

Review Paper

Effect of Manual Therapies on Parameters of Postconcussion Symptoms Recovery: A Systematic Review



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ABSTRACT

Objectives: Postconcussion syndrome (PCS) results from an injury to the head, leading to loss of consciousness. It includes symptoms like fatigue, headache, dizziness, and difficult concentration. PCS is frequently seen among athletes, and its treatment is still controversial. This systematic review aims to study the impact of manual therapies on recovery from postconcussion syndrome.

Methods: A systematic search was performed using three databases (PubMed, Google Scholar, and Research Gate) from 2011 to 2021. GRADE approach (grading of recommendations assessment, development, and evaluation) was utilized to evaluate and appraise the quality of studies deemed eligible for this study.

Results: A total of 5489 articles were identified. After undergoing the process of screening and review, only 7 articles were used in the systematic review. Data were extracted from these 7 articles (GRADE rating very low to low).

Discussion: Manual therapy is an intervention for treating postconcussion symptoms. More studies especially controlled trials with randomization with greater sample sizes, are required to confirm the existing findings.

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Highlights

- The postconcussion syndrome is a common clinical condition among athletes involved in collision sports.
- Manual therapies can be a better alternative in managing symptoms of postconcussion syndrome.
- There is a shortage of research evaluating the effect of manual therapeutic techniques in managing the symptoms observed in individuals following postconcussion syndrome.

Plain Language Summary

The postconcussion syndrome can last up to several months, negatively affecting athletic performance. In non-athletic populations, it also causes considerable interference and challenges in normal daily activities. Therefore, this clinical condition needs to be addressed by proper treatment interventions. Although systematic reviews have been performed earlier evaluating the effect of rest, pharmacotherapy, and cognitive behavioral therapy, few studies have been done on manual therapy. This systematic review has found few studies in this area. Their results suggest that manual treatments like lymphatic drainage, visceral manipulation, craniosacral therapy, and neural manipulation can provide substantial relief in the symptoms of postconcussion syndrome.

Introduction

A concussion is a clinical condition characterized by the alteration of brain function involving loss of consciousness caused by the biomechanical forces affecting orientation and memory. It is often called a “mild form of traumatic brain injury” [1]. The word “concussion” is rooted in the Latin word “*concussus*,” which means shaking vigorously [2]. Approximately 3.8 million concussions are reported annually, with more than 50% participating in sports. The World Health Organization (WHO) has defined postconcussion syndrome as a syndrome occurring after trauma to the head, usually sufficient enough to cause lack of consciousness, and several other symptoms, including fatigue, irritability, headache, insomnia, impairment of memory, and reduced tolerance to stress, emotional excitement, dizziness, and difficulty in concentration and performing mental tasks [3].

Simultaneous stretching of axons, increased permeability, and disruption of neuronal membranes leads to diffuse axonal injury, which forms the ultrastructural basis of concussion [4-6]. Biochemical changes include the abrupt and sudden release of glutamate, an excitatory neurotransmitter [7]. An excessive accumulation of extracellular potassium and intracellular calcium resulting from abnormal ion fluxes causes a massive excitation and depolarization of neurons, accompanied by catabolism of compensatory homeostatic ion pump-driven glucose to generate more adenosine triphosphate (ATP),

the energy currency of the cell—the excitation and hyperglycolysis phenomenon last several minutes to a few hours [8, 9]. The excitation phase is associated with seizures [10], followed by a wave of neuron suppression known as spreading depression. The depression occurs because of decreased ATP production due to malfunctioning of oxidation metabolism in the mitochondria, leading to early loss of consciousness, confusion, or amnesia found in concussed individuals [4, 6]. Cognitive deficits occur following a concussive injury due to dysfunctional neurotransmission in the cholinergic, adrenergic, or glutamatergic systems [6]. An abnormal elevation of intracellular calcium is part of a neurometabolic cascade of a concussion that occurs with the combined result of neuronal cell injury, including swelling of axons and disruption/cell deaths via apoptotic pathways [4, 6].

The manual therapy procedures used to treat postconcussion syndrome include neural manipulation, craniosacral therapy, and visceral manipulation. Upledger craniosacral therapy (CST) is a non-invasive type of manual therapy that includes gentle movements helping in the modification and correction of obstructions in the craniosacral system (CSS): Meninges, cerebrospinal fluid (CSF), CSS glia, and bones attached to the meninges. The craniosacral system surrounds the spinal cord and brain and protects, nourishes, and detoxifies the brain and spinal cord. Craniosacral therapy encourages the flow of cerebrospinal fluid into and out of the central nervous system (CNS) [11]. Autonomic nervous system (ANS) interactions and sensory and motor signals can be adversely affected if there are restrictions in the cranio-

sacral system and its components, resulting in changes in the normal physiological processes of the brain and spinal cord [12]. Glial cells help maintain brain homeostasis, regulate blood circulation, regulate CSF production and flow, regulate neuronal signaling, and develop CNS [12, 13]. Barral visceral manipulation (VM) is a manual therapy technique with gentle and specifically placed manual forces that help encourage vascularity, tone, pressure, and normal mobility [14]. Barral neural manipulation (NM) is a manual therapy technique that removes the local nerve restrictions to restore and balance the pressure between the cranium [15]. These manual therapies (CST/VM/NM) treat the vascular, neurological, and structural tissues corresponding to the concussion injury [16].

Other manual therapy techniques for postconcussion syndrome management include lymphatic drainage, massage therapy, and osteopathic manipulative treatment. Lymphatic drainage is the manual therapy technique in which fluid evacuation uses specific rhythms like the Chikly method (light touch and brain curriculum). This technique activates lymphangions, the pumping unit of lymph vessels, which enhances fluid exchange. Lymphatic drainage influences the physiological systems of the whole body mechanically [17, 18]. Massage therapy is a manual technique that manipulates soft tissues for psychological and physiological benefits. Concussion symptoms can be managed by massage therapy [19]. Osteopathic manipulative treatment (OMT) is the manual therapy technique in which there is lymphatic flow facilitation with the help of muscle energy, myofascial release, and low amplitude, high velocity. This treatment aids in clearing the inflammatory molecules from the brain and improving oxygenation [20]. Concussion symptoms like vertigo and imbalance can be treated with OMT [21, 22]. It can also be accompanied by headaches compared to relaxation exercises alone [23].

There are many treatments for postconcussion syndrome, including physiotherapy, massage therapy, chiropractic adjustments, neuromuscular rehabilitation, soft laser therapy, craniosacral therapy, low-level laser therapy, cognitive rehabilitation, biofeedback/neurofeedback, and soft tissue treatment. As a result, there is enormous conflict among the existing treatment of postconcussion syndrome symptoms. Other approaches were pharmacotherapy and cognitive behavioral therapy provided by various health professionals. Physiotherapists, psychologists, and medical professionals (sports medicine physicians) offer treatment parameters for postconcussion symptoms recovery in postconcussion survivors [24]. The role of pharmacotherapy, vestibular physical

therapy, cognitive rehabilitation, cognitive-behavioral therapy, education, rehabilitation programs, mindfulness-based interventions and relaxations, and rest has been well established, with many studies in the form of systematic reviews and even meta-analyses. There are numerous studies on novel postconcussion syndrome treatments, including hyperbaric oxygen therapy, exercise, and repetitive transcranial magnetic stimulation, in the form of systematic reviews and meta-analyses of the studies with and without randomization [25]. Manual therapies have been a topic of interest for many researchers and systematic reviewers who evaluated the effect of manual therapies on mechanical neck disorders [26] and migraines [27]. Thus, there is a shortage of research on manual therapy techniques' influence on postconcussion syndrome recovery. So, this systematic review aims at determining the impact of manual therapies like massage therapy, craniosacral therapy, lymphatic drainage, visceral manipulation, neural manipulation, and osteopathic manipulative treatment in managing postconcussion syndrome-affected individuals in sports-related injuries, combating, mild traumatic brain injuries, and accidents. The variables for assessing the recovery of postconcussion syndrome symptoms include cervicogenic headache, anxiety, quality of life (QoL), cervical range of motion, cervical muscle strength, and sleep patterns. This systematic review will also help identify the best manual treatment technique amongst the existing ones.

Materials and Methods

Protocol and registration

The guidelines of PRISMA (the preferred reporting item for systematic reviews and meta-analyses) 2015 were utilized in this systematic review of nonrandomized studies [28].

Inclusion criteria

This systematic review will include only those studies that included: a) Participants diagnosed with postconcussion syndrome symptoms like immobility, balance issues, cervicogenic pain, altered quality of life, sleep disorders, and altered cognition irrespective of the mechanism of concussion injury; b) Participants of the adult population; c) Description of the outcomes of manual therapies intervention only; d) Measuring parameters of postconcussion syndrome symptoms recovery; e) Published in the English language with available full-text.

Exclusion criteria

This systematic review will exclude those studies which are: a) Unpublished research studies and conferences; b) Studies that combined manual therapies with other treatment techniques like exercise therapy, rest, or medications.

Information sources

A systematically comprehensive electronic search was performed on the databases, namely [PubMed](#), [Research Gate](#), and [Google Scholar](#), within 10 years, from 2011 to 2021. An individual search was performed in these databases. Additional studies were done via manual search.

Search strategy

The search strategy included an initial search using key terms of “manual therapy,” “postconcussion syndrome,” “craniosacral therapy,” and “visceral manipulation.” These initial search terms were included in any combination. In the final search, ‘OR’ and ‘AND’ were used as Boolean operators in the form of “postconcussion syndrome and manual therapy,” which identified 5489 potential records. They included 10 articles from [PubMed](#), 79 from [Research Gate](#), and 5400 from [Google Scholar](#). The manual search retrieved 4 articles during the process of identification. Following an initial screening of abstracts and titles, 317 records were selected in the screening process. During the screening phase, duplicates were removed in the Mendeley software, which provided 296 records. They were assessed based on the inclusion criteria, which provided 161 articles eligible for subsequent screening. From these, 119 were excluded as their full text was unavailable. Consequently, 42 articles were deemed fit for the procedure of eligibility assessment in which 35 full-text articles were excluded because 28 articles were found irrelevant, 5 studies were not in the English language, 1 was a review, and 1 dissertation. Finally, 7 articles remained and were included in the qualitative synthesis.

Study selection

Case series, case reports, and pilot studies were utilized in this systematic review because of the scarcity of research work (randomized clinical trials or randomized cross-over trials) in manual therapy interventions for postconcussion syndrome symptoms management. Reviews, overviews, meta-analyses, systematic reviews, dissertations, editorials, unpublished articles, letters, and pre-prints were excluded. Mendeley reference manager

software was used to remove duplicates of electronic databases. The titles and abstracts of the identified records were screened, followed by full-text screening.

Data extraction and quality assessment

Data were extracted based on the study objectives. The primary outcome measures were different types of manual therapies for postconcussion syndrome management. The quality assessment of each study was done using the GRADE approach (grades of recommendation, assessment, development, and evaluation). The GRADE approach has 4 initial quality categories: High, moderate, low, and very low. Based on the GRADE approach, the case reports were graded very low, and case series and pilot studies were initially graded in the low category. Further potential grade changes are evaluated based on the five GRADE key factors. Five GRADE parameters were indirectness, publication bias, risk of bias, inconsistency, and imprecision [29].

Data collection process

The inclusion and exclusion criteria were applied to the studies retrieved from the search, irrespective of the methodological quality. Due to the unavailability of randomized studies, nonrandomized studies like case series, case reports, and pilot studies were included. However, meta-analysis, systematic reviews, unpublished work, and pre-prints were excluded. With the remaining pool of evidence, the GRADE approach was utilized. Final grade synthesis was done, and a group judgment was made with the approval of all review team members. A variety of study designs GRADE approach deemed fit for the quality appraisal for such nonrandomized studies [33].

Results

Study selection

A total of 317 potential articles were extracted from the database search via electronic media. Undergoing the PRISMA screening and eligibility procedure, only 7 articles were included in the qualitative synthesis [16, 19, 30, 31, 32, 33]. The details of the study selection are shown in [Figure 1](#). Out of 7 articles, there were 2 case series [16, 33], 4 case studies/reports [19, 20, 31, 32], and only 1 pilot study [30].

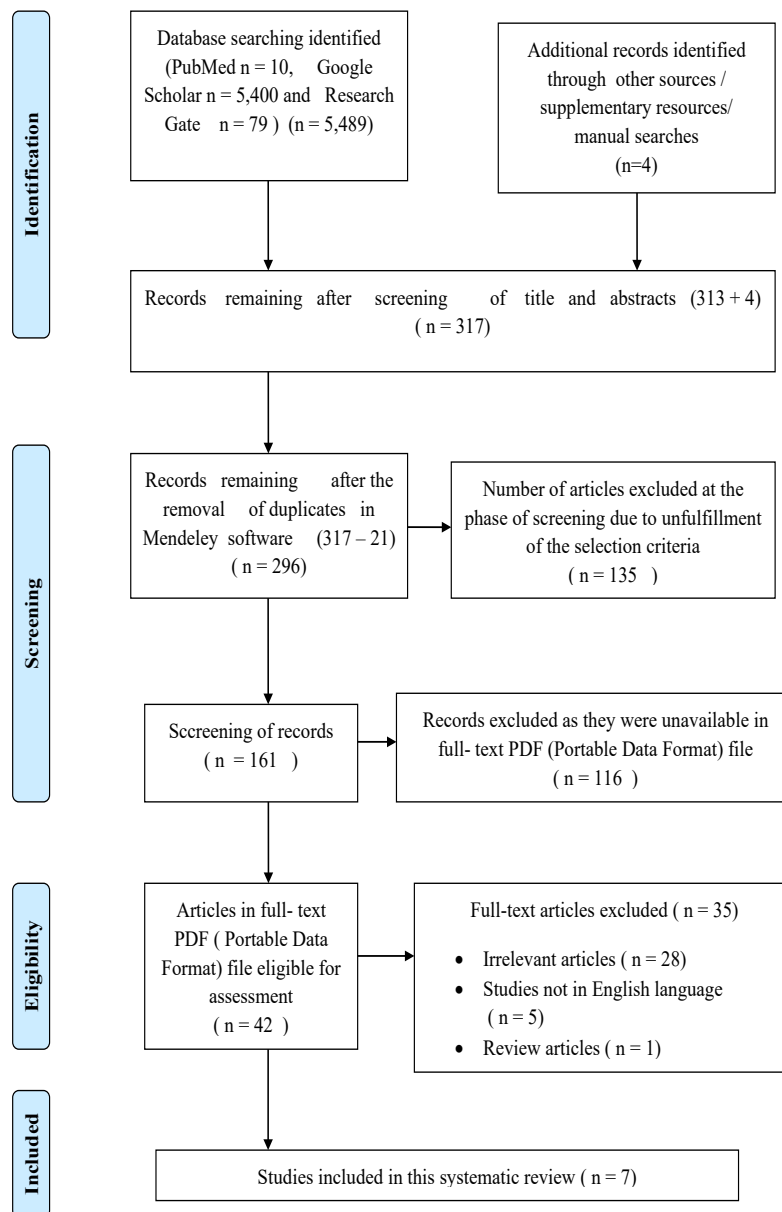


Figure 1. PRISMA flow diagram

Study characteristics

Table 1 summarizes the characteristics of the studies included in this systematic review.

Participant's characteristics of the studies included

Of 7 studies, 4 included athletic participants [16, 19, 31, 33], and the remaining 3 included non-athletic people [20, 30, 32]. The total number of participants included in the study was 32, of which 28 were males and 4 were females, from varied age groups ranging from 20 to 70 years.

Outcome measures used in included studies

Short form-36, also known as the SF-36 QoL survey, was utilized in 2 studies [16, 30]. One study used the postconcussion symptoms checklist outcome [31]. balance error scoring system (BESS) was used in 2 studies [19, 33]. Headache Impact-6 outcomes were used in 1 study [31]. Visual analog scale/numeric rating scale was utilized in 3 studies [16, 32, 33].

Quality assessment

The GRADE approach was used to assess the quality of included studies. The studies included in this systematic review were assessed based on their publication bias,

Table 1. Study characteristics

Author(s), Year and Country	Sample(s) and Research Design (RD)	Protocol	Outcome Variable(s)	Result(s)	Main Finding(s)
Wetzler et al. 2017, USA [16]	S: Eleven male retired professional football players (mean age is not mentioned) RD: Single-blinded case series	Each participant received treatment using specific CST/VM/NM techniques sessions x 5 days. Each participant received an initial evaluation in the morning of day 1, a post-evaluation in the afternoon of day 5, and a follow-up evaluation after 3 months.	Overall perceived pain level, cervical ROM, cervicogenic pain, memory score, visual and average reaction time, and QoL	Significant decrease in the participant's overall pain scores and cervicogenic pain levels. Significant increase in the AROM scores, memory scores, and neurocognitive average reaction time scores, and an increase in the sleep duration during the night as well as the issues of QoL like social functioning, emotional wellbeing, general health, level of energy, and body pain.	There is a statistically greater reduction in pain intensity and greater improvements in mechanical ROM, memory, physical reaction time, and sleep duration in patients with postconcussion up to 3 months after the intervention of providing ten sessions of specific CST/VM/NM.
Davis et al. 2016, USA [30]	S: Ten males who are accepted into IOP, positive screened for TBI and self-reported injury to the head at least 2 years before the start of the study (mean age is not mentioned) RD: A pilot study	Participants received two 60- minutes of mixed LTMT sessions 1 week apart. Certified massage therapists who have obtained advanced training in several specific LTMT techniques, including CST (Upledger, 3 levels), Brain Curriculum (Chilky, 3 levels), and VM (Barral, 5 groups) provided the CST according to the protocol's reported by Chilky (2004, 2007a, 200b), and petrissage was performed on the cervical spine for a short duration (2-5 minutes) as an LTMT session.	Anxiety, Headache, QoL	Significant reduction in the headache and anxiety with a large effect size with LTMT session indicating immediate effects from these sessions including pain in the head and a decreased level of anxiety. In the assessment center, the long-term effect of the CST included a significant decrease in pain interference.	Mixed LTMT has a significant effect in reducing anxiety, pain interference, and headache in the targeted population. LTMT may be considered a nonpharmacological intervention method.
Guernsey III et al. 2016, USA [20]	S: One 27-year-old man with a 2-day history of nausea, fogginess, and a sensation of blowing in the ear and dizziness for two days. RD: A case report	The resolution of symptoms related to concussion was achieved through a treatment session of osteopathic manipulation for a session of 25 minutes, including lifting cranial bones; low-amplitude, high-velocity to the cervical, lumbar, thoracic and sacral spinal segments; myofascial release and muscle energy to the upper thoracic and cervical spine; drainage of the venous sinus; creating balanced tension between the membranes and creating balanced tension among the ligaments of the thoracic outlet.	Dizziness, ImpACT, SCAT-3, tinnitus, and nausea balance	There is a reduction in the spinning room sensation (nausea), dizziness, and tinnitus. There is improvement in the vestibulo-ocular aspects of balance, also known as composite equilibrium.	OMT aids in the improvement of the symptoms of concussion by enhancing lymphatic drainage. A comprehensive approach is required to provide symptomatic relief to patients with concussions, including OMT. It also enhances patient outcomes and reduces the recovery time.

Author(s), Year and Country	Sample(s) and Research Design (RD)	Protocol	Outcome Variable(s)	Result(s)	Main Finding(s)
Haller et al. 2015, Germany [32]	S: One 50-year-old female, admitted for 2 weeks of integrative treatment following TBI and meningioma resection. RD: Case report/study	The patient was provided 5 1-hour sessions of CST for refractory headaches, vertigo, and cervicobrachial syndrome. In addition, she was given integrative treatment methods, including complementary, alternative, and conventional medicine. CST training was provided 5 1-hour times with special emphasis on palpation techniques at the cranium in a gentle manner. Compression of the lumbosacral/sacroiliac joint, dural tube traction, and fascial uncoiling of the lower and upper extremities via still point induction technique were the main CST technique utilized for mobilization.	Refractory headaches, vertigo, cervicobrachial syndrome, cervical mobility, muscle tension, sleep quality, and general wellbeing.	There is improvement in the flexibility of the cranial bones and the atlantooccipital joint resulting in improved cervical rotation. There is decreased numbness in the hands and neck and abdominal muscle tension. There is normalization in the posture and breathing pattern due to sacral and thoracic restrictions release. There is an improvement in the sleep pattern as sensitivity to noise decreases. General functioning/wellbeing improved by 60%.	There is decreased headache intensity from 6-9 to 2-4 cm on the VAS and vertigo symptoms from 6-10 to 2 cm, along with improvement in the quality of sleep, numbness in hands, general wellbeing, mobility, and muscle tension in the cervical region on the application of comprehensive treatment of inpatient involving CST for two weeks duration. There is a great contribution of CST in the improvement accompanied by the use of phytotherapy and hyperthermia.
Burns et al. 2015, USA [19]	S: One 23-year-old male with postconcussion syndrome resulting from a fall who was an intramural soccer player. RD: A case study	Two sessions of 45 minutes duration were delivered with two days rest in between for the treatment and assessment. At the site of injury, massage therapy techniques were applied by the massage practitioner having a license, including caudal traction in supine and prone positions, respectively, to the pelvic girdle and cervical spine (posterior) to release fascia and hypertonicities of muscles in the pelvic girdle and encouraging fascial release and range.	Fuzziness; stiffness in the neck; motion sickness; dizziness and pain level; balance, muscle strength; ROM in the cervical spine; hypertonicities in the shoulder girdle, cervical, and cranium; physical Activity; focus/concentration	There is a reduction in the symptoms as the atlanto-occipital joint was restored to the anatomical position. There is a significant reduction in headaches, medication dependency, and pain levels. There is a significant improvement in focus/concentration, level of physical activity postural balance. There is significant normalization in the hypertonicities in the cervical, shoulder girdle, and cranium, muscular strength, and neck mobility.	Muscle hypertonicity, headaches, medication consumption, and pain were reduced. There is improvement in the cervical range of motion, mental focus, posture, balance, and level of physical activity. Massage therapy is an efficient intervention in manipulation, which sensitively requires skillful palpation. Thus, it can be concluded that massage therapy techniques can be utilized as an intervention for concussion-related symptoms, especially in cases where there is atlantooccipital joint subluxation.

Author(s), Year and Country	Sample(s) and Research Design (RD)	Protocol	Outcome Variable(s)	Result(s)	Main Finding(s)
Kratz et al. 2021, USA [31]	S: One 24-year-old male athlete with repeated concussions who sustained six concussions related to sports starting from his pre-adolescent and ending at the collegiate level. The combined effect of these concussions worsened his condition in the last 18 months. RD: A case report	Manual lymphatic drainage was performed along with the following techniques: Wanveer-Glial, glymphatic release/drainage techniques, and the Chikly method of lymphatic drainage. These techniques were applied in 2 sessions. In the first session, there is a partial reduction in the pressure sensation at the head and pain caused by edema. In the second session, oxygen saturation is restored by 97%-99% by applying manual therapies to the rib cage. There are a total of 11 treatment sessions.	QoL measurement, headache impact test-6, and concussion symptom checklist	There is a marked influence on the QoL and function under all aspects followed by PCS. Headache and pressure pain is reduced in nausea and papillary reflex. The physical, emotional, sensory, and cognitive symptoms have a positive influence or decrease. There is an enhancement of the mood and development of hope for healing.	The non-invasive treatment help in the management of the central nervous system directly and is the evolving science of the human anatomy, especially the fluid model. The main cause of persistent symptoms from head injury or concussion is congestion and stagnation of the interstitial fluids, cerebral spinal, and lymphatics.
Walston et al. 2021, Kennesaw, GA [33]	Seven (4 males, 3 females) subjects diagnosed with sports-related concussions. RD: Case series	All participants were given a 3-phased treatment plan comprising exertional, cervical, vestibulo-ocular, and manual therapy components. Each patient underwent a baseline BCTT to assess for physiologic impairments.	BESS, FOTO, OHS, VOMS, NRS	There is the full resolution of symptoms, return to the prior level of function and subsequent discharge. NRS scores were decreased. VOMS tests were negative. BESS scores were reduced. There is an improvement in the FOTO OHS scores.	There is the feasibility of a symptomatic approach customized to rehabilitate concussions associated with particular sports.

Abbreviations: VM: Visceral manipulation; CST: Craniosacral therapy; NM: Neural manipulation; ROM: Range of motion; QoL: Quality of life; AROM: Active range of motion; TBI: Traumatic brain injury; LTMT: Light touch manual therapies; VAS: Visual analog scale; OMT: Osteopathic manipulative technique; SCAT: Sports concussion assessment tool; ImPACT: Immediate postconcussion assessment, and cognitive testing; BESS: Balance error scoring system; FOTO: Focus on therapeutic outcomes; OHS: Overall health status; VOMS: Vestibular/ocular motor screening; NRS: Numeric rating scale; BCTT: Buffalo concussion treadmill test.

risk of bias, indirectness, imprecision, and inconsistency. The 4 grades for reviewing the body of evidence of the study were high, moderate, low, and very low. Table 2 summarizes the quality of the included studies. The reviewers rated 4 studies [19, 20, 31, 32] in the very low category and 3 studies [16, 30, 33] in the low category, depending upon the study design.

Additional analysis

Effect of manual therapies on pain

Ten sessions of neural manipulation, visceral manipulation, and craniosacral therapy were administered in one

series on 11 male retired professional football players diagnosed with postconcussion syndrome. They reported a statistically significant reduction in pain intensity, as illustrated through a numeric pain scale (P=0.0448) [16]. Another pilot study employed mixed light touch manual therapies, including craniosacral therapy, visceral manipulation, and brain curriculum in two sessions of 2 hours each on 10 participants with postconcussion symptoms from injury to the head and post-traumatic stress disorder. They reported a significant decrease in the pain level (P=0.039) [30]. A case series on 7 patients with sports-related concussions used cervical, vestibulo-ocular, and manual therapy rehabilitation and reported a change in the pain level on the numeric rating scale

Table 2. Quality appraisal of study design

Study	Study Design	Initial GRADE Rating	GRADE Change Considerations	Final GRADE Rating
Wetzler et al. [16]	Case series	Low	Not eligible	Low
Davis et al. [30]	Pilot study	Low	Not eligible	Low
Haller et al. [32]	Case report	Very low	Not eligible	Very low
Kratz et al. [31]	Case report	Very low	Not eligible	Very low
Guernsey III et al. [20]	Case report	Very low	Not eligible	Very low
Burns et al. [19]	Case report	Very low	Not eligible	Very low
Walston et al. [33]	Case series	Low	Not eligible	Low

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(mean=4.3) [33]. A case study was performed in which massage therapy was administered as concussion treatment and found significant changes in pain levels on the visual analog scale—before the treatment, it was 8-9/10. After treatment, it was 0/10 [19].

Effect of manual therapies on headache

A significant decrease in headache ($P=0.031$) was reported in the pilot study of 10 patients on applying mixed light touch manual therapies (LTMT) protocols of two sessions of 2 hours each. Measure yourself medical outcome profile-2 was utilized to measure headache intensity [30]. A case study was done on a 24-year-old athlete with postconcussion syndrome symptoms and reported 90% relief from the initial headache level on the headache impact test-6 outcomes till the eleventh session. The researcher used specific craniosacral therapy techniques and manual lymphatic drainage techniques [31]. In a case study, craniosacral therapy was implemented in a patient with a traumatic brain injury that reported decreased headache intensity on a 10 cm visual analogue scale from 6-9 cm to 2-4 cm in the weeks intervention [32]. A case study on massage techniques for concussion treatment reported significant positive outcomes on headache intensity [19].

Effect of manual therapies on cervical range of motion

A case series was performed on 11 individuals diagnosed with postconcussion syndrome [16]. The cervical range of motion was reported to increase with the manual therapy interventions with a statistically significant ($P=0.0377$). Another case study was conducted utilizing massage therapy techniques like soft tissue release and

reported significant changes in the range of motion of the cervical spine. Before the intervention, there was reduced cervical rotation, lateral tilt, and forward flexion, while after the treatment, the cervical spine range of motion was within the normal range in all planes based on muscle testing of the cervical spine [19].

Effect of manual therapies on balance

A case study on concussion treatment utilizing massage techniques was conducted, which reported a significant change in the BESS (balance error scoring system) from 60/60 to 35/60 [19]. Another study was a case series of symptomatic treatment for sports-related concussion rehabilitation in adolescents. An average decrease of 17.4/60 in BESS scores was reported (the minimum detectable change was 9.3) [33]. A case report was conducted to resolve concussion symptoms after osteopathic manipulation, which reported an increase in the equilibrium from 76 pre-treatment to 81 post-treatment on the sensory organization test on SMART balance master [20].

Effect of manual therapies on sleep

Sleep disturbance was founded to decrease ($P=0.508$) on the neuro-QoL SF v 1.0 survey. In this study, a pilot study of 10 participants was performed in treatment [30]. Similarly, average hours of sleep per night were reported to increase on 5 days of treatment and continued to increase until follow-up in the case series [16].

Effect of manual therapies on QoL

In a case series performed on 11 retired male professional football players, QoL was significantly increased on the follow-up concerning energy level, general

health, social functioning, and emotional wellbeing and social functioning, using the short form-36 survey-QoL survey [16]. A pilot study evaluating the influence of mixed LTMT on chronic post-traumatic stress disorder and injury to the head among duty soldiers reported that LTMT had improved the QoL with respect to positive effects and wellbeing in social roles and activities. There is no change in the applied cognition executive functions, sleep disturbance, and satisfaction with QoL's social roles and activities parameters. There is a negative effect of LTMT on QoL factors like emotional and behavioral dysfunction, upper and lower extremity mobility, applied cognition, stigma, and general concerns. The neuro-QoL bank v1.0 was utilized for reporting the respective increase and decrease in QoL parameters [30].

Discussion

This systematic review was performed to determine the impact of manual therapies on postconcussion syndrome symptoms recovery parameters. After the systematic search, 7 articles were found, with study design levels ranging from very low to low quality because their design was case series and case report [16, 30, 33]. The remaining 4 studies were rated as very low quality consisting of a case report/study as a study design [19, 20, 31, 32]. Further research should support this evidence.

Regarding the study design, the highest quality of manual therapy interventions was seen in the pain reduction of the postconcussion syndrome [16, 19, 30, 33]. However, manual therapies play a significant role in the resolution of several other postconcussion symptoms as reported in low-quality evidence like reduction in headache intensity [19, 20, 31, 32], improvement in balance [19, 20, 33], improvement in QoL [16, 30], increased cervical range of motion [16, 19] and improvement in sleep patterns [16, 30]. Several other parameters of postconcussion symptoms recovery were insignificant in applying manual therapies, like cognition, immobility, memory, and reaction time. According to the synthesis of evidence, it is indicated that individuals with postconcussion syndrome may get benefited from manual therapy techniques. Manual techniques like craniosacral, massage, visceral, and neural manipulation may reduce postconcussion symptoms like pain, balance, quality of life, and headache.

In this systematic review, 7 studies examined manual therapy in postconcussion syndrome recovery. Different types of manual therapeutic techniques were utilized, which are craniosacral therapy [16, 30, 31, 32], massage therapy [19], visceral manipulation [16, 30], manual lym-

phatic drainage [31], neural manipulation [16], brain curriculum [30], osteopathic manipulative treatment [20], and generalized manual therapy (soft tissue mobilizations; thoracic manipulation and spinal mobilization) [33].

The results of this systematic review revealed that out of 6 manual therapy techniques for concussion management (craniosacral therapy, visceral manipulation, neural mobilization, massage therapy, osteopathic manipulative treatment, and general manual therapy), the most effective treatment was craniosacral therapy which was used in 4 studies [16, 30, 31, 32], followed by the visceral manipulation in two studies [16, 30]. Little evidence was in favor of the osteopathic manipulative treatment [20], massage therapy [19], brain curriculum [30], general manual therapy [33], and neural manipulation [16]. Thus, different types of manual therapies were incorporated in the included studies as a treatment intervention revealing a varied range of effects on the different parameters of the postconcussion syndrome symptoms recovery.

Study limitations

This systematic review had several limitations because the included studies have low quality, initially leading to uncertainty in making more robust conclusions. The limitations included a small sample size, lower-level study designs, and inconsistency in sample inclusion criteria (e.g. athletic and non-athletic population). Different tests and outcome measures were utilized in the included studies to perform the data analysis. These factors contribute to difficulty in synthesizing results across the included studies. One study by Davis et al. [30] included patients with post-traumatic stress disorder for prolonged periods and head injury. Likewise, in another case study by Haller et al. [32], the inclusion criterion was whether the postconcussion syndrome symptoms recovered. Thus, further research is required to provide clarification in the form of strong evidence studies like randomized controlled trials and cross-over trials. Studies included in this review had different protocols and methodologies. Some studies have conducted follow-ups [16, 30, 31, 32], while the remaining studies have not [19, 20, 32]. There is variation in the timing of intervention of the included studies. A 25-min single session of osteopathic manipulative treatment was given in one study [20], while in another study, there was a complete 2-week inpatient treatment [32]. In another study, two 45-min sessions with 2 days rest in between was conducted [19]. On the other hand, a 3-phased treatment plan including cervical, vestibulo-ocular, and manual therapy components was executed in one study [33].

Similarly, one study gave treatment for 5 days twice per day, and another pilot study in which two sessions of 60 minutes duration were scheduled 1 week apart [30]. Hence, the variation in the treatment duration exists in the studies included.

Also, there was limited access to the database making the review dependent on open-access databases like PubMed, Google Scholar, and Research Gate. Search algorithms were limited, too. Another limitation lies in the lack of generalized findings of the results of the included studies.

Future scope of the study

Postconcussion syndrome is a major concern as it may cause serious illnesses in the athletic and non-athletic populations. Physical therapists specializing in sports and neurological conditions can find this systematic review valuable in gaining knowledge regarding the new treatment in postconcussion recovery. The present study seems to be the first systematic review evaluating the existing contribution of manual therapeutics in treating individuals diagnosed with postconcussion syndrome. There is a growing requirement for the firm-quality evidence regarding postconcussion interventions to determine the beneficial effects of manual therapy and enable physiotherapists and manual therapy practitioners to include these treatment options to rehabilitate postconcussion syndrome patients. There is a shortage or lack of research evaluating manual therapy intervention in these populations. This systematic review is going to provide preliminary evidence for future studies. This study revealed different intensities of the effect of manual therapies on various parameters of postconcussion syndrome symptoms recovery. Of the 7 eligible studies, 4 claimed the effectiveness of manual therapies on the pain parameter and headache parameter of the postconcussion syndrome symptoms recovery, respectively. Three studies demonstrated the effectiveness of manual therapies on balance, and 2 studies showed efficacy on QoL, cervical range of motion, and sleep. Several other parameters, like dizziness, sleep disorders, and cognition, seem unaffected. Craniosacral therapy was most effective compared to other manual therapy techniques. This review further highlights the need for future good-quality randomized studies to support and confirm the existing findings and gather fruitful information regarding the effectiveness of manual therapy techniques in postconcussion syndrome. Upcoming research can focus on clinical trials, cohort studies, and cross-over trials so that meta-analysis can be performed and high-quality evidence can be gathered.

Conclusion

The results of this systematic review conclude that manual therapies are a treatment option for managing an individual diagnosed with postconcussion syndrome. Craniosacral therapy was the manual therapy technique that was found most effective in managing individuals with postconcussion syndrome. However, more studies were required in randomized controlled and clinical trials to reach any firm conclusion.

Ethical Considerations

Compliance with ethical guidelines

The protocol of this systematic review was registered by PROSPERO (Code: CRD42021239078).

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Authors' contributions

All authors equally conducted this systematic review.

Conflict of interest

The authors declared no conflict of interest.

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