3-1-2019

Indicators for Prolonged Recovery from Concussion in Adolescents

Nicola Juri
University of the Pacific, nicola.cooke12@gmail.com

Indicators for Prolonged Recovery from Concussion in Adolescents

By

Nicola Juri

Capstone Project

Submitted to the Faculty of the

Department of Physician Assistant Education

of University of the Pacific

in partial fulfilment of the requirements

for the degree of

MASTER OF PHYSICIAN ASSISTANT STUDIES

March 2019

INTRODUCTION

Each year, an estimated 3.8 million concussions occur in the United States related to sports and recreational activity.[1] Great gains have been made in the management of concussion, putting it in the spotlight as a leading public health crisis. The highest percentage of sports-related concussion occurs in those under the age of 21.[1] From initial time of injury to return to activity, the common definition of clinical recovery, is approximately 2 weeks for adults and 4 weeks in children under the age of 18. This is in stark contrast to the previously held understanding that all concussions, age independent, were expected to recover within 7-10 days.[2] This change in duration reflects the significant developments in and understanding of the importance of rest and graduated return to play in the management of concussion.[2] While the understanding of overall concussion management is growing, the ability to identify those who are at risk for long-term complications and prolonged recovery is still poorly understood. Clinically, this is a recurrent dilemma in determining treatment decisions as well as answering the common question of "When will they be better?" This paper aims to evaluate researched demographics of age and gender, symptom severity and characteristics, and physical exam findings on initial clinical evaluation that may indicate a protracted recovery, specifically as they relate to adolescents participating in sports.

AGE

One well researched and unmodifiable consideration is evaluating whether younger age at time of injury is a risk factor for delayed recovery. Researchers have studied this by looking between age groups and within age groups by year. Theoretically, the idea is that a developing

brain would take longer to return to normal functioning after injury. However, little evidence has been found to validate this theory on a year-by-year basis. Overall research substantiates that adolescents take longer than adults to recover. [3,4] Much of this research has been done comparing college and high school students who suffer concussions in athletics. While the correlation data may be substantial, additional motivation and pressure for college athletes to perform, as well as additional access to medical professionals may confound this data. Diversely, no link has been made that age from year to year within the adolescent age group (10-17) significantly alters recovery time. [5-8] For example, according to the available research, an 11-year-old is not more likely to take longer to recover than a 12-year-old. In addition to the variation between adolescent and adult age groups, additional confounders may be present. Adolescents likely have more parental involvement, may not have as rapid access to specialty care, and possibly have less functional demands then their adult counterparts. Compounded, these variables potentially explain the significant differences between adolescents and adult age groups and the lack of substantial differences from year to year.

GENDER

Another non-modifiable demographic to consider is gender. Overall, males recover faster than females.[5,9,10-11] Few studies, typically with smaller sample sizes, have found otherwise.[8] Multiple theories attempt to explain this including biomechanical differences between males and females. One example is the theory that, overall, females have less cervical muscle stability strength resulting in more substantial coup and countercoup forces during injury. Females were also found to require more interventions, including specialized rehabilitation and testing compared to their male counterparts.[11] Additional testing and

referrals to rehab inherently extend the duration of morbidity from concussion. Females also report higher symptom loads, both in number of symptoms and severity, compared to concussed males.[7] Little research is available to explain this phenomenon, but the significance of symptom burden is commonly studied in research evaluating concussion prognosis.

SYMPTOM SEVERITY AND CHARACTERISTICS

Symptom characteristics are implicated frequently in determining the severity of concussion as well as the trajectory of recovery. The most commonly reported symptoms are headache, dizziness, difficulty concentrating, photophobia, and phonophobia. The number of overall symptoms present at the clinical evaluation is associated with recovery, in that a higher number of symptoms typically results in a statistically significant longer recovery.[4-6,8] In addition, severity of these symptoms (mild, moderate, severe) is also correlated with recovery time.[7] The presence of certain symptoms, specifically sleep disturbance as defined by difficulty falling or staying asleep, was associated with patients with atypical recovery.[12] Adolescent group characteristics, such as sleep pattern, as well as individual differences in sensitivity or affect may confound the data mentioned. However, the significance of association with symptomatology further supports the use of symptom screening tools that look at the presence and severity of symptoms at each clinical visit as aids for tracking those who may be at increased risk for atypical recovery.

PHYSICAL EXAM FINDINGS

Objectively, findings on a physical exam can additionally differentiate those who may follow an atypical course and those at risk for protracted recovery. The concussion diagnosis

itself substantiates the lack of any persistent focal neurologic defects on exam.[2] However, more specific exam techniques have been implemented as a screening tool beyond a brief neurologic exam. First is the Vestibular Ocular/Motor Screening (VOMS). This brief exam looks at symptom provocation and abnormalities with smooth pursuits, near point convergence, horizontal and vertical saccades, and horizontal and vertical vestibular ocular reflex (VOR). Abnormalities and symptom provocation on this screening is associated with longer recovery.[13] Used as an easy screening tool, this not only identifies those with a vestibular component of concussion, but also can identify those who may require additional vestibular rehabilitation. Very few studies, many with a small population, have evaluated this link. However, with this early evidence there is the opportunity to identify concussions with a vestibular component sooner, potentially decreasing the overall recovery time.

Another associated area commonly affected by concussion is balance. Studies have looked to evaluate whether the presence of a balance abnormality can be as predictive as the VOMS. Overall, the results are mixed.[6-8] Balance is typically screened with the Balance Error Scoring System (BESS) or modified-Balance Error Scoring System (m-BESS), an objective method of evaluating postural stability. The presence of abnormalities on testing has been shown to indicate the presence of concussion, acting as more of a confirmatory test, rather than a finding associated with prolonged recovery.[6,8] Theoretically, balance involves multiple systems beyond the brain including functional muscle strength, possibly explaining the limited support of using mBESS/BESS for evaluating concussion prognosis. However, in cases where baseline balance data is available, abnormalities on these exams can further be utilized in determining return to

normal function. Collectively, both the VOMS and BESS/m-BESS provide objective measures in a rapid, easily utilized fashion that can be used for diagnosis and prognosis.

DISCUSSION

The significance of the research discussed here raises an opportunity to incorporate these known risk factors into a screening and risk stratification system for concussion recovery. First, providers must consider age group and gender as significant impactors on recovery. This assists providers in identifying patients who may take longer than average to recover based on unmodifiable information alone. Both female sex and the adolescent age group were associated with prolonged recovery. Acknowledging that symptom burden is associated with delayed recovery further supports the utilization of symptom screening tools at the first visit and at subsequent visits for trending.

The severity of the present symptoms was also found to be associated with longer recovery, so it is important not only to screen for the presence of these symptoms, but also the severity of them. Finally, incorporating simple special tests during the physical exam on an initial concussion evaluation can help identify those with abnormalities on VOMS. Vestibular abnormalities present on screening were associated with delayed recovery. VOM screening also identifies those who may need additional rehabilitation, such as vestibular or ocular therapy for their recovery. While balance testing alone was not associated with prolonged recovery, it was found to be a confirmatory test for concussion, providing support for incorporating balance screening via BESS/mBESS testing on initial evaluation. Collectively, these components add evidence to help providers clarify patient expectations of recovery time. While none of these

factors alone may answer the question, they do contribute to prognostic evaluation. This information also helps providers to make plans for follow up. A patient at higher risk for prolonged recovery may have a shorter threshold for referral to specialized therapy, medications, or additional interventions. Closer supervision may be utilized to ensure progress is being made.

LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

There are, however, significant limitations in researching concussion as well as with the generalizability of most of the research discussed here. First, the nature of studying concussion from a prognostic standpoint limits the possibilities of true randomized controlled trials. While observational studies do supply some significant data, a true causal relationship cannot be obtained. Second, most of the research available thus far has been completed at individual specialized centers. This raises the concern that perhaps the data is confounded by the fact that more of the severe concussions are likely to go to a specialized center. Further, most of the research is conducted specifically looking at concussion in sports. While that is the most common cause of concussion in the adolescent population, it raises the question of whether this data applies to other mechanisms of injury as well. From these limitations arise the opportunity for further research. More multi-center studies focused on concussion in a variety of age groups are needed to continue the progress in concussion evaluation and management. In addition, further research on prognostics and therapeutics for concussion injury will continue to help develop treatment recommendations and hopefully one day affect recovery duration. In the interim, focusing on health care provider education, and encouraging the incorporation of

the knowledge found in the research that is available, can continue the trajectory of progress in adolescent concussion evaluation and management.

REFERENCES

1. Centers for Disease Control and Prevention. Sports and recreation related-injuries https://www.cdc.gov/healthcommunication/toolstemplates/entertainmented/tips/SportsInjuries.html. Updated 2017. Accessed November 20, 2018.

2. McCrory P, Meeuwisse W, Dvořák J, et al. Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in berlin, october 2016. *British Journal of Sports Medicine*. 2017;51(11):838. http://dx.doi.org/10.1136/bjsports-2017-097699. doi: 10.1136/bjsports-2017-09769

3. Williams R, Puetz T, Giza C, Broglio S. Concussion recovery time among high school and collegiate athletes: A systematic review and meta-analysis. *Sports Med*. 2015;45(6):893-903. http://www.ncbi.nlm.nih.gov/pubmed/25820456. doi: 10.1007/s40279-015-0325-8.

4. Iverson GL, Gardner AJ, Terry DP, et al. Predictors of clinical recovery from concussion: A systematic review. *British Journal of Sports Medicine*. 2017;51(12):941-948. http://dx.doi.org/10.1136/bjsports-2017-097729. doi: 10.1136/bjsports-2017-097729.

5. Heyer, Geoffrey L., MD. Schaffer, Caroline E., BS|Rose, Sean C., MD|Young, Julie A., ATC|McNally, Kelly A., PhD|Fischer, Anastasia N., MD. Specific factors influence postconcussion symptom duration among youth referred to a sports concussion clinic. *Journal of Pediatrics, The*. 2016;174:38.e2. https://www.clinicalkey.es/playcontent/1-s2.0-S0022347616003176. doi: 10.1016/j.jpeds.2016.03.014.

6. Miller JH, Gill C, Kuhn EN, et al. Predictors of delayed recovery following pediatric sports-related concussion: A case-control study. *Journal of neurosurgery. Pediatrics*. 2016;17(4):491-496. http://www.ncbi.nlm.nih.gov/pubmed/26684762. doi: 10.3171/2015.8.PEDS14332.

7. Thomas D, Coxe K, Li H, et al. Length of recovery from sports-related concussions in pediatric patients treated at concussion clinics. *Clinical Journal of Sport Medicine*.

2017;28(1):56-63. https://www.ncbi.nlm.nih.gov/pubmed/28085687. doi: 10.1097/JSM.0000000000000413.

8. McCrea M, Guskiewicz K, Randolph C, et al. Incidence, clinical course, and predictors of prolonged recovery time following sport-related concussion in high school and college athletes. *Journal of the International Neuropsychological Society : JINS*. 2013;19(1):22-33. https://www.ncbi.nlm.nih.gov/pubmed/23058235. doi: 10.1017/S1355617712000872.

9. Bock S, Grim R, Barron T, et al. Factors associated with delayed recovery in athletes with concussion treated at a pediatric neurology concussion clinic. *Childs Nerv Syst*. 2015;31(11):2111-2116. http://www.ncbi.nlm.nih.gov/pubmed/26243160. doi: 10.1007/s00381-015-2846-8

10. Chand MR, Kanwar S, Calvo C, Peck E. Influence of sex and previous concussion history on postconcussive recovery in young athletes. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2017:1. https://www.ncbi.nlm.nih.gov/pubmed/29256929. doi: 10.1097/JSM.0000000000000554.

11. Kostyun RO, Hafeez I. Protracted recovery from a concussion. *Sports Health: A Multidisciplinary Approach*. 2015;7(1):52-57. http://journals.sagepub.com/doi/full/10.1177/1941738114555075. doi: 10.1177/1941738114555075.

12. Bramley H, Henson A, Lewis MM, Kong L, Stetter C, Silvis M. Sleep disturbance following concussion is a risk factor for a prolonged recovery. *Clinical Pediatrics*. 2017;56(14):1280-1285. http://journals.sagepub.com/doi/full/10.1177/0009922816681603. doi: 10.1177/0009922816681603.

13. Anzalone AJ, Blueitt D, Case T, et al. A positive vestibular/ocular motor screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescent athletes. *The American Journal of Sports Medicine*. 2017;45(2):474-479. http://journals.sagepub.com/doi/full/10.1177/0363546516668624. doi: 10.1177/0363546516668624.