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Original paper

Does exercise evoke neurological symptoms in healthy subjects?

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Abstract

Concussion is a common injury in collision sports and is evidenced by a variety of signs and symptoms. The recording of neurological symptoms is an important component of screening for a concussion and in return-to-play decisions. However similar symptoms are prevalent in the general population and are reported to be associated with participation in physical activities. The purpose of this study was to document the neurological symptoms reported by healthy individuals following controlled bouts of exercise. A crossover randomised design with 2 levels of exercise intensity, moderate intensity and high intensity, each of 15 min duration was used. Participants completed a standardised postconcussion symptom checklist prior to exercise (pre), immediately following exercise (post-1) and again after 15 min of rest (post-2). 60 participants were recruited into the study. A summed symptom score was calculated and analysed with a 2-way repeated measures ANOVA procedure. The intensity × time interaction ($F_{2,118} = 23.94$, $p < 0.001$) demonstrated a significant increase in symptom scores for the high intensity condition immediately following exercise ($p < 0.001$). Although the moderate intensity showed a similar trend this was not significant. These findings suggest that sports medicine professionals need to be aware of the effect of exercise on symptom reporting when assessing and in making return-to-play decisions.

Keywords: Brain concussion; Neurological manifestations; Postconcussion symptoms; Exercise; Athletic injuries; Return-to-play

1. Introduction

Sports concussion is a common injury in collision sports and is characterised by a wide range of neurological signs (e.g. loss of consciousness) and symptoms (e.g. headache and fatigue). There are a variety of clinical instruments and symptom checklists used to assess for a sports concussion and to assist with return-to-play decisions with experts recommending a multidimensional approach including the measurement of symptoms.[1]

The use of symptoms in screening for a sports concussion must be viewed with caution as similar symptoms (e.g. headache) are also observable in the uninjured population.[2] The initial assessment for a concussion generally takes place soon after the player is withdrawn from the game where they have been physically active. Recent reports on changes in neurocognitive,[3] balance[4] and motor performance measures[5] following physical activity suggest that some of the measures often used in determining if a player has been concussed may be contaminated by the physiological responses to exercise. This implies the need to investigate whether exercise itself provokes changes in the neurological symptoms which are commonly associated with a concussion. Therefore, the purpose of this prospective study was to document the neurological symptoms reported by the healthy participants following controlled exercise.

2. Methods

The participants (aged 18–35 years) were physically active (2–3 times per week) through training or sport, and accustomed to intense exercise. They reported no cardiac risk factors or musculoskeletal/neurological injuries (e.g. a

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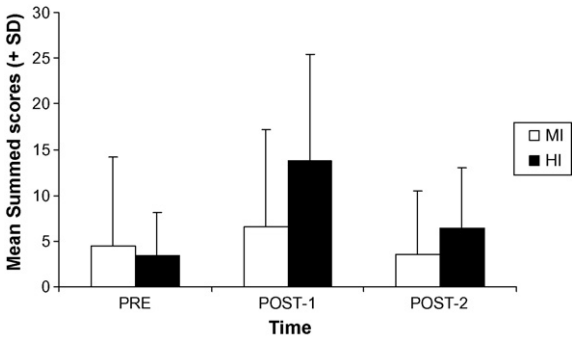

Fig. 1. Summed symptom scores reported following moderate (MI) and high intensity (HI) exercise at pre, post-1 and post-2 time periods.

concussion) in the previous 3 months. The study was part of a larger project evaluating the effect of exercise on neurological screening measures and approved by the University of Otago Human Ethics Committee.

A randomised crossover design was employed where each participant completed two levels of exercise intensity; moderate and high, 7–14 days apart. The moderate intensity condition required the participants to exercise continuously on a stationary cycle for 15 min at 75–85% of their age predicted maximum heart rate (APMHR). The high intensity condition included moderate intensity cycling (as previously) for 9 min, followed by 5 min of high intensity interval cycling, and 1 min of maximum intensity arm cranking to produce a near maximal heart rate (APMHR > 85%). These target heart rates corresponded respectively to those reported in rugby backs (<85% APMHR) and forwards (>85% APMHR) during a game.[6] Participant's ratings of perceived exertion (RPE) were also recorded.[7]

The neurological symptom scale of the Sport Concussion Assessment Tool[1] was used. Participants completed the scale: before exercise (pre), immediately following 15 min of exercise (post-1) and after 15 min of rest (post-2). Each of the 18-items was scored on a 7-point Likert scale.

Data were analysed using a 2-way (exercise intensity × time) repeated measures ANOVA with the level of significance set at $p \leq 0.05$. Subsequent post hoc tests were corrected with a Bonferroni procedure for multiple comparisons.

3. Results

Sixty subjects (30 male and 30 female) completed the study. Means (+S.D.) of the summed symptom scores for two levels of exercise intensity are presented in Fig. 1. The RPE (mean ± S.D.) reported for high and moderate intensity conditions (17.9 ± 1.9 and 14.7 ± 2.0) indicate that the intensities were perceived to be appropriate. There was considerable variability associated with the reporting of symptoms. A significant intensity × time interaction ($F_{2,118} = 23.\ 94$, $p < 0.001$) indicated that the summed symptom scores differed between the two exercise conditions over time.

For the high intensity exercise condition the symptom scores increased with exercise (mean ± S.D.; 3.4 ± 4.7–13.8 ± 11.6) and then declined following 15 min of rest (mean ± S.D.; 6.4 ± 6.6) relative to their pre exercise values. There was a statistically significant difference between pre and post-2 scores ($t_{59} = -4.495$, $p < 0.001$). There were no significant differences reported for the moderate intensity condition between pre and post-1, but post-2 scores were reduced relative to post-1 ($t_{59} = 4.395$, $p < 0.001$).

Comparison between the two intensities at each time period demonstrated a significant difference in symptom reporting at post-1 ($t_{59} = -4.075$, $p = 0.000$) and post-2 scores ($t_{59} = -3.525$, $p = 0.000$) indicating that neurological symptom scores remained elevated for the high intensity condition even after 15 min of rest.

4. Discussion

This study established that short 15 min bursts of exercise influenced the summed symptom scores differentially. The high intensity exercise condition resulted in an increased symptom score following exercise. This effect persisted even after 15 min of rest, whereas the moderate intensity exercise did not significantly elevate scores.

The most common neurological symptom cited at baseline and post-1 by the participants was "fatigue/low energy", which is in accordance with previous research.[2] We compared the frequency of symptom endorsements in the present study to those reported by athletes within 72 h of their concussion, using a slightly different postconcussion scale.[8] "Headache", "Difficulty concentrating", "Feeling slowed down" were the most frequent symptoms following concussion and interestingly; "balance problems/dizzy", "nausea/vomiting" and "vision problems" are endorsed less by the concussed athletes in comparison to that seen following the high intensity exercise (post-1).

Symptoms were assessed after 15 min of recovery only, thus limiting the conclusions from this study. This time frame and other sport specific exercise intensities/types could be explored further. This study indicates the need for awareness of the effects of pre-injury activity levels when assessing a player for a potential concussion immediately following activity. Therefore time should be allowed when using symptoms to assess the athlete as symptom endorsement may be related to the levels of pre-concussion activity rather than the consequences of the concussion itself.

5. Practical implications

- Exercise can provoke neurological symptoms in healthy individuals.
- Symptoms are related to exercise intensity.

- Caution is needed in making return-to-play decisions based on symptom measurements.

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