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Does Early Physical Therapy and Vestibular Rehabilitation after a Sports-related Concussion Decrease the Amount of Time for Symptom Resolution When Compared to the Standard of Care?

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Does early physical therapy and vestibular rehabilitation after a sports-related concussion decrease the amount of time for symptom resolution when compared to the standard of care?

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A SELECTIVE EVIDENCE BASED MEDICINE REVIEW

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ABSTRACT

OBJECTIVE: The objective of this selective EBM review is to determine whether or not early physical therapy and vestibular rehabilitation after a sports-related concussion (SRC) decreases the amount of time for symptom resolution compared to the standard of care.

STUDY DESIGN: Systematic review of two randomized controlled trials published in 2014 and 2017, and one case series published in 2010.

DATA SOURCES: All articles, which analyzed the effect of vestibular therapy on treatment of concussive symptoms, were presented in English and were taken from peer-reviewed sources using PubMed and EBSCOhost.

OUTCOMES MEASURED: Days from onset of vestibular rehabilitation for persisting concussive symptoms to medical clearance for return to play (RTP) through the clinical judgement of a sports medicine provider, and subjective resolution of concussive symptoms on symptom severity scales.

RESULTS: The two RCT's performed by Schneider et. al. and Reneker et. al. yielded a significant reduction in return-to-play time and symptom resolution in patients receiving vestibular rehabilitation when compared to the control ($p<0.001$). The case series by Alsalaheen et. al. utilized ANOVA to show a positive correlation between vestibular therapy for resolution of post-concussive symptoms ($p<0.001$).

CONCLUSIONS: Outcomes measured in these three studies demonstrate that earlier physical therapy and vestibular rehabilitation is effective in reducing a teenage or young adult athlete's time to return-to-play after sustaining a sports-related concussion, when compared to the standard of care, as it aids in symptom resolution. Further studies can be done with larger sample sizes to reinforce the significant outcomes.

KEY WORDS: concussion, vestibular, rehabilitation, dizziness

INTRODUCTION

Concussions are a form of mild traumatic brain injury (mTBI) that result in a short-term functional brain deficit with the absence of structural damage. In colloquial terms, a concussion is a "brain injury" caused by a blow to the head. Concussions can result from a number of inciting events: motor vehicle accidents, a slip-and-fall, a violent shaking force, or sporting events. The classic and most common symptoms of a concussion are an acute onset of a headache following head trauma and resulting dizziness. Other associated signs and symptoms may include nausea and vomiting, confusion, disorientation, irritability, emotional lability, inability to concentrate, aversion to light and sound, and occasionally a brief loss of consciousness or amnesia. The presentation of a concussion may vary widely, and it is important for healthcare providers to identify symptoms and provide treatment accordingly.

Concussions are a very common occurrence United States and are evaluated by ER physicians, pediatricians, nurses, and physician assistants almost every day. For those aged 15-24 years old, sports are the second leading cause of traumatic brain injury, succeeding only motor vehicle accidents.[1] There are an estimated 1.6 to 3.8 million sports concussions that occur annually; however, this number may be underestimated because many incidents can go unreported.[1] Although specific statistics on sports-related concussions (SRC's) and mTBI's were not reported, all TBI's, including severe TBI, in the United States accounted for $76.5 billion in healthcare costs and TBI is the diagnosis in approximately 2.5 million emergency department visits each year.[1] It is important to note that a "concussion" will not show up on a CT scan or an MRI, but these costly tests may be warranted in cases of severe head trauma to rule out a more serious brain injury or brain bleed.[2] Based on the incidence alone, concussion treatment and management is well-within the scope of the PA practice.

The current standard of care for concussion treatment is to rest until free of all symptoms, but the exact amount of rest time is not well-defined and requires further study.[3] Specifically for an SRC, athletes are removed from all sports activities for several days until all concussive symptoms resolve and are then re-evaluated.[4] After a period of physical and cognitive rest, athletes return to play via a tailored graded exertion program.[2] Medical treatment of persistent post-concussive symptoms may include acetaminophen or low-dose amitriptyline for headaches and low-dose promethazine, a vestibular suppressant, for dizziness.[4] However, athletes must caution with medication use because it may mask symptoms that would allow for medical clearance to return to play. Following this protocol, most patients recover within 10-14 days of symptom onset; however, some can develop persistent symptoms exceeding this timeframe.[3] The current standard management of concussions is widely accepted, but there is insufficient evidence to prove that complete rest is necessary to ease discomfort during acute recovery and that minimizing energy demands will decrease symptoms.[3] Early physical therapy and vestibular rehabilitation for treatment of an SRC is being proposed because even though the majority of athletes recover within two weeks of a concussion, these therapies could augment symptom improvement. The amount of rest needed for symptom recovery is insufficiently studied, and sources suggest that the proposed interventions aid in the resolution of persistent post-concussive symptoms. This paper evaluates two randomized control trials (RCT's) and one case series comparing the effect of early physical therapy and vestibular rehabilitation to the standard of care regarding time to resolution of concussion symptoms.

OBJECTIVE

The objective of this selective EBM review is to determine whether or not early physical therapy and vestibular rehabilitation after a sports-related concussion decreases the amount of time needed for symptom resolution when compared to the standard of care.

METHODS

The specific criteria used for the selection of all three studies for this review included patients aged 13-29 years old who had sustained an SRC within the past 7-10 days and suffered persistent symptoms. Patients in each study received vestibular therapy following their concussion and return to play time was compared to those receiving the standard of care. Measured outcomes included time needed for symptom recovery, specifically gait disturbances and dizziness. Types of studies utilized for this review included two RCTs comparing vestibular therapy to rest for concussion symptom resolution and one case series examining the effect of vestibular therapy for post-concussive symptom treatment.

Each data source used in this review was selected via a PubMed or CINAHL Plus search utilizing the following key words: vestibular, rehabilitation, dizziness, and concussion. Articles were chosen on the basis of pertinence and relevance to the clinical question and the inclusion of patient-oriented outcomes (POEMs). Each article was a published in English in a peer-reviewed journal between the years 2010 and 2017. Inclusion criteria for studies included those that were published after 2008 and ones that incorporated data from those aged 13-29 years old. Exclusion criteria included studies that did not evaluate any sports-related concussions. The statistics utilized and reported in this selective EBM review include numbers needed to treat (NNT), p-value, and ANOVA F-score.

Table 1: Demographics and Characteristics of Included Studies

Study	Type	# patients	Age	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Schneider[5] (2014)	RCT	31	12-30	Patients with a diagnosed sports-related concussion and persistent symptoms (>10 days) of dizziness, neck pain, or headaches reported on the SCAT2	Patients with fracture, other neurological conditions, skeletal injuries that restrict activity, medications that affect neural adaptation	2	Weekly sessions for eight weeks of postural education, range of motion exercises and cervical spine and vestibular rehabilitation
Alsalaheen[6] (2010)	Case Series	141	8-73	Patients referred to a tertiary balance center between 2006 and 2008 after being diagnosed with a concussion	None reported	30	Vestibular rehabilitation prescribed daily: gaze stabilization, standing balance, walking with balance
Reneker[7] (2017)	RCT	41	10-23	Patients with migraine symptoms plus one of the following: a score 3/7 on the Likert dizziness scale, a score of 10 within the 9-item migraine cluster, vestibular abnormalities on physical exam	Patients not managed by a sports medicine provider, symptoms did not meet threshold for inclusion, sustained concussion from MVA	4	Eight sessions over four weeks of vestibular rehabilitation (habituation and adaptation) and balance exercises

OUTCOMES MEASURED

The outcomes measured in each of the selected data sources incorporate patient-oriented outcomes, including days from onset of vestibular rehabilitation for persisting concussive symptoms to medical clearance for return to play (RTP) through the clinical judgement of a sports medicine provider. Medical clearance for a graded physical exertion protocol is granted based on the subjective and objective resolution of all concussive symptoms. Concussion signs and symptoms were evaluated via multiple self-reported symptom scales and objective gait assessments and neurological examinations. The study performed by Schneider et. al. utilized evaluation of neurologic function by a blinded sports medicine physician to objectively measure symptom recovery.[5] This study also subjectively measured patient's symptoms utilizing the Sport Concussion Assessment Tool 2 (SCAT2) and Dizziness Handicap Index (DHI).[5] The primary outcome measured was the number of days from treatment initiation to medical clearance to return to play, which was based on symptom resolution.[5] In the case series presented by Alsalaheen et. al., symptom recovery was subjectively reported on a dizziness scale and gait and balance improvement was objectively measured.[6] Self-reported measures included a dizziness severity score on a scale of 0 to 100 and objective measures included a Dynamic Gait Index (DGI) with a maximum score of 24.[6] The primary outcome measured was symptom recovery, specifically dizziness reduction and balance improvement.[6] The study performed by Reneker et. al. utilized similar subjective and objective measurements of symptom severity. Symptomatic recovery was based on the patient-reported Post-Concussion Symptom Scale (PCS).[7] Medical release to return to play was at the discretion of a blinded sports medicine provider based on objective physical examination.[7] The principal outcome measured was time from vestibular treatment initiation to medical clearance.[7]

RESULTS

The study performed by Schneider et. al. is an RCT that analyzed patients aged 12 to 30 years old who sustained an SRC, had persistent symptoms greater than ten days, and reported dizziness on the SCAT2.[5] Patients in this study presented to a primary care setting for an acute SRC and were referred to the University of Calgary Sports Medicine Centre for continuing vestibular symptoms. Patients were excluded from the study if they sustained a cervical fracture, suffered from other neurological conditions, sustained other musculoskeletal injuries, or were taking medications that alter neurological adaptation.[5] These patients were excluded because these variables could have an impact on persistent concussive symptoms when compared to vestibular involvement alone, and these factors could alter the natural progression of concussion resolution as well as response to treatment. There were 58 patients referred to the sports medicine center, 12 were excluded for reasons stated above, and 14 chose not to participate in the study.[5] Of the remaining 31 patients, two failed to complete the eight-week treatment course. Patients were randomly allocated into either a control group or a treatment group, which received vestibular therapy in addition to basic physical therapy, postural education, and range of motion exercises over an eight-week course. Patients were seen once weekly by their physical therapist and expected to complete at-home exercises every day, and compliance was self-reported by patients as follows: 66.7% (10/15 patients) for the treatment group and 64.3% (9/14 patients) for the control group.[5] At the completion of eight weeks of physical therapy and vestibular rehabilitation, 11/15 patients in the treatment group were medically cleared and only 1/14 patients in the control group was granted clearance. In the treatment group, 66.2% (95% CI 40, 97.3, $p<0.001$) of patients responded to the clinical intervention.[5] Patients in the treatment group were 10.27 (95% CI 1.51, 69.56) times more likely to obtain medical clearance for RTP when

compared to the control group.[5] All patients who were cleared for RTP reported no symptoms of dizziness or headache on the SCAT2. For patients in the treatment group who were cleared, they reported greater symptom improvement on the SCAT2 (p=0.009) and the DHI (p=0.019), when compared to those who were not cleared.[5] RBI, ABI, and NNT calculations are reported in Table 2. No safety statistics or adverse effects of this particular treatment were reported in this study.

Table 2: Calculations for Treatment from Schneider et. al. and Reneker et.al.

Study	CER	EER	RBI	ABI	NNT	p-value
Schenider et. al.[5]	0.077	0.733	8.52	0.726	2	<0.001
Reneker et. al.[7]	0.58	0.82	0.41	0.24	5	None reported

The case series performed by Alsalaheen et. al. analyzed 114 patients, including 67 children aged 18 and younger and 47 adults over 18 years old.[6] Patients included those that presented to a primary care setting for persisting concussive symptoms and were referred to a tertiary balance center for vestibular rehabilitation.[6] No exclusion criteria were presented in this study. A retrospective chart review was performed on the records of the 114 patients and a mixed-factor repeated-measures analysis of variance (ANOVA) was completed to determine if vestibular therapy affected patient outcomes.[6] Out of the 114 patients referred to the balance center, 30 of them only attended one session, with the main reason being unwilling to comply with treatment strategies.[6] For dizziness severity scores pre-treatment and post-treatment, there was a significant decrease in symptom severity from 21 points to 12 points ($F_{1,62}$=11.4, p<0.001), and there was a significant increase in DGI from 20 points pre-treatment to 23 points post-treatment ($F_{1,46}$=42.6, p<0.001), as presented in Table 3.[6] Specifically for dizziness severity, there was a significant interaction between treatment and age ($F_{1,62}$=8.6, p=0.005).[6] Children exhibited a significant decrease in dizziness severity by an average of 19 points ($F_{1,40}$=31.0, p<0.001), while adults did not demonstrate a significant difference in symptom severity

($F_{1,22}$=0.06, p=0.805).[6] In this study, there were no reports on safety, tolerability, or adverse effects of treatment.

Table 3: Mean (SD) of Outcome Measures at Times of Initial Evaluation and Discharge

Outcome Measure	Pre-treatment	Post-treatment	F test, p-value
Dizziness severity	21 (22)	12 (18)	$F_{1,62}$=11.4, <0.001
DGI	20 (3)	23 (1)	$F_{1,46}$=42.6, p<0.001

The study completed by Reneker et.al. is a double-blind RCT that analyzed patients aged 10 to 23 years old who presented to a sports medicine center with acute SRC and dizziness, and had persisting symptoms greater than ten days after the initial injury.[7] Patients were excluded from this study if their concussion was secondary to an MVA or if their symptoms were not severe enough to benefit from vestibular intervention.[7] Enrolled patients (41) were randomized into an experimental group (22) that received tailored physical and vestibular rehabilitation and a control group (19) that received sub-therapeutic "sham PT" to ensure blinding.[7] Continuous data was reported in the form of days from onset of therapy to RTP medical clearance, which was converted to dichotomous data comparing if patients did or did not obtain clearance at the end of the four-week program. Four patients dropped out of the study, resulting in 95% compliance in the experimental group and 74% in the control group, and worst-case analysis on these patients was utilized during data analyzation.[7] At the conclusion of the four-week rehabilitation program, 81.8% of patients (18/22) in the experimental group responded to the clinical intervention and were cleared for RTP, compared to only 57.9% of patients (11/19) in the control group.[7] The median number of days to medical clearance was 15.5 for the experimental group and 26 for the control group, and the median number of days to subjective symptomatic recovery on the PCS was 13.5 for the experimental group and 17 for the control group.[7] A hazard regression was performed, which yielded a 2.91 (95% CI 1.01, 8.43) times faster rate of medical clearance for

the experimental group when compared to the control.[7] It was also noted that those in the experimental group with a history of previous concussion obtained clearance 1.99 (95% CI 0.95, 4.15) times faster than those without a previous concussion, and reported symptom recovery 2.53 (95% CI 1.22, 5.26) times faster.[7] RBI, ABI, and NNT calculations are reported in Table 2. In terms of safety and tolerability, 17 out of 19 patients in the control group reported unexpected symptom provocation during exercises, and one patient dropped out due to symptom severity. Some symptom provocation was expected in the experimental group in order to elicit a treatment response.[7]

DISCUSSION

The RCTs performed by Schneider et. al. and Reneker et. al. demonstrated the feasibility of implementing vestibular rehabilitation strategies into the treatment plan for those with persisting concussive symptoms after an SRC. In Schneider's study, the calculated NNT is 2, which translates to a large treatment effect.[5] Similarly, Reneker's study yielded an NNT of 5, and while it is larger, still shows there was a large treatment effect.[7] Patients were shown to have benefitted from the clinical intervention, in that their RTP times were obtained sooner than patients in the control group. The case series performed by Alsalaheen et. al. showed a positive association between vestibular rehabilitation and improvement of persisting post-concussive symptoms, specifically dizziness and gait abnormalities.[6] These studies show that in the future vestibular rehabilitation may have a crucial role for treatment of post-concussive symptoms in athletes wishing to return to their sports following an SRC.

Although the three studies analyzed in this selective EBM review show that vestibular rehabilitation produces a moderate to large treatment effect for relieving symptoms of an SRC, each has its limitations. In Schneider et. al., patients were not blinded to the treatments they were

receiving, which could have created an expectation bias in subjective symptom recovery time.[5] Also, although outcomes measures were significant, as conveyed by the p-value, results were expressed with a wide confidence interval, limiting some credibility in the results. The wide confidence interval can be attributed to a small sample size of patients, which limits the generalizability of the results. The case series presented by Alsalaheen et. al. analyzes patients across a wide demographic, including children and adults, and patients who suffered a concussion secondary to multiple causes, rather than sports-related alone.[6] This makes it more difficult to deduce if the proposed treatment can be targeted to a specific subset of the population. Similar to Schneider's study, the RCT by Reneker et. al. analyzed a small sample size of patients, limiting its generalizability.[7] Also, patients received tailored physical and vestibular therapy programs based on their specific presenting symptoms.[7] The studies analyzed in this selective EBM review are the first performed to see if the proposed treatment for an SRC can be safe and effective, and more will need to be completed for greater generalizability among the population.

Vestibular treatment for post-concussive symptoms in athletes is becoming increasingly popular, but there are some limitations to this treatment. For one, each program must be tailored specifically to the particular athlete. Concussions present with a range of symptoms of varying severity, and some present with more of a severe functional injury to the brain than others. In the upcoming years, if vestibular therapy is implemented into an athlete's management plan, it will become an art of matching specific therapies to responding symptoms. Also, we as clinicians are only beginning to steer away from the widely accepted concept of "strict rest" after sustaining a concussion. Because this is such a new treatment strategy, we are unaware of potential long-term adverse effects, if any, on the patients' brains if they resume physical activity while experiencing

persistent symptoms. Finally, insurance companies can be fickle in their coverage of physical therapy, so availability to therapies may be limited to some patients, due to its cost. Hopefully, in the upcoming years, diagnosis of post-concussive symptoms can aid in insurance coverage for vestibular rehabilitation and physical therapy.

CONCLUSION

The two RCTs and one case series analyzed in this selective EBM review support that vestibular rehabilitation has a place in treatment of persisting symptoms of a sports-related concussion in teens and young adults. Although studies were limited by a relatively small sample size, these outcomes show a significant decrease in time from treatment initiation to return-to-play when compared to the standard of care, which can mostly be generalized to the studied population. Currently under the standard of care for concussion treatment, the amount of strict rest time is undefined in the literature, and symptom recovery can be augmented by the addition of vestibular therapy for persisting post-concussive symptoms. If feasible in the future, it would be interesting to study either only high school students or only collegiate athletes across one sport, and compare it to other sports to see if any disparities arise. Also, a cohort study on these patients could be performed down the line to inquire about the long-term safety of utilizing vestibular therapies with an acute brain injury. Every patient is different and concussions can present with a wide variation in symptoms, and individually-tailored exercise programs and vestibular rehabilitation strategies have been shown improve symptom recovery and allow athletes an expedited road to returning to play their sport.

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