Reduced Number of Saccades in Athletes with a History of Concussion

Vipul Lugade[1], Chao Shi[2], Stanley Hunter[3], Michael Dulas[4], Isiah Turner[1], Fabiha Islam[2], Monica Stapor[1], Natalia Gierlachowski[1]
[1] Motion Analysis Research Laboratory, SUNY Binghamton University, Binghamton, NY, USA;
[2] Systems Science and Industrial Engineering, SUNY Binghamton University
[3] United Health Services Hospitals, Vestal, NY, USA;
[4] Department of Psychology, SUNY Binghamton University; Email: vlugade@binghamton.edu

Summary

Young athletes in high-contact sports are at a high risk for mild traumatic brain injuries (mTBI). These injuries can result in neurological deficits, including saccadic abnormalities that may impact daily functioning. This study utilized eye-tracking technology to evaluate the preseason saccadic behavior in male athletes with and without a history of concussion. The results suggest that the number of saccades may be a potential indicator for residual concussion-related visual deficits. Eye-tracking assessments provide valuable insight into how sports-related concussions impact an athlete neurologically.

Introduction

Mild traumatic brain injuries or concussions, are a significant medical concern among young adults participating in sports and recreational activities. In the United States, sports-related concussions (SRC) account for an estimated three million cases annually, with many individuals remaining undiagnosed and/or lack access to treatment [1]. Without proper management, these injuries can lead to neurological deficits, including cognitive impairment, balance issues, and visual dysfunction [2]. Given their significance, past studies have explored the use of eye-tracking parameters in the diagnosis of SRC [3].

SRC during high-impact sports has been shown to contribute to visual impairments, including saccadic dysfunction, smooth pursuit deficits, and convergence insufficiency [2]. However, further research is needed to better understand the extent of these impairments and the potential usage of eye-tracking technology in monitoring long-term concussion-related visual dysfunctions. To address this gap, this study evaluated low-impact (CrossFit) and high-impact (Ice Hockey) athlete's preseason visual metrics (fixations and saccades). We hypothesized that, regardless of sport, concussed athletes would exhibit a reduced number of saccades, increased saccadic velocity, greater saccadic amplitude, and larger pupil size.

Methods

Young male ice hockey athletes were recruited from the local semi-professional team. Age- and gender-matched low-impact athletes were recruited from a local CrossFit gym. All participants provided informed consent to the study protocol before enrollment. Participants were instructed to perform an eye-tracking test while sitting as quietly as possible and following a moving dot at varying speeds in vertical and horizontal directions (Figure 1). Eye movements were recorded using Tobii Pro Glasses 3 and then automatically processed through Tobii Pro Lab to retrieve the eye tracking metrics. Our primary outcomes focused on the number of saccades, with secondary outcomes including saccadic velocity and amplitude. A two-way ANOVA was performed to evaluate differences between sports (high- and low-impact) and concussion history. All data analysis was conducted in SPSS 22.0, using an alpha level of P=0.05.

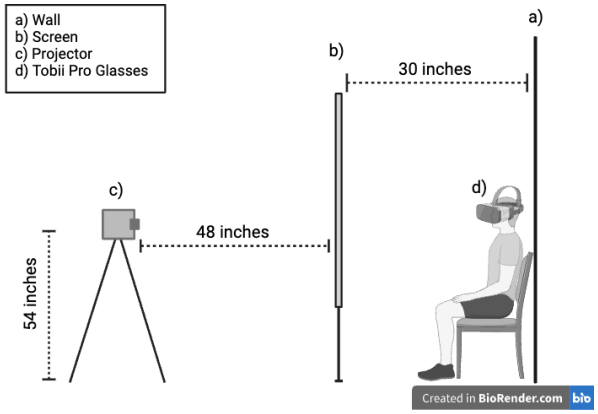

Figure 1: Experimental setup for this study, including the standardized distance for the screen-to-wall (30 in), screen-to-projector (48 in), and projector height (54 in) with a 16:9 screen ratio.

Results and Discussion

Sixteen professional male ice hockey players (age= 25.1±1.9 years; BMI= 25.8±2.6 kg/m^2) and 15 CrossFit players were evaluated, with hockey player results initially reported. Athletes with a history of concussion demonstrated a reduced number of saccades (P=0.044; Table 1), compared to athletes with no concussion history. Results suggest that concussions may lead to measurable impairments within ocular motor function. While athletes reported on average 2.5 concussions, none demonstrated clinical symptoms, and no significant difference in other outcome measures was found.

Conclusions

These results highlight the potential of eye-tracking technology as a valuable tool for assessing the lingering effects of concussions in athletes.

References

[1] Sussman et al. (2016). *Neurosurg Focus*, **40**: E7.
[2] Jain et al. (2022). *Optom Vis Sci*, **99**: 616-625.
[3] Murray et al. (2020). *J Neurotrauma*, **37**: 340-346.

Table 1: Performance during horizontal and vertical eye-tracking tasks among young adult male athletes; * P < 0.05.

	Saccadic Number *	Peak Velocity (deg/s)	Total Amplitude (deg)
Non-Concussed	18.3 (6.5)	460.4 (154.6)	690.1 (341.6)
Concussed	11.4 (8.0)	390.2 (130.8)	438.5 (439.8)