Efficacy of Immediate and Delayed Cognitive and Physical Rest for Treatment of Sports-Related Concussion

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Objectives To evaluate the efficacy of cognitive and physical rest for the treatment of concussion.

Study design High school and collegiate athletes (N = 49) underwent post-concussion evaluations between April 2010 and September 2011 and were prescribed at least 1 week of cognitive and physical rest. Participants were assigned to groups on the basis of the time elapsed between sustaining a concussion and the onset of rest (1-7 days, 8-30 days, 31+ days). Main outcome measures included Concussion Symptom Scale ratings and scores on the 4 composite indices of the Immediate Post-Concussion Assessment and Cognitive Testing measure, both before and following rest. Mixed-factorial design ANOVA were used to compare changes on the dependent measures within and between groups.

Results Participants showed significantly improved performance on Immediate Post-Concussion Assessment and Cognitive Testing and decreased symptom reporting following prescribed cognitive and physical rest ($P < .001$), regardless of the time between concussion and onset of rest ($P = .44$).

Conclusion These preliminary data suggest that a period of cognitive and physical rest may be a useful means of treating concussion-related symptoms, whether applied soon after a concussion or weeks to months later. *(J Pediatr 2012;■:■-■).*

Sports concussion, especially in youth, has become a public health concern.[1] From 1997-2007, visits to emergency departments for sports concussion doubled in the 8- to 13-year-old group, and in the 14- to 19-year-old age group, the incidence had increased by more than 200%.[2] The pathophysiology of concussion has been well documented,[3] with a "metabolic cascade" extending approximately 7-10 days. For 80% of high school-aged athletes, concussion symptoms usually resolve within 3 weeks,[4] which is consistent with findings that athletes ages 10-18 tend to take longer to recover and tend to be more symptomatic than adults.[5] In this regard, cognitive and physical rest, especially immediately following injury, has been promoted as the "cornerstone" of concussion management.[5] This term is loosely defined, but for the purposes of the present study is operationally defined as: (1) time off from school or work; (2) no homework; (3) no reading; (4) no visually stimulating activities, such as computers, video games, texting, or use of cell phones, and limited or no television; (5) no exercise, athletics, chores that result in perspiration/exertion; (6) no trips, social visits in or out of the home; and (7) increased rest and sleep.

The case for prescribed rest has support in both translational animal models as well as human subjects. Voluntary exercise in concussed rats has been shown to delay recovery if administered too soon following.[6] In athletes, engaging in activities requiring high levels of physical exertion after concussion is associated with greater impairment on neurocognitive testing and higher symptom endorsement.[7]

There are select studies documenting the use of pharmacologic interventions (following prolonged recovery from mild traumatic brain injury),[8] biofeedback to address emotional and behavioral adjustment,[9] neurofeedback to "normalize" brain wave patterns (eg, in the hopes of reducing symptoms),[10,11] and vestibular therapy for treatment of dizziness and balance problems[12] following concussion. However, cognitive and physical rest have not been systematically evaluated as an effective means of treating concussion related symptoms.

Methods

Participants were 49 high school to college-aged individuals (range = 14-23 years; mean = 15.0, SD = 2.58) who sustained a concussion and were referred to the Sports Concussion Center of New Jersey (SCCNJ) for assessment and management between April 2010 and September 2011. Diagnosis of having sustained a concussion was consistent with the consensus definition.[5] All participants were prescribed at least 1 week of cognitive and physical rest as treatment. Participants were not equally distributed by sex (67% male, 33% female), with the following sports most frequently played: ice hockey (27%), lacrosse (18%), soccer (12%), basketball (10%), and football (8%).

ImPACT	Immediate Post-Concussion Assessment and Cognitive Testing
SCCNJ	Sports Concussion Center of New Jersey

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Presentation of post-concussion symptoms varied across participants; the time between concussion and presentation to the SCCNJ ranged from 1 day to several months (range = 2-234 days; mean = 35.5; median = 11, SD = 66.0). As a result, participants were assigned to independent groups on the basis of the length of time between sustaining their concussion and their first post-concussion assessment at SCCNJ (see Analyses section). Patients were not prescribed treatment through any other modality (eg, psychotherapy, pharmacologic intervention) until after completion of prescribed rest, notwithstanding that some patients may have received other treatments prior to their initial examination at the SCCNJ.

The Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT),[13] online version, was used for the study. The ImPACT instrument is a computer-based program used to assess neurocognitive function and concussion symptoms. It consists of 6 tests that evaluate attention, working memory, and processing speed, yielding composite scores on the areas of Verbal Memory, Visual Memory, Processing Speed, Reaction Time, and Impulse Control (the sub-scales and psychometric properties of ImPACT are well documented).[14-17]

Procedures

Appropriate institutional review board approval was obtained for retrospective analysis of de-identified data. Patients were identified by the director of the SCCNJ (R.M.) as having been prescribed cognitive and physical rest as part of their treatment. Prescription of rest was verified by another individual (C.G.) who was not involved in the patients' assessment or treatment, who subsequently completed a retrospective chart review. Finally, another individual (P.S.), who was independent of the coding of the data and of the patients' treatment, was responsible for statistical analysis of de-identified data.

Patients underwent the standard protocol of SCCNJ that included, in this order: (1) completion of intake forms and required paperwork; (2) interview/clinical history exam of patient (for minors, parent(s) accompanied the child and provided additional history); (3) completion of ImPACT post-concussion testing; (4) explanation to patient/parents of ImPACT results and prescription of cognitive and physical rest with accompanying verbal instruction, take home report, and instructional handouts; and (5) follow-up examination, no sooner than 1 week later, that included ImPACT post-concussion testing, clinical interview for update in status, and prescription for next steps in recovery process.

Patients were followed until cleared to return to normal, pre-concussion activities. Patients were tested at additional follow-up examinations until ImPACT results were at or above baselines (if available) or until the results had stabilized with no further improvement in scores and with a patient report of no symptoms even with physical exertional testing and graduated exercise by a certified athletic trainer. Concussion care at the SCCNJ also included consultation with the patient's physician and/or other medical providers, consultation with school athletic personnel, and coordination of academic accommodations.

At the time of their first post-concussion assessment, patients were instructed to engage in cognitive and physical rest. Specifically, this included: no school, no homework or tests, no travel or shopping or trips outside of the home, no driving, no visits with friends or social visits in or outside of the home, increased sleep, significant reduction of television viewing and no watching athletic games or other visually intense movies, no video games, no computer usage, no texting, phone calls only if necessary, no reading unless minor in nature (such as reading directions on a medication bottle), no chores, no physical exercise, no lifting weights, and no physical activity that results in perspiration. Patients were provided with a checklist of recommendations to follow.

At the time of this first post-concussion assessment, patients were advised to engage in approximately 1 full week of rest, prior to returning for a follow-up examination and re-testing. Follow-up interviews were conducted to document level of compliance with prescribed rest. Parents monitored and reported on compliance, and no patients participated in sports or athletic activities, and all patients took approximately 1 week off from school. Compliance with 100% restriction of computer and cell phone use was less uniform, although all parents reported efforts to control access. As such, some patients were engaged in a "modified" level of rest for a number of reasons such as: (1) early resolution of symptoms; (2) previous commitments (such as a planned family holiday dinner at home); or (3) simple lack of strict compliance.

At the second post-concussion examination, a plan was formulated, depending on the patient's current level of symptoms, which might include additional rest or transition to part or full days of school with academic accommodations. If patients were transitioned back to school, they were still advised not to engage in after school activities and to continue strict cognitive and physical rest with increased sleep after school. All were advised at that point to continue not to engage in physical education classes/gym/playground time, athletics/sports, or contact risk activities. Academic/cognitive accommodations generally included: no tests/homework/note-taking/computer use initially, with a careful transition to include those activities over the following week if tolerated and if no headaches returned. Recommendations also included allowance for rest breaks and trips to the school nurse if not feeling well. Patients/parents were advised to contact the SCCNJ with their progress over the next week to determine if and when to transition to greater levels of cognitive/physical activity prior to their next examination. Ultimately, recommendations and treatment plans were tailored to each individual's course of recovery.

Analyses

Because the temporal presentation of post-concussion symptoms varied across participants, the time between concussion and presentation to the SCCNJ was not uniform, and ranged from days to months. As a result, participants were assigned

to independent groups on the basis of time between sustaining a concussion and their first post-concussion assessment: group 1 (1-7 days; N = 14); group 2 (8-30 days; N = 22); and group 3 (≥31 days; N = 13).

A mixed-factorial-design MANOVA was conducted for all 49 participants who underwent prescribed cognitive and physical rest and were assessed both pre- and post- treatment. Length of post-concussion symptoms was the between-subjects factor (groups as described above) and time (pre-rest, post-rest), as the within-subjects factor. ImPACT composite scores, as well as the Post-Concussion Symptom Scale served as the dependent variables.

As a sub-set of 28 patients required an additional period of prescribed rest, a second mixed-factorial-design MANOVA was conducted for these 28 participants who underwent additional prescribed rest and were assessed pre-rest, as well as 2 times post rest. Again, ImPACT composite scores, and Post-Concussion Symptom Scale scores served as the dependent variables.

Results

There were no between-groups differences with respect to age ($P = .36$), sex ($P = .09$), history of concussion ($P = .11$), or diagnosis of attention deficit disorder/learning disorder ($P = .22$) (Table I).

Mixed-factorial design MANOVA revealed a significant multivariate effect of prescribed rest on cognitive function and symptoms [$F(5,42) = 10.63$; $P = .001$] with no effect of time elapsed since concussion noted [$F(10,86) = 1.02$; $P = .44$]. Significant effects were noted on all 4 ImPACT composite scores, as well as concussion related symptoms (Table II). Although clinical improvement was noted across all indices, Total Symptom Scores improved beyond the 80% CI (10-point improvement[18]) established for reliable change across a 7-day time-period, and there was no significant difference between the 3 groups [$F(2,46) = 1.15$; $P = .33$] in symptom change scores from pre- to post-rest (average change scores of 15, 12, and 20 points, respectively).

Table I. Age, concussion history, and diagnosis of ADD or LD

	Time since concussion (in days)				
	1-7 (N = 14)	8-30 (N = 22)	31+ (N = 13)	F/χ^2	P
Age	15.1 (3.4)	14.4 (2.6)	15.8 (2.7)	1.06	.36
Sex					
Male (N = 33)	12 (36%)	15 (46%)	16 (18%)	4.81	.09
Female (N = 16)	2 (12%)	7 (44%)	7 (44%)		
Previous concussions (including current concussion)					
1 (N = 15)	6 (43%)	8 (36%)	1 (7%)	7.66	.11
2 (N = 14)	3 (21%)	8 (36%)	3 (23%)		
3+ (N = 20)	5 (36%)	6 (27%)	9 (69%)		
Diagnosis of ADD or LD					
None (N = 38)	9 (24%)	17 (45%)	12 (31%)	3.04	.22
Yes (N = 11)	5 (45.5%)	5 (45.5%)	1 (9%)		

F, frequency; *ADD*, attention deficit disorder; *LD*, learning disorder.

Table II. Post-concussion ImPACT and total symptom scores by time and group (n = 49)

	Time since concussion (in days)					
ImPACT index	1-7 (N = 14)	8-30 (N = 22)	31+ (N = 13)	F	P	η^2
Verbal memory						
Pre-rest	80.9 (10.9)	82.6 (11.5)	76.9 (11.2)	17.13	.001	.27
Post-rest	90.3 (8.9)	85.3 (7.9)	83.9 (11.9)			
Visual memory						
Pre-rest	65.9 (12.4)	69.7 (12.7)	70.0 (16.8)	16.03	.001	.26
Post-rest	76.4 (11.8)	75.2 (10.9)	79.9 (13.0)			
Processing speed						
Pre-rest	33.9 (10.6)	33.8 (7.4)	35.5 (10.1)	20.18	.001	.31
Post-rest	38.0 (8.1)	36.9 (7.5)	38.5 (8.3)			
Reaction time						
Pre-rest	.698 (.18)	.634 (.09)	.652 (.11)	7.59	.008	.14
Post-rest	.631 (.09)	.614 (.12)	.599 (.11)			
Total symptom						
Pre-rest	22.0 (21.1)	23.6 (21.5)	28.1 (18.9)	50.15	.001	.52
Post-rest	6.8 (7.4)	11.4 (17.6)	7.9 (5.5)			

Verbal: time: $F(1,46) = 17.13$; $P = .001$, group: $F(2,46) = 1.17$; $P = .32$.
Visual: time: $F(1,46) = 16.03$; $P = .001$, group: $F(2,46) = 0.46$; $P = .63$.
Motor: time: $F(1,46) = 20.18$; $P = .001$, group: $F(2,46) = 0.16$; $P = .85$.
React: time: $F(1,46) = 7.59$; $P = .008$, group: $F(2,46) = 0.76$; $P = .47$.
Symptoms: time: $F(1,46) = 50.15$; $P = .001$, group: $F(2,46) = 0.23$; $P = .79$.

As stated, a subset of 28 patients received an additional period of prescribed rest. There were no between-groups differences on sex ($P = .08$), history of attention deficit disorder/learning disorder ($P = .62$), or history of concussion ($P = .93$). One-way ANOVAs (with Bonferonni correction alpha set to $P < .01$) revealed that these 28 patients differed significantly from the 21 patients who did not receive additional rest on pre-rest measures of verbal memory [$F(1,47) = 7.69$; $P = .008$], processing speed [$F(1,47) = 15.94$; $P = .001$], and reaction time [$F(1,47) = 20.02$; $P = .002$], but not visual memory ($P = .11$) or total symptom scores ($P = .016$) (Table III). Following 1 week of prescribed rest, the 2 groups differed only on processing speed [$F(1,47) = 9.44$; $P = .004$].

Table III. ImPACT and total symptom scores by time and rest group

	Prescribed rest group				
ImPACT index	1 week (N = 21)	2 week (N = 28)	F	P	D
Verbal memory					
Pre-rest	85.4 (9.1)	77.0 (11.6)	7.69	.008	0.81
Post-rest	89.86 (8.4)	83.71 (9.6)	5.43	.024	0.68
Visual memory					
Pre-rest	72.2 (15.8)	66.0 (11.3)	2.60	.11	0.46
Post-rest	79.67 (12.8)	74.68 (10.5)	2.25	.14	0.43
Processing speed					
Pre-rest	39.4 (9.6)	30.4 (6.2)	15.94	.001	1.12
Post-rest	41.29 (7.5)	34.9 (6.9)	9.44	.004	0.19
Reaction time					
Pre-rest	.577 (.07)	.717 (.13)	20.02	.001	−1.34
Post-rest	.591 (.12)	.632 (.09)	1.82	.18	−0.30
Total symptom					
Pre-rest	16.3 (14.7)	30.3 (22.2)	6.25	.016	−0.74
Post-rest	6.1 (9.7)	11.43 (14.3)	2.20	.14	−0.44

D, difference.

For the subset of 28 participants who received continued prescribed rest, mixed-factorial design MANOVA again revealed a significant multivariate effect of rest on cognitive function and symptoms [$F(10,16) = 4.38$; $P = .004$] with no effect of time elapsed since concussion noted [$F(10,42) = 1.23$; $P = .30$]. Significant effects were again noted on all 4 ImPACT composite scores, as well as concussion related symptoms (Table IV). Again, although clinical improvement was noted on all indices, and reliable change[18] was noted (from pre-rest to the second post-rest assessment) on Verbal Memory (9 points), Reaction Time (.06 points), and Total Symptom Scores (10 points) for all 3 groups. With respect to change in symptom scores from post-rest time 1 to post-rest time 2, there was no significant difference between the 3 groups in either symptom change scores from pre-rest to post-rest time 2 [$F(2,25) = 0.04$; $P = .96$] (average change scores of 26, 28, and 26 points, respectively), or in symptom change scores from post-rest time 1 to post-rest time 2 [$F(2,25) = 0.89$; $P = .44$] (average change scores of 7, 11, and 4 points, respectively).

Discussion

A period of prescribed cognitive and physical rest is often applied as an immediate treatment for sports concussion, even though there is no empirical evidence to support such treatment. Health care professionals have been typically guided by their own judgment, as well as by position statements and policies of professional groups, in the treatment of sports concussion.[5,19,20] Without evidence to support the case for rest, especially when weeks or months have passed since the injury, clinicians are met with resistance from athletes, parents, and school and athletic officials who do not see the therapeutic value of missing school or sports when many weeks have already passed. Athletes, parents, and coaches may balk at the need for, or effectiveness of, rest and inactivity. Without supportive empirical data, patient compliance is threatened and clinician judgments are often challenged and questioned.

Our results represent the first data documenting the efficacy of prescribed rest for the treatment of post-concussion symptoms and cognitive dysfunction, whether the rest is applied in the early or prolonged stages of recovery. With the increased prevalence of sports concussion in youth, and the enduring effects that have been correlated with repeated concussions,[21,22] the need for effective, empirically-based treatments is evident.

Although these data are compelling and have much clinical relevance, there are significant limitations to this study. First, the study is retrospective in nature and, thus, lacks blinding, randomization, and comparison with a control group. As such, even with the documented improvement in the patients presenting over 1 month since their concussion, it is impossible to show that observed improvement was the result of prescribed rest. Second, prescribed rest, as a construct, needs to be more accurately defined to proceed with future research investigation. Factors such as type of prescribed rest (physical vs cognitive), length of prescribed rest period, and degree or nature of prescribed rest (for eg, no school vs partial school days or school attendance but no note-taking, homework, tests, computers, etc.) should be considered in any research design. In addition, variables such as time since the concussion (eg, before rest is prescribed), and severity of concussion symptoms at onset, could help determine the efficacy of prescribed rest as a treatment. Third, compliance with prescribed rest was not specifically monitored or documented on a prospective, systematic basis. Given the age of the sample, it is difficult to achieve "100% cognitive and physical rest." In this regard, whereas restriction from academic activities was recommended, and schools were provided with identical recommendations for academic accommodations, adherence to these recommendations by the schools was not monitored on a short- or long-term basis. Fourth, this was a small, selective, convenience sample of athletes reporting for treatment following concussion. Thus, it prohibits more detailed consideration of variables such as age, sex, ADD/LD, intellectual ability, and years in sports and type of sport. Fifth, no baseline cognitive testing was analyzed in this study as few patients had baseline data available for comparison. It is not known to what extent considering change from baseline would affect the interpretation of the present results. Finally, as athletes were evaluated on concussion and related symptoms, data were not recorded or coded regarding on-field signs and/or symptoms at the actual time of injury. As such, it is not clear what effect

Table IV. Post-concussion ImPACT and total symptom scores by time and group (n = 28)

	Time since concussion (in days)					
ImPACT index	1-7 (N = 8)	8-30 (N = 12)	31+ (N = 8)	F	*P*	η^2
Verbal memory						
Pre-rest	76.6 (12.1)	79.5 (12.9)	73.5 (8.9)	8.65	.001	.42
Post-rest1	86.4 (10.1)	83.6 (8.2)	81.3 (11.6)			
Post-rest2	89.9 (7.2)	89.9 (7.4)	83.1 (15.7)			
Visual memory						
Pre-rest	63.0 (10.5)	68.2 (11.5)	65.8 (12.5)	7.72	.003	.39
Post-rest1	75.9 (12.3)	73.2 (8.0)	75.8 (12.8)			
Post-rest2	80.8 (13.0)	75.2 (8.3)	70.9 (12.9)			
Processing speed						
Pre-rest	27.6 (6.2)	31.1 (5.3)	32.2 (7.2)	16.13	.001	.57
Post-rest1	33.1 (4.9)	34.7 (7.5)	37.2 (7.7)			
Post-rest2	36.8 (5.5)	37.8 (7.1)	36.9 (6.0)			
Reaction time						
Pre-rest	.820 (.14)	.652 (.09)	.711 (.11)	15.95	.001	.57
Post-rest1	.675 (.08)	.603 (.07)	.635 (.12)			
Post-rest2	.605 (.05)	.583 (.06)	.614 (.10)			
Total symptom						
Pre-rest	29.3 (22.9)	31.7 (24.3)	29.4 (21.1)	18.91	.001	.61
Post-rest1	10.5 (7.0)	14.7 (20.8)	7.5 (4.7)			
Post-rest2	3.0 (4.8)	3.3 (3.3)	3.9 (2.0)			

Verbal: time: $F(2,24) = 7.97$; $P = .001$, group: $F(2,26) = 1.02$; $P = .38$.
Visual: time: $F(2,24) = 7.72$; $P = .003$, group: $F(2,26) = 0.20$; $P = .82$.
Motor: time: $F(2,24) = 16.13$; $P = .001$, group: $F(2,26) = 0.27$; $P = .77$.
React: time: $F(2,24) = 15.95$; $P = .001$, group: $F(2,26) = 3.77$; $P = .04$.
Symptoms: time: $F(2,24) = 18.91$; $P = .001$, group: $F(2,26) = 0.18$; $P = .84$.

such variables may play in the efficacy of prescribed cognitive and physical rest.

Future research should be aimed at addressing these limitations. In addition, the incorporation of neuroimaging and electrophysiological assessment tools will better assist us in understanding the mechanisms of rest and help identify the brain activation patterns associated with different kinds of rest.

The idea that cognitive and physical rest may help improve the condition of patients with post-concussion syndrome is noteworthy. In contrast, there may be a perception among clinicians that once the 7- to 10-day time period in which the neurometabolic "cascade"[3] has passed, and a patient continues to experience concussive symptoms, cognitive and physical rest is of limited use. However, in such cases it has been proposed that patients should engage in light physical exertion,[23] and adolescent athletes have been shown to benefit from moderate exertion following concussion.[7] However, recent research suggests that at even 1 month or more post-concussion, 36% of 11- to 15-year-olds still exhibit decreased cerebral blood flow compared with non-concussed controls.[24] This supports an even longer recovery period than typically thought and is consistent with the notion that a period of rest may be therapeutic even in a post-concussion syndrome, which is defined by some as occurring when symptoms persist after 1 month.[25,26] In the current study, 26.5% of the sample continued with concussion symptoms past the 31-day mark and still demonstrated improvements with prescribed rest comparable with improvements made by those participants who were still in the early stages of concussion. Although interpretation of the present study must be tempered by the fact that group sizes are small, such that a more careful examination of time since concussion is limited, these data are compelling and the first to be presented that give credence to the importance of prescribed rest as a concussion treatment. As a cautionary note, there may also be negative effects or consequences of imposed rest, such as affective reactions, academic consequences, and social implications, which also need to be systematically examined. With so little currently known about rest from a research perspective, it is hoped that the present study will stir interest in this deceivingly simple, yet complex, construct and important treatment for concussion. ■

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