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ORIGINAL ARTICLE

The opportunity cost of managing toric intraocular lens rotation cases for a private cataract surgery center in India: A decision-analytic model comparing three toric intraocular lenses

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Abstract

Aim: This study estimated the opportunity cost and post-operative chair and operating time with toric intraocular lens (IOL) repositioning surgery in a single private surgical center in India.

Methods: A decision-analytic model estimated the annual number of cataract surgeries with toric IOL implantation and compared the number of cases requiring repositioning surgery. The model considered three scenarios, each with the utilization of a different toric IOL including AcroSof toric (Alcon Laboratories, Inc.), TECNIS toric (Johnson and Johnson Vision, Inc.), and HOYA 355 toric (HOYA). Each repositioning case resulted in an opportunity cost and lost chair and surgery time as the private surgical center was responsible for conducting and absorbing the cost for the repositioning surgery. Repositioning rates for AcrySof® toric (0.2%), TECNIS toric (1.8%), and HOYA 355 (1.94%) were derived from the literature. The opportunity cost (₹45,000) and post-surgical chair and operative time (60 min) were provided through expert opinion. All costs are reported in 2022 Indian Rupees.

Results: The base case scenario analyzed an annual volume of 250 cataract surgeries with toric IOL implantations. AcrySof® toric IOL had 0.5 repositioning cases at an opportunity cost of ₹22,500 and additional surgical and chair time of 30 min. Compared to TECNIS toric and HOYA 355 toric, AcrySof® toric IOL resulted in fewer cases (−4.0 and −4.4, respectively), associated opportunity costs (₹180,000 and ₹195,750, respectively), and time saved (240 and 261 min, respectively).

Conclusion: A single surgery center in India could reduce opportunity costs and the time associated with repositioning surgery by utilizing AcrySof toric IOLs.

Introduction

Visual impairments are a major global health issue with over 40% of visual impairment caused by uncorrected refractive errors (myopia, hyperopia, and astigmatism).[1] Astigmatism, which occurs when two paralll rays of light are brought to a focus perpendicular to each other instead of at a single point, is the most common refractive error with an estimated pooled prevalence of 40.4% in adults.[2,3] Cataracts are a common, age-related condition that leads to cloudiness in the lens of the eye.[4] Cataract surgery, which replaces the clouded lens with an intraocular lens (IOL), is safe and effective.[4] It is estimated that up to 47% of patients undergoing cataract surgery have a pre-existing astigmatism of >1 diopter.[5] If left uncorrected after cataract surgery, uncorrected vision is associated with a significant lifetime economic and humanistic burden.[5]

Traditional IOLs compensate for spherical refractive errors such as myopia and hyperopia through different curvatures.[6] Toric IOLs, first designed in 1992,[7] allow for the correction of corneal astigmatism during cataract surgery. The correction of pre-existing astigmatism during cataract surgery with toric IOL implantation can lead to spectacle independence.[8] Implantation of toric IOLs has been found to be cost-effective compared to traditional IOLs in patients with pre-existing astigmatism undergoing cataract surgery.[9,10] However, IOL implantation can lead to complications such as PCO, cystoid macular edema, peripheral vitreous detachment, macular hole, retinal detachment, and misalignment.[8]

Patients with misalignment, which is unique to toric IOLs, can require repositioning surgery to correct this specific complication.[11] Misalignment includes both misplacement and rotation of the toric IOL. Misplacement is defined as the difference between the intended axis and the actual implanted axis, whereas misalignment is the difference between the actual implanted axis and the axis 6 months or later after the toric IOL implantation.[12] The misalignment of toric IOLs can lead to residual refractive astigmatism and reduced visual acuity.[13] Studies have shown that different toric IOLs are associated with varying rates of repositioning.[11,14]

Opportunity cost in health-care represents the potential value and/or benefit associated with treating or caring for one patient instead of another in a resource-limited setting.[15] The need for repositioning surgery is associated with additional burden to both patients and an opportunity cost for surgical centers. In India, toric IOLs are only implanted in private cataract surgical centers. While patients pay the overall cost of the toric IOL and initial surgery, the surgical center is responsible for absorbing the cost and time associated with repositioning surgeries for patients with toric IOL misalignment. This incentivizes surgical centers to minimize the rate of misalignment through surgical procedures and toric IOL selection as they could be using that time to treat other patients with unmet needs. In this study, a model was developed to estimate the opportunity cost and post-operative chair-time and operating room time associated with different toric IOLs from the perspective of a single private surgical center in India.

Methods

A decision-analytic model was developed to estimate the opportunity cost of repositioning surgery associated with the utilization of three different toric IOLs. Opportunity costs are the losses of potential gain (or benefits foregone) from best alternative options when a particular option is selected (e.g., lost revenue opportunity).[15,16] In this analysis, the opportunity cost of repositioning surgery represents the lost revenue opportunity from the next best alternative, which would be another toric IOL procedure.

The toric IOLs included in the model were (1) Acrysof toric IOL (Alcon Laboratories, Inc.), (2) TECNIS toric IOL (Johnson and Johnson Vision, Inc.), and (3) HOYA 355 toric IOL (HOYA). Over a 1-year time horizon, the model compared three scenarios based on 100% utilization rates of each of the three included toric IOLs. The annual number of toric IOL surgeries, subsequent repositioning surgeries, and outcomes for three different toric IOLs were considered (Figure 1).

The lost revenue and time per surgery were then applied to the number of repositioning surgeries and the outcomes were compared across the different toric IOLs. The time of surgery included the time required to manage patients and conduct the surgery in the operating room. The model took the perspective of a single surgery center in India and all costs are reported in 2022 Indian Rupees and US Dollars (1 INR = 0.0126 USD).[17]

The model inputs are summarized in Table 1.

The base case model considered a scenario of a single center with 1,000 annual cataract surgeries per year, of which 25% utilized toric IOLs. Each of the three toric IOLs were assumed to have 250 cases.

The incidence of IOL repositioning surgery for each of the three toric IOLs was 0.2% for AcrySof toric 1.8% for TECNIS toric, and 1.94% for HOYA 355 toric. The repositioning rates were taken from a previously conducted retrospective study of ten ophthalmic surgical sites in Japan.[14] The lost revenue and time associated with repositioning surgery were estimated through consultation with a clinical expert in India.

The base case analysis reported outcomes for 100% utilization rates for each of the three toric IOLs. AcrySof toric IOL was then compared to TECNIS toric IOL and HOYA IOL separately to determine the incremental number of cases, opportunity cost (lost revenue), and time. One-way sensitivity analysis was performed for both comparisons by varying the parameters by 20% and using the incremental cost of repositioning surgery as the primary outcomes.

Results

The outcomes of the base case analysis are shown in Table 2.

AcrySof toric had the fewest repositioning cases (0.5), repositioning costs (22,500), and post-operative chair and operating room time (30 min). The outcomes for TECNIS toric and HOYA 355 toric were comparable with HOYA toric having a slightly higher number of cases (4.85 vs. 4.5), opportunity costs (₹218,250 [$2,750] vs. ₹202,500 [$2,552]), and post-operative chair and operating room time (291 vs. 270 min).

The annual number of cases was estimated to be reduced by four if the center utilized AcrySof toric instead of TECNIS toric for all annual cases. This reduction in cases translated to an annual opportunity cost and time savings of ₹180,000 ($2,268) and 240 min, respectively. In a scenario of switching from HOYA 355 toric to AcrySof toric, it was estimated that 4.4 fewer annual repositioning cases would be incurred. An opportunity cost saving to the surgery center was estimated to be ₹195,750 ($2,466) and the time savings was estimated to be 261 min.

Sensitivity analysis

The results of the one-way sensitivity analysis using incremental repositioning costs as the primary outcome are shown in Figure 2.

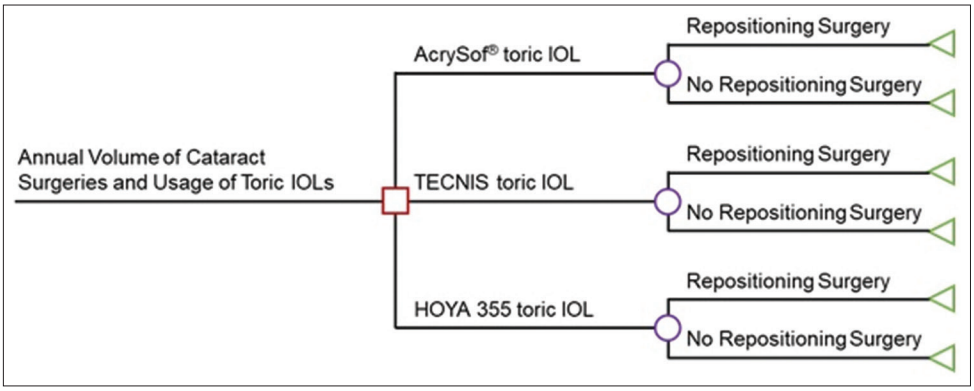

Figure 1: Model structure

Table 1: Clinical and economic inputs

Variable	Base case	Range	Source
Population inputs			
Annual volume of cataract surgeries, n	1,000	-----	Assumption
Toric penetration, %	25%	-----	Assumption
Clinical inputs			
Incidence of IOL repositioning surgery			
AcrySof toric	0.2%	0.16–0.24%	Oshika *et al.* 2020
TECNIS toric	1.8%	1.44–2.16%	Oshika *et al.* 2020
HOYA 355 toric	1.94%	1.55–2.33%	Oshika *et al.* 2020
Economic inputs			
Lost Revenue per repositioning surgery	₹45,000 ($567)	₹36,000–₹54,000 ($454–$680)	Expert opinion
Time for repositioning surgery*	60	48–72	Expert opinion

*Includes office chair-time and operating room time

Table 2: Base case results

Repositioning outcomes	AcrySof toric	TECNIS toric	HOYA 355 toric	AcrySof toric versus	
				TECNIS toric	HOYA
Cases	0.5	4.5	4.85	−4.0	−4.4
Opportunity Cost	₹22,500 ($284)	₹202,500 ($2,552)	₹218,250 ($2,750)	−₹180,000 ($2,268)	−₹195,750 ($2,466)
Time (min)	30	270	291	−240	−261

In both the comparison of AcrySof toric with Tecnic toric and HOYA toric, the model was most sensitive to the comparators repositioning rate, followed closely by the cost per surgery. The model was least sensitive to the repositioning rate of AcrySof toric in both comparisons. AcrySof toric demonstrated opportunity cost savings for both comparisons across all tested variable ranges.

Discussion

We conducted an evaluation of the annual opportunity cost associated with repositioning surgery due to toric IOL rotation from the perspective of a private surgical center in India. The analysis was undertaken from this perspective as the cost and time of repositioning surgery is absorbed by the surgical center. We found that the use of AcrySof Toric resulted in an 88.9% and 89.7% reduction in cases, surgery costs, and time for surgery centers when compared to TECNIS toric IOL and HOYA 355 toric IOL, respectively.

Economic evaluations of toric IOLs have previously been conducted to estimate their relative value compared to conventional IOLs in patients with cataracts and pre-existing astigmatism.[9,10,18,19] Most of the previous analyses took the payer perspective rather than the perspective of a surgery center. Furthermore, to the authors' knowledge, there have not been any previous economic evaluations of the opportunity cost associated with repositioning surgery post the implantation of toric IOLs. Opportunity cost models with the perspective of a

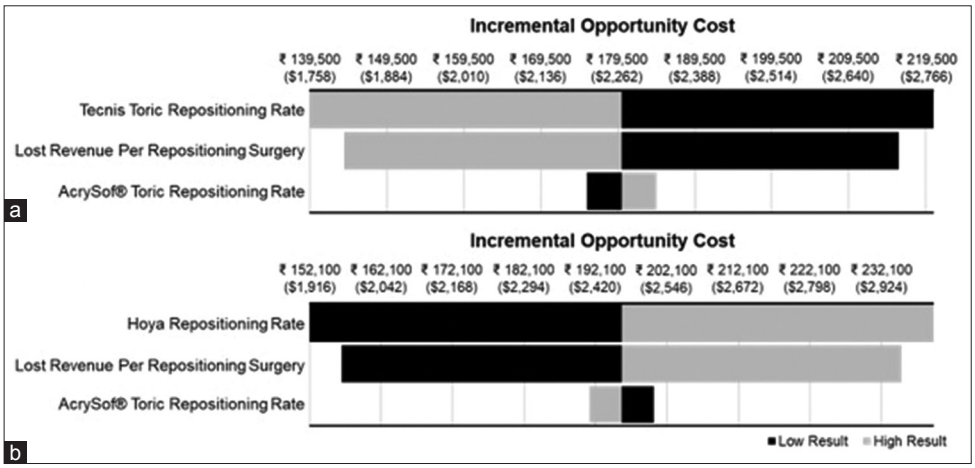

Figure 2: One-Way sensitivity analysis (a) AcrySof Toric versus TECNIS Toric and (b) AcrySof Toric versus HOYA 355

surgical center or hospitals have been used frequently, although they do not always utilize the "opportunity cost" term.[20-23]

This analysis provides surgical centers with an estimate of the opportunity cost, or the lost revenue opportunity, associated with initial toric IOL selection. In addition to the estimated lost revenue of ₹180,000 ($2,268) and ₹195,750 ($2,466), the center would also experience 240 and 261 lost minutes per year of chair time with TECNIS toric IOL and HOYA 355 toric IOL compared to AcrySof, respectively. For a high-volume private practice in India, lost revenue and post-operative chair time due to repositioning surgery can have a ripple effect throughout the health system. Patients requiring repositioning surgery experience visual acuity loss, additional burden due to repeated visits to the surgical center, the potential of lost wages as well as transportation fees and may not be experiencing the quality of life benefits that have been previously demonstrated with toric IOLs.[10,24] Assuming the surgical center is operating at full capacity, the lost time due to repositioning could push back surgeries for unrelated patients and extend reduced quality of life and/or financial loss due to their condition before surgery. Finally, additional finance and reputation loss could be incurred by surgical centers due to patients that are unhappy with the need for repositioning surgery.

This wide-ranging impact on surgical centers, patients, and health systems have important implications for stakeholder. The importance of initial toric IOL selection to limit post-operative complications not only impacts patients and surgical centers, but also can delay care for other patients in a resource-constrained setting. Incentives could be considered to increase the utilization of toric IOLs with low rates of repositioning, which could improve efficiency and improve outcomes across stakeholders.

A future extension of this study would be to include additional perspectives to estimate the opportunity cost from the patient and societal perspectives. While patients incur the cost of the initial toric IOL and surgery, they do not incur the cost of repositioning surgery. However, patients may experience opportunity cost due to their time spent attending the repositioning surgery, the value of reduced quality of life, and other repositioning-related direct and indirect costs. Other studies have examined the opportunity cost for patients, and reported these costs to be highly impactful, specifically costs associated with ambulatory visits in the United States.[25]

This study has several limitations. First, the model relied on data from a previously published retrospective multicenter case series in Japan. A single surgical center in India may experience different rates of repositioning due to differences in training, techniques, and available equipment among other factors. The demographics and clinical characteristics of the patient population in Japan may also not represent the patient population in India, which could influence repositioning rates. Second, the opportunity cost was calculated based on the assumption that the time lost for repositioning surgery would have been used to conduct new toric IOL implantations. It is possible that the time used to perform these surgeries would not impact the number of new surgeries per year and thus not impact total revenue. It is also possible surgeries other than toric IOL implantations could have occurred, which would impact the opportunity cost. The model also assumed that the need for repositioning surgery would happen in the same year as the surgery as most rotations occur within a few days of the initial surgery.[26] Finally, this model only took the perspective a single health center and did not consider the outcomes to patients and their caregivers.

Conclusion

The use of AcrySof toric IOLs compared to TECNIS toric IOLs or HOYA 355 toric IOLs could reduce opportunity costs associated with the cost and time of repositioning surgery in a single center private surgical center in India.

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