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Osteopathic manipulative treatment for concussions and postconcussive syndrome in athletes: a literature review

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Abstract

Context: Concussions are the most common type of traumatic brain injury (TBI) and can often occur in athletes. These injuries have many deleterious acute symptoms and can lead to the development of postconcussive syndrome (PCS). Osteopathic manipulative treatment (OMT) is a treatment option that may benefit patients with concussions and PCS.

Objectives: The objective of this review is to determine whether OMT can improve symptoms associated with concussions and PCS in athletes.

Methods: A comprehensive literature review was conducted between August 2021 and March 2022 by two authors (Z.K.L. and K.D.T.) who searched the literature utilizing PubMed, Google Scholar, and Cochrane Library. Articles reviewed included case reports, case studies, randomized control trials, meta-analyses, and peer-reviewed journal articles. Search terms included concussion, postconcussive symptoms, osteopathic manipulative medicine, and manipulation. To be included into this study, articles must have included OMT from an osteopathic physician or manipulative techniques by nonosteopathic providers for patients with a concussion or PCS, and the insulting injury must have occurred in an athletic setting. No disagreements occurred between authors about what studies to include. However, we were prepared to come to a unanimous

decision through discussion among the authors. A narrative synthesis was performed. No other data analyses were conducted in this study.

Results: Included in this review were nine articles including randomized control trials, retrospective review, case series, longitudinal, retrospective studies, and case reports. The literature shows the positive effects of OMT and manipulative techniques on symptom resolution after a concussion. However, most of the literature is qualitative rather than quantitative in nature, lacking in randomized control trials.

Conclusions: There is a scarcity of high-quality studies evaluating the effectiveness of OMT on concussions and PCS. More research is needed to understand the degree of benefit for this treatment option.

Keywords: concussions; mTBI; osteopathic manipulative treatment; post-concussive syndrome.

Mild traumatic brain injuries (mTBIs), also known as concussions, continue to affect a staggering number of people all over the world [1]. In 2014, there were 2.9 million traumatic brain injuries (TBI) diagnosed in the United States, among which 1.7 million were classified mTBIs [2]. According to the Centers for Disease Control and Prevention (CDC), in 2019 alone, over 223,000 individuals were hospitalized due to their TBI, while mTBIs accounted for close to 75 % of all TBIs in the United States [3, 4]. The severity of TBIs are determined by the patient's Glasgow Coma Scale (GCS) score at the time of the injury. Patients with concussions have a normal GCS, and a diagnosis is based on the patient's presentation and mechanism of injury [5]. Symptoms experienced fall under the following categories; vestibular, cognitive, fatigue, anxiety/mood, headache, and ocular [6]. The most common symptoms associated with concussions include headache, dizziness, nausea, and balance issues [7]. The most common causes include unintentional falls and motor vehicle accidents, which make up to 70 % of the total cases, but additional causes, and the focus of this review, include sports-related injuries [8]. The sports with the highest risk of concussions

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in males include football, rugby, ice hockey, and wrestling, and for females, soccer and basketball [9].

In recent years, there has been a more prominent discussion about the effects of TBIs on children and adolescents as a result of the CDC's HEADS UP Campaign. In a child, the potential long-term effects of a concussion include, but are not limited to, problems with critical thinking and challenges with social engagement/behavioral issues. Adults can develop problems with their memory, thinking process, or activities of daily living [10]. Symptoms of concussions can be differentiated into signs observed vs. signs reported by the patient [1]. For example, signs observed include the inability to recall events, appearing confused, not answering questions appropriately, behavior changes, or appearing to move with lack of coordination. In comparison, symptoms reported by the patient may be headache, nausea, vomiting, dizziness, blurry vision, photophobia, problems with academic or sports performance, and difficulty sleeping or foggiess [11].

There are various standardized tools that physicians can utilize to help with the diagnosis and management of concussions: CogSport, ImPACT, Headminder, King Devick, Acute Concussion Evaluation (ACE), the Sport Concussion Assessment Tool (SCAT), and Post-Concussion Symptom Inventory [12, 13]. Evidence surrounding the utility of these tests is still in debate; this is due to variability in test performance. However, some organizations, including the National Collegiate Athletic Association (NCAA), recommend baseline testing as a best practice [6]. The CogSport sensitivity and specificity for diagnosing a concussion was 67.0 % and 96.0 %, respectively [14]. The ImPACT sensitivity was 81.9 % and specificity 89.4 %, whereas Headminder has a sensitivity of 78.6 % [15, 16]. The King-Devick sensitivity and specificity was 80.0 % and 41.0 %, respectively, and the SCAT sensitivity was 89.1 % with a specificity of 80.9 % [17,18]. The Post-Concussion Symptom Scale (PCSS) has a sensitivity and specificity of diagnosing a concussion in the first 3–5 days of 47.4 %–72.2 % and 78.6 %–91.7 %, respectively [19]. The ACE is part of the CDC's HEADS UP to Health Care Providers Toolkit and has versions for the emergency department setting, as well as an in-office setting with identical symptom scales. This consistency is beneficial when trying to measure and assess progression between the initial injury and follow-up visits. The SCAT is a standardized protocol that is utilized to help assess the severity of the patient's symptoms and identify what symptoms they are experiencing. This assessment tool allows the patient to report symptoms as well as quantify their severity and can be utilized by the provider to objectively evaluate the patient's progression throughout their clinical course,

especially as complaints associated with concussions are highly variable.

Treatment of patients with a concussion is a challenging task due to the variation and expansive range of complaints. Although the primary treatment plan depends on the severity of symptoms and initial presentation, the current guidelines tend to focus on education of the patient, symptomatic control including symptom-limited rest, return to play/activity precautions, return to exercise, physical/vestibular therapy, and cognitive behavioral therapy (CBT) [20, 21]. Postconcussive syndrome (PCS) is diagnosed in adults when symptoms continue beyond 2 weeks and in children/adolescents when they persist beyond 4 weeks. Most patients experiencing continued symptoms have difficulty completing simple tasks and may experience challenges with their daily activities.

As the search for more effective treatment options continues, it is imperative that osteopathic manipulative treatment (OMT) options are considered. When a patient experiences an mTBI, the body experiences overt musculoskeletal and neurologic somatic dysfunctions, but other derangements within the different osteopathic treatment models are often subtle yet contributory to the patient's presentation. After a thorough structural examination, osteopathic physicians can formulate a treatment plan that will address the panoply of somatic dysfunctions associated with concussions and PCS. With the ability to provide holistic care through the use of hands-on techniques, OMT is an underutilized and underappreciated treatment option. This literature review will highlight some of the current literature addressing the use of OMT in the treatment of mTBIs/concussions and PCS that occurred in an athletic setting.

Methods

Approval for publication was submitted and accepted by the institution's publication clearance committee. A comprehensive and thorough search occurred from August 2021 to March 2022. The authors (Z.K.L. and K.D.T.) were involved in the collection and review of publications. PubMed, Google Scholar, and Cochrane Library were the chosen databases utilized for gathering information. To ensure that the review was comprehensive in nature, the following strings were utilized to search the above databases: "Osteopathic manipulative medicine and concussions," "Osteopathic manipulative treatment and concussions," "Osteopathic manipulative medicine and mTBI," "Osteopathic manipulative treatment and mTBI," "Osteopathic manipulative medicine and postconcussive syndrome," and "osteopathic manipulative treatment and postconcussive syndrome," "manipulation and concussions," "manipulation and mTBI," and "manipulation and postconcussive syndrome." A common archive of articles was compiled, and each author

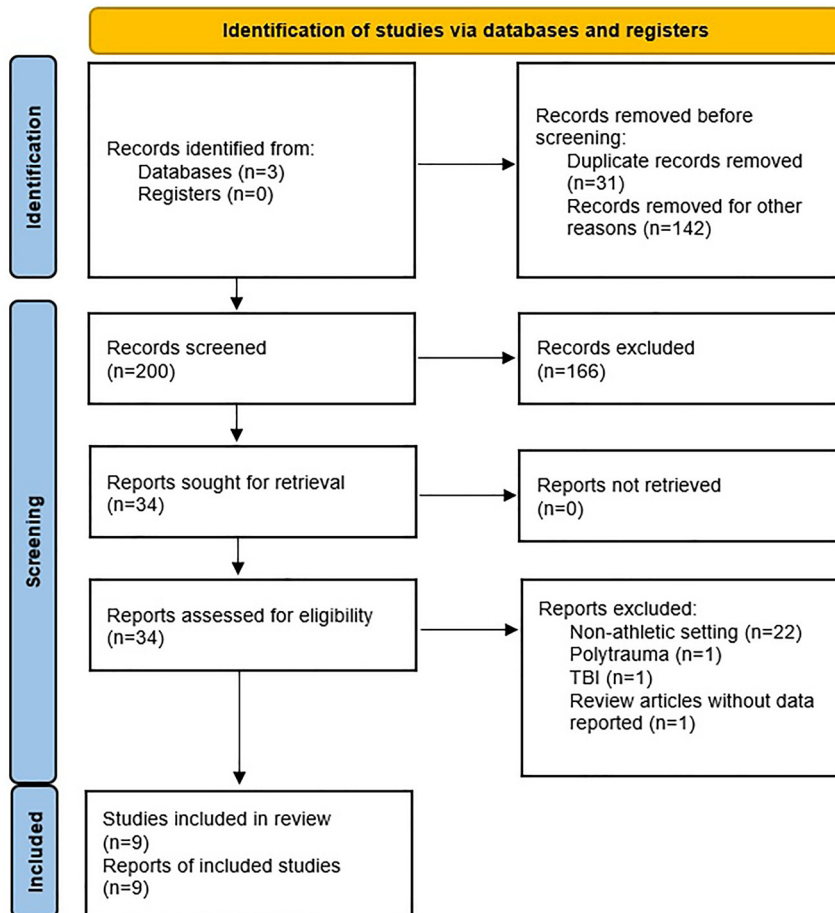


Figure 1: Preferred reporting items for systematic reviews and meta-analyses (PRISMA) diagram.

had the opportunity to review the articles for inclusion in this review. For inclusion in this review, the articles must have discussed the use of osteopathic manipulative medicine by osteopathic physicians or manipulative techniques (in line with osteopathic principles) by non-osteopathic providers in the treatment of concussions/mTBIs and in patients suffering from PCS. Each study must have had subjective and/or objective reports of pre- and posttreatment results and must have described the techniques utilized to treat the patients. The participants must have received their concussion in an athletic setting, and the age range of participants was set to greater than 10 years old and less than 75 years old. The exclusion criteria included articles in which the patients did not have a diagnosis of a concussion, mTBI, or PCS, even if the patient had symptoms that could possibly be attributed to a diagnosis of concussion/mTBI or PCS, the concussion/mTBI was not received in athletic setting, or the participants' ages were outside of the predetermined limit (Figure 1) [22]. If there was an article upon which the authors disagreed about its inclusion in the review, a discussion occurred between the two authors in which the article in question was compared to articles deemed appropriate for the review, with a unanimous decision reached between the two authors regarding inclusion or exclusion of that article. Articles referenced in this literature review are case reports, case studies, randomized control trial, and peer-reviewed journal articles that fall under the Centre for Evidence-Based Medicine (CEDM) Levels of Evidence levels 2–4. Project approval was submitted to the primary author's Institutional Review Board (IRB) committee, and this review was granted IRB exempt status. There was no funding for this project.

Results

It became clear during the review of the literature that other medical providers in addition to osteopathic physicians were utilizing manipulation as part of their treatment plans to manage their patient's concussion and/or PCS. As such, the articles reviewed will be categorized according to provider type for organizational purposes (Tables 1 and 2).

Manipulative treatment of concussions by osteopathic physicians

After searching the literature, five articles were found demonstrating the use of OMT to treat concussions and PCS in athletes: two randomized control trials, one retrospective review, and two case reports. Each study employed a personalized treatment plan, as opposed to a standardized protocol, that appears to be a key component of concussion management. Only the randomized control trials reported statistical analyses, whereas the other studies tracked the lone participant's scores across multiple treatments, with

Table 1: Manipulative techniques performed by osteopathic providers.

Study	Study design	Number of patients	Treatments utilized	Outcomes
Yao et al. [24]	RCT, OMT treatment group vs. education	n=31, concussion education n=15, OMT n=16	Thoracic inlet release, rib raising, OA decompression, V spread, BMT for cranial strain patterns, cranial lifts and compression of the fourth ventricle.	No difference in severity of symptoms between the OMT and education group pre-intervention. OMT group had less severe symptoms, $p=0.196$. OMT group had less severe ($p=0.001$) and fewer symptoms after treatment ($p=0.001$)
Mazzeo et al. [25]	RCT	n=30, clinical education n=16, OMT n=14	OA decompression, venous sinus drainage, cranial lifts, CV4, thoracic inlet release, rib raising, and abdominal diaphragm doming	There was an overall, yet not statistically significant, trend between the education group and OMT with regard to the improvement of sleep quality across three treatment sessions ($p=0.24$)
Yao [26]	Case report	n=1, 17 years old, female soccer athlete	OA decompression and BMT to the cranium. MFR, FPR, and HVLA to the cervical and thoracic spines. BLT to the lumbosacral and sacroiliac junction	Reduction in pain from 5/10 to 2/10 after initial treatment session. Return to baseline after multiple sessions
Guernsey et al. [27]	Case report	n=1, 27 years old, male snowboarder	BLT, ME, MFR, HVLA to multiple spinal segments and cranial bone lifts	An increase in the composite equilibrium from 76 prior to treatment to 81 on the SOT with the most improvement on testing conditions associated with the visual and vestibular aspects of balance.

BMT, balanced membranous tension; FPR, facilitated positional release; HVLA, high-velocity, low-amplitude; ME, muscle energy; MFR, myofascial release; OA, occipitoatlantal; OMT, osteopathic manipulative treatment; RCT, randomized control trial; SOT, sensory organization test.

Table 2: Manipulative techniques performed by nonosteopathic providers.

Study	Study design	Number of patients	Treatments utilized	Outcomes
Marshall et al. [28]	Case series	n=5, where 3 cases were sports-related injuries (19 year-old MMA athlete, 21 year-old and 51 year-old hockey athletes) and two were not sports-related	Active release therapy, localized vibration, spinal manipulation	Subjective report of symptom reduction
Wetzler et al. [29]	Single-blinded case series	n=11, retired NFL athletes	Craniosacral techniques, visceral and neural manipulation, twice a day for 5 days	Significant improvements in overall pain reduction ($p=0.0448$), especially cervicogenic ($p=0.0486$), a doubling of sleep time and increased active ROM ($p=0.0377$), and increased average memory performance ($p=0.0156$), allowing for less difficulty with learning, reading and making appropriate decisions
Grabowski et al. [30]	Retrospective study	n=25, cervicogenic PCS group n=3	Joint and soft-tissue mobilization	PCSS data reported for all 25 participants showed a decreased in symptoms ($p<0.01$) from initial to final PT; however, subgroup data was not reported.
Kratz [31]	Case report	n=1, 24-year-old male collegiate athlete	Craniosacral therapy	90.0 % resolution of symptoms after 11 treatment sessions
Hugentobler et al. [32]	Case series	n=6, Four of the cases occurred in an athletic setting, while two cases did not	Multimodal treatment approaching including cervical manipulation	Effect of manipulation not a primary outcome measure

PCSS, post-concussion symptom scale; PT, physical therapy; ROM, range of motion.

only the retrospective review utilizing a standardized scoring tool. In addition, both randomized control trials focused on treating an initial injury, whereas the case

reports and retrospective review focused on PCS. The randomized control trial and case reports were included in the review because the injury occurred in a sports setting, but

the retrospective review detailed the results of OMT to treat a 16-year-old girl with a history of multiple head injuries who was involved in a head-to-head collision on a school bus [23]. All four of the following studies were conducted from the same research group.

Yao et al. [24] performed a randomized control trial ($n=31$) that investigated the difference in symptom severity and quantity between two groups of student-athletes, one of which received OMT and the other receiving a detailed, physician-led concussion education discussion. A total of 71 patients were screened to participate in the study, although only 31 were chosen to participate, and one was excluded due to having incomplete data. The average age of the patients was 19.9 years (range, 18–27 years), and there was a predominance of males ($n=19$). All participants in the OMT arm were treated with the following techniques: thoracic inlet release, rib raising, occipitoatlantal (OA) decompression, V spread, balanced membranous tension for cranial strain patterns, cranial lifts, and compression of the fourth ventricle. These techniques aimed to improve lymphatic drainage, while also addressing other common dysfunctions found in concussion patients. Other techniques chosen were picked based on the patient's specific evaluation. In order to evaluate symptom severity and progression, the SCAT, 5th edition (SCAT5) was utilized. The severity of symptoms was not found to be statistically significant between the OMT group ($n=16$; $M[SD]=14.38[5.04]$) and the education group ($n=15$; $M[SD]=13.07[5.00]$) in the pre-intervention setting. There was also no statistical significance between the initial severity of symptoms when comparing the OMT group ($M[SD]=38.21[22.20]$) and the education group ($M[SD]=31.00[16.03]$, $p=0.196$). However, they were found to be statistically significant following treatment, with the OMT intervention group reporting a decrease in the severity of symptoms ($M[SD]=-3.93[3.92]$, $p=0.001$) and a decrease in the number of overall symptoms ($M[SD]=-17.33[17.38]$, $p=0.001$).

A pilot study (and randomized control trial) from Mazzeo et al. [25] looked at how sleep quality in athletes postconcussion could benefit from OMT vs. concussion education counseling (CEC). Athletes ($n=30$) were recruited into the study 2 weeks after a sports-related head injury and exhibiting concussive symptoms. One group ($n=16$), the controls, received CEC, whereas the other group ($n=14$) was to undergo OMT over a series of three visits. Three treating physicians utilized techniques such as OA decompression, venous sinus drainage, cranial lifts, CV4, thoracic inlet release, rib-raising, and abdominal diaphragm doming. If these participants exhibited any additional dysfunctions that were contributory to their presentation, those were also treated. The primary outcome measure was the comparison

of scores on the SCAT5 “trouble falling asleep” subset section, which was obtained prior to sessions 1, 2, and 3. Overall, a medium-strength yet significant correlation existed for the “trouble falling asleep” items with the total SCAT5 symptom score across all participants ($Y=7.233x + 22.278$, $r^2=0.302$, $p=0.001$). For visits 2 and 3, there were large, significant correlations for visit 2 ($Y=12.673x + 8.819$, $r^2=0.645$, $p<0.001$) and visit 3 ($Y=8.956x + 5.268$, $r^2=0.471$, $p<0.001$). Between groups, the OMT group had scores of 1.33, 0.27, and 0.36 for the “trouble falling asleep items” from each visit, whereas the CEC group had scores of 1.00, 0.64, and 0.54. This correlated to an 80.0 % improvement in sleep symptom severity between visits 1 and 2 for the OMT group, whereas the CEC group only showed a 36.0 % improvement between those same visits ($p=0.24$). From the second to the last visit, the OMT group experienced 73.0 % improvement compared to the CEC group 46 % improvement ($p=0.24$). There was no significant difference when comparing groups. Although there was no statistically significant difference in interventions, these authors posited that there was a greater trend toward clinical improvement when OMT was utilized vs. standard educational practices.

Among the two case reports, one addressed PCS while the other treated more immediate symptoms. Yao [26] ($n=1$) presented the case of a 17-year-old girl who was referred to his clinic for OMT after two months of persistent headaches following a head injury during a soccer game, whereas Guernsey et al. [27] ($n=1$) detailed the treatment of a 27 year-old male who was experiencing concussive symptoms after a snowboarding accident. Yao utilized techniques with the goal of improving the circulatory and lymphatic flow and restoring proper proprioceptive input. Success of treatment was based off the patient's pain scale. He employed a variety of techniques such as OA decompression and balanced membranous tension (BMT) to the cranium, myofascial release (MFR), facilitated positional release (FPR), and high-velocity, low-amplitude (HVLA) to the cervical and thoracic spines, and BLT to the lumbosacral and sacroiliac junction. After her initial treatment, the patient reported an improvement from 5/10 to 2/10. She also returned for multiple treatment sessions (of unknown length), which improved her symptoms and allowed her to return back to her baseline activity level. Guernsey et al. [27] did not have a specific focus when selecting their techniques, but utilized balanced ligamentous tension, muscle energy, MFR, and HVLA to multiple spinal segments and cranial bone lifts. Their patient's treatment response was evaluated with the sensory organization test (SOT) and SMART Balance Master before and after treatment. Sessions were consistently 25 min long, and after the session, the patient reported immediate relief of his symptoms. His

SOT showed an increase in the composite equilibrium from 76 prior to treatment to 81, and the testing conditions associated with the visual and vestibular aspects of balance improved the most.

Manipulation performed by nonosteopathic medical providers with similar techniques

Five articles were included in this subsection, each of which identified as having an aspect of their study that involved manipulative techniques that were in line with osteopathic principles: one case report, three case series (one single-blinded, one as part of a review), and one retrospective study. Overall, the primary focus of the majority of these articles was PCS, with only Hugentobler and colleagues [32] examining how the treatment provides immediate concussion-symptom relief.

Marshall et al. [28] authored a review with associated case series (n=5), in which three cases were sport-related (one sparring and two hockey-related injuries) and two were due to other nonathletic causes. They found that although not much is known about the pathophysiology of PCS, skilled manual therapy–related assessment and rehabilitation of cervical spine dysfunction should be considered for chronic symptom management following concussion injuries [28]. Their conclusions were based on the subjective reports from those five cases in which the subjects had various mobilization modalities and manipulations performed by chiropractors during their assessment of the subjects' deficits due to their concussions. In the 25-year old sparring athlete, eight treatments led to resolution of symptoms including headache, dizziness, and noise sensitivity. The 19-year old hockey athlete experienced an 80.0 % reduction of symptom severity after four treatments over a 21-day period; his symptoms included headache, dizziness, visual problems, fatigue, sensitivity to light, mental fogging, concentration difficulties, and memory difficulties. In a 51-year old hockey athlete, there was full resolution of symptoms after three treatments over 6 weeks including headache and neck pain.

In their single-blinded case series, Wetzler et al. [29] worked with retired NFL players (n=11) who were experiencing long-term symptoms from repetitive head trauma. The techniques they utilized included craniosacral techniques as well as visceral and neural manipulation, and the therapy sessions took place twice a day for 5 days. These researchers found statistically significant improvements in overall pain reduction ($p=0.0448$), especially cervicogenic ($p=0.0486$) and increased active ROM ($p=0.0377$). Qualitatively, a doubling of sleep time was also reported. Most

importantly, average memory performance increased ($p=0.0156$), allowing for less difficulty with learning, reading, and making appropriate decisions. Compared to the other studies, these participants experienced multiple years of high-velocity, head-to-head impacts that had a cumulative affect in their presentation. However, the uniqueness of this patient population bodes well for long-term concussion research by highlighting how successful manipulation was in improving sustained, chronic symptoms.

In a 2017 retrospective study by Grabowski and colleagues [30], participants (n=25) were sorted into PCS subgroups (physiologic, vestibular/oculomotor, cervicogenic, or some mix thereof) based on a subjective interview from their self-reported PCSS [30]. Each subgroup underwent a physical therapy (PT) modality that corresponded to the deficit characterizing the subgroup and sport-specific training; however, only the cervicogenic PCS subgroup (n=3) received soft-tissue and joint mobilization. Six patients were assigned to subgroups with mixed presentations that included cervicogenic PCS: physiologic-cervicogenic (n=3) and cervicogenic-vestibular (n=3). For all 25 patients in the study, the mean PCSS scores (SD) at the initial PT visit were 18.2 (14.2). At the final PT visit, the mean PCSS score was 9.1 (10.8). There was a significant decreasing trend of total scores ($p<0.01$) after supervised PT. Overall, 88.0 % (n=22) of the study's total participants reported improvement in symptom scores, while 24.0 % (n=6) achieved a symptom-free state by the end of treatment. Only the primary outcome measure of PCSS was utilized to assess the cervicogenic group's response to manipulation, and the data were not reported for each individual subgroup within this study to determine to what effect each subgroup benefited from their respective targeted treatment plan.

An occupational therapist credentialed in craniosacral therapy was able to successfully treat a collegiate athlete (n=1) experiencing 18 months of symptoms following a sports-related head injury [31]. Over the course of 11 treatments, the patient was able to improve his scores on the Post-Concussion Symptom Checklist (0–126, higher numbers indicate greater severity, reported in a range). The patient's initial intake range was 81–92 (borderline moderate-severe) and decreased before the fourth session to 63–68 (moderate). The patient's scores continued to decrease as obtained before the sixth session, 41–47 (borderline mild-moderate), to 24–32 (mild) after the eighth session, to 12–14 (none-mild [activity-related]) after the 11th session. In addition, the patient had an improvement on the Headache Impact Test (HIT-6) outcomes (range 36–78 indicating severity that headaches impact daily quality of life) from initial intake, 65 (25.0 % relief from initial headache [HA] level), to before the sixth session, 58.5, and after

the eleventh session, 44 (90.0 % relief from initial headache level). In review of the patient's self-report sleep journal, he was able to normalize his sleep schedule by the end of his participation.

Through their series of case studies (n=6), Hugentobler and colleagues [32] further investigated if a multimodal approach to PT, including graded physical activity, sports-specific exercises, cervical manipulation, vestibular rehabilitation, and postural stabilization, would help pediatric athletes manage and improve their prolonged postconcussive symptoms [32]. Four of the six cases in this study dealt with a head injury that occurred in an athletic setting, and the other two were motor vehicle accident-related. The cervical manipulation aspect of this study was minimal in comparison to the other modalities utilized and was not a primary outcome measure in order to see if this component of the treatment plan changed symptomatology. This study was able to suggest that a multimodal individualized treatment plan may help to facilitate symptom reduction, improve self-management abilities, and safely enhance function, but not to determine which specific interventions provided the greatest benefit to patients.

Discussion

In our review of the literature, only nine studies were included that examined the possible benefits of treating concussions and PCS with OMT or manipulative techniques in line with osteopathic principles. Six of the nine included articles were either case reports or case studies with minimal statistical analysis but with strong subjective reports of improvement. Most of the studies included in this review article lack the sample size needed to allow for generalizability of their results into the greater population. In addition, most of the studies employing OMT come from the same lead author, which could lead to a slightly biased perspective regarding the effectiveness of OMT in treating concussions and PCS. However, patients who received OMT reported quicker improvement of symptoms, faster return to play/normal activity, and better scores on outcome measures. With concussions and their management becoming a keystone issue in sports medicine across all levels of play and resulting in visits to primary care providers, it is imperative to be able to equip providers with the best evidence-based practices for treating their patients.

Nonosteopathic providers who utilized manipulation also had success improving their patients' quality of life and outcome measures when this modality was utilized in

conjunction with or apart from other treatment modalities. Importantly, the techniques these providers utilized are very similar to those that an osteopathic physician would employ when treating patients with OMT. In studies with multiple simultaneous treatments, it is unclear if the benefits sustained were due to the OMT or other aspects of the treatment.

Additional research is necessary to truly quantify the positive effects of OMT in treating concussions and PCS. However, given how the treatment for concussions appears to require an individualized approach, it may be difficult to design a large sample randomized control trial, which may be one reason why Yao and his authors have only been able to publish two studies of this design-type with small sample sizes. The best study design may, in fact, be a case-control series with one group receiving dysfunction-specific OMT, while the control group receives the standard of care as outlined in the literature thus far. In order to quantify the effect, the same outcome measure should be utilized for all participants. This may offer the best opportunity to analyze between-group differences while allowing for the variability inherent in treating individuals with concussions and PCS.

During the review process, limitations became evident with the scarcity of research in this area. Most of the studies had very small sample sizes with a lack of variability in age and unclear distinctions in background injuries or other potentially confounding factors. Most of the clinical studies and case reports investigated the treatment of patients who obtained the initial injury during a sporting event as opposed to other mechanisms of injury. Almost all of the articles concluded with the need for continued research in the area of OMT as a treatment modality for concussions. Another component is that there is not a lot of quantitative data associated with the current publications. In addition, most of the improvements reported did not make use of any specific assessment tool.

Limitations

Articles were searched utilizing several databases but were not universally inclusive. This may have led to authors missing other articles not listed in our review article, which would impact our results.

Conclusions

Concussions are a common injury that affect a large portion of the population each year and can result from various

activities including sporting events, military combat, and motor vehicle collisions. Although concussions are common, effective/consistent treatment has proven to be a challenge. This review identified literature that discussed the use of OMT in regard to treating and addressing the symptoms associated with concussions and PCS. In our reviewed studies, there were different screening tests utilized on different patient populations. In our review, we found that OMT was utilized as either sole therapy or as part of multimodality treatment. There was no standardized treatment protocol for concussions and PCS utilizing OMT. Outcomes were measured with varied methods. Our review highlights the need for continued clinical research in this area. More exploration into this topic will serve to better support the use and application of OMT when creating concussion treatment plans.

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Competing interests: None reported.

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