OPTIMAL SINGLE INTRAOCULAR LENS POWER (IOL) CALCULATION FOR ADULT POPULATION

ASIF IQBAL¹, FAKHAR UL ISLAM², BILAL BASHIR³, MOHAMMAD IDRIS³, OMER KHAN ORAKZAI⁴.

1. Department of Ophthalmology, Hayatabad Medical Complex, Peshawar.
2. Department of Ophthalmology, Saidu Teaching Hospital, Swat.
3. Department of Ophthalmology, Lady Reading Hospital Peshawar.
4. Department of Ophthalmology, Khyber Girls Medical College, Hayatabad Medical Complex, Peshawar.

ABSTRACT

OBJECTIVES: To determine the single optimal intraocular lens power based on average biometric assessment for adult cataract surgery in free eye camps.

MATERIALS AND METHODS: Prospective observational study of 4 years duration from 1st February 2010 to 31st January 2014.

SETTING: Community based Trust eye hospital in Tarakai village of District Swabi.

METHODS: All adult patients, undergoing cataract surgery with intraocular lens (IOL) implantation were included in the study after informed consent and fulfilling the inclusion and exclusion criteria. All patients were operated by manual small incision cataract surgery by the same surgeon (AI). Pre-operative and Post-operative best spectacle corrected visual acuity (BSCVA) at two months follow up was noted. Keratometric readings (K1 & K2), axial length and IOL power were calculated and data analyzed by using SPSS version 20 software database.

RESULTS: Out of 1500 patients with cataract 668 (44.5%) were males and 832 (55.5%) were females. Right eye was involved in 826 (55.1%) patients whereas; left eye was involved in 674 (44.9%) patients. Mean K1 reading was 44.82 ± 1.80 D. Mean K2 reading was 44.94 ± 1.80 D. Mean axial length reading was 23.11 ± 1.28 mm. 36.6 % (n=403) patients had axial length between 23-23.99 mm. Mean IOL power in dioptres for males was 20.06 ± 2.53 D with minimum power of 2.00 D, maximum was 27 D and mode was 20.00 D. Mean IOL power in dioptres for females was 20.12 ± 3.43 D with minimum power of -2.00 D, maximum was 36.50 D and mode was 20.00 D. Mean IOL power was 20.10 ± 3.06 D. In 798 patients (53.2 %) IOL used was in the range of 20.00 D to 22.00 D. Pre-operative best spectacle corrected visual acuity was $<6/60$ in 58.4% (n=877) patients. Post operative best corrected visual acuity 6/18 or better was present in 90.5% (n= 1357) patients at two months follow up.

CONCLUSION: In community eye care centers located in far-flung areas with no facilities for proper biometric assessment of cataract patients, using an IOL power in the range of 20.00 D to 22.00 D would give optimal visual results.

KEY WORDS: Biometry, Keratometric readings, Axial Length, Intraocular lens.

INTRODUCTION

Cataract is the commonest age related disease in most countries worldwide and is the leading cause of preventable blindness¹. According to WHO estimates, 285 million people are visually impaired worldwide, of these 39 million people

are blind and 246 million people have low vision². Globally cataract is the leading cause of blindness and about 90 % of blind people live in low income countries². Pakistan is the sixth most populous country in the world with total population of over 170 million³. The number of blind people is 2 million, of these 1.3 million are

estimated blind due to cataract ⁴. In 1997, approximately 10 million cataract operations were performed globally but despite this cataract blindness is thought to be increasing by 1- 2 million / year ⁵. To prevent this backlog, WHO has launched Vision 2020- the right to sight, a global initiative for the elimination of avoidable blindness. The plan calls that by year 2020, the number of cataract surgeries be increased from the current level of 10 million / year to over 30 million / year.

In many developing countries significant progress is made in increasing the output of cataract surgical services. In India, half of population blind from cataract received surgery ⁶, in china and Nepal 46- 48% of patients had cataract surgery ⁷. Pakistan is amongst many developing countries which has very limited medical and financial resources. Large proportion of cataract blind population live in remote areas where eye care facilities are either absent or scarce. Thus it is not feasible both practically and financially to provide technologically advanced facilities like keratometry, A- scan & B- scan ultrasound allowing for proper biometric assessment which are the standard in developed countries. Although, the goal of cataract surgery is to implant an IOL with power to achieve emmetropia but for high volume cataract surgery in camps the minimal goal is to provide adequate refraction enabling the patient to continue daily activities of life. In order to obtain optimal refraction for majority of patients in a cost effective manner, it is necessary to use single power IOL for all patients undergoing cataract surgery. In the past, some researchers advocated using a single IOL power in order to decrease the surgery cost ^(7, 8, 9, 10). The single IOL power use for community eye centers were based on average biometry assessments.

This study was conducted to evaluate single optimal IOL power based on average biometric assessment for eye camp cataract patients in adults.

MATERIALS AND METHODS

It was a prospective, observational, cross sectional study conducted at community based trust eye hospital in Tarakai village of district Swabi. Duration of the study was four years from 1st February 2010 to 31st January 2014.

Inclusion Criteria:

- i. All patients above 20 years and upto 80 years, both male and female.
- ii. Co-operative patients having cataract.

Exclusion Criteria:

- i. Patients less than 20 years of age and very old patients who cannot co-operate.
- ii. Patients having fixation problems like nystagmus, mentally unstable etc.
- iii. Patients having ocular surface irregularities like corneal opacity, corneal dystrophy, corneal edema, keratitis, advanced pterygium etc.
- iv. Patients having anatomically abnormal globe like pthysis, microphthalmia, buphthalmos.
- v. Patients having silicone oil in vitreous cavity.
- vi. Patients having previous ocular surgery and ocular co-morbidity like glaucoma, age related macular degeneration, diabetic retinopathy, retinal vascular occlusion etc.
- vii. Patients unable to complete the follow up.

METHODS: Adult patients assessed properly and enrolled for cataract extraction were included in the study after fulfilling inclusion and exclusion criteria. Informed consent was taken from every patient. Keratometric readings were measured with manual keratometer using Schin Nippon keratometer (SO- 21, Ohira Co. Japan). The axial length measured and IOL power calculated by using A- scan (Quantel Medical Axis-II, Clermont- Ferrand, France) using dense long mode built in the A- scan software. The IOL power calculated by SRKII formula; $\text{Power (D)} = A - 0.9 (0.5K1 + 0.5K2) - 2.5(\text{Axial length})$. Serial axial length measurements were taken and average calculated by built-in software to avoid error. A- Constant of 118.3 was used for all patients. All patients

were operated by single surgeon (AI) by manual small incision cataract surgery (MSICS). The best spectacle corrected visual acuity was noted pre-operatively and post operatively on 1st day, second week, one month and two months. Age, gender and laterality were also recorded in the proforma. Data was entered into SPSS version 20, analyzed and presented as frequencies and percentages.

RESULTS

Total of 1500 patients were included in the study. Males were 44.5% (n=668) and females were 55.5% (n=832). 60% (n= 900) patients were in the age range 51- 70 years comprising 55.6% (n=501) female patients in this age group. Age and gender distribution is shown in Table- 1.

Table-1; Age and Gender Distribution.

Age in years	Sex of patient		Total
	Male	Female	
21- 30	25 (1.7%)	23 (1.5%)	48 (3.2%)
31- 40	52 (3.5%)	79 (5.3%)	131 (8.7%)
41-50	116 (7.7%)	159 (10.6%)	275 (18.3%)
51- 60	170 (11.3%)	283 (18.9%)	453 (30.2%)
61- 70	229 (15.3%)	218 (14.5%)	447 (29.8%)
71- 80	76 (5.1%)	70 (4.7%)	146 (9.7%)
Total	668 (44.5%)	832 (55.5%)	1500 (100.0%)

Overall, right eye was involved in 55.1% (n= 826) patients and left eye was involved in 44.9% (n= 674). Laterality is shown in Figure- 1.

Figure-1: Laterality

Results of corneal vertical meridian power in diopters (K1) showed that mean was 44.82 D with minimum reading of 39.50 D, maximum was 52.00 D, Standard deviation of 1.80, mode was 44.00 D and range of 12.50 D. 23.1% (n=347) patients were having K1 reading between 44- 44.99 D, followed by 13.6% (n=204) patients between 45- 45.99 D. Frequency distribution of keratometric readings is shown in Table- 2.

Variable	Gender	Mean	SD	Minimum	Maximum	Range	Median	Mode (n)
K1 (D)	Male	44.51	1.83	39.50	49.75	10.25	44.50	44.00 (44)
	Female	45.06	1.74	40.00	52.00	12.00	45.00	44.50 (58)
	Overall	44.82	1.80	39.50	52.00	12.50	44.75	44 (100)
K2 (D)	Male	44.60	1.82	37.50	50.00	12.50	44.50	44.50 (41)
	Female	45.22	1.72	38.50	50.50	12.00	45.25	44.50 (75)
	Overall	44.94	1.80	37.50	50.50	13.00	45	44.50 (116)
Axial Length (mm)	Male	23.23	1.07	20.41	30.50	10.09	23.21	23.21 (12)
	Female	23.01	1.41	18.06	31.81	13.75	22.90	23.39 (12)
	Overall	23.11	1.28	18.06	31.81	13.75	23.06	23.21 (16)
IOL power (D)	Male	20.06	2.53	2.00	27.00	25.00	20.00	20.00 (83)
	Female	20.12	3.43	-2.00	36.50	38.50	20.50	20.00 (89)
	Overall	20.10	3.06	-2.00	36.50	38.50	20.00	20.00 (172)

Table-2; Variables and Gender Distribution.

Results of corneal horizontal meridian power in diopters (K2) showed that mean was 44.94 D with minimum reading of 37.50 D, maximum was 50.50 D, Standard Deviation of 1.80, mode was 44.50 D and range of 13.00 D. 20.8% (n=312) patients were having K2 reading between 44- 44.99 D, followed by 20.2% (n= 303) patients between 45- 45.99 D. Frequency distribution of keratometric readings is shown in Table- 2.

Figure-2: IOL Power Distribution

Axial length (AL) measured in millimeters, results showed that mean was 23.11 mm with minimum reading of 18.06 mm, maximum was 31.81mm, Standard Deviation of 1.28, mode was 23.21 mm and range of 1.27mm. In males mean was 23.23 ± 1.07 mm with minimum reading of 20.14 mm, maximum was 30.50 mm, mode was 23.21 mm and range of 10.09 mm. In females mean was 23.01 ± 1.41 mm with minimum reading of 18.00 mm, maximum was 31.81mm, mode was 23.39 mm and range of 13.75mm. Frequency distribution of axial length readings is shown in Table- 2.

Intraocular lens (IOL) power was calculated in diopters by using SRK-II formula. A-constant of IOL was taken as 118.3. Study results showed that mean IOL power was 20.11D with minimum reading of -2.00 D, maximum was 36.50 D Standard Deviation of 3.09, range of 38.50 D 1.27mm and mode was 20.00 D. Mean IOL power in dioptries for male was 20.06 ± 2.53 D with minimum power of 2.00 D, maximum was 27 D and mode was 20.00 D. Mean IOL power in dioptries for female was 20.12 ± 3.43 D with minimum power of -2.00 D, maximum was 36.50 D and mode was 20.00 D. Frequency distribution of IOL power is shown in Table- 2 & Figure- 2.

Presenting best spectacle corrected visual acuity (BSCVA) was $<6/60$ in 58.4% (n=877) patients. Final best spectacle corrected visual acuity (BSCVA) at two months follow up $6/18$ or better was present in 90.5% (n= 1357) patients. Pre-operative and Post operative best corrected visual acuity is shown in Table- 3.

Table- 3: Preoperative and Post operative Best Spectacle Corrected Visual Acuity

BSCVA	Pre- Operative	Post- Operative
	n (%)	n (%)
$< 1/60$	96 (6.4)	---
1/60- 5/ 60	781 (52.1)	---
6/60- 6/24	554 (36.9)	143 (9.5)
6/18- 6/12	69 (4.6)	1231 (82.1)
6/9- 6/6	---	126 (8.4)
Total	1500 (100.0)	1500 (100.0)

DISCUSSION

Cataract is the leading cause of treatable blindness. Worldwide, 20 million people are blind due to cataract. In 1997, approximately 10 million cataract surgeries were performed globally but despite this, cataract blindness is thought to be increasing by 1- 2 million/ year. Most developing countries are unable to cope with the new cases due to limited medical and financial resources. Due to increasing population and lifetime expectancy, there is growing backlog of cataract blind patients in these countries. Cataract surgery is thus a cost effective treatment. It is not practically or financially feasible to individually measure IOL power for each patient in developing countries. By providing a single power IOL which can be used for every patient undergoing cataract surgery with IOL implantation, an effective and practically economical solution is obtained.

In this study 1500 adult patients undergoing cataract surgery with IOL implantation are included. Males are 44.5% (n=668) and females are 55.5% (n=832). This is similar to the study of Marchison A ⁷ who reported 52.5% females and 47.5% males. Studies of Iqbal S ¹² and El-Maghreby A reported male predominance. Poverty, social constraints, lack of eye care facilities all counted for high prevalence of female patients in our study.

Right eye is involved in 55.1% (n=826) patients and left eye is involved in 44.9% (n=674) patients. This is also like Marchison A ⁷ who reported right eye involvement in 53.12% and left eye involvement in 46.89%. Contrarily Iqbal S ¹² reported left eye involvement in 55% cases and right eye involvement in 45% cases. This difference may be because of the fact that most of our cases are related to agriculture and they present mostly when their dominant right eye is involved, which may be a co- incidence.

Mean axial length is 23.11 mm with SD ± 1.28 mm. Marchison A ⁷ reported mean axial length as 23.08mm with SD ± 1.26 mm. Study of Iqbal

S¹² reported mean axial length as 23mm with SD ± 1.5 mm. Study of Riley AF¹³ reported mean axial length as 23.14mm with SD ± 1.03 mm with ethnicity including 72% Europeans, 8% Maori, 10% Pacific Islanders, 4% Asians, 3% Indians and 3% other ethnic origins. The difference in mean axial lengths are due to the cultural, sex, age, ethnic and regional differences which is reported in different studies 7,11,12,13,14,15,16.

Mean IOL power is 20.10D with SD ± 3.06 D using SRK-II formula and A constant of 118.3. Different studies reporting mean IOL power with SD and range of IOL power are listed. All these studies reported a wide range of IOL power. Mean IOL power reported in all these studies are more or less in the same range.

Population	Number of Cases (n)	A-Constant	IOL Formula	IOL power (D) Mean $\pm$ SD	IOL power (D) Range
Current Study	1500	118.3	SRK-II	20.10 $\pm$ 3.0	-2.0- 36.5
Nepal ⁽⁷⁾	5109	118.3	SRK-II	21.37 $\pm$ 3.0	-5.5- 37
Taiwan ⁽¹⁶⁾	3068	118.5	SRK-II	20.00 $\pm$ 5.1	6.5- 25.5
Pakistan ⁽¹²⁾	500	118.3	SRK-II	21.80 $\pm$ 2.8	19- 25
Vietnam ⁽¹⁴⁾	346	118.3	SRK/T	21.44 $\pm$ 2.8	11.0- 29.5
Eritrea ⁽¹¹⁾	405	118.3	---	21.83 $\pm$ 3.5	1.6- 34.5
Humanitarian Mission ⁽¹⁷⁾	103	118.4	Holladay-I	20.38 $\pm$ 2.3	12.0- 28.0

Pre-operative best spectacle corrected visual acuity is $<6/60$ in 58.4% (n=877) patients. This is similar to Iqbal S¹² and Yorston D¹⁸ who reported pre-operative visual acuity $< 6/60$ in 77.8% and 93.8% patients respectively. Post-operative best corrected visual acuity 6/18 or better is present in 90.5% (n= 1357) patients. This is similar to Iqbal S¹² and Yorston D¹⁸ who reported post-operative visual acuity 6/18 or better 92.4% and 82.9 % patients respectively.

CONCLUSION

In far-flung areas of Pakistan, there are many barriers to delivery of cataract surgical services to the most needy people. Socioeconomic concerns, limited access to eye care, equipments and surgical costs are major factors contributing to high prevalence of blindness from cataract. This study shows that in conditions where proper biometric assessment is not available and/ or impossible. Using an IOL of 20- 22 diopter power would give optimal visual results. Further more extensive population based studies on different ethnic groups are required for calculating mean axial lengths and IOL power for emmetropia.

REFERENCES

1. Fasih U, Ahmed I, Shaikh A, Fahmi MS. Comparison of complications after primary and secondary anterior chamber intraocular lens implantation. *Pak J Ophthalmol* 2010; 26 (2): 57- 64.
2. World Health Organization. VISION 2020 Action Plan for 2006–2011 Planning Meeting. Geneva, 11–13 July 2006.
3. Saleem M, Khan SB, Khattak MA, Muhammad L. Analysis of intra ocular lens power estimation in patients admitted for cataract surgery. *GJMS* 2009; 7(9): 22- 6.
4. Shaikh PS, Aziz TM. Rapid assessment of cataract surgical services in age group 50 years and above in lower Dir district Malakand. *Pak J Coll Physicians and Surg Pak* 2005; 15: 145-8.
5. Malik AR, Qazi ZA, Gilbert C. Visual Outcome after high volume cataract surgery in Pakistan. *Br J Ophthalmol* 2003; 87:937-40.
6. Chanchlani M, Sarkar N, Manghani J, Soni B, Chanchlani R. Evaluation of Visual Outcome after Cataract Surgery in Camp Patients - A Study from Central India. *JEMDS* 2014; 3(06): 1536- 41.
7. Murchison A, Richards M, Tabin G, Ruit S, Gurung R. Optimal power intraocular lens for Nepali population. *Br J Ophthalmol* 2004; 88: 1235-6.
8. Ruit S, Tabin GC, Nissman SA, Paudyal G, Gurung R. Low-cost high-volume extracapsular cataract extraction with posterior chamber intraocular lens implantation in Nepal. *Ophthalmology* 1999; 106:1887– 92.
9. Yorston D, Foster A. Audit of extracapsular cataract extraction and posterior chamber lens implantation as a routine treatment for age related cataract in east Africa. *Br J Ophthalmol* 1999; 83:897–901.
10. Beatty J, Cook C, Murdoch I. Refractive error following cataract extraction with the implantation of

- a standard power intraocular lens in a rural African blindness prevention programme [letter]. *Eye* 2004; 18:194-5.
11. Connell B, Brian G, Bond M. A case-control study of biometry in healthy and cataractous Eritrean eyes. *Ophthalmic Epidemiol* 1997; 4:151- 5.
 12. Iqbal S, Zaman M, Daud K. Optimal standard intraocular lens power based on biometry asseessment. *J Postgrad Med Inst* 2006; 20:21- 4.
 13. Riley AF, Grupcheva CN, Malik TY, Craig JP, McGhee CN. The Auckland Cataract Study: demographic, corneal topographic and ocular biometric parameters. *Clin Exp Ophthalmol* 2001; 29:381- 6.
 14. La Nauze J, Thanh TK, Lap TD, Tai NA, Chau NTN, Chuong HN, Van Nam P. Intraocular lens power prediction in a Vietnamese population; a study to establish a limited set of intraocular lens powers that could be used in a Vietnamese population. *Ophthalmic Epidemiol* 1999; 6:147- 58.
 15. Percival P. Lens power calculation: is it necessary? *Trans Ophthalmol Soc UK* 1983; 103:577- 9.
 16. Yeh LK, Tan H-Y, Huang SC-M, Tsai SY, Tsai RJ- F. Annual database of intraocular lens power in a Taiwanese population. *Chang Gung Med J* 2004; 27:44- 8.
 17. Lombard PN, Mc Clatchey SK, Borges OA. Intraocular lens power requirements for humanitarian missions. *J Cataract Refract Surg* 2009; 35:1734- 8.
 18. Yorston D, Gichuhi S, Wood M, Foster A. Does prospective monitoring improve cataract surgery outcomes in Africa?. *Br J Ophthalmol* 2002; 86: 543- 7.

CORRESPONDENCE ADDRESS

Name: Dr. Asif Iqbal

Address: House No. 413, Street 12, Sector E-2,
Phase- 1, Hayatabad, Peshawar.

Cell No: 0333- 911- 6370.

E-mail Address: dcasif @ yahoo.Com.