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CHRI Pediatric Research Forum 2021 Abstract

Computer-Assisted Analysis of Soccer Ball Trauma of the Eye

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Purpose: Sports-related eye injuries are common in the United States and around the world, particularly in youth. Over half of patients presenting with these injuries are of 18 years or younger, and sports and recreation account for nearly a quarter of all pediatric eye injuries treated in US emergency departments. Soccer is the most popular game in the world and is the leading source of sports-related eye injury in Europe and Israel. Soccer injuries cause visual impairment at a disproportionately higher rate than other sports. This study investigates the mechanisms of injury.

Methods: A finite element simulation was developed to study the distribution of stresses in the eye following the impact of a soccer ball. The eye model was composed of sclera, vitreous, and retina. The retina was simulated as three layers: preretinal, intraretinal, and subretinal. Vitreoretinal adhesions were incorporated along retinal vessels.

Results: The anterior pole experienced a peak stress of 69.8 kPa following impact of the soccer ball. The impact induced a pressure wave within the vitreous that traveled latitudinally along the anterior-posterior axis and repeatedly reflected from the intraocular tissue. Oscillations of high and negative pressure in the vitreous resulting from the pressure wave were greatest at the posterior pole. Stresses within the retina were highest along the retinal vasculature, especially at the distal bifurcations where the peak stress was 15.4 kPa. The subretinal layer experienced more stress than the preretinal and intraretinal layers except along the vasculature, at which the preretinal layer experienced more stress.

Conclusions: The distribution of stresses within the eye quantify and expand on frequently proposed biomechanical bases for ocular injuries resulting from soccer ball trauma. High stress near the point of impact may account for commonly observed anterior segment injuries. Negative pressures within the vitreous adjacent to the posterior retina provide further support for the anterior pulling of the retina as a potential mechanism for posteriorly localized retinal lesions. These patterns of stress throughout the eye highlight the importance of eye protection in soccer and other sports, which have been demonstrated to prevent up to 90% of ocular injury.