Annual Database of Intraocular Lens Power in a Taiwanese Population

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Background: To derive a unique database of intraocular lens (IOL) power for Taiwanese, an ethnic group with a strikingly high prevalence of myopia.

Methods: A retrospective series of 3068 cases visiting Chang Gung Memorial Hospital, Linkou for cataract removal and posterior chamber IOL implantation between July 1999 and June 2000 was reviewed. The distribution of IOL powers and a possible age-correspondence was analyzed by one-way analysis of variance (ANOVA) test and multiple regression.

Results: Using the SRK/II linear regression formula, with an "A" constant of 118.5, the mean predicted IOL power required for emmetropia was 20.0±5.1 diopter (D). The mean IOL power for males was 19.8±5.1 D. The mean IOL power for females was 20.1±5.1 D. Moreover, ANOVA results documented a statistically significant tendency of age-dependence for IOL power distribution in the 3 groups (male, female, and male and female; $F=24.53$, $p<0.05$; $F=16.39$, $p<0.05$; $F=40.54$; $p<0.05$, respectively). In particular, it statistically significantly differed among decades over 40 years indicating that IOL power increased with age. However, the implanted IOL power decreased with age in patients younger than 40 years old. Multiple regression analysis showed that age, but not gender, was statistically significantly correlated to the IOL power distribution ($p<0.05$).

Conclusion: We provide a unique database of IOL power for cataract surgeries in Taiwan. An age-related correspondence of the database of IOL powers was also documented in this study, which can therefore be regarded further cross-sectional evidence for the age-dependence prevalence of myopia.

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Key words: **intraocular lenses, cataract surgery, Taiwan.**

Taiwan has rapidly developed over the past few decades, not only economically but also with respect to standards of education, which have caused great impacts on the prevalence of myopia. The prevalence and severity of myopia noticeably and continuously increased in the past few decades.(1-5) In 1959, Ko et al. showed only a 5.3% myopic population among primary school students.(6) According to nationwide surveys in 1986 and 1995, by the age of 18, the prevalence of myopia had increased to 74%

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in 1986 and 84% in 1995.[1-4,7] In view of the marked increase in the prevalence of myopia in the past few decades, as well as the significant correspondence between axial length elongation and myopic progression,[1-4] we were interested in deriving a unique, possibly age-correlated database of intraocular lens (IOL) power from among patients undergoing cataract surgery in Taiwan. Retrospectively, we reviewed the annual database of IOL power in cases after cataract removal with posterior chamber intraocular lens (PC-IOL) implantation at Chang Gung Memorial Hospital (CGMH), Linkou, Taiwan between July 1999 and June 2000.

METHODS

Retrospectively, 3068 consecutive cataract surgeries with PCIOL implantation carried out between July 1999 and June 2000 at CGMH, Linkou were enrolled. A case series was chosen as the most practical method to determine the database of IOL power for the Taiwanese. Routine cataracts were defined as cataracts occurring with no associated pathology which could possibly affect the measurements or distort the anatomy of the eye. Exclusion criteria included patients under 20 years old, and those with high myopia with posterior staphyloma, previous ocular surgery, or corneal scarring. Preoperatively, all patients visiting for cataract surgeries underwent a thorough ophthalmological examination including visual acuity, refractive status, tonometry, fundus examination, A-scan, and keratometric measurement. The axial length measurement was taken with a SonoMed A-scan (SonoMed Inc., NY, USA). The keratometric measurement was taken with a Topcon OM-3 type keratometer (Topcon Inc., Japan). The corneal refractive index used in converting corneal curvature to corneal refractive power was 1.3375.

Routine calibration was carried out according to the manufacturer's instructions. The Sanders-Retzlaff-Kraff (SRK/II) linear regression formula was used for IOL power calculation in all cases: Power = (A constant) - 2.5 (axial length) - 0.9 (K reading).[8,9] The A constant was 118.5, and the anterior chamber depth was assumed to be 5.1 mm. The mean of individual IOL calculations was taken rather than using mean axial length and mean keratometric values, and then the IOL powers were determined using the SRK/II formula.

Statistical analysis

One-way analysis of variance (ANOVA), Scheffe's multiple-comparison test, and Student's t-test were used to compare different age groups, while multiple regression analysis was used to assess the parameters of age and gender on IOL power. Statistical calculations were performed using the Statistical Program for the Social Sciences (SPSS Inc., Illinois, USA) software package. A value of $p < 0.05$ was considered statistically significant.

RESULTS

In this study, 3068 eyes of 2808 patients visiting CGMH, Linkou for cataract surgery with posterior chamber IOL implantation between July 1999 and June 2000 were included. Of the 3068 eyes, 1466 (47.78%) belonged to males and 1602 (52.22%) to females. The mean age of the sample was 67.2 ± 12.1 (median, 69) years. The mean age for males was 66.1 ± 13.0 (median, 69) years. The mean age for females was 68.2 ± 11.0 (median, 70) years. All patients were of Taiwanese origin. Using the SRK/II linear regression formula, with an "A" constant of 118.5, the mean implanted IOL power required for emmetropia was 20.0 ± 5.1 (median, 21.2) diopter (D). The mean implanted IOL power for males was 19.8 ± 5.1 (median, 21.2) D. The mean implanted IOL power for females was 20.1 ± 5.1 (median, 21.2) D (Table 1). There was no significant difference between the female and male groups (t-test, $p = 0.9204$; Table 1). The distribution of implanted IOL power is shown in Fig. 1. The prevalence of low-power implanted IOLs (below10 D) was 5.54%. The age-correspondence of IOL power was further analyzed. One-way analysis of variance (ANOVA test) showed that the implanted IOL powers statistically significantly differed among decades in the male group, female group, and total cases ($F = 24.53$, $p = 0.0001$; $F = 16.39$, $p = 0.0001$; $F = 40.54$, $p = 0.0001$, respectively) (Table 1). In particular, in patients over 40 years old, the implanted IOL power statistically significantly differed among decades: the implanted IOL power increased with age (Table 1). However, in patients under 40 years old, the implanted IOL power statistically significantly differed among decades: the implanted IOL power decreased with age. To assess the effect of age and gender on IOL power, the multiple regression analysis showed

Table 1. One-Way Analysis of Variance (ANOVA) Test, Scheffe's Multiple-Comparison Test, and t-Test Analysis of IOL Power at Chang Gung Memorial Hospital, Taiwan (N=3068)

Age (y)	IOL Power									T-test
	Male			Female			Total			Gender
	Examined No.	Mean±SD	Group Difference*	Examined No.	Mean±SD	Group Difference*	Examined No.	Mean±SD	Group Difference*	Difference *p*
Group 1: ≥90	5	20.2±5.4	--	7	19.3±4.7	--	12	19.6±4.8	--	0.7255
Group 2: 80-90	165	21.2±1.8	Group 5,6,7	171	21.0±4.0	Group 5,6,7	336	21.1±3.1	Group 5,6,7	<0.0001
Group 3: 70-79	529	20.9±3.6	Group 5,6,7	626	20.7±3.9	Group 5,6,7	1155	20.8±3.8	Group 5,6,7	0.0484
Group 4: 60-69	393	20.2±4.4	Group 5,6,7	534	20.4±4.8	Group 5,6,7	927	20.3±4.6	Group 5,6,7	0.0742
Group 5: 50-59	203	18.2±6.6	Group 2,3,4,6	170	18.1±6.8	Group 2,3,4	373	18.2±6.7	Group 2,3,4,6	0.7359
Group 6: 40-49	104	15.5±7.9	Group 2,3,4,5	55	15.8±7.7	Group 2,3,4	159	15.6±7.8	Group 2,3,4,5	0.8860
Group 7: 30-39	44	16.4±7.8	Group 2,3,4	20	14.8±8.0	Group 2,3,4	64	15.9±7.8	Group 2,3,4	0.8229
Group 8: 20-29	23	19.5±4.2	--	19	18.2±7.1	--	42	18.9±5.7	--	0.0213
Total	1466	19.8±5.1		1602	20.1±5.1		3068	20.0±5.1		0.9204
Age Difference**	F=24.53	*p*=0.0001		F=16.39	*p*=0.0001		F=40.54	*p*=0.0001		

*Scheffe's multiple-comparison test (alpha level=0.01)
**One-way analysis of variance (ANOVA test)

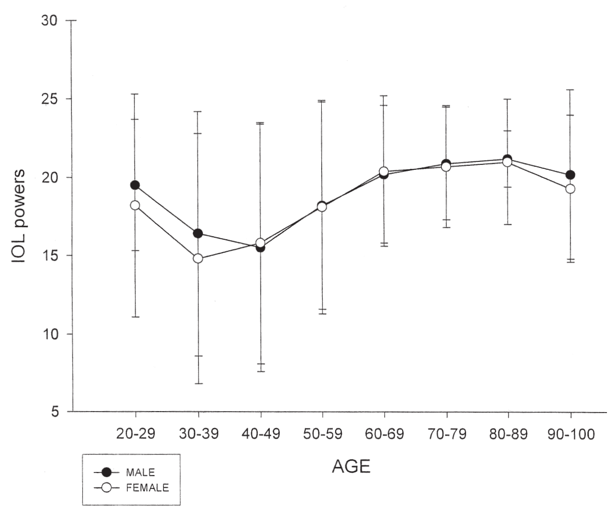

Fig. 1 Changes in different implanted IOL powers for each age group (by decade).

Table 2. Multiple linear regression analysis on IOL power in Chang Gung Memorial Hospital, Taiwan (n=3068)

Variables	Parameter estimate	Standard error	*p*	R^2, %
Intercept	12.863	0.551	0.0001	6.35
Age (continuous)	0.106	0.007	0.0001	
Gender (Female vs male)	0.005	0.178	0.9754	

that implanted IOL power was correlated to age, not gender (Table 2).

DISCUSSION

In an epidemiologic study of ocular refraction among school children in Taiwan in 1995, the axial length was demonstrated to increase with age and severity of myopia, with close correspondence shown with ocular refraction, whereas the corneal curvature remained unchanged.(1) The effect of the cornea on the development and progression of myopia is evident by the ratio of axial length to cornea radius (the AL/CR ratio). Moreover, a high AL/CR ratio is a risk factor for youth-onset myopia.(10) Therefore, we were able to deduce a conclusion from the SRK/II linear regression formula that IOL power decreased in proportion to axial length elongation. In view of the marked axial myopic progression and strikingly high prevalence of myopia in this population, we were interested in deriving a unique database of IOL power in Taiwan.

According to the SRK/II linear regression formula, the mean implanted IOL power required for emmetropia was 20.0±5.1 (median, 21.2) D. In determining what IOL powers should be used for a population, one must look at the distribution of powers.(11) In this study, mean and median values were within 1.2 D, and the distribution had a relatively longer myopic tail than the results of Nauze et al.

(0.12 D),[12] which supports the high percentage of high myopia reported in a nationwide survey in 1995.[1] Furthermore, the mean implanted IOL power for males was 19.8±5.1 (median, 21.2) D, and that for females was 20.1±5.1 (median, 21.2) D (Table 1). The mean IOL power was larger in females than in males. However, it did not statistically significantly differ ($p=0.9204$). Since the axial length is shorter in females, it is reasonable to observe a larger IOL power in the female group.

One-way analysis of variance (ANOVA) showed that the implanted IOL power decreased with age by decade under 40 years and increased with age by decade from 40 to 80 years (Table 1). There was a significantly high prevalence of myopia and myopic progression in the younger age group. We deduced that younger cataract patients had a higher prevalence of myopia and a tendency for myopic progression. However, the myopic progression in elderly patients seemed to have been arrested and slowed down because of the increased IOL power with aging after 40 years. In addition, we discovered a statistically significant generational difference in IOL powers, and the result can be regarded as further cross-sectional evidence for the age-dependent model of myopic progression. Furthermore, multiple regression analysis showed that implanted IOL powers were correlated to age, but not to gender (Table 2).

In this annual survey, the 3068 cases had a mean age of 67.2 years, reflecting the elderly population chosen, as seen in other studies, e.g., studies by Nauze et al. (64.11 years),[12] Hoffer (72 years),[13] and Bishara et al. (74 years).[14] The difference in mean age among studies might merely imply a difference in the timing of presentation and selection criteria for cataract surgery at a particular institution, without significant clinical relevance.[15] In addition, the trend of myopia correction by cataract removal with low-power IOL implantation may further contribute to a lowering of the mean age of the sample and increasing the prevalence of low-power IOL. The prevalence of low-power IOLs (below10 D) implanted was 5.54%.

The clinical practice weights a trend of slight myopic correction for selected IOL powers to allow for some degree of near vision. The mean implanted IOL power in our series, with an "A" constant of 118.5, was 20.0±5.1 D. The mean IOL power of 20.0 D was relatively lower compared to the results of Nauze et al. from a Vietnamese population (mean, 21.44±2.77 D; median, 21.56 D; with an A constant of 118.3).[12] Regarding possible geographical or genetic influences between Taiwanese and Vietnamese, we were not surprised at the lack of a marked discrepancy between these 2 ethnic groups. In addition, we have reasons to expect more-striking divergence as compared with populations in Western countries, since the prevalence and severity of myopia in ethnic groups like Asians and Jews[16] are tremendously higher than those of Africans and African-Americans.

According to epidemiological evidence, the prevalence of myopia is increasing, especially in Asian populations.[17,18] Additional evidence supporting the role of genetics in the development of myopia includes the wide variability in the prevalence of myopia in different ethnic groups such as 70%-90% in Asia, 30%-40% in Europe and North America, and 10%-20% in Africa.[19,20] Although the exact pathogeneses of myopia and myopic progression remain unclear, the close correspondence between myopic progression and axial length elongation was documented to be statistically significant.[1,19] In this study, the parameter of axial length was not the main issue studied, and we just analyzed the database of implanted IOL powers for a Taiwanese population. Further studies are required to study the effect of the parameter of axial length on myopia.

In conclusion, we provide a unique database of implanted IOL powers for the high myopic prevalence within the Taiwanese population. We further point out the age-dependence of implanted IOL power, which therefore provides additional cross-sectional evidence for the age-dependence of the prevalence of myopia.

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臺灣人白內障人工水晶體度數資料年報

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背 景： 由近視盛行的臺灣人之白內障人工水晶體度數去分析推論。

方 法： 在1999年7月至2000年6月在長庚醫院收集3068個白內障手術的病例，依不同的年齡層以單因子變異數分析和多元迴歸分析去分析人工水晶體度數之分佈和年齡、性別之相關性。

結 果： 使用SRK/II公式，平均人工水晶體度數爲20.0±5.1度，男性平均人工水晶體度數爲19.8±5.1度，女性平均人工水晶體度數爲20.1±5.1度。單因子變異數分析顯示不同的年齡層人工水晶體度數之分佈有顯著之差別，特別是40歲以上的人工水晶體度數隨年齡增加而增加，而40歲以下的人工水晶體度數隨年齡增加而減少。多元迴歸分析顯示年齡與人工水晶體度數有關，而性別與人工水晶體度數較無關。

結 論： 我們提供近視盛行的臺灣人之白內障人工水晶體度數分析資料，可以作爲橫斷面研究近視之參考。

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關鍵字： 人工水晶體，白內障手術，臺灣。

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