



Original research

Multimodal impairment-based physical therapy for the treatment of patients with post-concussion syndrome: A retrospective analysis on safety and feasibility



Patrick Grabowski^{a, b, *}, John Wilson^c, Alyssa Walker^c, Dan Enz^a, Sijian Wang^d

^a University of Wisconsin Hospitals and Clinics, 621 Science Dr., Madison, WI 53711, United States

^b University of Wisconsin-La Crosse, Physical Therapy Program, 1725 State St., La Crosse, WI 54601, United States

^c University of Wisconsin-Madison, School of Medicine and Public Health, 1685 Highland Avenue, Madison, WI 53705, United States

^d University of Wisconsin-Madison, Department of Biostatistics, 600 Highland Ave., Madison, WI 53705, United States

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ABSTRACT

Objective: Demonstrate implementation, safety and feasibility of multimodal, impairment-based physical therapy (PT) combining vestibular/oculomotor and cervical rehabilitation with sub-symptom threshold exercise for the treatment of patients with post-concussion syndrome (PCS).

Setting: University hospital outpatient sports medicine facility.

Participants: Twenty-five patients (12–20 years old) meeting World Health Organization criteria for PCS following sport-related concussion referred for supervised PT consisting of sub-symptom cardiovascular exercise, vestibular/oculomotor and cervical spine rehabilitation.

Design: Retrospective cohort.

Main measures: Post-Concussion Symptom Scale (PCSS) total score, maximum symptom-free heart rate (SFHR) during graded exercise testing (GXT), GXT duration, balance error scoring system (BESS) score, and number of adverse events.

Results: Patients demonstrated a statistically significant decreasing trend ($p < 0.01$) for total PCSS scores (pre-PT $M = 18.2$ ($SD = 14.2$), post-PT $M = 9.1$ ($SD = 10.8$), $n = 25$). Maximum SFHR achieved on GXT increased 23% ($p < 0.01$, $n = 14$), and BESS errors decreased 52% ($p < 0.01$, $n = 13$). Two patients reported mild symptom exacerbation with aerobic exercise at home, attenuated by adjustment of the home exercise program.

Conclusions: Multimodal, impairment-based PT is safe and associated with diminishing PCS symptoms. This establishes feasibility for future clinical trials to determine viable treatment approaches to reduce symptoms and improve function while avoiding negative repercussions of physical inactivity and premature return to full activity.

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1. Introduction

The incidence of concussion is high, with estimates approaching nearly 4 million sports-related concussions annually in the United States (Langlois, Rutland-Brown, & Wald, 2006). This increasingly common injury is a substantial concern to both medical professionals and the general population worldwide (Finch, Clapperton, & McCrory, 2013; Lincoln et al., 2011). The majority of patients with sports-related concussion will recover within 7–10

days (McCrea et al., 2003); however, a significant proportion, with estimates ranging from 24% to 84%, will suffer from prolonged symptoms despite appropriate conservative care (Ryan & Warden, 2003). If symptoms persist after the initial injury, the constellation may be classified as post-concussion syndrome (PCS). The World Health Organization (WHO) defines PCS as a persistence of three or more of the following symptoms succeeding a traumatic head injury: 1) headache, 2) dizziness, 3) fatigue, 4) irritability, 5) insomnia, 6) concentration difficulty, 7) memory difficulty (Boake et al., 2005).

Traditional treatments for PCS include rest, education, cognitive behavioral therapy, neurocognitive rehabilitation, and medications (Davies & McMillan, 2005). Recent recommendations from the

* Corresponding author. University of Wisconsin-La Crosse, Physical Therapy Program, 1725 State St., La Crosse, WI 54601, United States.

E-mail address: pgrabowski@uwlax.edu (P. Grabowski).

Concussion in Sport group's (CISG) 4th consensus statement acknowledged that a substantial number of patients do not spontaneously recover; however, they provided little guidance beyond recommending a multimodal approach in these difficult cases (McCrary et al., 2013). While cognitive and physical rest are effective for many individuals in the acute stage of recovery, evidence suggests they may not be effective or appropriate for patients with PCS (Jotwani & Harmon, 2010; Willer & Leddy, 2006). Physical inactivity alone can precipitate secondary symptoms of fatigue, depression, anxiety, and physical deconditioning (Alosco et al., 2012; Ariza-García et al., 2013; Bogdanis, 2012; Nishijima et al., 2013). These unintended consequences are more likely to occur when recovery from concussion is prolonged (Leddy et al., 2010; Makdissi, Cantu, Johnston, McCrary, & Meeuwisse, 2013). Contrary to the effects of inactivity, increasing evidence supports the hypothesis that cardiovascular exercise may help treat PCS (Baker, Freitas, Leddy, Kozlowski, & Willer, 2012; Gagnon, Galli, Friedman, Grilli, & Iverson, 2009; Leddy et al., 2010).

Published evidence to support exercise as a treatment option for patients with PCS is encouraging, but remains limited. Leddy and colleagues concluded that PCS may be safely and effectively treated with individualized progressive sub-symptom threshold aerobic exercise (Leddy et al., 2010). After treatment, patients were able to exercise longer, achieving peak heart rate (HR) and systolic blood pressure without symptom exacerbation; 8 out of 11 patients significantly reduced their symptoms. Similarly, Baker and colleagues found an exercise rehabilitation program to be effective in returning over 70% of patients with PCS to full daily functioning (Baker et al., 2012). Majerske and colleagues retrospectively analyzed the neurocognitive performance and activity levels of 95 athletes for up to 33 days after concussion (Majerske et al., 2008). They noted that individuals who performed some exercise performed better than those who either performed no activity or returned to sports participation early on.

While it appears that cardiovascular exercise may provide an overall benefit to individuals with PCS, the syndrome often includes a spectrum of distinct symptoms that require more than exercise, or any single treatment, alone. For example, individuals often have concurrent cervical spine disorders, vestibular and visual disturbances, and various biopsychosocial influences that must be considered (Alsalaheen et al., 2010; Browne, 2006; Silverberg & Iverson, 2011). Due to this complex presentation and etiology, PCS is thought to be best treated with an individualized, multidisciplinary, and flexible approach (Leddy et al., 2010; Makdissi et al., 2013; McAllister & Arciniegas, 2002; Meehan, 2011; Reddy, 2011). Support for multimodal rehabilitation of patients with PCS is very limited (Schneider et al., 2013). One recent trial investigating the efficacy of cervical and vestibular physical therapy (PT) showed promising results when compared to the CISG guidelines, with more individuals in the PT group returning to their sport 8 weeks after injury (Schneider et al., 2014). While studies have shown the individual merits of cervicovestibular physical therapy and cardiovascular exercise, no study has combined the treatments in a complementary, impairment-based approach. The aim of this study was to assess whether an approach combining sub-symptom threshold exercise with comprehensive PT in an impairment-based treatment plan could safely treat the symptoms of post-concussion syndrome, establishing feasibility for this approach in future clinical trials.

2. Patients and methods

2.1. Study population

We retrospectively analyzed the clinical outcomes of 25 patients

who were referred for physical therapy consultation. Patients were treated at University of Wisconsin Hospitals and Clinics (UWHC) from February 2012 to July 2013. The six therapists involved in the concussion clinic had primary background in sports PT with experience treating individuals after concussion. All six were experienced in manual therapy techniques and exercise prescription for the cervical and thoracic spine. Four of the six held board certifications in sports and/or orthopedic clinical specialties. Three had clinical experience in vestibular rehabilitation. Two were PhD trained in biomedical engineering and neuroscience. Prior to joining the concussion clinic team, therapists participated in seminars and 6 months of bimonthly study sessions to standardize the approach to patient management. An evaluation template was created within the electronic medical record to assist treating therapists in maintaining consistency with this general approach. However, therapists were responsible for making individual clinical decisions for each patient.

Patients aged 12 years and older who satisfied WHO criteria for PCS following a sports-related concussion were eligible. WHO criteria were used due to their reliance on self-reported symptoms after concussion, rather than the cognitive deficits and three month symptom duration required by DSM-IV criteria (American Psychiatric Association, 2000). While there is no consensus on use of these standards, research shows that the DSM-IV criteria are more exclusive than WHO standards, due mainly to the requirement of cognitive deficits in attention and/or memory which must be documented by objective neuropsychological tests (Boake et al., 2005). A recent survey of practicing physicians also suggests the criteria are widely considered too stringent for clinical use, as only 2% of respondents indicated practice patterns consistent with the DSM-IV (Rose, Fischer, & Heyer, 2015). The most recent edition of the DSM does not contain a specific designation for post-concussion syndrome, further suggesting the DSM-IV criteria were flawed (American Psychiatric Association, 2013). Exclusion criteria were presence of PCS symptoms <3 weeks or >36 weeks, or if they did not complete at least 2 visits of supervised PT. All patients were initially evaluated by fellowship-trained primary care sports medicine physicians experienced in the treatment of sports-related concussion. Patients were referred for PCS rehabilitation based on guidelines developed at UWHC (Fig. 1). These guidelines were developed by two of the authors as a recommendation to help physicians determine when patients should be referred for consultation.

They are derived from published recovery timeframes that indicate too much activity early after injury may be detrimental to recovery, yet inadequate activity over a month-long period may be just as problematic (Griesbach, Hovda, Molteni, Wu, & Gomez-Pinilla, 2004; Majerske et al., 2008). Additionally, these recommendations consider the primary modifying factors believed to increase the risk of post-concussion syndrome (Broshek et al., 2005; Collins et al., 2003; Karlin, 2011; Lau, Collins, & Lovell, 2012; Lau, Kontos, Collins, Mucha, & Lovell, 2011; Marar, McIlvain, Fields, & Comstock, 2012; McCrary et al., 2009; Schatz, Moser, Covassin, & Karpf, 2011; Silverberg & Iverson, 2011). A total of 33 consecutive patients were screened for inclusion in the review, with 25 eligible for analysis (Fig. 2). The two patients who were excluded for failure to return for follow-up visits were both male, aged 15 and 17, with PCSS scores of 22 and 5, respectively. They had no other distinguishing factors that appeared related to their lack of follow-up, and a reason could not be discerned from the medical records at the time of review as neither patient had further contact with any provider in the system.

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