The accuracy of axial length measurements in cases of macula-off retinal detachment

Mohsen Abou-Shousha, MD, Hany Ahmed Helaly, MD, Ihab Mohamed Osman, MD

ABSTRACT • RÉSUMÉ

Objective: To assess the accuracy of axial length measurements in cases of macula-off retinal detachment using different methods (optical biometry, A-scan ultrasound, and combined applanation vector-A/B-scan biometry).

Methods: This prospective clinical study included 100 eyes of 100 patients who underwent vitrectomy alone or phacovitrectomy for macula-off retinal detachment. All patients included signed an informed consent. Preoperative examination of the patients included recording the axial length measurements using optical biometry, A-scan ultrasound, and combined applanation vector-A/B-scan biometry.

Results: The mean postoperative IOLMaster axial length after macular reattachment was 26.11 ± 2.91 mm. The mean preoperative IOLMaster axial length with macula-off was 25.32 ± 2.72 mm. The mean preoperative A-scan axial length with macula-off was 25.29 ± 2.80 mm. The mean preoperative vector-A/B-scan axial length with macula-off was 26.03 ± 2.90 mm. The preoperative vector-A/B-scan mean absolute error was 0.59 ± 0.48 D (range, 0.10–2.25 D).

Conclusions: Regular methods (optical biometry and A-scan biometry) of measuring the axial length in cases with a detached macula proved to be variable and less accurate. The vector-A/B-scan offered good measurements of the actual axial length in the patients. This was reflected on more accurate postoperative refractive outcome.

Objectif : Évaluer la précision des mesures de longueur axiale dans les cas de décollement de rétine impliquant la macula en utilisant différentes méthodes (biométrie optique, échographie oculaire [A-scan] et le vecteur d'aplanation combiné [biométrie A-scan/B-scan]).

Méthodes : Cette étude clinique prospective porte sur 100 yeux de 100 patients qui ont subi une vitrectomie seulement ou une phacovitrectomie pour décollement de rétine impliquant la macula. Tous les participants à l'étude ont signé un formulaire de consentement éclairé. Pendant l'examen préopératoire des patients, nous avons mesuré la longueur axiale en utilisant trois méthodes : la biométrie optique, l'échographie oculaire [A-scan] et la biométrie avec vecteur d'aplanation combiné [A-scan/B-scan].

Résultats : La longueur axiale moyenne postopératoire selon IOLMaster après le rattachement maculaire était de 26,11 + 2,91 mm. La longueur axiale moyenne préopératoire selon IOLMaster dans les cas impliquant la macula était de 25,32 + 2,72 mm. La longueur axiale moyenne préopératoire selon l'échographie (A-scan) dans les cas impliquant la macula était de 25,29 + 2,80 mm. La longueur axiale moyenne préopératoire selon la méthode combinée (vecteur-A-scan/B-scan) dans les cas impliquant la macula était de 26,03 + 2,90 mm. L'erreur moyenne absolue (EMA) préopératoire selon la méthode combinée (vecteur-A/B-scan) était de 0,59 + 0,48 D (l'écart étant de 0,10 à 2,25 D).

Conclusion : Les méthodes régulières (biométrie optique et A-scan) de mesure de la longueur axiale dans les cas comprenant un décollement maculaire ont produit des résultats variables et moins précis. La méthode combinée (vecteur-A/B-scan) a donné de bonnes mesures de la longueur axiale réelle de ces patients. Elle a également produit des résultats réfractifs postopératoires plus précis.

Intraocular lens (IOL) power calculation in patients undergoing phacovitrectomy for macula-off retinal detachment seems to be problematic. Measurements of the axial length (AL) of the eye in these patients is not very accurate because of difficult fixation with the detached macula and fovea, which may result in measuring a distance other than the required one. The measurement is accurate, but it is simply in the wrong position and the distance between the corneal vertex and the foveal vitreoretinal interface is shortened.[1–5]

A-scan ultrasound was the gold standard for measuring the AL for many years. Currently, optical biometry has become more and more popular and is now the most common method for measurement of AL.[6,7] Optical biometry provides a more accurate ocular measurements, used not only for AL but also for anterior chamber depth, lens thickness, pachymetry, and retinal thickness measurements.[8–10]

Optical biometry uses a partially coherent light with higher resolution than sound waves, which makes the measurement of AL very precise. The measurement technique also helps to avoid operator variations in the measurements. Also, contact with the cornea is not needed, which avoids variations caused by corneal compression. Because optical biometry measures to the centre of the macula, it gives the refractive AL versus the anatomic AL achieved with ultrasound biometry.[2,6–10] The refractive AL is defined as the distance from the

http://dx.doi.org/10.1016/j.jcjo.2015.12.011
ISSN 0008-4182/16

corneal vertex to the photoreceptor outer segments at the centre of the fovea. A-scan biometry is offset from the outer segments of the photoreceptors at the centre of the macula by the retinal thickness.[11–14]

Achieving the required postoperative refraction state necessitates a more accurate measurement of the AL. An error of 1 mm in preoperative AL measurement results in about 2.5 D in the calculated IOL power in an eye with average AL. This error decreases to 1.75 D/mm in a 30-mm eye and increases to 3.75 D/mm in a 20-mm eye.[15–19]

The aim of this study was to assess the accuracy of AL measurements in cases of macula-off retinal detachment using different methods (optical biometry, A-scan ultrasound, and combined applanation vector-A/B-scan biometry). The combined applanation vector-A/B-scan biometry technique has the advantage of the operator being able to direct the AL measurement to the region of the fovea, giving the refractive, rather than the anatomic, AL. This technique is particularly important when the macula lies on the sloping wall of the staphyloma in high-axial myopic eyes, with a mature cataract, or when the macula is detached, as the cases included in the current study.

Methods

This prospective clinical study included 100 eyes of 100 patients who underwent vitrectomy alone or phacovitrectomy for macula-off retinal detachment. Patients treated with scleral buckling were excluded from this study because of its postoperative effect on AL. All included patients signed an informed consent. This study was approved by the local research committee of Faculty of Medicine, Alexandria University, Alexandria, Egypt. The tenets of Declaration of Helsinki were followed.

Preoperative examination of the patients included recording the AL measurements using optical biometry (IOLMaster; Carl-Zeiss Meditec, Dublin, CA), A-scan ultrasound using EZ Scan AB5500+ (Sonomed Inc., New York, N.Y.), and combined applanation vector-A/B-scan biometry also using EZ Scan AB5500+ ultrasonic biometer. Patients included in this study had clear lens or mild cataract that allowed optical biometry to be recorded preoperatively. K readings were obtained using the IOLMaster, which measures 6 points at a 2.3-mm diameter in a hexagonal pattern. All cases were examined by the same operator. The average of 3 good-quality scans was recorded.

For the combined applanation vector-A/B-scan biometry technique, the 2-dimensional B-scan image guided the overlying vector-A-scan to directly measure to the fovea. The B-scan image was obtained using a horizontal axial scan. The operator aimed at cantering the cornea and lens echoes in the echogram while simultaneously displaying the optic nerve void near or slightly above the centre. The vector-A-scan was then adjusted so as to pass through the middle of the cornea as well as the anterior and posterior lens echoes. Such a method ensured that the vector-A-scan intersected the retina in the region of the fovea. Using such an alignment, the vector-A-scan intersected the retina at the approximate centre of the macula, just below the void of the optic nerve. In the current study, all the cases were measured by the same operator using the same technique to minimize variation.

Table 1—Axial length measurement using different methods pre- and postoperatively

	Mean ± SD (mm)	Range (mm)
IOLMaster preoperative	25.32 ± 2.72	21.00–31.10
A-scan preoperative	25.29 ± 2.80	21.40–31.20
Vector-A/B-scan preoperative	26.03 ± 2.90	22.00–32.10
IOLMaster postoperative	26.11 ± 2.91	22.15–32.40

All cases underwent vitrectomy alone or phacovitrectomy with foldable hydrophobic acrylic IOL and were followed up postoperatively. At 4 to 6 weeks after surgery, optical biometry was done to record the postoperative AL measurement. In silicon-filled eyes, the mode of AL measurement was adjusted on the machine. Postoperative manifest refraction after macular reattachment was done to patients with no silicon oil in their eyes and who had adequate vision to allow for manifest refraction (n = 30). The refractive prediction error was recorded for each of the 3 methods of measuring the AL by calculating the difference between the actual and the expected postoperative refraction. The mean absolute error (MAE) was then calculated. Percentages of cases within ±0.5 D, within ±1.0 D, and within ±2.0 D were recorded.

Analysis of variance (ANOVA) with post hoc analysis was used to compare different means of measured pre- and postoperative ALs. Pearson correlation was used to correlate between different variables. The χ^2 test was used to compare different percentages. A p-value <0.05 was considered statistically significant.

Results

This study included 100 eyes of 100 patients. There were 65 males and 35 females. The mean age was 43.6 ± 12.8 years (range, 20–68 years). Vitrectomy alone was performed in 58 patients, and phacovitrectomy was performed in 42 patients. Postoperative manifest refraction was recorded for 30 patients.

Table 1 shows the different measurements of the AL of the included eyes. The mean postoperative IOLMaster AL after macular reattachment was 26.11 ± 2.91 mm. The shortest AL was 22.15 mm and the longest was 32.40 mm. The mean preoperative IOLMaster AL with macula-off was 25.32 ± 2.72 mm. The shortest AL was 21.00 mm and the longest was 31.10 mm. The mean preoperative A-scan AL with macula-off was 25.29 ± 2.80 mm. The shortest AL was 21.40 mm and the longest was 31.20 mm. The mean preoperative vector-A/B-scan AL with macula-off was 26.03 ± 2.90 mm. The shortest AL was 22.00 mm and the longest was 32.40 mm.

ANOVA was used to compare the aforementioned different means of AL measurements taken pre- and postoperatively by different methods, and the difference was