Post traumatic retinal injuries: Does the ocular protective reflex play a crucial role?

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ABSTRACT
Traumatic retinal injuries are commonly encountered in most retinal subspecialty clinics. Retinal dialysis, detachment and other complications consequent to blunt trauma are often thought to be due to equatorial expansion of the globe following an antero-posterior compressive force. However, stretching of the globe along the primary anatomical equator may not hold true for the adjusted globe position as a consequence of the protective Bell’s phenomenon which gets activated before impact. The upward and outward rolling of the globe likely creates a new equator, with the compressive forces acting along this new plane, thereby leading to stretching along the ocular coats closer to the retinal periphery. Additionally, the coup and countercoup mechanisms with increased vulnerability of temporal sclera predisposes to retinal complications more commonly along the temporal and the nasal retina. Further, retinal complications involving other quadrants can also be explained through understanding of the Bell’s phenomenon.

Introduction

Traumatic ocular complications have a huge bearing on the patient’s long term visual outcomes and are of important concerns to any ophthalmologist [1–3]. Consequent to blunt ocular trauma, the widely known seven crucial vulnerable injuries are -iris sphincter tear, iridodialysis, angle recession, trabecular mesh work disruption, cyclodialysis, zonular dialysis and retinal dialysis. Retinal dialysis is characterized by a separation of the retina along the ora serrata. The separation can be anterior to the ora along the posterior ciliary epithelium or posterior to the ora along the peripheral retina [1]. These retinal injuries can be located in any quadrant of the eye, but are more commonly seen along the infero-temporal quadrant and along the superonasal quadrant. However, the simple concept of antero-posterior globe compression with equatorial expansion does not sufficiently explain the occurrence of dialysis at the ora. Therefore, here in this observation we elaborate the probable crucial role of protective ocular reflex in the causation of such complications.

What literature says

Retinal complications following trauma can either be due to blunt trauma or penetrating trauma; here we have considered the scenario of blunt trauma only. Since their description, traumatic retinal detachments have been studied extensively to understand the pathomechanisms, and, clinical implications and outcomes [1–7].

In an observation by Hagler et al involving a total of 523 eyes with retinal dialysis, blunt ocular trauma was found to be a significant factor in the causation of retinal dialysis. They also noted that these injuries were more common in young males and this observation has been shown to be true till date [1]. Similarly, in another observation by William H. Ross, the author stated that virtually all cases of retinal dialysis are due to blunt trauma [3]. However, some authors suggest, that patients are likely to forget the event of trauma or it may not have been noticed by them, thus, subjective verification with the objective findings is of utmost importance to reach a definitive diagnosis of a traumatic retinal detachment [1,3,5].

In the event of a blunt trauma, as the forces are transmitted along the globe, they intend to displace the globe into the orbit, however, the orbit being full of other soft tissues, provides only a minimal space for any posterior displacement of the globe, thereby leading to the phase of compression/sandwich. As the globe is an elastic structure, in order to dissipate the tension due to the compressive phase, it expands in an axis perpendicular to the original forces, i.e. along the equator. This equatorial stretch puts a significant traction over the retinal periphery, and the temporal part of the globe being more exposed, receives the added...
major brunt of coup or direct injury impact. In addition, this area is inherently weaker due to many other pathological changes such as microcystoid degeneration, progressive enlargement of intra retinal cysts, and congenital weakness of retinal periphery. Therefore, all these factors combined together, increase the risk of retinal complications along the temporal quadrant [8].

However, it is not universal for the complications to be restricted to only the temporal retina, the clinically defined quadrants, that is, supero-temporal, infero-temporal, supero-nasal and the infero-nasal quadrants do manifest such complications but at a variable rate. The percentage of traumatic retinal dialysis according to the recent edition of the Retina textbook by Ryan is, 66% along the infero-temporal quadrant, 14% along the supero-nasal quadrant, 10% along supero-temporal quadrant and 4% along the infero-nasal quadrant [9]. Therefore, in addition to any inherent or other pathological predisposition of the temporal retina to trauma, the transmission of forces along the other quadrants and the position of the globe during the impact along with some other factors appear to play a key role in the causation of retinal complications.

The likely role of protective ocular reflex in the transmission of forces and causation of retinal complications

Bell’s phenomenon is a protective ocular reflex described by Sir Charles Bell [10]. The normal phenomenon consists of an upward and outward rolling of the eyeball during forceful eye closure. This reflex is intended to protect the anterior ocular surface from an impending threat approaching the eye; it is commonly seen in up to 90% of normal individuals and it may be absent in remaining 10% of the normal population, which, however, is not abnormal. In addition to this, a downward movement of the eyeball has also been noted in some individuals and is commonly termed as inverse Bells phenomenon. This downward movement can be noted in normal individuals as well as following a large levator muscle resection for blepharoptosis. The neurological pathway for this reflex involves a complex co-ordination between the third and the fifth cranial nerves. This phenomenon of upward rolling of the eyeball is more pronounced in cases of seventh cranial nerve palsy due to an over exposure of the palpebral fissure, in addition, it can also be elicited in normal individuals while opening the eyelid forcibly, however, this reflex is absent in cases of regular blinks. Therefore, it is likely that this protective reflex needs an active threat from outside in order to reposition the globe into a relatively safer place within the orbit, thus ensuring minimal damage to the anterior eyeball structures. The nature of forces exerted on the exposed sclera can be a direct coup injury or a compressive injury, but as the sclera and rest of the globe being elastic in nature, an exact understanding regarding the extent of compression and causation of coup and counter coup consequences are difficult to decipher at any given point of time.

During the event of an acute trauma, it has been thought that, this protective reflex may come into action and because of this; certain other ocular structures may be more commonly prone for injury. During post traumatic extra ocular muscle injuries, due to Bell’s phenomenon the inferior rectus muscle has been thought to be more commonly injured as compared to rest of the extra ocular muscles [11]. Similarly, during optic nerve avulsion and indirect choroidal rupture, the role of Bells phenomenon has been highlighted [12].

The normal eyeball possesses an anatomical equator and in primary orthophoric position if the antero-posterior compressive pressures are exerted, the equatorial portion of the globe will distend. Objects with different dimensions are likely to impose compressive forces with different magnitude and hence the equatorial expansion is likely to vary.

If we take the Bell’s reflex into consideration then the position of globe’s equator would change from that in the primary position and hence the compressive forces are going to act in a different manner resulting in the compressive and expansive changes in entirely different axes.
Limitations

Our hypothesis is based on the consistent observation of retinal complications following blunt trauma, and do not involve the actual simulation of injuries on human eyes. In addition, the forces depicted along the new anatomical landmarks needs to be studied further in future observations.

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Declaration of Competing Interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.mehy.2019.109286.

References