Manual Therapy and Cerebral Palsy: A Narrative Literature Review

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ABSTRACT

Objective: The purpose of this paper was to collect and review articles to determine the effectiveness of manual therapy for the treatment of cerebral palsy. This exploration of such a diverse topic would help to synthesize the body of evidence available to practitioners of manual therapy-based disciplines.

Methods: A systematic search was performed to identify literature related to manual therapy and cerebral palsy symptoms. For potential inclusion, articles must have been published in a peer-reviewed journal. Database access was provided by Palmer College of Chiropractic and included: Index to Chiropractic Literature, Alt Health watch, MEDLINE Complete, CINAHL Complete, Academic search primer, Information Science and Technology Abstracts, EBSCO host, Dynamed, and PubMed.

Results: The current level of evidence in the literature, while overall positive, is limited and inconclusive due to complications of small study sample size, mixed results across techniques, and multiple trials consisting of mainly pilot studies. The findings of this review are consistent with reviews that had evaluated portions of the investigated topic.
**Conclusion:** While the studies in this review outline the prospective benefits of manual therapy on visceral function and management of spasticity, the results were complicated by study limitations. Further inquiry into the effectiveness of manual therapy techniques including joint manipulation, tissue mobilization, and diaphragmatic stretching techniques should be conducted in larger studies to determine the replicability of the observed optimistic therapy effects.

**Key Words:** cerebral palsy, spasticity, manual therapy, manipulation, visceral function.

**INTRODUCTION**

The purpose of this project was to collect and review articles to determine the effectiveness of manual therapy for the treatment of cerebral palsy. The exploration of such a diverse topic would allow for practitioners of manual therapy-based disciplines to have a synthesized review to inform clinical decision making. An examination of the current published literature around the effectiveness of manual therapy as a treatment for individuals with cerebral palsy was conducted.

Cerebral palsy is a neurodevelopmental disorder involving abnormalities in muscle tone and motor function due to damaged cerebral tissue in development and is not a single disease but rather a heterogeneous clinical syndrome. Cerebral palsy is the most common physical disability of childhood, occurring in 1 out of 323 children in the United States. Despite nonprogressive neurological deficits, the prognosis varies depending on severity of impairment, birth weight, and socioeconomic status. Due to the incurable nature of this condition the overall goal of clinical management of cerebral palsy is to improve function, participation, and mobility while reducing complaints of limitations and pain. The significance of this project is to evaluate the current literature on management of cerebral palsy through utilization of manual therapy.

The current healthcare model calls for an optimum team which includes “a primary care physician experienced in neurological rehabilitation, a psychologist, a physical therapist, an occupational therapist, a speech therapist, a social worker, and a schoolteacher” to provide high quality patient care. Encompassing a wide-range of techniques, manual therapy has been defined as “physical treatments used by physiotherapists, chiropractors, osteopaths, and other practitioners” for the treatment of musculoskeletal disabilities and pain. Commonly included under this umbrella term are techniques such as “massage therapy, joint mobilization, and manipulation”. If a manual therapy specific treatment is shown to have a positive impact on patient outcomes, it could provide the opportunity for manual therapy to play a valuable role in the management of cerebral palsy. It would be beneficial to have a collection of current literature to examine the potential that manual therapy has in a treatment plan for cerebral palsy.
METHODS

A systematic search was performed to identify literature related to manual therapy and cerebral palsy symptoms. For potential inclusion, articles must have been published in a peer-reviewed journal. Database access was provided by Palmer College of Chiropractic and utilized the databases listed in Table 1. The search terms utilized, along with the associated MESH IDs are listed in Table 2. The compiled research used for this review consisted of randomized clinical trials and controlled clinical trials. An additional requirement for inclusion was the reviewed literature must include an aspect of manual therapy. The treatment effect of manual therapy techniques was evaluated using outcome measures quantifying quality of life changes such as the Gross Motor Function Measures (66 item or 88 item),\(^5\)\(^-\)\(^8\) Timed up and Go (TUG),\(^9\) Peabody Gross Motor scale,\(^10\) and the Visual Analogue Scale.\(^6\)\(^,\)\(^11\)\(^-\)\(^13\) Clinical evaluations such as Center of Pressure (COP) displacement,\(^9\) Spirometry,\(^14\)\(^,\)\(^15\) musculoskeletal ultrasound,\(^14\) and the “Neuroflexor”\(^16\) spasticity measuring device were used as objective measures in clinical evaluation. These measures have been shown to be valid and reliable for evaluation of functional performance in individuals with cerebral palsy. Articles used were selected based on the use of manual therapy specifically for cerebral palsy with the intention to decrease symptoms or improve functional ability. All additional treatment interventions to manual therapy were noted to ensure that outcomes were reflective of the effects of manual therapy. Additionally, supplemental treatment interventions or medications the patient was taking were recorded. This review did not require human subject considerations as it consisted only of a search of the current body of literature. The inclusion and exclusion criteria below were used to determine what studies were included in this review.

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<th>Table 1</th>
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<td>(Databases searched 1980-February 2021)</td>
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<td>- Index to Chiropractic Literature</td>
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<td>- Hand Searching for articles</td>
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<tr>
<td>- Cerebral Palsy: MeSH Unique ID: D002547</td>
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<td>- Spinal Manipulation: MeSH Unique ID: D020393</td>
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<td>- Manual Therapy: MeSH Unique ID: D026201</td>
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<td>- Manipulation, chiropractic: MeSH Unique ID: D026882</td>
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<td>- Muscle spasticity: MeSH Unique ID: D009128</td>
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<td>- Quality of life: MeSH Unique ID: D011788</td>
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Inclusion Criteria:
- The study must be peer reviewed
- Treatment must include manual therapy as a primary treatment
- Treatment effect must be examined with an applicable outcome assessment tool
- Study must be a randomized controlled trial or clinical trial
Exclusion Criteria:
- Unrelated to cerebral palsy
- No manual therapy component
- Incomplete study

Figure 1: Inclusion/Exclusion Flow Chart

Table 4: Evidence Table

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<th>Reference</th>
<th>Study Design</th>
<th>Group Compared to</th>
<th>Results</th>
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<tr>
<td>Bennett et al. 2021</td>
<td>Randomized crossover design</td>
<td>Experimental (n = 27) vs. control (n = 22)</td>
<td>The dorsiflexion ROM, TUG, and 10-m walk test significantly increased in the ankle mobilization group compared to the control group. Ankle joint mobilization can be performed 5 minutes postintervention.</td>
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<tr>
<td>Kachmar et al. 2018</td>
<td>Randomized Control Trial</td>
<td>Experimental (n = 22) vs. control (n = 20)</td>
<td>The outcome variables were evaluated using the Gross Motor Function Classification Measure 66, and the control intervention (play). Half of the children underwent play followed by manual diaphragmatic stretching technique and the other half in the reverse order. The MDST significantly increased the percent predicted FVC (M = 86.37%, SD = 26.22%), when compared to pre-treatment (M = 81.81%, SD = 24.56%, t(26) = 2.112, p &lt; 0.001). There was also a significant increase in time (M = 103.77%, SD = 11.50%) when compared to pre-treatment (M = 100.00%, SD = 11.00%, t(26) = 2.112, p &lt; 0.001).</td>
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<tr>
<td>Hansen et al. 2012</td>
<td>Randomized crossover design</td>
<td>Experimental (n = 27) vs. control (n = 22)</td>
<td>The outcome variables were evaluated using the Gross Motor Function Classification Measure 66, and the control intervention (play). Half of the children underwent play followed by manual diaphragmatic stretching technique and the other half in the reverse order. The MDST significantly increased the percent predicted FVC (M = 86.37%, SD = 26.22%), when compared to pre-treatment (M = 81.81%, SD = 24.56%, t(26) = 2.112, p &lt; 0.001). There was also a significant increase in time (M = 103.77%, SD = 11.50%) when compared to pre-treatment (M = 100.00%, SD = 11.00%, t(26) = 2.112, p &lt; 0.001).</td>
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RESULTS

The literature search identified 860 articles and 87 potentially relevant studies were reviewed. After evaluation, 11 articles met the requirements for inclusion and were included in the final analysis. The included studies are summarized in Table 4 below.
Research found regarding the effect of manual therapy on patient outcomes in individuals with cerebral palsy, was included in this review regardless of positive or negative outcomes. While most of the research evaluated the effect of manual therapy techniques on spasticity and motor function, three studies evaluated the use of manual therapy as treatment of visceral limitations such as constipation and depressed pulmonary function. Bennet et al utilized manual diaphragmatic stretching technique (MDST) in children with cerebral palsy. This technique was hypothesized to stretch diaphragmatic muscles and improve chest wall expansion while also potentially activating the muscle spindle and Golgi tendon organ of the diaphragm, thus improving its contraction ability. In this study, the intervention group received 18 treatments of MDST and standard physiotherapy while the control group received only standard physiotherapy. Physiotherapy consisted of mat activities, stretching.
exercises, balance training, range of motion exercises, and neuro-developmental training for 40 minutes per day, three days per week, for six weeks. Results showed a clinically significant increase in diaphragmatic mobility on both sides, as well as lower chest and abdominal expansions in the MDST group, when compared with the control group. Despite the changes to mobility, no clinically significant difference in pulmonary function test variables between groups were found. However, weakness of the diaphragm can lead to recurrent pneumonia and respiratory distress, two of the most common causes of mortality in children with cerebral palsy. Therefore, the authors concluded any improvement in the motion of the diaphragm may consequently lead to a reduction in respiratory complications and improvements to these other organ systems. The limitations of this study were outlined by the authors. For example, most study participants were found to have spastic diplegia, with no GMFCS level V. This specificity in tested subjects makes it difficult to extrapolate the same treatment benefits recorded in the study to different individuals.

A second study evaluated the effect of manual diaphragmatic release technique. Rutka et al evaluated the effect manual therapy plays on chest and diaphragm function as measured by spirometry in patients with cerebral palsy. In the therapeutic intervention group, a clinically significant improvement in forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) was noted after the first session of therapy. The improvements of both parameters were on average 15% to 16% after the first therapeutic session. Further treatment brought a further increase in the average values of these parameters, but they were insignificant in relation to the results obtained after the first therapeutic session in the experimental group. The control group who received sham therapy had no differences in the stated parameters. Because the sham group had no treatment effect, the author concluded that the measurable effect after manual therapy was not related to learning or the placebo effect.

A third study which evaluated changes in visceral function was a pilot study that evaluated the effect of osteopathic treatment on children with cerebral palsy who were suffering from constipation. Tarsuslu et al found constipation is one of the most frequent problems in children with cerebral palsy because of several reasons such as insufficient nutrition, malnutrition, increased muscle tone, decreased defecation, and immobilization. The osteopathic treatment in the study included fascial release, iliopsoas muscle release, sphincter release, and bowel mobilization which were conducted in the given order during a 30-minute session. The intervention group was treated with osteopathic methods and included seven participants. The second group included six participants and underwent both medication and the same osteopathic treatments as group one. Although there were important improvements of symptoms in both groups, there was no difference between groups. The authors concluded this may indicate that the drug regimen had no additional beneficial effects on constipation whereas osteopathic methods alone might cause these improvements.

Spasticity/mobility Improvements

The most measured impact of manual therapy on cerebral palsy was regarding changes in spasticity. Eight studies evaluated the impact of various forms of manual therapy from
utilization of joint or osteopathic manipulation to various massage techniques.

First, Youn et al found a clinically significant increase in all ankle range of motion in the experimental group after joint mobilization compared to the control group which received sham therapy. Spasticity exacerbates joint contracture and muscle weakness as well as contributes to changes in muscle contractile properties. Ankle joint mobilization can be applied to reduce the spasticity of the soleus muscles, restore ankle joint flexibility, and causes articular reflexogenic effects consequently increasing dorsiflexion muscle strength. Furthermore, ankle joint mobilization may also improve balance as the authors found that it can reduce center of position displacement by improving sensory motor function and arthrokinematic restrictions. The study concluded ankle joint mobilization improved ankle range of motion and gate in cerebral palsy. However, the beneficial effect on standing balance was not confirmed.\textsuperscript{9} The largest limitation of this study was that it failed to compare the treatment intervention to current treatment methods of patients with cerebral palsy. The authors also failed to identify adverse effects, if any occurred, of the evaluated therapy. For these reasons, the benefit of implementation in the clinical setting cannot be fully determined.

Next, three studies evaluated the treatment effect of osteopathic manipulation for management of spasticity. First, Duncan et al evaluated gross motor function changes in children following osteopathic manipulation. The authors concluded that there was statistically significant improvement from baseline Gross Motor Function Classification System scores in the osteopathic manipulation treatment group. No clinically significant changes were found in the acupuncture groups nor in the waiting list groups.\textsuperscript{11} One limitation to this study was the failure to provide confidence intervals or P-values to support evaluation of treatment effectiveness. Additionally, it should be noted that this study was a pilot study and may serve as foundation for further research trails to be conducted.

A second study evaluated the impact of manipulation on spasticity. Kachmar et al assessed spasticity quantitatively with a Neuroflexor device by measuring the resistance to passive movement of the wrist, performed with different velocities by a computer-controlled step motor. Wrist muscle spasticity was measured quantitatively as a neural component of the muscle tone. Spinal manipulation was carried out in the thoracic, lumbar, and cervical regions. Statistically significant reduction of neural component after spinal manipulation was noted in the experimental group values dropped from the median 5.53 N to 3.35 N. In the control group, there was only a slight reduction of values from the median 6.83 N to 5.7N. Comparison between the groups revealed statistically significant difference in spasticity reduction (P=.034). The second outcome measure in the study was the study of hand dexterity measured by means of the box and block test. There was a statistically significant difference between baseline and post intervention assessment measured in both groups. In the experimental group, the pre-and post-difference was a positive 4.1 blocks per second (95% confidence interval = 5.52-2.68). In the control group, the pre-and post-difference was a positive 3.01 blocks (95% confidence interval = 4.41-1.69). While the experimental group showed a more substantial improvement, the difference between groups was not statistically significant (P=.28). The contribution of this study is that it corroborates the hypothesis that spinal manipulation may decrease muscle spasticity temporarily in
participants with disordered muscle tone regulation, specifically children with cerebral palsy. Despite these positive findings, the limitations of this study were outlined extensively by the authors. The short-term design, the potential that participants in the control group may have suspected sham therapy, and the preliminary nature of findings of decreased spasticity associated with spinal manipulation were listed as considerations by the authors.  

A study on the potential effectiveness of Cranial Osteopathic Therapy was conducted by Wyatt et al. This study attempted to evaluate the potential improvement that this therapeutic approach may provide in the health or quality of life of children with cerebral palsy. The authors found little evidence that cranial osteopathic therapy had a sustained improvement in the health or quality of life of children aged 5 to 12 years with cerebral palsy. At six months, neither the independent assessment of motor function (GMFM-66), nor caregiver quality of life, sleep, or pain, suggested any statistically significant difference between children who had a course of cranial osteopathic treatment and those assigned to a waiting list.

Myofascial Structural Integration was examined regarding the impact that it may have on gross motor function of pediatric cerebral palsy patients. In this crossover study, each child underwent 10 weekly 60-to-90-minute sessions of myofascial structural integration, in addition to 10 weekly sessions of play, which was the control intervention of the study. The advantages of this approach, as suggested by the authors, are the fact that it targets changes in the muscle and fascial tissue directly, is a noninvasive therapy, and does not interfere with the developing movement patterns of the individual. The authors found improvement in gross motor function measure scores in six children after myofascial structural integration treatment. While it was not observed that there were consistent improvements in ankle range of motion across the group, three children showed considerable improvements in ankle dorsiflexion after myofascial structural integration treatment. While the largest limitation to these findings is the small sample size of study participants, the authors concluded this preliminary study indicates that using myofascial structural integration as a specific, complementary technique to loosen and realign muscles and joints could facilitate improved motor function in young children with spastic cerebral palsy.

In their study, Mahmood et al, studied the effects of traditional massage on spasticity of children with cerebral palsy. Their determination was that traditional massage, when coupled with routine physical therapy was found to have a statistically significant effect on the reduction of spasticity when compared to routine physical therapy alone. While the right-side changes were both clinically and statistically significant the left-side did not meet either of these benchmarks.

Deep friction massage was investigated by Rasool et al. In their investigation, they evaluated the effect of this therapeutic approach on both spasticity and functional ability. The study described a statistically significant reduction in spasticity after six weeks, five sessions a week, of deep friction massage within the experimental group. However, between the two groups, spasticity reduction was not significant (P = .26). Moreover, there was no significant improvement observed in the functional level of study subjects on both within and between the group analysis.
A third study evaluated the effect of massage techniques on children with cerebral palsy and down syndrome. Silva et al evaluated qigong massage techniques in the treatment group of the study. The children with cerebral palsy who received the treatment intervention experienced positive, statistically significant improvements in all three motor domains including stationary body control, locomotion/movement, and object manipulation. Children in the control group experienced minimal, non-statistically significant changes. While there were large and significant overall treatment effects in motor development (p=.039), the overall results for the sensory impairment indicated no treatment effect (p=.265). Despite the positive findings of massage intervention in this study, the authors outlined limitations that should be considered. Limitations are consistent with those of a small pilot study, including a small sample size, short period of intervention, and the need for a wider battery of outcome measures to be administered by blinded examiners.

The current level of evidence in the literature, while overall positive, is limited and inconclusive due to complications of small study sample size, mixed results across techniques, and multiple trials consisting of mainly pilot studies. The findings of this review are consistent with reviews that had evaluated portions of the investigated topic. For example, Pin et al conducted a systematic review evaluating the effectiveness of passive stretching on children with cerebral palsy. The authors found that the evidence to support the effectiveness of passive stretching in children with spastic cerebral palsy remains weak. It was concluded there is some evidence favoring passive stretching to increase range of motion in children with cerebral palsy, although the effect size remains small. Additionally, there is evidence indicating that passive stretching may reduce spasticity in children with cerebral palsy, but the effect size and clinical merit remains limited. Lastly, there is some evidence to indicate that sustained stretching is preferable to manual stretching in improving range of motion and reducing spasticity in targeted joints and muscles.

CONCLUSION

The prevalence of cerebral palsy has remained steady at 2.11 per 1000 live births despite increased survival of at-risk preterm infants. The consistency of the prevalence of cerebral palsy warrants additional investigation into proper management and treatment options. While the studies in this review outline the prospective benefits of manual therapy on visceral function and management of spasticity, the results were complicated by study limitations. Further inquiry into the effectiveness of manual therapy techniques including joint manipulation, tissue mobilization, and diaphragmatic stretching techniques should be conducted in larger studies to determine the replicability of the observed optimistic therapy effects. Once manual therapy has been found to be effective, further studies on frequency would also be beneficial. In a similar vein, a recent study by Ryu and Suh examined the optimal frequency of physical therapy in young children with cerebral palsy. The “current treatment for people with cerebral palsy involves substantial expense. The size, nature and distribution of the economic burden emphasizes the importance of finding effective strategies to reduce the risk and severity of cerebral palsy”. After treatment effectiveness and optimal frequency has been determined, clinical application of manual therapy can be compared in both effectiveness and cost-benefit ratio to current management techniques.
REFERENCES


