The effects of rest and treatment following sport-related concussion: a systematic review of the literature

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ABSTRACT

Objective To evaluate the evidence for rest, treatment, and rehabilitation following sport-related concussion (SRC).

Data sources PubMed, CINAHL, PsychInfo, Cochrane Controlled Trials Registers, Health STAR, Sport Discus, EMBASE, Web of Science, and ProQuest.

Study selection Articles were included if they met the following criteria: original research, reported SRC as a source of injury, and evaluated the effect of rest or treatment.

Data extraction Study design, participants, treatment, outcome measures, and key findings.

Data synthesis Three studies met the inclusion criteria for evaluating the effects of rest and twelve for treatment. Low-intensity aerobic exercise may be of benefit.

Conclusions The current evidence evaluating the effect of rest and treatment following SRC is sparse. An initial period of rest may be of benefit. Low-level exercise and multimodal physiotherapy may be of benefit for those who are slow to recover. There is a strong need for high level studies evaluating the effects of rest and treatment following SRC.

INTRODUCTION

The current recommendation for managing a sport-related concussion is to rest until symptoms resolve and then follow a protocol of graded exertion prior to returning to sport.[1] These recommendations have been developed from a series of agreement and consensus statements by a panels of experts in the area of sport-related concussion.[1 2] As of the 2008 consensus meeting on concussion in sport, there was a paucity of evidence evaluating the effects of various treatments following a concussion.

The purpose of this systematic review was to evaluate the evidence for management of concussion. The following questions were addressed: (1) When is rest useful and/or beneficial as part of the management recommendations for sport-related concussion? and (2) What treatment and rehabilitation strategies are beneficial following a sport-related concussion?

METHODS

A literature search was conducted for each research question using the following databases: PubMed, CINAHL, PsychInfo, Cochrane Controlled Trials Registers, Health STAR, Sport Discus, EMBASE, Web of Science and ProQuest. To search for articles evaluating the effect of the rest, the following search terms were used: (Brain Concussion [MeSH] or Post-Concussion Syndrome [MeSH] or Sport-related concussion [tw] or mild traumatic brain injury [tw]) AND (Rest [MeSH] or Treatment Outcome [MeSH] or Cognitive rest [tw] or Physical exertion [MeSH] or Therapy or Rehabilitation or Treatment) AND Sport [tw]. To search for articles evaluating the effect of treatment, the following search terms were used: (Brain Concussion [MeSH] or Post-Concussion Syndrome [MeSH] or Sport-related concussion [tw] or mild traumatic brain injury [tw]) AND (Therapy [MeSH] or Treatment Outcome [MeSH] or Rehabilitation [MeSH] or treatment [tw] or Exercise therapy [MeSH]) AND (Exercise [MeSH] or Brain training [tw] or Cervical spine [tw] or Neck [MeSH] or Vertigo [MeSH] or Dizziness [MeSH] or Headache [MeSH] or Postural Balance [MeSH] or Cognitive therapy [MeSH] or pharmacotherapy [tw]). Inclusion criteria were determined a priori as follows: (1) report of original research (including randomised controlled trials, cohort studies, quasi-experimental designs, case series, case crossovers and case studies), (2) report of a sport-related concussion as a source of symptoms and (3) evaluation of the effect of a resting period or treatment. In order to include the most up-to-date research, peer-reviewed published articles and abstracts were included. All searches were performed by one investigator (KJS).

Data extraction

For all included articles, the following data were extracted: study design, participants (sample size, age and gender), treatment (type, intensity and duration), key findings (including effect size and means with 95% CIs which were calculated, if possible, if not presented in the original study) and relevant comments. Each study was graded for level of evidence according to the Oxford Centre for Evidence Based Medicine.[3] Downs and Black criteria were used to assess the quality of the evidence.

RESULTS

The initial search revealed 749 potential articles evaluating the effects of rest and 1175 articles evaluating the effects of treatment. The initial search results revealed: (i) 6 potential studies evaluating rest, 2 of which met the inclusion criteria for the effect of rest following a sport-related concussion and (ii) 15 abstracts that evaluated the effects of treatment, 10 of which met the inclusion criteria. One additional treatment article was identified and included using a Web of Science citation search,[4] and two others were identified by the

authors.[5 6] The study design, study sample, outcome measures, description of rest/intervention, key findings and level of evidence are presented in online supplementary table S1.

Rest

Two papers met the inclusion criteria for evaluating prescribed rest following a sport-related concussion.[7 8] One uncontrolled retrospective observational study of rest and activity level was identified.[9] The majority of abstracts that were initially screened and were subsequently excluded did not specifically evaluate the effects of a resting period, did not include participants who had suffered a sport-related concussion or did not present original research. Online supplementary table S1 provides a summary of the included studies.

A retrospective review of 184 athletes found that those individuals who were recommended to have a period of cognitive rest had a longer duration of symptoms than those who did not.[7] However, the individuals who were prescribed rest may have been perceived to have suffered a more severe injury. The effect of prescribed rest on neurocognitive test performance and symptom reporting was evaluated in high school and collegiate athletes who presented to an outpatient clinic at varying times since injury.[8] Regardless of the time since injury (eg, less than 1 week or greater than a month), the athlete was prescribed 1 week of complete physical and cognitive rest. Significant improvements in Post-Concussion Symptom Scale ratings and ImPACT composite scores were evident following 1 week of rest. However, there was no control or comparison group, so the improvements could have been attributed to a diverse range of factors.

Majerske *et al*[9] followed a group of 95 student-athletes presenting to a university hospital sport medicine concussion programme following a sport-related concussion. The athletes were retrospectively assigned to groups based on their self-reported activity level at the time of their visits (see online supplementary table S1). Those who reported moderate levels of cognitive and physical exertion (eg, participation in school and light activity at home such as jogging) over the first month after injury appeared to have better neuropsychological outcomes than those with very little (eg, no school or exercise) or high levels of activity (eg, school activity and participation in a sports game). Individuals reporting a high level of activity performed the worst on measures of visual memory and reaction time. Although causal explanations cannot be drawn from this observational study, their findings suggest that under-activity and over-activity might both be counterproductive for some injured athletes.

Treatment

Twelve studies met the inclusion criteria evaluating the effect of treatment. The majority of abstracts reviewed that did not meet the inclusion criteria were not original research or did not evaluate the effect of treatment in individuals who had suffered a sport-related concussion. The nature of the treatment and the patients varied enough that a meta-analysis was not possible.

Pharmacotherapy

Medications have been prescribed in case studies of athletes with headaches and neuroendocrine problems. One group pharmacological study has been published. Treatment with amantadine (100 mg twice daily for 3–4 weeks) was evaluated in individuals with symptoms greater than 21 days.[5] Data were collected retrospectively in a cohort of individuals who received amantadine as treatment and compared with historical controls (who were treated at the same clinic prior to the clinic utilising amantadine as treatment). All patients improved over time for the measures taken, but the amantadine group improved more on measures of verbal memory, reaction time and number of symptoms endorsed. However, the individuals in the treatment group were at a lower baseline point at the start of the study for verbal memory and visual memory, and they reported more symptoms. Also, there may have been other differences between the groups (aside from amantadine) that could have accounted for any observed effect.

Exercise

Three articles that met the inclusion criteria evaluated the effects of exercise as treatment, including one case study.[10–12] The effect of a combined treatment approach was evaluated in a case series of 16 children and adolescents (11 boys and 5 girls; median age 14, range 11–18 years) with persistent symptoms following concussion.[10] The treatment regimen consisted of a combined approach of submaximal aerobic training, light sport-specific coordination exercises, visualisation and imagery techniques, and a home exercise programme. The mean duration of treatment was 4.4 weeks (95% CI 3.1 to 5.7), and all children were able to resume normal physical activity participation following the treatment period.[10]

The effect of the subsymptom threshold daily aerobic exercise programme was evaluated in a crossover study of 12 patients with persistent symptoms following a concussion.[12] Symptoms were present at rest for a duration greater than 6 weeks but less than 1 year. All patients had symptoms during a graded exercise treadmill test. They completed a treadmill exercise test before and after a 2 or 3 week baseline non-intervention period. All patients continued onto the treatment phase at the completion of the baseline phase. Participants exercised 5–6 times per week until they were asymptomatic with exhaustive exercise. An overall reduction was found in the mean symptom score between baseline and treatment periods, and all patients were able to return to preinjury levels of activity.[12]

Participating in a 1 week regimen of hyperbaric oxygen therapy was associated with improvements in mental activation and cognitive flexibility in a case crossover design compared to a 1 week period of rest.[13] A case series of elite athletes with persistent symptoms of dizziness, neck pain and headaches had functional improvements and reported symptomatic improvements following a course of combined cervical spine manual therapy, neuromotor retraining, sensorimotor retraining and vestibular physiotherapy treatment following a sport-related concussion.[14] A randomised controlled trial including individuals with persistent symptoms of dizziness, neck pain and headaches following a sport-related concussion found that individuals treated with a combination of cervical spine manual therapy, neuromotor retraining, sensorimotor retraining and vestibular physiotherapy treatment were more likely to be medically cleared to return to sport within 8 weeks of initiating treatment (risk ratio 10.3; 95% CI 1.51 to 69.6).[14 15]

DISCUSSION

There are very few published studies evaluating the effects of various forms of treatment or rest in athletes who have suffered a sport-related concussion. The included studies were case studies[6 11 16 17] (n=4) or case series (n=6),[4 8–10 14 18] quasi-experimental (n=1),[5] case crossover (n=2)[12 13] and one randomised controlled trial.[15] The overall quality of the literature reviewed lacked randomisation and many designs were retrospective and did not include a comparison group. In order to provide a more comprehensive discussion in this area,

additional references have been brought into the discussion from the non-sport-related concussion literature where appropriate.

How much rest is too much?

In the initial days following a concussion, mental and physical rest has been strongly encouraged.[19 20] Three lines of evidence indirectly support the value of rest.[21 22] First, concussions can have a large adverse effect on physical and cognitive functioning in the first few days postinjury.[23] Acutely, the brain might be in a state of neurometabolic crisis,[24 25] at which time increased energy demand may hinder the restorative process, and it is believed that rest might facilitate recovery. Second, in animal injury models, there appears to be a 'temporal window' of vulnerability in which a second overlapping injury results in greater levels of traumatic axonal injury and magnified cognitive and behavioural deficits.[26–28] Thus, a rest period will reduce the likelihood of the athlete experiencing an overlapping injury. Finally, it has been demonstrated in rodent models that exercise appears to be good for the injured brain; however, animals that are allowed to exercise too soon after injury do not show the expected exercise-induced increases in molecular markers of neuroplasticity.[29–32] For these reasons, it is believed that rest is very likely beneficial following injury. However, this is largely based on animal research, theory and expert consensus.

At present, there are no evidence-based guidelines for how to manage athletes with slow recovery. The optimal time period for rest is unknown. Moreover, the specific schedule and type of rest (eg, bed rest versus greatly restricted activities) have not been studied and it has recently been argued that absolute rest is unrealistic.[33] In general, prolonged bed rest following medical procedures or as an intervention for health problems has rarely been shown to be beneficial and may cause harm.[34] There has been only one clinical trial involving bed rest following mild traumatic brain injury (MTBI) in civilians recruited from the emergency department, and this trial did not support the use of 6 days of bed rest as a management strategy.[35]

Although resting until symptom free is widely recommended following a concussion, only three studies met the inclusion criteria evaluating rest. One case crossover study did not show improvements in symptoms during a period of non-intervention,[12] and a case series demonstrated a longer duration of symptoms in individuals who were prescribed cognitive rest.[7] Positive effects on neurocognitive function and symptoms were reported following a 1-week period of prescribed rest in another study irrespective of the time since injury.[8] However, no long-term follow-up was discussed, so the impact that the resting period had on the ability to resume activity is not known. Additionally, individuals were not randomised to rest versus other activity levels, so it is not known if improvements in cognitive function and symptom reports were due to physical rest, cognitive rest, combined rest, non-specific effects of contact with a specialist, education and reassurance or other factors. Further studies to evaluate the effects of a resting period and the optimal duration of this period are needed. In the absence of evidence-based recommendations, a sensible approach involves the gradual return to school and social activities (prior to contact sports) in a manner that does not result in a significant exacerbation of symptoms.

Pharmacotherapy

A wide variety of medications, such as non-steroidal anti-inflammatories, sleep agents, methylphenidate, antidepressants and anticonvulsants, have been used for persistent headache, sleep problems and other symptoms following MTBI in civilians and military personnel. Clinical practice guidelines have been developed for how to manage civilians, active duty military personnel and veterans who are slow to recover from MTBI.[36] However, there is very little research evaluating pharmacological treatment following sport-related concussion. There is evidence that cases with a secondary diagnoses may respond to medical intervention. One study suggests that amantadine may facilitate the alleviation of symptoms and promote neurocognitive recovery in some athletes. However, although greater improvements were reported in the medication group, the control group and all patients demonstrated improvement over time.[5]

Using exercise as treatment for athletes who are slow to recover

From a practical perspective, athletes need to, and naturally will, transition back into an active lifestyle. If their normal activities are restricted for extended periods of time, they are at risk for secondary problems such as physical deconditioning, anxiety and stress, mild depression, and irritability. Over time, the strength of the relation between the neurobiology of the injury and the ongoing symptoms very likely diminishes, and the pre-existing, current and contextual factors increasingly contribute to causing, maintaining or exacerbating symptoms. In the absence of good scientific evidence, clinicians must decide when to transition from activity restrictions and watchful waiting to more active treatment and rehabilitation, including exercise.

Converging lines of diverse, albeit indirect, medical and scientific evidence support the use of exercise as a core component of treatment for children, adolescents and young adults who are slow to recover from concussion.[21 22] Some of the benefits of exercise that have been reported include facilitation of molecular markers of neuroplasticity and neurogenesis,[29 30 37–41] improved cognitive functioning,[42–45] greater bilateral hippocampal volumes and better performance on a memory test in children with greater fitness levels,[46 47] changes in neurotransmitter systems,[48 49] higher ratings of self-esteem[50] and improved sleep quality.[51–53] Exercise has also been reported to be an effective adjunctive treatment in adults for depression[54–61] and anxiety,[62–67] chronic fatigue[68 69] and migraines.[70 71] Interestingly, adults who exercise regularly, and then abruptly stop for a few days (and up to 2 weeks), report increased levels of fatigue, a negative mood and symptoms of depression.[72–75] Thus, there may be non-specific adverse effects of abrupt discontinuation of exercise in concussed athletes that mimic and/or magnify ongoing symptoms of concussion.

Two published studies have examined exercise as a component of active rehabilitation for children, adolescents or adults who are slow to recover from a concussion.[14 20] Symptoms were reported to decrease and functional levels were reported to increase in these studies. However, further studies evaluating the effect of exercise compared to rest are needed because none of the currently available published studies included randomisation of patients to the treatment group, making a causal association difficult to determine and allowing for the potential of selection bias.

Psychological intervention

Researchers have successfully used psychological treatment, such as modified forms of cognitive behavioural therapy, with adults who have chronic symptoms and problems following MTBI.[76–79] Psychological treatment is recommended in clinical practice guidelines for MTBI in civilians and the military,[36] and it has been strongly promoted as a component of a sequenced

care model for MTBI.[80] There is a large and mature literature indicating that psychological treatments are effective for reducing symptoms and improving functioning in adults with depression[81 82] and generalised anxiety disorder.[83] Behavioural and psychological treatments are effective for improving sleep and reducing psychological distress in people with insomnia.[84] Therefore, although not studied in sport-related concussion, it is plausible that psychological treatment for athletes who are slow to recover may be of benefit and should be studied more systematically.

Rehabilitative treatment

There is some evidence that vestibular rehabilitation is effective for dizziness and balance problems in children and adults who have sustained an MTBI.[85 86] Commonly reported symptoms following a concussion include headaches, dizziness, nausea and neck pain.[87] Rehabilitation aimed at reducing symptoms and facilitating functional recovery of balance may be of benefit, as illustrated in one paper included in this review.[10] A randomised controlled trial and a case series reported benefit associated with a combined approach of orthopaedic and vestibular physiotherapy treatment following a concussion.[14 15] It may be that the cervical spine and/or balance centres are injured in some athletes and may benefit from treatment targeting these areas.[88] If the assessment of a patient with persistent headache after a concussion suggests that there is a cervicogenic aetiology, then cervical spine manual therapy and specific neuromotor control exercises for the cervicoscapular region have been demonstrated to have benefit in relieving the headache.[89 90]

CONCLUSIONS

- The current evidence evaluating the effect of rest and treatment following a sport-related concussion is sparse.
- An initial period of rest may be of benefit. However, further research to evaluate the long-term outcome of rest, and the optimal amount and type of rest, is needed.
- Low-level exercise may be of benefit, although the optimal timing postinjury for initiation of this treatment is currently unknown.
- Rehabilitative techniques in individuals with clinical findings suggesting cervical spine or vestibular dysfunction may facilitate recovery.
- There is a strong need for high-level studies evaluating the effects of a resting period, pharmacological interventions, rehabilitative techniques and exercise for individuals who are slow to recover from a sport-related concussion.

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Competing interests See the supplementary online data for competing interests (http://dx.doi.org/10.1136/bjsports-2013-092190).

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