Axial Length Measurement in Asteroid Hyalosis: Comparing Laser Interferometry and Ultrasound A-scan

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Abstract

Purpose: To compare laser interferometry (LI) and ultrasound A-scan in measurement of axial length (AL) in eyes with asteroid hyalosis

Methods: Twenty three patients with unilateral moderate to severe asteroid hyalosis determined by B-scan ultrasonography images participated in the study. The AL measurements were obtained by LI and ultrasound A-scan in both asteroid hyalosis and noninvolved eyes. The measurements were performed by the two methods as well as for affected and contralateral normal eyes and were statistically compared using the paired T-test. A P-value less than 0.05 was considered significant.

Results: The ultrasound AL measurements were taken in every case but measurement with the LI method was not possible in 4 eyes with asteroid hyalosis (17.3%). There was a high correlation between LI and ultrasound A-scan measurements in both asteroid hyalosis and noninvolved eyes ($r^2=0.97$, $P<0.001$ and $r^2=0.95$, $P<0.001$ respectively). There was no significant difference between AL taken by either method in asteroid hyalosis and noninvolved eyes.

Conclusion: The failure rate of AL measurement using LI was relatively high in eyes with asteroid hyalosis. There was a high correlation between AL measured by ultrasound A-scan and LI method in both asteroid hyalosis and noninvolved eyes.

Keywords: Laser Interferometry, Ultrasound, Asteroid Hyalosis, Axial Length

Introduction

Cataract extraction is the most frequently performed ophthalmic surgery today. The refractive outcome following phacoemulsification cataract surgery is dependent on a number of factors including axial length (AL) measurement, keratometry, anterior chamber depth, IOL power formulae, and the quality of the IOL.¹ Of these factors, inaccurate AL measurements have been shown to be the major deterrent to the predictability of the refractive outcome.² The studies based on ultrasound show that 54% of refractive surprises are caused by errors in AL measurement.³,⁴ Partial coherence laser interferometry (LI) was developed in 1990s and is considered as a noncontact method which reduces the risk of corneal erosion and infection. In addition, no local anesthesia or pupil dilation is necessary and the risk of infection is reduced.

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It also facilitates to obtain keratometry values, anterior chamber depth and AL measurements in a single setting.\textsuperscript{5} More importantly, optical biometry has been proved to be superior to ultrasound applanation in terms of precision, resolution, and accuracy of AL measurement.\textsuperscript{4,5} However, measurements by optical biometry in eyes with dense or subcapsular cataracts, severe opacities of the cornea or the vitreous cavity cannot be performed successfully.\textsuperscript{6} Thus, optical biometry cannot replace ultrasound biometry in all cases.

Asteroid hyalosis is a well-known clinical entity consisting of white focal opacities of varying sizes that are adherent to vitreous fibrils. Ultrastructural studies have revealed that their composition consists mainly of complex lipids, phosphate, and calcium. These opacities may be scattered throughout the vitreous cavity or accumulate in only a localized part of it.\textsuperscript{7-9} These opacities might scatter the light and theoretically, biometry using interferometry might perform with difficulty. Although there are reports evaluating the effect of asteroid hyalosis on automated and manual A-scan ultrasound biometry,\textsuperscript{10,11} to our knowledge there is no study in the literature comparing LI and ultrasound in the measurement of AL in eyes with asteroid hyalosis. In this study we compared measurements of AL obtained with LI with those obtained with ultrasound in both eyes of a group of patients with unilateral asteroid hyalosis.

Methods
In this prospective study, 23 patients with unilateral moderate to severe asteroid hyalosis were recruited who presenting at the cataract surgery pre-assessment clinic at the Farabi Eye Hospital, Tehran, from May 2005 to June 2006. Ethical approval for the study was provided by the Ethical Committee at Tehran University of Medical Sciences. The patients’ informed consent was obtained. All patients had complete ophthalmologic examinations including visual acuity, refraction, slit-lamp evaluations, and direct and indirect ophthalmoscopy. B-scan ultrasonography was used to obtain high-resolution B-scan images of the eyes with asteroid hyalosis. Using these images, the density of asteroid bodies was rated as mild, moderate or severe. A masked investigator (S.K.) rated the density based on B-scan images from Erkin study.\textsuperscript{11} Patients were excluded if they had a condition that would affect accurate AL measurement, such as extreme refractive errors, previous vitreoretinal surgery, retinal tumors, posterior staphylomas, or elevated lesions of the macula. Eyes with localized asteroid hyalosis and moderate to severe cataract were excluded.

AL was measured using both A-scan ultrasound (Nidek Echoscan US-2500, Tokyo, Japan) and partial coherence LI (IOL Master\textsuperscript{TM} V1.1, Carl Zeiss) methods. The AL of both eyes of each patient was measured, first by the LI and then by the ultrasound A-scan method using manual immersion technique. All measurements of each patient were taken in the same setting by an experienced examiner. For each of the two techniques, the AL was recorded as the mean of five readings. The reliability of intraocular distance measurements was checked based on signal-to-noise ratio (>2) in LI and retinal spikes in ultrasound scans. The IOL power was calculated using the SRK II formula. The measurements obtained by the two methods as well as those of affected and contralateral normal eyes were statistically compared using the paired T-test. A P-value less than 0.05 was considered significant.

Results
AL of 46 eyes in 23 patients (between 47 to 83 years) who had unilateral asteroid hyalosis were evaluated by the two techniques. Ten patients (43.5%) were men and 13 (56.5%) were women. The mean age of the patients was 63.43±10.15 years. Seventeen patients (73.9%) had type 2 diabetes mellitus. The density of asteroid hyalosis was assessed by B-scan ultrasonography and was rated. Twelve eyes (52.2%) were rated as moderate, and 11 (47.8%) were rated as severe.

Ultrasound AL measurements were taken in every case but LI readings could not be taken in 4 (17.39%) asteroid hyalosis eyes because of a low signal-to-noise ratio. All patients had severe asteroid hyalosis and only one of them had mild subcapsular opacity. The mean ALs as taken by the ultrasound and LI methods in the asteroid hyalosis eyes
were 22.81±0.62 mm and 22.87±0.56 mm, respectively. Using the SRK II formula, the mean IOL powers determined for emmetropia was 20.81±1.45 diopters (D) and 20.73±1.37 D in asteroid hyalosis eyes, respectively. There was a high correlation between the AL determined by the two techniques in eyes with asteroid hyalosis (Pearson correlation $r^2=0.97$, $P<0.001$) (Figure 1). The mean difference between measurements taken by the ultrasound and LI techniques in the asteroid hyalosis eyes was -0.06±0.30 mm which was not significant ($P=0.08$).

The mean AL measurements in the ultrasound and LI methods in the noninvolved eyes were 22.80±0.59 mm and 22.73±0.65 mm, respectively. The mean difference between measurements taken by the two methods in noninvolved eyes was 0.07±0.20 mm which was not significant ($P=0.15$). There was a high correlation between the AL determined by the two techniques in noninvolved eyes with asteroid hyalosis ($r^2=0.95$, $P<0.001$) (Figure 2).

Using either LI or ultrasound technique, there was a high correlation between the AL of asteroid hyalosis and noninvolved eyes ($r^2=0.87$, $P<0.001$ and $r^2=0.80$, $P<0.001$ respectively). There was no significant difference between the AL of asteroid hyalosis and noninvolved eyes determined by ultrasound technique ($P=0.86$) nor by LI method ($P=0.11$).

With LI technique, one of 5 measurements in one of the eyes with severe asteroid hyalosis had a 1.26 mm error. This would result in a difference calculated IOL powers of 3.15 D.
Discussion

Our study showed a high correlation between AL measured by ultrasound and LI method in both asteroid hyalosis and noninvolved eyes. There was also a high correlation between AL measurement of asteroid hyalosis and noninvolved control eyes taken by either method. The LI as a noncontact method, is less time consuming, provides more comfort for the patient, minimizes the preoperative infection risk, and can improve the postoperative refractive outcome.\(^4,5\) However, in our study, AL measurement was impossible in nearly one sixth of eyes with asteroid hyalosis by this method.

Asteroid hyalosis is a degenerative process resulting in small, white vitreous opacities consisting of calcium phosphate and complex, layered lipid deposits. Previous studies have suggested a prevalence of 0.83% to 1.96%, bilaterality of 10%, and association with age.\(^6,12,13\) The correlation between asteroid hyalosis and diabetes mellitus remains controversial. Most studies in clinical population suggest a significant association between asteroid hyalosis and diabetes mellitus.\(^14-18\) In accordance with previous studies, a high proportion of our patients (73.9%) had diabetes mellitus.

To our knowledge, this is the first study for evaluation of AL using LI in patients with asteroid hyalosis. Using LI, AL measurement were impossible in 17.3% of asteroid hyalosis eyes which can be considered as a limitation of this technique in asteroid hyalosis eyes. This failure rate is higher than other studies which have reported a failure rate of 9-12%.\(^19,20\) Like those eyes with dense or subcapsular cataract, dense asteroid opacities could be a source of light scattering of the incoming and outgoing laser rays, preventing exact recognition of the vitreoretinal surface, which results in such a high failure rate.

LI is now used increasingly for biometry before cataract extraction, because it has high precision, is non-contact, and is faster.\(^19-21\) It has been demonstrated that there is a high correlation between the AL determined by ultrasound technique and LI \((r^2=0.99)\) in cataract patients. Likewise in our patients the correlation was high \((r^2=0.97)\). There are
studies reporting AL measurements by ultrasound technique are shorter than those measured with the LI technique which have been attributed to corneal indentation with placement of ultrasound probe. In the current study, we did not detect a significant difference between AL measurements obtained by immersion technique and LI methods in either asteroid hyalosis or normal eyes. This is in agreement with those findings previously reported by Lam et al and Santodomingo-Rubido et al who found no significant difference in AL measured with ultrasound and LI. Our data show that the AL in noninvolved eyes (measured by both methods) was not statistically different from those in the eyes with asteroid hyalosis. One limitation of our study was small size. Moreover, different types of lens opacity might have different effects on LI. We did not exclude patients with mild posterior subcapsular opacities, and this might have interfered with our results. Only moderate to severe subcapsular opacities have been reported to interfere with AL measurement by LI. In kiss et al study, 6 of 55 eyes (11%) could not be measured with LI. Five patients had fixation problems in 1 eye because of a mature cataract or macular degeneration and one eye was extremely hyperopic. Moreover, only one of the 4 eyes with measurement error in our study had subcapsular opacity.

Conclusion
This study showed that AL measurement using LI in patients with moderate to severe asteroid hyalosis has a failure rate higher than those of general population referring to cataract surgery pre-assessment clinic published in other studies. Nevertheless, there is a high correlation between AL measured by ultrasound A-scan and LI method in both asteroid hyalosis and noninvolved eyes. Further work with greater sample size is required to confirm whether the use of LI provides a consistent improvement in the accuracy of predicted postoperative emmetropia following cataract surgery.

References