Journal of Athletic Training 2016;51(9):739–742
doi: 10.4085/1062-6050-51.12.01

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Physical Activity and Intermittent Postconcussion Symptoms After a Period of Symptom-Limited Physical and Cognitive Rest

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Reference: Schneider KJ, Iverson GL, Emery CA, McCrory P, Herring SA, Meeuwisse WH. The effects of rest and treatment following sport-related concussion: a systematic review of the literature. *Br J Sports Med.* 2013;47(5):304–307.

Clinical Question: After concussion and a period of symptom-limited physical and cognitive rest, do athletes who experience intermittent symptoms return to asymptomatic condition more quickly with physical activity than with prolonged physical rest?

Data Sources: One investigator performed an individual search for each research question using the following databases: CINAHL, Cochrane Controlled Trials Registers, EMBASE, HealthSTAR, ProQuest, PsychInfo, PubMed, SPORTDiscus, and Web of Science. Search terms for *rest* were *brain concussion, cognitive rest, mild traumatic brain injury, physical exertion, postconcussive syndrome, rehabilitation, sport-related concussion, therapy, treatment,* and *treatment outcome*. Search terms for *treatment* were the same terms as for rest, as well as *brain training, cervical spine, cognitive therapy, dizziness, exercise, headache, neck, pharmacotherapy, postural balance,* and *vertigo*. The authors included peer-reviewed, published articles and abstracts and performed a citation search.

Study Selection: Studies were included based on the following criteria as determined before searching: classified as original research, symptoms resulted after sport-related concussion, and investigation of the effects of either rest or treatment on symptoms. Abstracts that were excluded failed to evaluate rest, omitted sport-related concussion as the cause of symptoms, failed to evaluate a treatment's effect on sport-related concussion, or did not present original research.

Data Extraction: The following data were extracted from each study that fit the selection criteria: study design; sample size; participants' demographic information (age and sex); type, duration, and intensity of treatment; key findings including effect sizes and means with 95% confidence intervals (calculated when possible using the data provided in the original study, even if not presented in the original study); and relevant comments.

Main Results: The search revealed 749 articles evaluating the effects of rest and 1175 articles evaluating the effects of treatment. Of the 749 articles evaluating the effects of rest, only 2 met all the inclusion criteria. Of the 1175 articles evaluating the effects of treatment, only 10 met all the inclusion criteria. Ultimately, the authors were able to identify additional treatment articles that met the inclusion criteria, for a total of 12. The nature of the treatments and the participants differed enough that meta-analysis was not possible.

One of the 2 articles that evaluated rest was a retrospective analysis of athletes that showed those who were prescribed a period of cognitive rest had a longer duration of symptoms. The other study followed athletes postconcussion who were retrospectively assigned to groups based on self-reported activity level after injury. Those who reported moderate levels of cognitive and physical exertion over the first month postinjury appeared to demonstrate improved outcomes compared with those who pursued small or large amounts of activity.

Twelve studies evaluated the effects of treatment on symptoms after sport-related concussion. Various interventions were reviewed, including pharmacotherapy, light aerobic activity, graded exercise treadmill test, hyperbaric oxygen therapy, vestibular physiotherapy, and cervical spine manual therapy. Unfortunately, the authors did not report effect sizes for specific interventions, and due to the varied nature of each study and its respective treatment approach, no pooled data could be analyzed. However, a group of adolescents treated with submaximal aerobic and coordination exercises, visualization, and imagery returned to full normal physical activity at a mean duration of 4.4 weeks (95% confidence interval = 3.1, 5.7 weeks). Furthermore, a randomized controlled trial of patients experiencing persistent neck pain, dizziness, and headaches who underwent manual and physical therapy showed they were more likely to return to sport after 8 weeks of treatment. Despite the inability to pool data, the authors concluded that each treatment appeared to positively influence specific aspects of certain patients' symptoms.

Conclusions: Little high-quality evidence has addressed the effects of rest and treatment after sport-related concussion. Current evidence suggests that an initial period of rest appears to be beneficial. Further research is needed to evaluate the long-term outcomes of rest (including the quality and quantity of the rest). Low levels of exercise may benefit the athlete postinjury, but additional study is required to determine the optimal timing for initiation of treatment postinjury. Patients with cervical spine or vestibular dysfunction may benefit from rehabilitation techniques targeted at their individual symptom profile to facilitate recovery. Overall, we need high-quality studies evaluating resting period, pharmacologic interventions, rehabilitative techniques, and exercise and their effects on patients slow to recover from concussion symptoms.

COMMENTARY

A common injury encountered by sports medicine providers and publicized by sports media outlets is concussion. Typically, the diagnosis of concussion is based on the examination and interpretation of somatic, cognitive, behavioral, and emotional symptoms and signs after direct or indirect forces that cause brain injury.[1] A generally accepted principle of concussion is that symptoms appear quickly, are relatively short in duration, and often resolve spontaneously.[1] Expert consensus holds that the appropriate management of most concussions includes a period of rest during symptom resolution, followed by a gradual return to physical activity.[1] However, approximately 10% to 15% of patients do not experience the expected spontaneous resolution of symptoms.[1] Given that concussion symptoms typically resolve in 7 to 10 days[1] in adults, a clinical question can be asked as to whether persistent symptoms are from the initial concussion or the long-term sequelae of concussion related to the initial injury? Due to the overlap of symptoms between many conditions and concussion,[1] this information invites the question, "Are there interventions that may improve outcomes in individuals suffering persistent symptoms after concussion?"

Schneider et al[2] performed a systematic review of the available literature to examine the effects of both rest and treatment after sport-related concussion. The authors evaluated a total of 14 articles (2 on rest and 12 on treatment). Overall, despite the dearth of evidence on the topic, the authors[2] concluded that a period of symptom-limited physical and cognitive rest after concussion is probably beneficial. Also, although the authors[2] did not report the effect sizes of specific treatments, it appears that particular patients, based on physical examination and symptom presentation, may benefit from certain interventions.

Before discussing the length of rest recommended after concussion, it is important to understand the concept of symptom-limited rest as it relates to physical and cognitive stress. *Symptom-limited rest* includes the removal from both physical tasks (eg, participation in sports and military duties, household chores, outings) and mental exertion (eg, use of television, smartphones, and other electronic devices and participation in academic pursuits such as reading and writing).[3] Symptom-limited rest is prescribed until the symptoms of concussion have subsided; however, some patients do not follow the typical timeline of symptom resolution postconcussion.[3] In these cases, the risks of prolonged rest are of great interest to treating clinicians. Patients who remain symptomatic with rest may have postconcussive disorder or postconcussion syndrome.[4] For these patients, prolonged rest may result in physical deconditioning, absence from normal life activities, and mental health degeneration.[3] These patients, who normally live an active lifestyle and are told to discontinue their usual activities for prolonged periods of time, can experience withdrawal, lethargy, and other symptoms of depression that closely mimic the symptoms of concussion.[3] They may actually benefit from light activity, which has been shown to improve patients with depression.[3] Also, patients who have a mental illness before sustaining a concussion may experience longer-duration symptoms than patients who did not have a mental illness before the concussion.[3] Because the symptoms of mental illness often closely resemble the symptoms of concussion, prolonged rest may not always be the most appropriate course of treatment for patients who do not follow the normal timeline in resolution of symptoms. For these reasons, the investigation of alternative interventions for patients with prolonged symptoms is important to give treating clinicians the tools to care for these patients.

The first intervention reported by the authors was pharmacotherapy. A group of individuals suffering from concussion symptoms for more than 21 days was given amantadine, which is prescribed for both antiviral and anti-Parkinson indications.[2] It is believed that concussion results in a neurometabolic cascade that includes many chemical processes and structural changes.[5] Amantadine increases the availability of dopamine by facilitating its release and inhibiting its reuptake, which is believed to improve symptoms and increase quality of life.[6] In this sense, it would appear that clinical indications exist for the study of its effectiveness in patients with concussion. The authors[6] of this study found significant improvements in reported symptoms, verbal memory, and reaction time. However, Schneider et al[2] cautioned that, although significant improvements occurred in the treatment group, all participants (including controls) improved over time. Future researchers should focus on the effectiveness of medication after sport-related concussion because other drugs (eg, nonsteroidal anti-inflammatories, sleep agents, antidepressants) have not been investigated in athletes. Clinicians should weigh the risks and benefits of pharmacologic interventions after concussion, comparing the very limited evidence for the effectiveness of these interventions in treating the cause of symptoms versus the benefit of symptom reduction.

Exercise as a treatment for athletes suffering persistent symptoms postconcussion seems like a reasonable solution. Schneider et al[2] addressed the favorable results of subsymptom-threshold aerobic activity in patients with persistent symptoms. A promising new test has been developed by Leddy and Willer[7] involving a standardized treadmill test (Buffalo Concussion Treadmill Test) for patients who have had at least 3 weeks of symptoms postconcussion. The incline is progressively increased during treadmill walking, with measures of perceived exertion and symptoms taken every minute and heart rate and blood pressure assessed every 2 minutes.[7] The test continues until symptoms increase significantly or the patient reaches his or her maximum perceived exertion.[7] Originally, the authors intended the treadmill protocol as a test to rule concussion in or out as the cause of persistent symptoms.[7] The underlying theory was the belief that symptoms originating from concussion would increase with physical exertion, whereas those from other causes would decrease or remain the same.[7] Evidence[2] supported the use of this specific treadmill test, as well as similar protocols of aerobic exercise, for both adults and adolescents with persistent symptoms after concussion. All patients eventually returned to their preinjury levels of

physical activity.[2] It is reasonable to conclude from this that clinicians should consider implementing physical activity at a subsymptom threshold for postconcussive patients with persistent symptoms. However, the athlete should be referred to a supervising physician before implementation, and clinical judgement must determine the proper timing postinjury.

When evaluating a patient with persistent symptoms after concussion, it is important to realize that no symptom on the graded symptom checklist that is generally used for evaluation is unique to concussion.[1] The logical conclusion is that the intervention that may be beneficial in treating these symptoms should be matched to the specific symptom profile. Another intervention reviewed by the authors[2] was manual and physical therapy for patients complaining of neck pain, dizziness, and headaches. Clinically, 2 conditions that may lead to these symptoms and are thought to be sequelae of concussion are upper cervical (joint) and vestibular dysfunction.[8] Atlanto-occipital joint dysfunction can cause headache and neurologic symptoms, whereas vestibular dysfunction usually leads to dizziness. The reviewers reported on a randomized clinical trial of patients with these persistent symptoms who were treated with manual therapy, neuromotor and sensorimotor retraining, and vestibular therapy. Patients treated with this approach demonstrated better outcomes within 8 weeks of the initial treatment.[8] One vestibular problem that has been associated with postconcussive symptoms is benign paroxysmal positional vertigo (BPPV). It is reported[8] to be the most common vestibular condition in the general public and is extremely responsive to treatment and rehabilitation. Because BPPV can result from the movements associated with the forces that cause concussion, it is reasonable to suggest that a patient whose persistent symptom is dizziness may be suffering from BPPV and may benefit from treatment.[8] Although vestibular therapy is not outside the scope of practice for athletic trainers, they must establish clinical proficiency before providing evaluation and intervention. A patient-centered, multidisciplinary team is recommended to manage athletes with complex concussion. Based on the clinical findings, this may include a vestibular therapist, audiologist, or both.

A finer point in the paradigm of rehabilitation after concussion was not included in the authors' review. The actual makeup of the exercise prescription and specific alterations have been theorized to affect recovery from persistent symptoms.[9] One concerning finding was that athletes continued to show deficits in single tasks (specifically walking in both obstructed and unobstructed environments) after they had returned to full participation.[10] In another systematic review, Register-Mihalik et al[9] concluded that athletes might display a deficit when asked to complete dual- or divided-attention tasks (eg, a physical task with a concurrent cognitive objective) postconcussion. Although the evidence for managing this deficit in the presence of increasing demands from divided-attention tasks is inconclusive, the authors[9] surmised that these tasks may aid in the return-to-play progression. This again illustrates the need for a collaborative approach to concussion management, with other team members aiding in the development of progressive dual-task challenges.

After reviewing the literature on interventions as a means of recovering from persistent symptoms, the reasonable and prudent provider may ask, "Is it safe to physically or cognitively exert oneself after concussion, and if so, when?" This question reflects the need for the aforementioned Buffalo Concussion Treadmill Test.[7] It is important to remember that after a period of symptom-limited physical and cognitive rest, an evaluation should occur before the decision to move forward with a particular intervention, as 5 days of strict rest resulted in an increase in symptoms and a longer duration to symptom resolution.[11] The treadmill test appears to be an appropriate place to start.[7] The next question regarding implementation involves the timeline. The neurometabolic cascade has many factors; however, most processes involved in the cascade seem to stabilize or return to baseline between 10 and 30 days after injury.[5] It is important to note that, during this time, the brain may be vulnerable to subsequent injury, so interventions should be conducted in a supervised environment to eliminate or minimize the risk of subsequent head injury.[5] Finally, one must also consider the age of the patient. Adolescent patients may take longer to recover from concussion than adult patients, and caution should be exercised when initiating treatment for persistent symptoms.[5] Yet in spite of these concerns, clinicians should remain aware of the current literature, not rely solely on strict physical and cognitive rest to treat prolonged concussion symptoms, and consider therapeutic exercise when appropriate for the treatment of patients with prolonged symptoms after concussion.

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