

Development of a Mobile, Low-cost Pupillometer for Early Detection of Concussion Lynn B McGrath MD; Anthony Law MD/PhD; Randall Bly

Introduction

The CDC estimates that of the 3.8 million sportsrelated concussions in the US each year, half will be missed. This is largely due to the lack of readily measurable objective findings in patients with concussion. Significant derangements in pupillary light reflex (PLR) have been demonstrated, but the expense of pupillometers has prevented a well-powered community-based study. We have developed a low-cost pupillometer to facilitate large-scale real-world prospective data collection in the hope of demonstrating the first reliable objective measure of concussion that can be obtained on the sidelines.

Methods

Smartphone-based pupillometry software was developed utilizing two convolutional neural networks running parallel algorithms for detecting and tracking pupil diameter. 50 normal volunteers and 50 patients with severe TBI were assessed by the novel pupillometer six times each and ground-truth assessment was performed. PLR was measured simultaneously with and compared to the NeurOptic pupillometer system as a gold-standard reference.

Results

Across all subjects tested, the distribution of absolute errors in diameter estimation and tracking has a median of 0.36 mm. According to Meeker et al, the error of our diameter estimation is better than that of expert examination (0.50mm), but worse than that of the standard pupillometer (0.23 mm). We found our results impacted by a small subset of outliers with very dark brown irises (0.40mm vs. 0.11mm for light irises).

Conclusions

Significant derangements of PLR have been demonstrated in concussion, but the expense of pupillometers has prevented a well-powered community-based study. We developed a lowcost pupillometer available on a smartphone platform, and have demonstrated that it is more accurate than expert examination, and nearly as accurate as the current gold standard. This novel smartphone-based pupillometer should reliably facilitate large-scale real-world prospective data collection and the confirmation of PLR as an objective early indicator of concussion.

Learning Objectives

1) to review limitations in concussion diagnosis

2) to emphasize the public health problem represented by concussion

3) to determine the utility of pupillometry for concussion detection

4) to emphasize the need for low-cost biosensor capability

References

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