Original Article

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Comparison of Ultrasound Biometry with Optical Biometry for Measurement of Axial Length and Calculation of Intraocular Lens Power in Patients Undergoing Routine Cataract Surgery

Sumaira Rahim[1], Nida Fatima[2], Khadeeja Imran[3], Nida Armoghan[4], Fahmina Nazir[5], Arif Khan[6]

[1]Senior Registrar Shaikh Zayad Hospital, Lahore
[2-5]Post graduate Resident, Dept of Opthomology, Pakistan Institute of Medical Sciences, Islamabad
[6]Associate Professor, Dept of Opthomology, Pakistan Institute of Medical Sciences, Islamabad

Author`s Contribution

[1]Conception and design, [2,3,4]Collection and assembly of data, Analysis and interpretation of the data, [5]Drafting of the article, Critical revision of the article for important intellectual content, [6]Final approval and guarantor of the article

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Address of Correspondent
Dr. Fahmina Nazir
Post graduate Resident, Dept of Opthomology, Pakistan Institute of Medical Sciences, Islamabad
fahmina@outlook.com

ABSTRACT

Objective: To compare the axial length and intraocular lens power calculated by using ultrasound biometry and optical biometry in patients with cataract

Methodology: It was prospective randomized control trial carried out at eye department of Pakistan Institute of Medical Sciences Islamabad from Oct 2021-December 2021, comprising of 50 patients undergoing contract surgery in Eye Department of PIMS using non-probability consecutive sampling. After taking informed written consent from patient's biometry was performed using optical scan and ultrasound biometry (with appalation probe). Axial length and intraocular power calculated by both methods was recorded.

Results: The mean axial length measurement by ultrasound of the patients' eyes was 22.72±0.85 mm and by optical biometry was 22.67±0.86 mm. Similarly the mean intraocular lens power calculated by ultrasound was 20.60±1.56D and by optical was 20.51±1.51D. Optical and ultrasound method showed strong positive correlation in measurements of intraocular lens power and axial length of eyes, i.e. r=0.965 & 0.939 respectively.

Conclusion: The findings of this study suggested that optical biometry is good alternate of ultrasound in measurement of axial length and intraocular lens power of patients, as strong correlation exist between both techniques.

Keywords: Axial Length, Ultrasound Biometry, Optical Biometry, Cataract

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Introduction

Visual impairment in adults is mostly due to age related Cataract. In the ophthalmology setting cataract extraction is a very common and routine procedure. This surgery involves the removal of natural cataractous lens and implantation of intraocular lens. However, cataract is still most common cause of blindness all over the world. Visual impairments are widespread, impacting approximately 2.2 billion individuals across the globe.[1]

Cataract surgery is considered to be a very safe and effective procedure. It is observed that after surgery the best-corrected visual acuity of 20/40 was gained among 95% of the patients.[2] Improvement was observed in mental health, emotional health, social interactions along with watching television, recognizing others and near vision as well, who reported the improvement after surgery. One of the ophthalmic pathologies is cataracts and this is categorized by the lens opacification. In more than 22 million people cataracts were diagnosed in 2013, in United States[3] and till 2020 this number was increasing and reached till 30.1 million.[4] In United States 3.7 million cataract surgeries were done in 2015.[4]

To get the good postoperative results proper and accurate measurements of axial length (AL) and also corneal curvature are needed. Intraocular lens (IOL) power is then measured using the appropriate formula. Error in pre-operative AL will lead to a significant error in IOL power calculation i.e. a change of 1mm in axial length will lead to a change of 2.5D in IOL power. This correlation between AL and IOL power decreased to 1.74 D/mm in an

eye having axial length of ≥30 mm and increased by 3.75 D/mm in measurements of ≤20 mm.[5]

The phenomenon of signal reflection is utilized to measure the eye axial length through both optical biometry and/or ultrasound. The next step is to put axial length into appropriate formula to calculate IOL power by the same device.[6] Sonic waves emitted by ultrasound biometry are transmitted through the different structures of eye, at each interface a peak is observed in the reflected beam, signal is thus, bounced back from inner limiting membrane of retina. Optical biometry employs the same basic princples but emits a light signal which is bounced back from brusch membrane of retina thus the final axial length is slightly longer than one calculated by ultrasound biometry. Another key difference between the two modalities is that optical biometry measures in the line of visual axis rather than the anatomic axis.[7] Despite these differences the results from both techniques can be compared.[8] According to many retrospective researches refractive errors post operatively measured with both techniques are equally comparable and calculation of post-operative refractive errors are equal.[9]

Ultrasound biometry is user experience dependent technique. This method is used for measurement of axial length and IOL power calculation but along with this the accuracy of results and reproducibility depends on the experience of the user. On the other hand optical biometry is a non-contact method that uses partial coherent light source with shorter wavelength. This is relatively new method than ultrasound biometry. Using optical biometry in cataract surgery lies in its ability to provide accurate and reliable measurements, minimize refractive errors, reduce the risk of complications, enhance predictability, improve patient outcomes, ensure safety, and take advantage of technological advancements. This technology has become an integral part of modern cataract surgery, helping surgeons achieve better results and optimize the visual quality and satisfaction of their patients[10]. We conducted this study to see whether the axial lengths and IOL power calculated by the two methods is comparable or not.

Methodology

It was prospective randomized control trial carried out at eye department of Pakistan Institute of Medical Sciences (PIMS) from Oct 2021-December 2021. The duration of the study was 02 months. Patients already enrolled for surgery and having age-related cataract were included in the study. Patients having traumatic or juvenile cataract, glaucoma, macular or retinal diseases, high myopes, corneal opacities or diseases, vitreous hemorrhages and uveitis were excluded in this study. The calculated sample size was 40 by using the agreement between optical biometry and ultrasound measurement of axial length of eye as 0.495[11] taking Beta error as 90%. So we took sample size of 50 eyes. Non-probability consecutive sampling was used. This study was conducted after permission from the Institutional Ethical Review Committee. After taking informed written consent patients bio data like age, gender, ethnicity was recorded along with type and grade of cataract. Firstly the readings were taken from optical biometry and secondly ultrasound biometry was used to take the readings. The axial length and intraocular power was recorded by both procedures. SPSS version 22 was used to enter and analyze the collected data. All the quantitative data was presented in the form of mean±SD and all the qualitative data was presented in the form of frequency and percentages. For comparison of axial length and intraocular lens power calculated by using ultrasound biometry and optical biometry in patients with cataract, correlation was applied. The comparative result was presented by using scatter plot.

Results

In this study total 50 eyes of the patients were examined. The average age of the patients was 60.22±814 years (minimum age=35 years and maximum age=75 years). Out of 50 eyes 28(56%) patients were male. Right side involvement of eye was observed in 24(48%) patients. (Table I)

Table I: Demographic detail of the patients.

		N	%
Gender	**Male**	28	56.0
	Female	22	44.0
Eye Side	**Right**	24	48.0
	Left	26	52.0
Age (mean±SD)		**60.22±8.14 years**	

Table II: Distribution of cataract types.

Cataract types		**n**	**%**
Nuclear Sclerosis	**Yes**	29	58.0
	No	21	42.0
PSCC	**Yes**	31	62.0
	No	19	38.0
Mature	**Yes**	3	6.0
	No	47	94.0
Cortical	**Yes**	17	34.0
	No	33	66.0

According to this study in 29(58%) of patients the cataract type nuclear sclerosis was found, In 31(62%) patients PSCC type was observed, In 3(6%) patients mature type

was found, cortical type was noted in 17(34%) patients and no patients appeared with polar cataract type (Table II).

The mean axial length measurement by ultrasound of the patient's eyes was 22.72±0.85 mm and 22.67±0.86 mm was mean axial length taken by optical biometry. Similarly, ultrasound measurement showed the mean intraocular lens power of 20.60±1.56D while optical showed mean intraocular lens power of 20.51±1.51D. In terms of axial length measurement by optical and ultrasound we found strong positive correlation between them (i.e. r=0.965). (Figure 1) Similarly in terms of axial intraocular lens power measurement by optical and ultrasound we found strong positive correlation between them (i.e. r=0.939). (Figure 2)

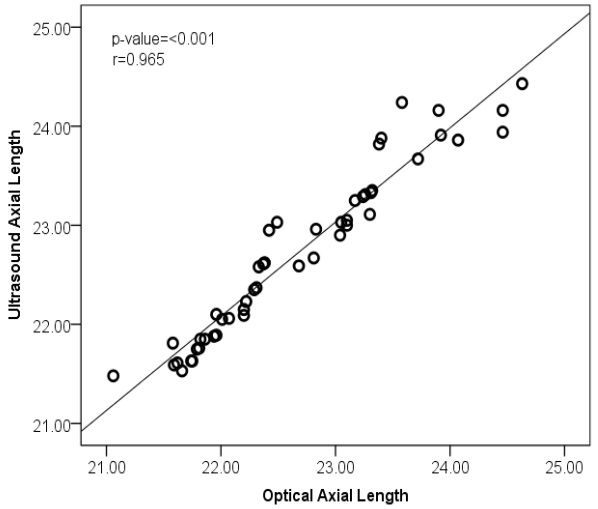

Figure 1. Correlation between the optical and ultrasound findings in measurements of axial length (AL).

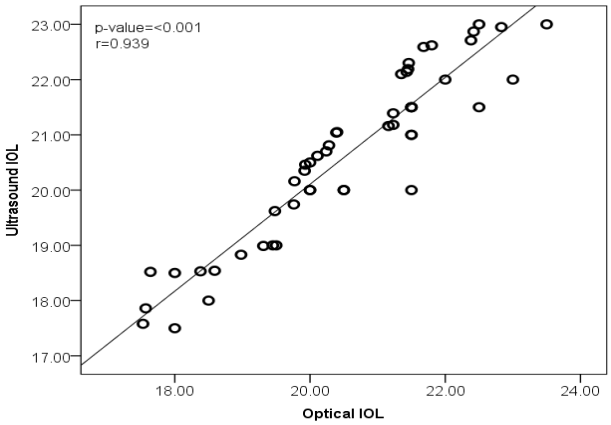

Figure 2. Correlation between the optical and ultrasound findings in measurements of intraocular lens (IOL) power.

Discussion

The outcome of cataract surgery and patient satisfaction are both dependent on the accuracy of axial length measurement and intraocular lens power calculations.[12] The occurrence of visually noticeable cataracts is quite common. Cataract surgery ranks among the most frequent and effective medical interventions today, with roughly 434,000 cataract procedures conducted annually in England and Wales. [Naderi, 2020 #40]

Today one of the main objectives of cataract surgery is to gain the target refractive outcome, and intraocular lens (IOL) power calculation is the main step in achieving this goal. According to a past study 54% refraction errors observed after IOL implantation were due to inaccurate AL measurements by ultrasound biometry, errors in kerometry readings accounted for errors in 8% of the patients, while 38% errors occurred due to incorrect assessment of the postoperative effective lens position (ELP).[13]

According to a local study conducted by Aisha Rafique et al., biometry has been determined as an effective and safe technique for calculating intraocular lens power. Optical biometry, which is a noncontact method, carries a minimal risk of infection and is well-suited for various eye types.[14] An additional local study, conducted by Mehvash Hussain and colleagues, found that utilizing optical biometry for intraocular lens power calculations is straightforward, dependable, and leads to superb refractive outcomes. It should be noted, however, that ultrasound biometry may remain necessary in cases involving mature and dense posterior subcapsular cataracts.[15]

Similar to our study findings a study by Fouad R. Nakhli et al[11] concluded that the axial length measurements after ultrasound biometry and optical biometry are mostly related. Though, in short eyes the optical biometry is preferred. The literature showed that both devices had agreement (r=0.986) as well as strong repeatability (99.3%) as well (p<0.001).[11]

A study by Dupe S.Ademola-Popoola et al[16] depicted the significant difference among measurements taken from ocular biometry and immersion ultrasound technique. Better repeatability was found in immersion technique, and this is good for practice in training hospital settings because in such hospitals there is a lack of resources to hire a dedicated person for performing biometry. Different A-scan machines require different level of experiences and expertise.

Many studies have shown that if operator is well experienced, then there is no significant difference between the measurements taken by ultrasound biometry via the immersion technique or direct contact technique.[17, 18]

In this study the sample size was the only limitation, and it is suggested that in further studies a big sample size will be taken from multicenter settings in order to obtain a better comparison.

Conclusion

The findings of this study suggested that optical biometry is good alternate of ultrasound biometry for measuring axial length as well as intraocular lens power of patients, as strong correlation exist between both techniques. Optical biometry is comparatively new technique compared to ultrasound but is less user dependent. Optical biometry provides comparable results and can be used interchangeably with ultrasound biometry.

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