 - pre-to-post intervention (mean $\pm$ SD): placebo, 4.9 ± 1.8 to 5.0 ± 1.8 ($P=0.42$);
 - pre-to-post intervention (mean $\pm$ SD): SMT, 4.3 ± 1.6 and 4.0 ± 1.8 ($P=0.42$);
2. frequency (%) of days with headache:
 - pre-to-post intervention (mean $\pm$ SD): placebo, 41.2 ± 28.5 to 31.8 ± 28.3 ($P=0.009$);
 - pre-to-post-intervention (mean $\pm$ SD): SMT, 40.4 ± 28.3 and 30.7 ± 32.9 ($P=0.027$).¹⁶

The trial was stopped when an interim analysis of the data showed a greater than anticipated variation in headache intensity and frequency that would have necessitated a 10-fold increase in the number of subjects needed to sufficiently power the study. In the interim analysis, the groups did not differ to a statistically significant extent in terms of headache frequency. In the end, the study was flawed by its sample size which, according to the authors, led to the distinct possibility of a type II error.¹⁶ Using the assessment recommended by the Cochrane Collaboration,¹⁴ the study by Borusiak *et al.*¹⁶ was assessed to have a low risk for bias. However, in view of the limitations of this study, it does not offer

adequate support for the use of SMT to address cervicogenic headaches in a pediatric population.

In the study by Ahlquist *et al.*¹⁵ on LBP in 45 subjects ages 12–18 years, the evaluation of the influence of SMT was not as clear as in the study by Borusiak *et al.*¹⁶ In the study by Ahlquist *et al.*,¹⁵ the experimental group's available interventions included possible use of SMT, but the decision to use those techniques was left to the discretion of the therapist. Furthermore, the percentage of subjects in the experimental group who actually received SMT is not provided. Both the experimental and control groups demonstrated improvements in pain and functional outcome measures; those are reflected below:

- Roland Morris score mean (SD) change [pre-to-post intervention: control: -2.73; experimental: -4.56 ($P=.016$)]
- VAS mean score mean (SD) change [pre-to-post intervention: control: -3.33; experimental: -3.83 ($P=$ 'NS', as reported by the authors)].¹⁵

The major flaw in this study, however, as acknowledged by the authors, was that the experimental group received considerable face-to-face time that was not afforded to the control group over the 12 weeks of the study. This introduces the possibility of a Hawthorne effect in favor of the experimental group. Given the lack of concealment plus the influence of the Hawthorne effect, the study by Ahlquist *et al.*¹⁵ was rated at a moderate risk for bias using the assessment recommended by the Cochrane Collaboration.¹⁴ Despite the fact that the study by Ahlquist *et al.*¹⁵ is an RCT (level 1b on the Oxford Centre for Evidence-based Medicine Levels of Evidence),¹¹ the study provides very weak evidence for SMT as a complementary intervention in managing pediatric patients with LBP. However, the study does not provide evidence to support SMT as a stand-alone intervention for this population.

Prospective cohort studies

The study by Hayden *et al.*⁵ was also complicated by the use of multiple interventions. This prospective cohort study examined the outcomes of 15 Canadian chiropractors' interventions on 54 pediatric LBP patients with a mean age of 13.1 years. In this study, the patients who received forms of intervention other than manipulation represented only 7.7% (4–5 patients) of the 56 included in the study. The outcomes of these 4–5 patients, however, were not removed from subsequent data analysis. 'Favorable' outcomes on the pain inventories were reported in this study. This cohort study is a level 4 in the Oxford Centre levels of evidence.¹¹ The study's relatively small sample size, in conjunction with its design, provides no basis for a statement about cause and effect of the intervention, as noted by the authors. Furthermore, it was felt that

this study had notable potential for bias since the majority of participants in this study, as well as one of the study's authors, graduated from the same chiropractic college. In addition, there was no randomization or blinding.

Pilot study

The pilot study by von Stulpnagel *et al.*¹⁷ examined trigger point management of nine children with tension-type headaches. This case series is level 4 evidence on the Oxford Centre's hierarchy.¹¹ The study was included in this systematic review as it was one of a very small collection of articles that met all of the inclusion/exclusion criteria for review. The subjects in this pilot study were nine girls, ages 5–15 years. They received an average of 6.5 treatment sessions, which involved manual therapy in the form of trigger point releases and local stretching (active and passive). Improvements in headache frequency (67.7%) and intensity (74.3%) were found. These findings can only be described as weak and very preliminary evidence for manual trigger point releases in this patient population. Based on the Cochrane Collaboration¹⁴ criteria, there is significant risk for bias due to the lack of randomization, blinding, and allocation concealment.

Discussion

The objective of this systematic review was to determine if there is evidence to support the utilization of SMT in a pediatric population with spinal pain and/or headaches. Only four studies met the inclusion/exclusion criteria for the review. All of the included studies offered some form of outcome measure and all were studies exclusively of the pediatric population. Many studies assessed for relevance but ultimately omitted from this review used manual, spinal techniques, but not exclusively to pediatric patients.

It is apparent, from this systematic review of the literature, that there is almost no research available to inform the practice of SMT in pediatric patients. The four studies that met the criteria for review did not produce sufficient meaningful evidence to support mobilization, manipulation, soft tissue, or myofascial interventions for children with mechanical spinal pain and/or headaches. These four studies were fraught with methodological concerns. In addition, the studies were dispersed across only two diagnostic areas of interest (two headache, two LBP). There were no relevant articles on the thoracic or cervical spine gleaned from the literature search that met the criteria for inclusion. The application of the GRADE criteria¹² and the assessment for bias¹⁴ in the four eligible studies render the limited available evidence to a qualitatively unusable status. Inasmuch, the PICO question used to direct this systematic review

remains unanswerable in the context of the quality of evidence in the literature.

Fritz *et al.*¹⁸ highlighted the importance of subgrouping patients with LBP into treatment subgroups (treatment-based classification, TBC) as a research priority and as a mechanism for improving clinical outcomes. That same commentary highlighted the progress that had been made with development of the TBC system in the past decade. However, there appears to be no such classification system for conservative management of pediatric patients with LBP, or any other regional spinal pain disorder. As noted earlier, an inherent risk of this situation is that manual therapy practitioners might assume that the adult TBC system may be extrapolated to include pediatric spinal pain conditions.⁹ It is conceivable, if not likely, that this assumption may be erroneous and result in suboptimum treatment outcomes if applied. It may also explain why the study by Borusiak *et al.*¹⁶ failed to demonstrate a meaningful difference in the treatment of patients with cervicogenic headaches.

The paucity of literature in the realm of manual therapy for pediatric patients should serve as notice to practitioners of physical therapy, chiropractic, and osteopathic manual medicine that significant resources and effort should be devoted to developing quality research endeavors for the pediatric population. Patient safety is an obvious and compelling concern for additional research. Although not systematically assessed in this review, it is probable that current practice patterns utilizing SMT in pediatric patients poses no greater risk of adverse events than in adults when proper screening and treatment procedures are applied. It appears that a significant number of pediatric patients are already receiving manual interventions as ‘aggressive’ as spinal manipulation for both musculoskeletal and non-musculoskeletal diagnoses on a regular basis.^{19–22} However, as noted by Vohra *et al.*,²³ neither causation nor incidence of adverse events can be inferred from observational data, which is all that is available in the literature to date. If future studies are to be undertaken, it is imperative that they be sufficiently powered and have well-conceived methodologies.

Limitations

The study was limited to articles in the English language and those published within the last 15 years. In addition, it is plausible that, given the number of ‘hits’ in the multiple searches conducted in this review, there is some risk that a relevant article was inadvertently missed.

Conclusion

The four studies appraised in this systematic review were not of sufficient quality to either support or

refute the practice of SMT in pediatric patients with spinal pain and/or headaches. If specialists in manual therapy are to provide evidence-based interventions for this patient population, it is essential that resources and effort be immediately directed to research the influence of SMT on pediatric patients.

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