Commentary on determining the tractional forces on vitreoretinal interface.

Donny W Suh*

Department of Pediatric Ophthalmology and Adult Strabismus, Children's Hospital and Medical Center, Omaha, Nebraska, USA

Accepted on 02 February, 2021

About the Study

Abusive head trauma (AHT) encompasses a form of inflicted head trauma in infants usually younger than two years of age. With or without blunt head trauma, AHT produces characteristic injuries to the central nervous system, cervical skeleton, and eyes, especially when the victim is subjected to repetitive acceleration and deceleration. AHT is the leading cause of infant mortality and long-term morbidity from injury. In most of these children, retinal hemorrhage (RH) demonstrates multifocal and multilayered involvement extending out to the ora serrata, with possible macular retinoschisis and vitreous hemorrhage. While the exact mechanism for RH is not known, one hypothesis suggests it may be due to vitreoretinal traction that occurs during repetitive acceleration-deceleration with or without blunt head impact. Other theories explore the possibility of increased intravascular pressure as the culprit behind vascular wall damage and hemorrhage, seen in Valsalva maneuvers or chest injuries. The exact reason for the extensive nature of RH involving both the macula, periphery, and all layers of the retina is still not fully understood.

Discussion

Computer simulations employing finite element (FE) analysis offer a valuable way to study AHT. This approach is relatively inexpensive compared to other models and has become popular due to its ability to incorporate both external and internal parameters that retain maximum biofidelity of the eyeball in response to predicted tissue stresses and strains. With the FE model, the eye is divided into very small pieces, akin to a brick (solid element) or thin plate (shell element), with similar physiologic properties and characteristics to an infant eye. These elements aggregate to produce an approximate model of an eye that can be manipulated computationally with relative conformity. Nodes can be created where the elements join to create flection points, and stresses may be applied to both the elements and nodes, to measure resulting forces. Components of the infant eye, such as the unique hyper-viscous vitreous and firmly attached retina, can be incorporated into a FE eye model. Since 1999, a number of FE analysis models applicable to AHT or shaken baby syndrome (SBS) have been developed to study the blunt impact following ocular trauma. However, previously created models assumed a homogenous, full-surface attachment between the retina and vitreous, ignoring stronger adhesive forces in particular structures including perivascular areas.

To better understand the mechanisms associated with AHT ocular manifestations, namely RH, we developed a new FE analysis of the eye and orbit that could be exposed to virtual forces experienced during shaking. A previous study on the physiologically biomimetic infant dummy doll via shaking by a human adult was used to define the parameters of acceleration, deceleration, range of motion of the eye in space, frequency of shaking, and velocity. This helped us to determine the compressive and tractional forces as well as the pressure applied to the retina and its vasculature using our FE model for the first time. Previous models only subjected the eye to simple rotational or translational movements along a single axis in an arc pattern. We examined our model by simulating multidirectional movements of the dummy doll model in a figure 8 pattern. Furthermore, we also examined the forces applied to different layers of the retina by dividing it into pre-retinal, intra-retinal and sub-retinal spaces using different elements for each layer. This allowed more precise forces to be applied to different sub-layers of the retina and thus better understand the impact of the injury throughout the full thickness of the retina. This allows a correlation to the retinal hemorrhage patterns commonly seen in AHT related to violent shaking.

The goal of this paper was to advance understanding of the pathophysiological process of vitreoretinal traction by determining the forces generated during shaking of an infant using the newly developed FE model. We hypothesized that a newly developed FE model could advance understanding of vitreoretinal traction in AHT by determining the forces on posterior ocular tissues during shaking of an infant.

*Correspondence to

Dr. Donny W Suh

Chief of Pediatric Ophthalmology and Adult Strabismus

The John & Irene Graether Endowed Chair in Pediatric Ophthalmology

Director of Fellowship

Children's Hospital and Medical Center

Professor, Truhlsen Eye Institute

University of Nebraska Medical Center

USA

E-mail:dsuh@childrensomaha.org

Citation: *Suh DW. Commentary on determining the tractional forces on vitreoretinal interface. J Clin Ophthalmol 2021;5(S2):350.*