Original Article

Distribution of Ocular Biometry and Intraocular Lens Power in Patients Undergoing Cataract Surgery in an Eye Camp in Northern Pakistan

PJO – Official Journal of Ophthalmological Society of Pakistan

Erum Shahid[1], Asad Raza Jaffery[2], Uzma Fasih[3]
[1-3]Karachi Medical and Dental College (KMDC), Karachi

ABSTRACT

Purpose: To report ocular biometric data of patients undergoing cataract surgery in an eye camp in a city of Northern area of Pakistan.

Design: Cross-sectional descriptive study.

Place and Duration of Study: A surgical eye camp was set up in the month of September 2022 for 6 days in a private hospital in Skardu.

Methods: A total of 119 patients were selected with a non-probability consecutive sampling technique. Ocular biometry of permanent local residents with significant cataracts was included. Incomplete biometry data and coexisting diseases like corneal opacity, pterygium, and severe dry eye causing errors in biometry were excluded. Keratometry was done with an automated refracto-keratometer. Axial length was calculated with an A-scan (ultrasound contact method) and intraocular lens (IOL) power was calculated.

Results: A total of 119 patients were selected for biometry among 3908 individuals visiting an eye camp. The mean axial length was 22.13 ± 1.25 SD mm. The mean keratometry readings (K1) was 43.28 ± 1.83 Diopter and (K2) 44.26 ± 1.67 D. The mean intraocular lens (IOL) power was 24.78 ± 3.43 D. The mean K readings were more in males as compared to females (p-value <0.005). There was no significant difference in axial length and IOL power among genders.

Conclusion: This study gives normative data on ocular biometric parameters of patients undergoing cataract surgery at high altitudes in Skardu, Pakistan. These biometric values can be used as reference values in the local population.

Key words: Axial length, Cataract, Keratometry, Biometry, Pakistan.

How to Cite this Article: Shahid E, Jaffery A, Fasih U. Distribution of Ocular Biometry and Intraocular Lens Power in Patients Undergoing Cataract Surgery in an Eye Camp in Northern Pakistan. 2024;40(4):414-419.
Doi: 10.36351/pjo.v40i4.1770

Correspondence: Erum Shahid
Karachi Medical and dental college (KMDC), Karachi
Email: drerum007@yahoo.com

Received: November 02, 2023
Accepted: September 03, 2024

INTRODUCTION

Regions above 3000 meters above sea level are considered to be high-altitude locations. Their atmospheric conditions are hypobaric, with strong ultraviolet radiations and more sunshine hours leading to biological effects on the human body.[1] High altitude is a documented risk factor for the development of cataracts due to high exposure to ultraviolet radiation.[2]

Skardu perches 2,438 meters above sea level and is one of the districts of Gilgit Baltistan, Pakistan. It is a valley situated in the mountainous terrain, 10 kilometers wide and 40 kilometers long in the backdrop of the great peaks of the Karakoram range. Baltistan is also known as “little Tibet” due to its resemblance with the geographic features of Tibet peaks. It has a cold climate zone with harsh winter (-25°). The valley is accessible via flight and road. It becomes inaccessible in winter due to the blocking of

Karakoram highway with landsliding and intense snowfall.[3]

Precise measurement of axial length, corneal powers, and anterior chamber depth is imperative for calculating an intraocular lens (IOL) power for desired refraction and minimizing post-operative astigmatism.[4] The design and power of intraocular lenses are based on keratometry, the axial length of an eyeball, anterior chamber depth, and corneal astigmatism.[5] Biometric characters are influenced by gender, race, and genetics. Their difference across the different populations help to determine the distribution of these parameters in different regions of the world.[6]

Globally cataract is the most common cause of blindness and it is the number one cause of reversible blindness particularly in underdeveloped countries.[7,8]

The Himalayan cataract foundation has used single-power IOL in remote areas of Nepal cost-effectively for optimal refraction based on average North American axial length.[9] Very limited data is available regarding ocular biometry in cataract patients residing in high altitudes from our country. Average values will aid in choosing the correct power of intra-ocular lenses in mountainous terrain with limited resources. The aim of the study is to report the ocular biometric parameters of patients undergoing cataract surgery in an eye camp set up at a high altitude in northern Pakistan.

METHODS

This was a cross-sectional descriptive study conducted in a private Hospital located in the Skardu district. The Ethical Committee of the Ophthalmological Society approved the study and followed the tenants of the Declaration of Helsinki. Due to the harsh terrain of Skardu district, an eye camp was set up in its main city Gamba, for cataract surgery in the month of September 2022 for 6 days. The campaign of the eye camp was done beforehand by distributing brochures, displaying banners, and making public announcements. The team consisting of eye surgeons and medical officers went there to treat common ocular diseases and select patients for cataract surgery. The mobile eye camps were set up in the main town Dambodasin Roundo district, Khaplu in the Ghanche district, and Shigar in the Shigar district (Figure 1). A number of small villages were also covered along the way before reaching the campsite for the initial three days. The camp's outpatient department (OPD) was set up in the hospital at Gamba for the next three days for biometry and cataract surgery. Patients selected from the nearby villages were provided transportation to reach the hospital for surgery. A total of 3908 patients were reported in the eye camp. A total of 119 patients were selected for ocular biometry and cataract surgery with a non-probability consecutive sampling technique.

Ocular biometry of all the permanent local residents attending the camp for cataract surgery was included in the study. Patients with incomplete biometry data and coexisting diseases like corneal opacity, pterygium, and severe dry eye causing errors in biometry were excluded from the study.

Detailed history and ocular examination were carried out for every patient before cataract surgery. Ocular biometry was performed before the surgery by an experienced optometrist. Keratometry (K readings) was done with the help of an automated refractor-Keratometer (Topcon KR-800) in two meridians i.e. flat and steep. Axial length was calculated with an A-scan (Alcon ultrasound contact method) and IOL power was calculated using the formula SRK II (Power D = A constant – 0.9 (K1+K2) – Axial length x 2.5) for a target refraction of 0.00 D. A constant 118.30 was used in every patient for calculating the power of an intraocular lens. Keratometry, A-scan, operating microscopes, and phacoemulsification machines were present in the hospital. Other logistics including intra-ocular lenses, phaco-knives, viscoelastic, Tryptan blue, and injection carbachol were transported along the team to the hospital.

Data was collected, entered, and analyzed on SPSS version 21. Frequencies were computed for descriptive data like gender, occupation, laterality, type of cataract, and stages of cataract. Means with standard deviation (SD), median (0.25-0.75 percentile), minimum and maximum values were calculated for numerical data including age, keratometry, axial length, and power of the intraocular lens. The means of ocular biometric data were compared among genders with an independent t-test. A p-value of < 0.05 was considered statistically significant.

RESULTS

A total number of 3908 individuals visited an eye camp in six days, among them 119 patients were selected for biometry before surgery. This made the cataract turn out to be 3.04% in a camp. The mean age

of the patient in our study was 65.08 ± 11.90 years. There were 74 (62.2%) males and 45 (37.8%) females. Mean axial length of an eyeball was 22.13 ± 1.25 mm (range 18.24 mm to 27.05 mm). Other details are depicted in Table 1.

Mean keratometric readings K1 and K2 are higher in females than in males (p= 0.001). No statistically significant difference was seen in axial length and power of IOL in males and females. The details of biometric values among gender are given in Table 2. Other demographic details are given in Table 3.

Table1: *Descriptive data of ocular biometric parameters.*

Variables	Mean ± SD	Median (0.25-0.75)	Range
Age in years	65.08±11.90	67 (60-72)	16-90
Axial length in mm	22.13±1.25	22.27 (21.48-23.00)	18.24-27.05
K1in D	43.28±1.83	43.50(42.00-44.25)	37.75-47.75
K2 in D	44.26±1.67	44.25(43.00-45.50)	40.75-48.75
IOL in D	24.78±3.43	24.50 (22.50-27.00)	17.00-37

SD: standard deviation. K1 & K2: keratometry. IOL: intraocular lens. D: diopter

Table 2: *Comparison of ocular biometric parameters in gender by independent t test.*

Gender n (%)	Mean AL in mm	Mean K1 in D	Mean K2 in D	Mean IOL Power
Male 74 (62.1%)	22.25±1.1	42.85±1.6	43.90±1.5	24.65±3.4
Female 45(37.8%)	21.94±1.4	43.95±1.8	44.85±1.7	25.00±3.5
p-value	0.192	0.001	0.001	0.593
Total (119)	22.13±1.25	43.28±1.83	44.26±1.67	24.78±3.43

AL: axial length. K1 & K2: keratometry. IOL: intraocular lens. D: diopter

Table 3: *Distribution of demographic features of the participants.*

Variables	Frequency (%)
Gender	
Males	74 (62.2)
Females	45 (37.8)
Occupation	
Student	01 (0.8)
Housewives	45 (37.8)
Farmer	46 (38.7)
Force personnel	09 (7.6)
Skilled job	10 (8.5)
Labor	08 (6.7)
Education	
Uneducated	119 (100)
Laterality	
Right eye	58 (48.7)
Left eye	61 (51.3)
Type of cataract	
Senile cataract	116 (97.5)
Traumatic cataract	02 (1.7)
Complicated cataract	01 (0.8)
Staging of cataract	
Immature	67 (56.3)
Mature	35 (29.4)
Hypermature	16 (13.4)
Cataracta nigra	01 (0.8)

Figure 1: map of northern Pakistan displaying places of eye camp

Figure 1: Gilgit-Baltistan map with tehsils labelled (Reference: https://en.wikipedia.org/wiki/Geography_of_Gilgit-Baltistan)

DISCUSSION

This study provides normative ocular biometric data of inhabitants living at high altitudes i.e. Skardu in the north of Pakistan.

The mean adult axial length ranges from 22mm to 25 mm with mean refractive power of -25.0± 1.0 D.[10] The mean AL of an eyeball in our study was 22.13 ± 1.25 SD mm. Studies from the same country but from different topographical locations have reported a mean axial length of 23.36mm and 22.96mm.[11,12] These studies were conducted at lower altitudes and they have a large sample size including variable age range.

Bali et al, has reported mean axial length of 23.23mm on a specific tribal population of high altitudes (>3000m) in a neighboring country.[13] An Indian study has reported 23.34 mm mean AL from a hill station 500 meters above sea level.[14] A Chinese study has reported a higher ALof 24.07 mm.[4] In Western countries it is reported to be 23.38mm and 23.40mm.[15,16] Mendefro S et al, have reported a mean AL of 22.98 mm in an eye camp of 765 patients.[17] One of the study conducted in Lhasa, an altitude of 3658m has reported a significant change in the axial length in participants moved from low land (24.61mm) to high land (24.98mm).[18] Axial length is also affected by the urbanization of population. It is also reported that rural inhabitants have short axial length than urban population.[19] Participants of our study were mostly elderly, illiterate and farmers. Inhabitants of Skardu are simple people with simple lifestyle and limited access to electronic gadgets. An association of the female gender with short axial length is also reported.[17,19] However, our study could not generate an association due to its small sample size.

The mean keratometry (K) reading in the participants of this study was 43.77 D. Shoaib et al, reported a mean K reading of 42.87 D.[20] An Indian study has reported a mean K reading of 44.41 D.[14] In Nepal the mean K readings reported were 43.69 D and 43.96.[6,9] The K readings in Lhasa, a Tibetan city was 43.56 D.[18] The K readings in our patient are close to those reported in the population of Nepal and Lhasa. The topography of the highlands of Nepal is similar to the Northern areas of Pakistan. The mean K readings were greater in females as compared to males, with a significant p-value in this study. It is also reported by other studies that females have a steeper cornea than males.[14,21] Some studies have also reported steeper corneas in men.[22,23]

The mean power of the intraocular lens (IOL) in this study was 24.78 ± 3.43 D. The mean IOL power reported by Noor Bakht et al,[12] was 21.10 D and 21.20 D by Shoaib et al from the same country.[12,20] The place of both the studies was near the sea level and topographically in the plains of the South of our country. A study conducted by Natung et al at a hill station 550 meters above the sea level reported a mean IOL power of 20.53.[14] Other studies in Nepal have reported a mean IOL power of 21.37 D and 21.28D.[6,9] Studies from Ethiopia and New Zealand have calculated smaller mean IOL power i.e. 19.34 D and 19.45D.[17,24] Only 5% of their study population required IOL power of more than 24D.[17] It is reported in literature that anthropometric measurements, education, occupation, and social status influence the ocular biometric parameters.[24]

In our experience, most residents of this district also known as Balti, require high power of an IOL to be emmetrope post-operatively. Their axial length is less and refractive power of cornea is more to be emmetrope. Anthropometric measurements of tribal people living at high altitudes revealed a wide nasal bridge, inter-pupillary distance, inter-canthal distance, and a narrow palpebral aperture in vertical height. A narrow palpebral aperture is a nature's protective mechanism against the direct and reflected sunlight from the snow.[13] Eskimos living at high altitude of Alaska are reported to have a shallow anterior chamber, a flatter radius of corneal curvature, longer axial length, and hyperopia.[25]

The Himalayan cataract foundation has used single-power IOL in remote areas of Nepal cost-effectively for optimal refraction based on average North American axial length. In Nepal, a large fraction of the population resides in distant mountainous landscapes mostly inaccessible by road.[9] Skardu has a similar landscape. Modern healthcare services are inaccessible and curtailed for the natives because of the scattered population in high and rough terrains. Mean ocular biometric parameters of our study will help the surgical team to decide the power of IOL if biometry device is lacking and in presence of ocular disorders causing errors in biometry calculation like corneal opacity and pterygium. It will also help the teams to arrange different powers of IOLs in sufficient quantity beforehand for an eye camp.

The values of axial length, keratometry, and power of the intra-ocular lens (IOL) represent native inhabitants of this area. The results can be generalized to some extent in this remote area as it represents three districts of Gilgit Baltistan.

The limitation of the study is the small sample size for ocular biometry, so casual associations cannot be generated. Our study did not include the depth of an anterior chamber in the parameters of biometry. This would have provided a better understanding of the eye anatomy of the Balti people. Some studies suggest anthropometric measurement is a confounding factor. The height and weight were not recorded in our study.

CONCLUSION

This is the first study to give normative data on ocular biometric parameters of patients undergoing cataract surgery located at high altitudes in northern Pakistan. People residing in the mountainous landscape of the North of our country require high power of IOL to be emmetrope. These biometric values can be used as reference values for calculating the power of IOL in a local population of this area.

Funding: This study was not funded by any organization.

Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board **(OSP-IRB-007-2023)**.

REFERENCES

1. **Mader TH, Tabin G.** Going to high altitude with preexisting ocular conditions. High Alt Med Biol. 2003 Winter;**4(4):**419-430. Doi: 10.1089/152702903322616173.
2. **Yuan XB, Zhang DY, Chen SJ, Wu PC, Zhang WF.** Prevalence of cataract among the population aged 50 years and over at different altitudes in Gansu Province. [Zhonghuayanke za Zhi] Chinese J Ophthalmol. 2019;**55(8):**589-594. Chinese. Doi: 10.3760/cma.j.issn.0412-4081.2019.08.008.
3. **Muhammad A, Moinuddin A, Muhammad A, Farooq C, Zafar MU.** Phytosociology and structure of some forests of Skardu District of Karakorum range of Pakistan. Am Eurasian J Agric Environ Sci. 2010;**9(5):**576-583.
4. **Cui Y, Meng Q, Guo H, Zeng J, Zhang H, Zhang G, et al.** Biometry and corneal astigmatism in cataract surgery candidates from Southern China. J Cataract Refract Surg. 2014;**40(10):**1661-1669. Doi: 10.1016/j.jcrs.2014.01.039.
5. **Hill W, Angeles R, Otani T.** Evaluation of a new IOL Master algorithm to measure axial length. J Cataract Refract Surg. 2008;**34(6):**920-924. Doi: 10.1016/j.jcrs.2008.02.021.
6. **Shrestha S, Kaini KR, Basnet B.** Gender differences in ocular biometry among cataract patients of Western Nepal. Am J Public Health Res. 2015;**3(4A):**31-34. Doi: 10.12691/AJPHR-3-4A-6
7. **Wang GQ, Bai ZX, Shi J, Luo S, Chang HF, Sai XY.** Prevalence and risk factors for eye diseases, blindness, and low vision in Lhasa, Tibet. Int J Ophthalmol. 2013;**6(2):**237-241. Doi: 10.3980/j.issn.2222-3959.2013.02.24.
8. **Rao GN, Khanna R, Payal A.** The global burden of cataract. Curr Opin Ophthalmol. 2011;**22(1):**4-9. Doi: 10.1097/ICU.0b013e3283414fc8. PMID: 21107260.
9. **Murchison A, Richards M, Tabin G, Ruit S, Gurung R.** Optimal single intraocular lens power for the Nepali population. Br J Ophthalmol. 2004;**88(10):**1235-1236. Doi: 10.1136/bjo.2003.032706.
10. **Bhardwaj V, Rajeshbhai GP.** Axial length, anterior chamber depth-a study in different age groups and refractive errors. J Clin Diagn Res. 2013;**7(10):**2211-2212. Doi: 10.7860/JCDR/2013/7015.3473.
11. **Moin M, Amjad A.** Distribution of axial length readings in patients undergoing cataract surgery. Pak Postgrad Med J. 2017;**28(4):**122-126.
12. **Nizamani NB, Surhio SA, Memon S, Talpur KI.** Axial length variability in cataract surgery. J Coll Physicians Surg Pak. 2014;**24(12):**918-921.
13. **Bali J, Chaudhary KP, Thakur R.** High altitude and the eye: a case-controlled study in clinical ocular anthropometry of changes in the eye. High Alt Med Biol. 2005 Winter;**6(4):**327-338. Doi: 10.1089/ham.2005.6.327.
14. **Natung T, Shullai W, Nongrum B, Thangkhiew L, Baruah P, Phiamphu ML.** Ocular biometry characteristics and corneal astigmatisms in cataract surgery candidates at a tertiary care center in North-East India. Indian J Ophthalmol. 2019;**67(9):**1417-1423. Doi: 10.4103/ijo.IJO_1353_18.
15. **Shufelt C, Fraser-Bell S, Ying-Lai M, Torres M, Varma R.** Los Angeles Latino Eye Study Group. Refractive error, ocular biometry, and lens opalescence in an adult population: the Los Angeles Latino Eye Study. Invest Ophthalmol Vis Sci. 2005;**46(12):**4450-4460. Doi: 10.1167/iovs.05-0435.
16. **Knox Cartwright NE, Johnston RL, Jaycock PD, Tole DM, Sparrow JM.** The Cataract National Dataset electronic multi-centre audit of 55,567 operations: when should IOL Master biometric measurements be rechecked? Eye (Lond). 2010;**24(5):**894-900. Doi: 10.1038/eye.2009.196.
17. **Kassa MS, Gessesse GW.** Ocular Biometry and Intra Ocular Lens Power among Cataract Patients in Rural Eastern Ethiopia. Ethiop J Health Sci. 2021;**31(4):**823-830. Doi: 10.4314/ejhs.v31i4.17.
18. **Wu Y, Qiong Da CR, Liu J, Yan X.** Intraocular pressure and axial length changes during altitude acclimatization from Beijing to Lhasa. PLoS One. 2020;**15(1):**e0228267. Doi: 10.1371/journal.pone.0228267. Erratum in: PLoS One. 2020;15(3):e0231208.

19. **Liu H, Xu Z, Qian Z, Liang J, Wei K, Zu L, et al.** Comparison of Ocular Biometry Profiles in Urban and Rural Cataract Candidates in Eastern China. J Ophthalmol. 2020;**2020:**2863698. Doi: 10.1155/2020/2863698.
20. **Shoaib KK, Shakoor T.** Biometric Findings in Patients Undergoing Cataract Surgery; Gender Comparison. Pak J Ophthalmol. 2018;**34(4)**.
21. **Popov I, Waczulikova I, Stefanickova J, Valaskova J, Tomcikova D, Shiwani HA, et al.** Analysis of biometric parameters of 2340 eyes measured with optical biometer Lenstar LS900 in a Caucasian population. Eur J Ophthalmol. 2022;**32(1):**213-220. Doi: 10.1177/1120672121998920.
22. **Lim LS, Saw SM, Jeganathan VS, Tay WT, Aung T, Tong L, et al.** Distribution and determinants of ocular biometric parameters in an Asian population: the Singapore Malay eye study. Invest Ophthalmol Vis Sci. 2010;**51(1):**103-109. Doi: 10.1167/iovs.09-3553.
23. **Yoon JJ, Misra SL, McGhee CN, Patel DV.** Demographics and ocular biometric characteristics of patients undergoing cataract surgery in Auckland, New Zealand. Clin Exp Ophthalmol. 2016;**44(2):**106-113. Doi: 10.1111/ceo.12634.
24. **Wong TY, Foster PJ, Johnson GJ, Klein BE, Seah SK.** The relationship between ocular dimensions and refraction with adult stature: the Tanjong Pagar Survey. Invest Ophthalmol Vis Sci. 2001;**42(6):**1237-1242.
25. **Wojciechowski R, Congdon N, Anninger W, Teo Broman A.** Age, gender, biometry, refractive error, and the anterior chamber angle among Alaskan Eskimos. Ophthalmology. 2003;**110(2):**365-375. Doi: 10.1016/S0161-6420(02)01748-7.

Authors Designation and Contribution

Erum Shahid; Assistant Professor: *Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

Asad Raza Jaffery; Associate Professor: *Concepts, Data acquisition, Statistical analysis.*

Uzma Fasih; Professor: *Concepts, Literature search, Manuscript editing.*