Altered globe dimensions of axial myopia as risk factors for penetrating ocular injury during peribulbar anaesthesia

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We measured the range of equatorial horizontal widths (EHW) in axially myopic eyes and identified the sites of staphyloma using B scan echography. One hundred eyes in 50 patients were studied. The axial lengths (ALs) were sorted into five groups of increasing severity of myopia. The group mean AL, group mean EHW and the ratio of EHW/AL was calculated for each range. The results suggest that the increase in the AL in an axially myopic eye is associated with an increase in the EHW. However, this increase in the group mean EHW is relatively small (2.3 mm) compared with the increase mean AL (8.2 mm) across the entire range. The ratio of EHW/AL decreased with an increase in the group mean AL. Therefore, the increase in EHW in an axially myopic eye is unlikely to be a significant risk factor for inadvertent ocular injury for peribulbar injections if a careful single medial canthal approach is used. There was high incidence of staphylomas in eyes with AL >29 mm, most were inferior to the posterior pole of the globe, and there were none at the equator.


Keywords: myopia; axial length; equatorial horizontal width; staphyloma; globe penetration

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Regional anaesthesia of the eye is a safe and reliable technique for various types of ocular surgery. However, complications include the sight-threatening inadvertent needlestick injuries of the globe. There are a number of risk factors that predispose to needle penetration during retrobulbar and traditional peribulbar injections, including axial myopia. The risk of perforation is said to be 30 times greater in eyes with an axial length (AL) of 26 mm or greater compared with eyes with normal AL (23 mm or less).1

Recently, there has been an increase in the use of peribulbar blocks using the single medial canthal approach for various types of ocular surgery. In patients with axial myopia, the AL of the globe increases and the equatorial horizontal width (EHW) is expected to increase with it. Theoretically, this increase in the width of the globe in these eyes could be perceived to be a risk factor for an inadvertent ocular injury with the medial canthal approach. However, to date, there have been no studies addressing this issue. We looked into the relationship between the AL and EHW of the axially myopic eyes in order to identify the risk of perforation with the changing width of the globe. The incidence as well as the site of staphyloma in the axially myopic eyes was also investigated.

Patients and methods
ALs and EHWs of 100 axially myopic yes (AL >23 mm) in 50 patients presenting for cataract surgery were measured. The patients were recruited consecutively for each group of myopia of increasing severity: borderline myopia (AL: 23–25 mm); mild myopia (25.1–27 mm); moderate myopia (27.1–29 mm); high myopia (29.1–31 mm); and very high myopia (>31 mm). Each group had 10 patients (20 eyes). There were 26 females and 24 males with an age range of 52–85 yr (mean 70.3 yr). None of the patients had undergone any form of ocular surgery previously and their eyes were healthy other than lens opacification.

ALs were measured using a Canon KU1™ biometry apparatus and checked using an Alcon Digital B 2000™ B scanner to ensure that the measurements were to the macula. EHW was measured from the temporal to nasal equator using the B scanner. The scans were recorded through closed lids holding the scanning probe in the horizontal position. None of the B scan measurements was made through the lens. This was done to avoid distortion of the globe produced as a result of higher speed of transmission of sound waves through the lens compared with other ocular media. Three measurements
of AL and EHW were made from each eye and mean values obtained for each. The presence or absence of staphyloma and its location were also noted during B scan echography.

The correlation coefficient of the AL and EHW measurements was calculated and analysis of covariance used to represent the relationship between them.

**Results**

The correlation coefficient between the measurements of the AL (n=100) and EHW (n=100) obtained from 50 patients was 0.80 (P<0.001, Fig. 1).

By apportioning the total variation in EHW between subjects, the within-subject association with length and unexplained or residual variation, a relationship of the following form was produced:

\[ \text{EHW} = a\cdot \text{constant} + b\cdot \text{AL} + \text{residual} \]

where \( b \) is the slope of the line that best describes how EHW changes with AL within an individual. The regression coefficient \( b \) was 0.281, that is, for each increase of 1 mm in AL within an individual, the EHW is predicted to increase by 0.281 mm. The within-subject correlation, which reflects how well the pairwise points all conform to a line with the same slope, was 0.93.

Similar results were obtained when a log EHW–log AL relation was explored \((r=0.81)\). The coefficient of the slope was 0.32 \((r\text{-value}=18.5)\).

Table 1 shows the grouped mean values including AL, EHW and the ratio of the group mean EHW versus group mean AL for each range of AL. The group mean AL increased by 8.2 mm, the group mean EHW increased by only 2.3 mm across the full range of axial lengths studied. The ratio EHW/AL decreased with the increasing severity of axial myopia (Fig. 2).

There were no staphylomas in the eyes of AL <27 mm, whereas 22 out of 60 eyes (37%) with AL >27 mm revealed the presence of a staphyloma. This incidence increased to 60% in the group with AL >31 mm (Table 2).

Eighteen (82%) staphylomas were located inferior to the posterior pole, whereas four (18%) were at the posterior pole of the globe. No staphylomas were found at the equator. Twelve (54.5%) of the staphylomas were unilateral, three in the 27.1–29 mm group, five in the 29.1–31 mm group, and four in the group with AL >31 mm.

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**Fig 1** Relationship between AL and EHW of 100 axially myopic eyes.

**Table 1** Grouped data–mean AL, mean EHW and mean ratio EHW/AL

<table>
<thead>
<tr>
<th>Group</th>
<th>AL (mm) (number of eyes)</th>
<th>Mean AL (mm) (sd)</th>
<th>Mean EHW (mm) (sd)</th>
<th>Mean ratio EHW/AL (sd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23–25 (20)</td>
<td>24.2 (0.45)</td>
<td>23.7 (0.47)</td>
<td>0.98 (0.01)</td>
</tr>
<tr>
<td>2</td>
<td>25.1–27 (20)</td>
<td>26.0 (0.60)</td>
<td>24.4 (0.60)</td>
<td>0.94 (0.01)</td>
</tr>
<tr>
<td>3</td>
<td>27.1–29 (20)</td>
<td>28.1 (0.62)</td>
<td>25.4 (0.76)</td>
<td>0.91 (0.02)</td>
</tr>
<tr>
<td>4</td>
<td>29.1–31 (20)</td>
<td>30.5 (0.50)</td>
<td>25.5 (0.67)</td>
<td>0.83 (0.03)</td>
</tr>
<tr>
<td>5</td>
<td>&gt;31 (20)</td>
<td>32.4 (0.88)</td>
<td>26.0 (0.84)</td>
<td>0.79 (0.02)</td>
</tr>
</tbody>
</table>
Discussion

Local anaesthetic blocks are widely used for eye surgery. The first description of the retrobulbar block using cocaine was published by Herman Knapp in 1884. Whilst retrobulbar blocks have been in use for over a century, peribulbar blocks have developed since the 1970s. In the traditional retrobulbar block, the local anaesthetic is deposited in the posterior intraconal space using an inferotemporal route.

During the traditional peribulbar block, injections are made around the mid or retrobulbar but essentially in the periconal space of the globe. Two injections are usually performed, one inferior and another superior to the globe. Complications resulting from local anaesthesia for the eye are relatively few. However, loss of vision as a consequence of the inadvertent puncture of the globe is obviously a dire outcome of what is considered to be a simple procedure. The puncture can result in vitreoretinal and choroidal haemorrhage, retinal detachment and delayed proliferative vitreoretinopathy. Foveal injury, optic nerve trauma and endophthalmitis have also been reported.

The incidence of perforation during local anaesthesia for various types of eye surgery was reported to be 0.1% in 1965 and 0.075% in 1978. The incidence of perforation during peribulbar anaesthesia in patients presenting for cataract surgery has been quoted to be 0.024%. There are various factors that predispose to the inadvertent puncture of the globe during local anaesthesia. Axial myopia and anatomical abnormalities resulting from previous scleral buckling procedures are well known hazards. The presence of a staphyloma, enophthalmos, multiple injections, faulty technique, uncooperative patient and the type of needle used are also important.

Patients presenting with axial myopia have a 30 times greater risk of globe puncture compared with those patients with normal AL. A risk rate of one perforation for every 140 peribulbar blocks in eyes with AL >26 mm has been calculated. The inferotemporal quadrant of the globe, followed by disc and macula, is the commonest reported site of perforation following retrobulbar and the traditional double peribulbar blocks. This is not surprising as the majority of blocks are performed using an inferotemporal route. Perforation has also been reported in the nasal quadrant. Attempts have been made to reduce the incidence of ocular injury by using blunt or curved needles. However, contrary to the expectation and the view expressed by Lichter, the incidence of needle penetration is not lowered with the use of these needles.

The single medial canthal approach for peribulbar anaesthesia is a promising technique for ocular surgery. The injection is made using a 25G, 16-mm or 25-mm-long needle at the medial canthus with the eye fixed in the primary gaze. The path of the needle is essentially

![Fig 2 The relationship between EHW/AL and the group mean of ALs.](image)

<table>
<thead>
<tr>
<th>Group</th>
<th>AL (mm)</th>
<th>Number of eyes</th>
<th>Number of staphylomas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23–25</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>25.1–27</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>27.1–29</td>
<td>20</td>
<td>3 (15%)</td>
</tr>
<tr>
<td>4</td>
<td>29.1–31</td>
<td>20</td>
<td>7 (35%)</td>
</tr>
<tr>
<td>5</td>
<td>&gt;31</td>
<td>20</td>
<td>12 (60%)</td>
</tr>
</tbody>
</table>

Table 2 Incidence of staphyloma with increasing myopia
perpendicular to the coronal plane along the medial wall of the orbit. The local anaesthetic is injected beyond the equator of the globe, around the posterior pole, in the peribulbar, extracanal space. The injection provides a high quality of analgesia and akinesia of the globe as well as lids especially, with a large volume of local anaesthetic. This is due to episcleral, that is, a subtenon spread of local anaesthetic.\textsuperscript{15}

It is a well-established fact that AL, particularly in axial myopes, is a risk factor for globe injury during the inferotemporal approach. However, the literature has not addressed the issue of the relationship between the EHW and AL in axial myopia. More importantly, what has not been investigated is whether the change in EHW is large enough to be a risk factor during the single medial canthal approach. Our results would suggest that there is an increase in the EHW associated with the increase in AL in the axially myopic eyes. However, the increase in the EHW is a modest one. It is clear from the analysis of the grouped data for AL and EHW in Table 1, that the increase in the group mean EHW width of 2.3 mm across the full range of ALs studied is significantly lower than the increase in the group mean AL of 8.2 mm. Expressed differently, there is a decrease in the ratio EHW/AL with increasing severity of axial myopia. It is obvious that the shape of the eye would tend to become increasingly ellipsoid rather than globular in the patients with increasing axial myopia.

Therefore, the increase in EHW in an axially myopic eye is possibly not a significant risk factor for inadvertent ocular injury during peribulbar injections where a careful single medial canthal approach is used, provided the eye is fixed in the primary gaze during the injection. However, it is conceivable that poor technique, angulation of the needle tip towards the globe, poor patient cooperation, movements of the head or eye, especially abduction, may cause problems.

Staphyloma is an outpouching of the globe resulting from the pathological thinning of sclera, choroid and retina. It is a fairly common finding in axially myopic eyes. However, previous studies have not established the relationship between the incidence or location of staphylomas and the severity of myopia.\textsuperscript{16} It is noteworthy that there were no staphylomas in the eyes with AL <27 mm (mild myopia) in our study. The numbers increased dramatically from 15\% in group 3 (moderate myopia) to 60\% in group 5 (very high myopia) presenting with AL >31 mm. The site of the staphyloma in relation to the site of injection is of obvious importance. The majority of the staphylomas in our study were found to be inferior to the posterior pole of the globe. There is a high incidence of perforations in the inferotemporal quadrant of the globe even in the eyes with normal AL. Therefore, it is not difficult to conceive that the axially myopic eye is at risk, not only due to its increased AL, but also to the presence of an inferior or posterior staphyloma. It would be prudent to avoid the use of inferotemporal route in these eyes. It is interesting to note that there were no staphylomas in the nasal equatorial region in the eyes studied. Thus, the medial canthal approach, theoretically, may be less hazardous in axial myopes. Of course, the relative ratio of globe and orbital volumes, the extent of the space available between the medial aspect of the globe and the medial wall of the orbit are the factors that also have to be considered. Whilst biometry gives an indication of AL during routine assessment of the cataract patients, B scan echography is needed to locate the site and size of the globe wall abnormalities.

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References