ORIGINAL ARTICLE

Mean Errors From The Target Refraction at 1 Month After Phacoemulsification Surgery in High Myopes: A Comparison Of SRK/T, Haigis And Holladay 1

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Abstract:

Objectives: To assess differences in mean numerical errors in high myopes from the predicted target refraction using SRK/T, Haigis, and Holladay 1 IOL formulas

Methods: High myopes having ≤ - 6 D SER and/ or ≥ 26mm axial lengths undergoing uncomplicated phacoemulsification surgery for cataracts and completing 1-month follow-up were included. SRK/T was used for the implanted IOL and the target refraction was predicted using the 3 formulas mentioned above. At 1-month, spherical equivalent refraction was calculated and the difference from the predicted refraction was reported as a mean numerical error (MNE). The Kruskal-Wallis test was used to find differences between the data as it was not normally distributed. Mann-Whitney U test was used to find differences between genders and 2 age groups of 50-59 and 60-70 years.

Results: There were 57 females (45.6%) and 68 males (54.4%) included in the study with a mean age of 57.36 ± 6.17 years. There were no significant differences between the mean numeric error using the Kruskal-Wallis test, (p = 0.161). The Mann-Whitney U test did not find differences between the genders or the age groups using the 3 formulas.

Conclusions: Keeping in view, the limitations of the study, the 3 formulas in our sample performed similarly in high myopes for post-operative refractive outcomes. More studies with randomized designs and optical biometry are needed to elucidate differences in mean numeric error more accurately between the formulae. *Al-Shifa Journal of Ophthalmology 2024; 20(3): 88-92.*

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Introduction:

According to the ICD-11 classification, myopia is listed as a disorder of refraction, in which light rays parallel to the optic axis are brought to focus in front of the retina, because of a large axial length, overly curved cornea or a lens with increased optical power. A World Health Organization (WHO) report in 2015 defined myopia as SER ≤-0.5D, and high myopia as SER ≤-5 D, and acknowledged the absence of standard definitions in the literature. The International Myopia Institute task force in 2019 [1], defined high myopia as ≤ - 6 D and proposed that the former WHO definition may be relevant to the prevalence and population studies, whereas the latter may be more relevant

clinically as the risk of uncorrected vision loss increases significantly beyond this value. Furthermore, clinically ≥ 26mm axial length is considered as high myopia.

Myopia and high myopia, significantly increase the risk of ocular complications, including a higher risk of cataracts, glaucoma, retinal detachment, and macular degeneration to name a few. This is especially more common in high myopia [2], where the pathogenesis may be different than in low-moderate myopia. Moreover, the prevalence of myopia is increasing worldwide, which is projected to increase to 49.8% of the global population by 2050[3]. As the rates increase, the associated complications will become more prevalent, especially considering that cataracts are already one of the leading causes of blindness worldwide [4].

The primary goal of uncomplicated cataract surgery is to provide the best optical correction and good visual outcomes to the patients. Failure to achieve these outcomes may lead to medicolegal issues [5], apart from the poor satisfaction of patients and surgeons. To ensure accurate power calculations, various sources of error need to be eliminated. These include variations in axial length measurement, keratometry, post-operative anterior chamber depth prediction, and IOL position [6]. For axial length measurement, optical biometry may be superior to ultrasound measures, especially in cases of posterior staphyloma found more commonly in high myopes, but cannot be used in cases of dense cataract, corneal edema, or vitreous hemorrhage.

The NHS benchmark for post-op refractive outcomes dictates that 85% of eyes should be within 1 D, and 55% within 0.5D of the intended spherical equivalent refraction [7]. To this end, various IOL formulae have been devised. Current NICE guidelines advise the use of Haigis or Hoffer Q for axial lengths < 22 mm, between 22- and 26-mm Barret universal II formula should be considered if it is installed in the machine and does not need to be calculated manually, otherwise SRK/T is recommended. For axial lengths >26mm, Haigis or SRK/T should be used [8]. However, data regarding high axial lengths are inconclusive, and Barret universal formula has been shown to be superior according to some studies [9].

The goal of the present study is to evaluate the postoperative mean refractive (numeric) errors from the intended outcomes in high myopes with cataracts, using Haigis, Holladay 1, and SRK/T IOL formulas for power calculations, to better match formula selection in a Pakistani patient population.

Materials and Methods:

This observational, cross-sectional study was conducted at the Department of Ophthalmology, Fauji Foundation Hospital, Rawalpindi, Pakistan, between 5th April 2018 and 5th October 2018, after approval from the ethical review committee of the institute. High myopes were defined as having spherical equivalent refraction (SER) of ≤-6D and/or axial lengths ≥26mm. Those undergoing routine cataract surgery and completing the 1-month follow-up were included. Cases having a complicated, eventful surgery, or not having in-the-bag IOL implantation, a history of previous ocular surgeries, or those requiring combined procedures were excluded from the study.

After obtaining informed consent, patients were included in the study after full preoperative refraction and anterior and posterior segment examination where applicable. Data were collected including age, axial length, and k-readings, along with IOL-power predicted using 3 different formulas, namely, Haigis, Holladay 1, and SRK/T. The corneal power was measured with the Canon RK-F1 Auto-refractor-keratometer. A scan was done after k readings, via a Quantel Medical Axis-II biometry device. Biometry was performed by a single user, using the same technique each time. Multiple measured readings of axial lengths and chamber depth were used, and the standard deviation was kept below 0.1 to keep the accuracy of measurements

as high as possible. All surgeries were done by a single surgeon and the IOL implanted was from the same manufacturer. Only SRK/T was used for the actual implanted IOL. At 1-month post-op, the SER from the intended outcome was measured and compared with the predicted IOL power from the formulas. The mean numeric error (MNE) was calculated for each formula as the difference between predicted post-operative refraction and the actual refraction at 1 month.

After data cleaning and entry, descriptive analysis was done using SPSS version 26. Quantitative data were reported as mean ± SD and categorical data were reported as frequencies and percentages where applicable. To differentiate between the MNE, the Kruskal-Wallis test was used after checking the normality of data, and a p-value of < 0.05 was taken as significant. For comparing MNE between males and females and age groups, the Man-Whitney U-test was used.

Results:

There were 57 females (45.6%) and 68 males (54.4%) included in the study with a mean age of 57.36 ± 6.17 years (Range 50 – 78). The mean axial lengths were 25.68 ± 0.78 mm.

The Mean numeric error (MNE) for SRK/T was 0.127 ± 0.33 D, for Haigis, it was 0.214 ± 0.18 and for Holladay 1, it was 0.215 ± 0.189. The Kruskal-Wallis test was used to assess differences between the post-operative mean numeric errors of the 3 formulas. However, the p-value was not significant (p=0.161).

Similarly, between genders, there were no significant differences in the MNE among the formulas used (Table 1), nor for age groups between 50-59 and 60-70 (Table 2).

Table 1: Mann-Whitney U test for comparing MNE using different formulas between genders

Formula	Gender	n	Mean Rank	p-value
SRK/T	male	68	59.43	0.226
	female	57	67.25	
Haigis	male	68	67.76	0.104
	female	57	57.32	
Holladay I	male	68	63.88	0.765
	female	57	61.95	

Table 2: Mann-Whitney U test for comparing MNE using different formulas between age groups

Formula	Age group	n	Mean Rank	p-value
SRK/T	50-59	80	63.81	0.440
	60-70	43	58.64	
Haigis	50-59	80	61.20	0.731
	60-70	43	63.49	
Holladay I	50-59	80	59.03	0.204
	60-70	43	67.53	

Discussion:

The present study was carried out to assess differences between the post-operative mean numeric errors from the intended refractive outcome, using the 3 IOL-formulas, namely, SRK/T, Haigis, and Holladay 1 for high myopes undergoing uncomplicated cataract surgery. The

Kruskal-Wallis test was used as the data were not normally distributed, and the result was not statistically significant (p=0.161).

There is some variation in the literature as to the best formula for use in myopic eyes. A study in Germany reported relatively poor outcomes with SRK II but recommended the use of Haigis and SRK/T [10]. Thus, there were no significant differences between the 2 formulas, which is in line with our study. Of note, however, is that optimizing the constants for positive and negative IOLs, improved outcomes for all the formulas included in the study. However, axial myopia was not defined, biometry was done using optical methods, and those having glaucoma, amblyopia, and myopic degeneration were not excluded.

Another study showed that Haigis has better outcomes compared to SRK/T, but high myopia was defined as having ≥ 24mm axial length, and the target refraction was -1.0 D. There were 25 individuals in both groups however [11]. The present study has a higher sample for the analysis.

A few studies report better outcomes with SRK/T in very highly myopic eyes [12], while others report better outcomes with Haigis and Barrett Universal II formula [13]. However, the former study included only negative power IOLs with an average axial length of 32.65mm, while the latter study included cases with more than 28 mm axial length. Comparing outcomes with such variations should be done with caution, as our study included cases with a mean of 25.68 ± 0.78 mm axial length.

Finally, some evidence points to the similarity of these formulas in high myopes. Apart from the evidence presented above [10], a study reported no difference in mean errors after using Holladay I, Haigis, and SRK/T in myopes with ≥24.5 mm axial length [14]. This seems to be in line with our study.

The results of this study should be interpreted with some limitations in mind. The corneal incisions were not taken into account using K readings to neutralize astigmatism while performing the surgery. This should impact the mean errors post-operatively. Furthermore, grouping patients into different categories of formulas and then implanting IOLs will yield more accurate results, unlike the present work where only IOLs calculated with SRK/T were implanted, and the powers predicted for the rest of the formulas. Furthermore, high myopes may have thinner corneas, and optical biometry may have better accuracy as the deformation induced via contact with A scan machine may lead to erroneous measurements.

Conclusion:

Keeping in view the limitations of the study, more research is needed to elucidate the ideal formula in high myopes, however, in our research, the 3 formulas performed similarly.

References:

1. Flitcroft DI, He M, Jonas JB, Jong M, Naidoo K, Ohno-Matsui K, Rahi J, Resnikoff S, Vitale S, Yannuzzi L. IMI–Defining and classifying myopia: a proposed set of standards for clinical and epidemiologic studies. Investigative ophthalmology & visual science. 2019 Feb 28;60(3):M20-30.
2. Haarman AE, Enthoven CA, Tideman JW, Tedja MS, Verhoeven VJ, Klaver CC. The complications of myopia: a review and meta-analysis. Investigative ophthalmology & visual science. 2020 Apr 9;61(4):49-.
3. Holden BA, Fricke TR, Wilson DA, Jong M, Naidoo KS, Sankaridurg P, Wong TY, Naduvilath TJ, Resnikoff S. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. Ophthalmology. 2016 May 1;123(5):1036-42.
4. Steinmetz JD, Bourne RR, Briant PS, Flaxman SR, Taylor HR, Jonas JB, Abdoli AA, Abrha WA, Abualhasan A, Abu-Gharbieh EG, Adal TG. Causes of blindness and vision impairment in 2020 and trends over 30 years, and

prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. The Lancet Global Health. 2021 Feb 1;9(2):e144-60.
5. Lee BS. Medicolegal pitfalls of cataract surgery. Current Opinion in Ophthalmology. 2015 Jan 1;26(1):66-71.
6. Norrby S. Sources of error in intraocular lens power calculation. Journal of Cataract & Refractive Surgery. 2008 Mar 1;34(3):368-76.
7. Gale RP, Saldana M, Johnston RL, Zuberbuhler B, McKibbin M. Benchmark standards for refractive outcomes after NHS cataract surgery. Eye. 2009 Jan;23(1):149-52.
8. NICE guidelines. Cataracts in adults: Management, 2017 https://www.nice.org.uk/guidance/ng77/chapter/Recommendations
9. Zhang Y, Liang XY, Liu S, Lee JW, Bhaskar S, Lam DS. Accuracy of intraocular lens power calculation formulas for highly myopic eyes. Journal of ophthalmology. 2016 Mar 29;2016.
10. Petermeier K, Gekeler F, Messias A, Spitzer MS, Haigis W, Szurman P. Intraocular lens power calculation and optimized constants for highly myopic eyes. Journal of Cataract & Refractive Surgery. 2009 Sep 1;35(9):1575-81.
11. Padmini HA, Dhananjaya KH, Budihal SB, Naik GT. A comparative study on accuracy of SRK-T and Haigis formulas in IOL power calculation in axial myopes undergoing cataract surgery. Journal of Pharmacy & Bioallied Sciences. 2022 Jul;14(Suppl 1):S907.
12. Kapamajian MA, Miller KM. Efficacy and safety of cataract extraction with negative power intraocular lens implantation. The Open Ophthalmology Journal. 2008;2:15.
13. Chu YC, Huang TL, Chang PY, Ho WT, Hsu YR, Chang SW, Wang JK. Predictability of 6 intraocular lens power calculation formulas in people with very high myopia. Frontiers in Medicine. 2022;9.
14. Doshi D, Limdi P, Parekh N, Gohil N. A comparative study to assess the predictability of different IOL power calculation formulas in eyes of short and long axial length. Journal of Clinical and Diagnostic Research: JCDR. 2017 Jan;11(1):NC01.

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