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ORIGINAL RESEARCH

Clinical Results of a Monofocal Aspheric Bitoric Intraocular Lens with Plate Haptics in Hyperopic Eyes

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Purpose: To assess the refractive and visual outcomes of hyperopic and astigmatic eyes implanted with a monofocal, aspheric, bitoric intraocular lens (IOL) with plate haptics following cataract surgery.

Methods: The study evaluated 51 eyes implanted with the AT TORBI 709M IOL (Carl Zeiss Meditec AG, Jena, Germany) during a follow-up of 12-months. Refractive error, rotational stability, monocular uncorrected distance visual acuity (UDVA), monocular corrected distance visual acuity (CDVA), and contrast sensitivity were analyzed at 1-, 6-, and 12-months post-surgery.

Results: At 12 months, the cumulative CDVA was 20/25 in 94.12% of eyes and 20/32 or better in 98.04%. The UDVA was the same as, or better than, the CDVA in 88.24% of eyes. The mean logMAR UDVA and CDVA values were 0.06 ± 0.11 and 0.00 ± 0.08, respectively. In addition, 92.16% of eyes were within ±0.50 D and 98.04% were within ±1.00 D of a spherical equivalent, and 86.27% of eyes had refractive astigmatism ≤0.50D and 100% were ≤1.00D. The mean spherical equivalent was 0.21 ± 0.31D and the mean refractive cylinder 0.34 ± 0.27D. The IOL rotation was 1.18 ± 1.35 degrees and all eyes had a rotation ≤5 degrees. The log contrast sensitivity functions were good and similar for all spatial frequencies during follow-up.

Conclusion: Our results demonstrate that implantation of the AT TORBI 709M IOL in hyperopic and astigmatic eyes is effective and safe. The visual and refractive outcomes were good, showing excellent rotational stability.

Keywords: cataract, intraocular lens, aspheric, bitoric, plate haptics

Introduction

It is well known that the simultaneous correction of both spherical and astigmatic refractive errors after cataract surgery provides patients with the best quality of vision. Specifically, for astigmatism, several clinical studies have shown that about 60% of eyes undergoing cataract surgery have an astigmatism of up to 1.00 diopters (D): 59.9%[1] and 58.7%.[2] A recent multivariate analysis performed in a large population demonstrated that low values of residual astigmatism can degrade postoperative visual acuity, thus suggesting that corneal astigmatism ≥0.50D should be included in the surgical plan.[3] Similarly, a systematic review and meta-analysis states that the use of toric intraocular lenses (IOLs) provided better uncorrected distance visual acuity (UDVA), greater spectacle independence, and lower amounts of residual astigmatism than non-toric IOLs.[4]

Previous prospective and retrospective studies[5–22] have evaluated the clinical outcomes of the bitoric AT TORBI 709 IOL (Carl Zeiss Meditec AG, Jena, Germany) after cataract surgery. This lens distributes the cylindrical power on the front and back surfaces of the lens with a plate haptic design and is intended to be implanted in the capsular bag. Moreover, this lens has been assessed in vitro[23] and used in keratoconic eyes with cataracts,[24–26] in combined vitrectomy,[27] can be repositioned after misalignment[28] or using a specific nomogram.[29] The different studies, with a variety of samples, that have reported clinical data in standard cataract surgery have shown good visual, refractive and rotational stability outcomes in the short- (1 month),[17–19] medium- (3[7,9–11,13,15,16,20–22] and 6 months[6,8]) and long-term

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follow-up (12 months[14]) for a general population, and specifically for myopic eyes.[8,16] However, to the best of our knowledge, up to March 2024 no clinical studies have been carried out to analyze this lens when implanted in hyperopic eyes.

As such, the purpose of the present prospective observational study was to analyze the refractive error, rotational stability, visual acuity and contrast sensitivity in order to describe the clinical outcomes obtained with the AT TORBI 709 IOL in a series of hyperopic astigmatic eyes with cataracts during a 12-month follow-up period.

Methods

This multicenter, prospective, observational study was conducted following the tenets of the Declaration of Helsinki and approved by the Ethics Committee of the Hospital Clínico San Carlos (Madrid, Spain, Reference 21/358-O_P) and the Valencia regional committee on post-marketing studies CAEPRO (Valencia, Spain). All patients recruited for our study gave their informed consent to participate. The study was registered with the National Institutes of Health (clinical trial identifier NCT05058274, http://www.clinicaltrials.gov).

The inclusion criteria were patients with cataracts, aged ≥50 years, regular corneal astigmatism between 1.00 and 4.00D, spherical equivalent IOL power implanted between 21.00 and 26.00D, hyperopic eyes between 1.00 and 4.00D, and white-to-white (WTW) distance measured with the IOLMaster 700 optical biometer (Carl Zeiss Meditec AG, Jena, Germany) >11.6 mm. Exclusion criteria were patients who did not provide informed consent, patients who did not understand the study procedure, history of corneal surgery, irregular cornea (ie, keratoconus), myopic eyes, and ocular abnormalities or diseases that could reduce visual function or postoperative IOL stability (eg, severe amblyopia or macular degeneration).

Intraocular Lens and the Surgical Procedure

All eyes were implanted with the AT TORBI 709M IOL, which is a monofocal, bitoric, aspheric (aberration neutral) lens. It comprises hydrophilic acrylic (25%) with hydrophobic surface properties. The optical diameter is 6.0 mm, and the total diameter is 11.00 mm. As it is plate-haptic, it shows a 0-degree haptic angulation. The lenses have a sphere diopter ranging from –10.00 to +32.00 D in 0.50 D increments, and a cylinder diopter ranging from +1.00 to +12.00 D in 0.50 D increments. Standard cataract surgery was performed using phacoemulsification.

Pre- and Postoperative Assessment

All patients included in the study underwent slit-lamp and fundoscopic examinations before surgery to assess their ocular health and measure the logMAR UDVA, corrected distance visual acuity (CDVA), manifest refraction (sphere, cylinder and axis), corneal topography, and ocular biometry using the IOLMaster 700 device. Barrett, Hoffer Q or Kane formulas were used to calculate the IOL power, and the target refraction was emmetropia.

Follow-up examinations were performed at one, six and 12 months post-surgery, and included a standard eye exam considering refraction (sphere, cylinder and axis), rotational stability measured using the slit lamp, monocular UDVA and CDVA, and log contrast sensitivity at 3, 6, 12 and 18 cycles per degree spatial frequencies. An astigmatism vector analysis was also performed using the double-angle tool.[30] Any complications during surgery or postoperative adverse events related to the IOL were also recorded up to the last follow-up visit.

Statistical Analysis and Sample Size

The results were analyzed using Excel (2019, version 16.43, Microsoft Corporation, Redmond, WA, USA). Quantitative data are presented as ranges, means, and standard deviations. In a previous prospective study, Zhu et al[16] considered a minimum sample of 24 eyes (90% power and a significance level of 5%) to detect a 4-degree inter-group difference in IOL rotation in a comparison of this lens with another in a group of myopic eyes at three months of follow-up. Taking into account possible dropouts, we therefore enrolled a large sample.

Results

This prospective clinical study evaluated the Results of 51 eyes in 31 patients implanted with the AT TORBI 709M IOL. The sample of patients considered in our series included 22 females (9 males) with a mean age of 75.28 ± 7.06 years, ranging from 56 to 87 years. Table 1 shows the patients' preoperative demographics, as well as refraction, biometric parameters, visual acuity, and IOL power. No intra- or postoperative IOL-related adverse events were reported either during surgery or up to the final follow-up visit at 12 months. Mean axial length, anterior chamber depth and WTW values were 22.90 ± 0.63 mm, 2.88 ± 0.48 mm and 11.97 ± 0.27 mm, respectively.

Visual Acuity Outcomes

Figures 1 and 2 show the monocular visual acuity results obtained post-surgery. Specifically, Figure 1 provides the cumulative proportion of eyes with a given CDVA value (20/x or better) at one, six and 12 months post-surgery, and Figure 2 shows the change in visual acuity lines between the 12-month postoperative UDVA and preoperative CDVA values. Figure 1 shows that 72.55% and 98.04% of eyes showed a cumulative Snellen visual acuity of 20/20 and 20/25 or better, respectively, at one month post-surgery. These values were 72.55% and 100% at six months and 68.63% and 94.12% at 12 months post-surgery, respectively. It is clear from Figure 2 that the difference between UDVA and CDVA was the same (23.52%) or better (37.25%) in all eyes analyzed in our sample. The mean logMAR UDVA was 0.05 ± 0.08 (range: –0.10 to 0.30), 0.05 ± 0.09 (range: –0.16 to 0.30) and 0.06 ± 0.11 (range: –0.14 to 0.50) at one, six and 12 months post-surgery, respectively. The corresponding CDVA values were 0.01 ± 0.05 (range: –0.10 to 0.15), –0.01 ± 0.06 (range: –0.16 to 0.10) and 0.00 ± 0.08 (range: –0.18 to 0.30), respectively.

Refractive, Rotational Stability and Contrast Sensitivity Outcomes

As regards the refractive outcomes, Figure 3 shows the distributions of postoperative spherical equivalent refraction (A) and refractive cylinder (B, astigmatism) for the three follow up visits. At one month, nearly half of all implanted eyes (45.10%) had a spherical equivalent of ±0.13D, while 33.33% fell in the range between +0.14 and +0.50D. At six months, similar values were found for these ranges (39.22% and 35.29%, respectively). Finally, at the last follow-up visit, 47.06% of eyes had a spherical equivalent in the range of +0.14 to +0.50D and 35.29% 0.13D. Looking at the accumulative results, 91.16% of eyes were within ±0.50D and all eyes were within ±1.00D at one month (88.24% and 98.04% at six months and 92.16% and 98.04% at 12 months, respectively). The mean spherical equivalent was 0.09 ±

Table 1 Preoperative Demographics of Participants Implanted with at TORBI 709M IOL Shown as Means, Standard Deviations (SD), and Ranges

Parameter	Values
Eyes (n)	51
Patients (n)	31
Sex (male/female)	9/22
Age (years)	75.28±7.06 (56 to 87)
SE (D)	1.40±1.10 (–0.75 to 3.50)
CDVA (logMAR)	0.19±0.12 (0.50 to 0.00)
K1 (D)	43.03±1.59 (40.39 to 46.98)
K2 (D)	44.59±1.54 (41.41 to 49.54)
Corneal astigmatism (D)	1.57±0.67 (1.02 to 3.98)
Axial length (mm)	22.90±0.63 (21.46 to 24.34)
Anterior chamber depth (mm)	2.88±0.48 (1.43 to 3.78)
White-to-white (mm)	11.97±0.27 (11.70 to 12.60)
IOL SE power (D)	22.68±1.18 (21.00 to 25.00)
IOL Cyl power (D)	1.90±0.87 (1.00 to 5.00)

Abbreviations: SE, spherical equivalent; CDVA, best-corrected distance visual acuity; K, keratometry; IOL, intraocular lens; Cyl, cylinder.

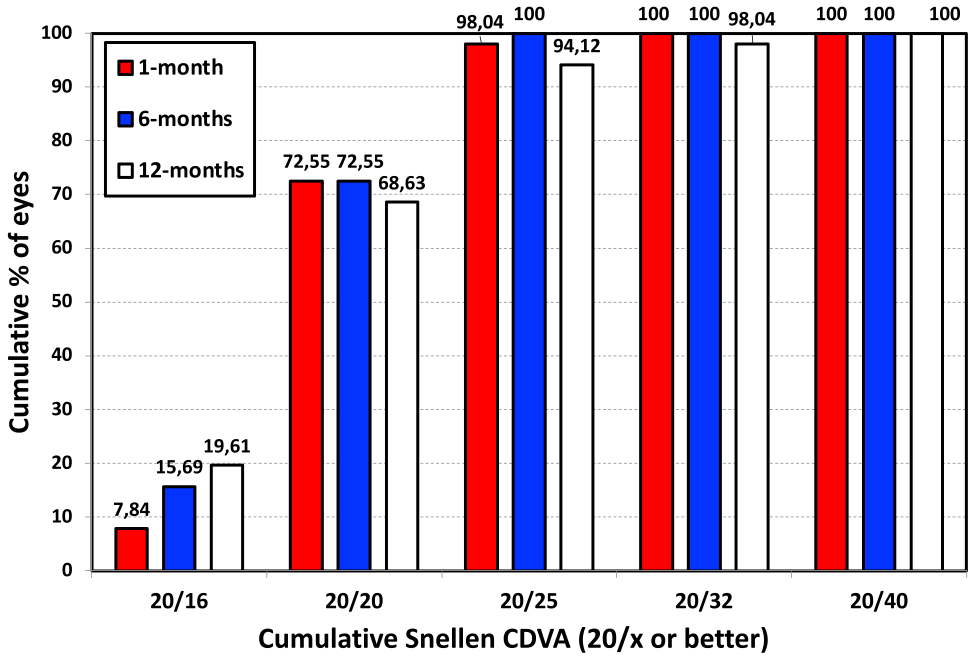

Figure 1 Cumulative proportion of eyes with a certain level of best-corrected distance visual acuity (CDVA) (20/x or better) at one, six and 12 months post-surgery.

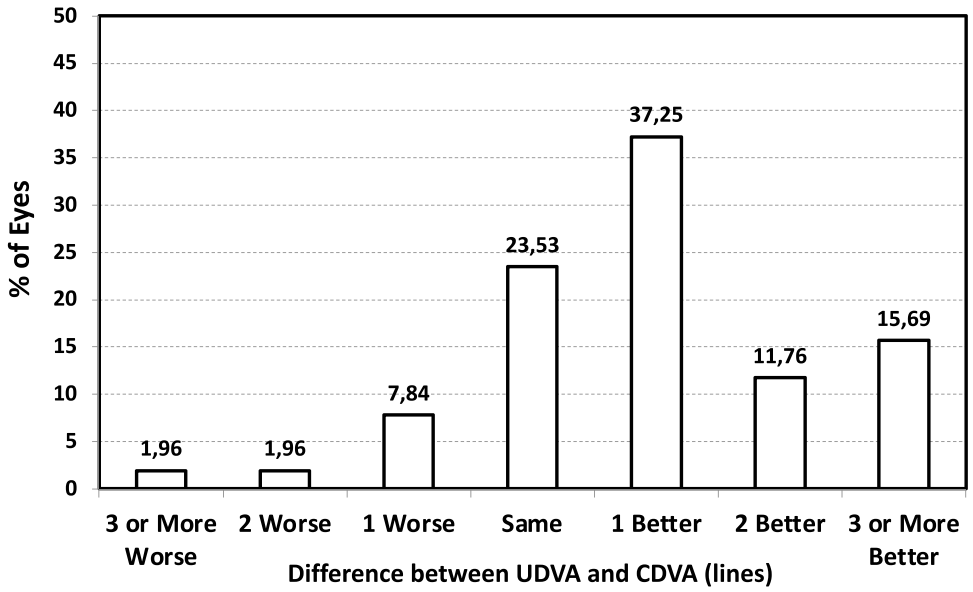

Figure 2 Change in visual acuity lines between the 12-month postoperative uncorrected distance visual acuity (UDVA) and [preoperative] best-corrected distance visual acuity (CDVA).

0.32D (range: –0.63 to 0.88D) at one-month, 0.21 ± 0.34D (range: –0.50 to 1.13D) at six months and 0.21 ± 0.31D (range: –0.38 to 1.13D) at 12 months. Figure 3 also presents the distribution of postoperative refractive cylinder. At one month, 80.39% of eyes had refractive astigmatism ≤0.50D and 98.04% were ≤1.00D. These percentages were 90.20% and 100% at six months, and 86.27% and 100% at 12 months. The mean postoperative refractive cylinder was –0.25 ± 0.35 D (range: –1.25 to 0.00D) at one month, 0.26 ± 0.27D (range: –1.25 to 0.00D) at six months and 0.34 ± 0.27 D (range: –0.75 to 0.00D) at 12 months. The double-angle plots of preoperative corneal astigmatism and postoperative refractive astigmatism at one, six and 12 months given in Figure 4 show a mean absolute preoperative corneal astigmatism of 1.57 ± 0.66D and a mean postoperative refractive astigmatism of 0.25 ± 0.34D at one month, 0.26 ±

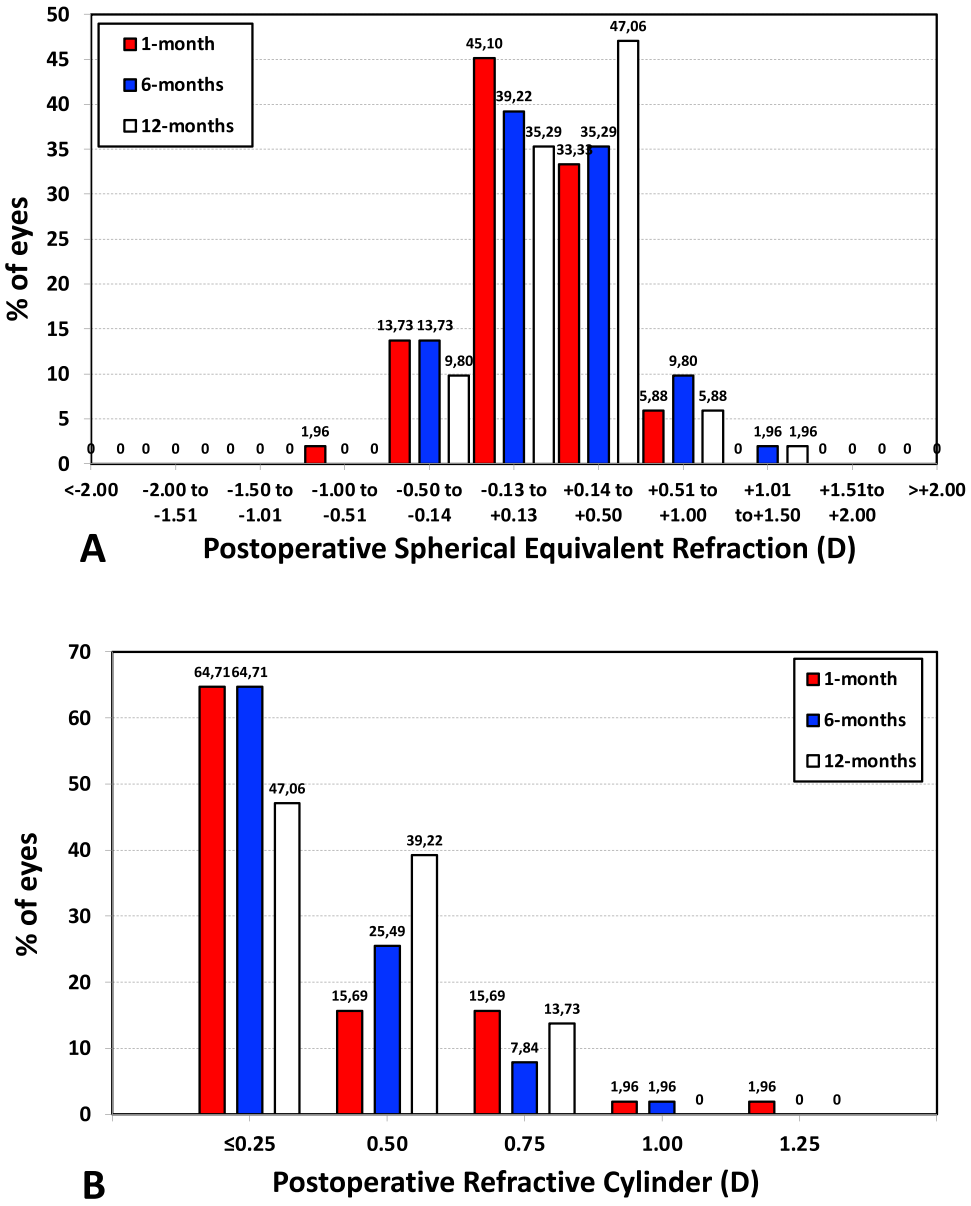

Figure 3 Distribution of postoperative spherical equivalent refraction ((**A**), in D) and refractive cylinder ((**B**), in D) at one, six and 12 months post-surgery.

0.27D at six months and 0.34 ± 0.27D at 12 months. The centroid was 0.10 ± 1.71D at 37 degrees preoperatively and 0.10 ± 0.42D at 12 degrees following cataract surgery at the last postoperative visit.

At one, six and 12 months, the lens had a mean rotational stability of 0.84 ± 1.21 degrees (range: 0 to 5 degrees), 0.82 ± 1.14 degrees (range: 0 to 5 degrees) and 1.18 ± 1.35 degrees (range: 0 to 5 degrees), respectively. Note that no significant rotation was reported in any of the eyes during follow-up, as all eyes had a rotation of ≤5 degrees.

Figure 5 shows the log contrast sensitivity determined for the spatial frequencies of 3, 6, 12, and 18 cycles per degree. The results revealed good contrast sensitivity for all spatial frequencies and were similar at all three postoperative visits.

Discussion

The correction of both spherical and cylindrical refractive errors in cataract patients using toric IOLs offers them the best visual quality and spectacle independence. The AT TORBI IOL is one of the most widely used monofocal toric lenses in cataract surgery procedures. Table 2 shows the main characteristics of different clinical studies reporting data for this lens. Our study is the only one to date to specifically analyze the performance of this lens in hyperopic eyes with axial

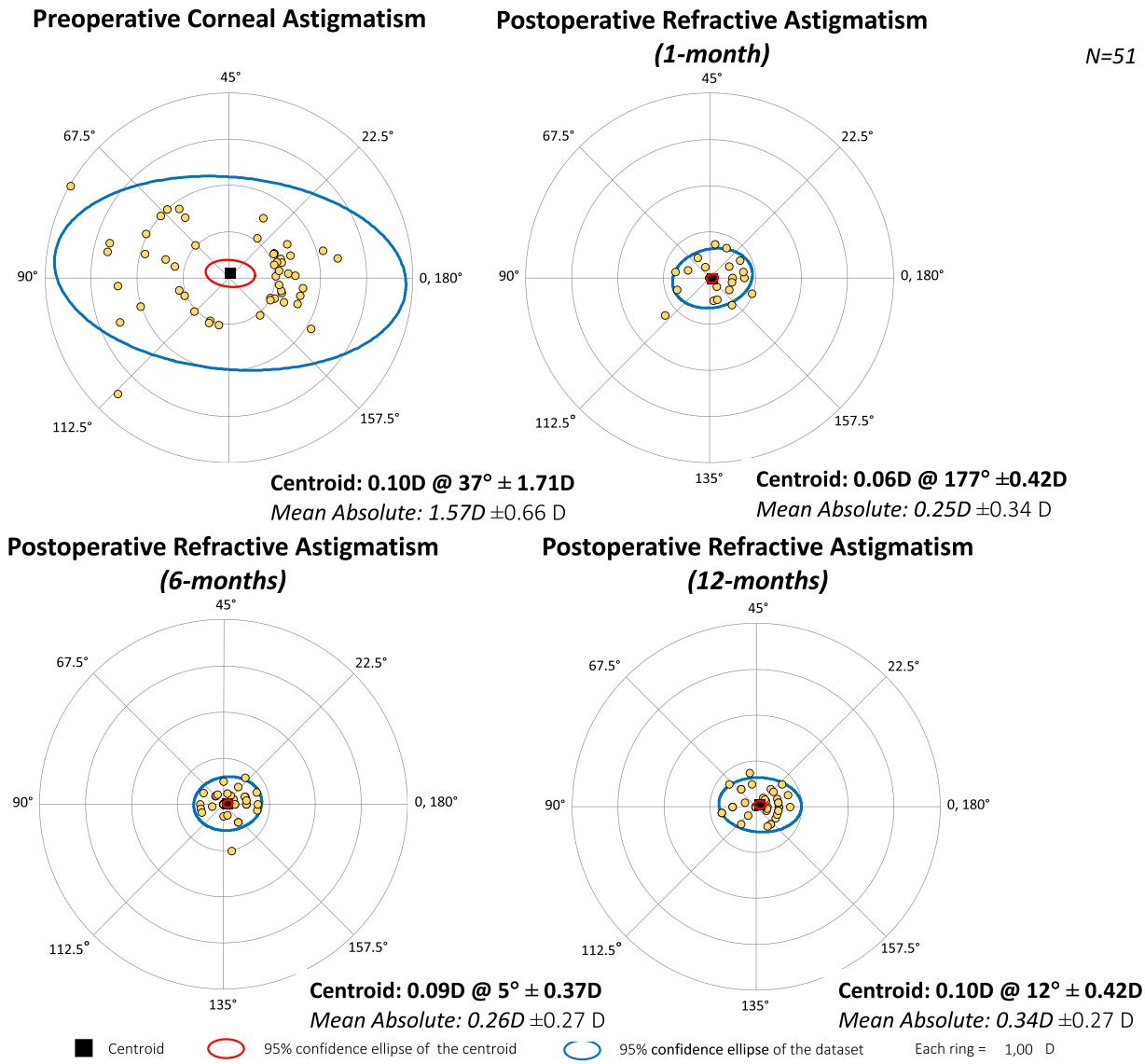

Figure 4 Double-angle plots of preoperative corneal astigmatism and postoperative refractive astigmatism at one, six and 12 months post-surgery. Centroids, mean absolute values with standard deviations, and 95% confidence ellipses of the centroid and dataset are also shown.

values of between 21 and 26 mm and a preoperative sphere of between 1.00 and 4.00D. Although it was not possible to compare our findings with similar studies considering only hyperopic eyes, it was nevertheless of interest to us to compare at least those previous prospective clinical studies that reported outcomes at the same follow-up, namely six and 12 months. In this regard, only three previous prospective studies were considered for comparison.[6,8,14]

Our results revealed good outcomes in terms of visual and refractive performance. Thus, at the last visit, 94.12% of eyes showed a cumulative Snellen visual acuity of 20/25 or better, with a mean logMAR CDVA of 0.00 ± 0.08 logMAR (see Figure 1). Moreover, 92.16% of eyes were within ±0.50D and 98.04% were within ±1.00D at 12 months (Figure 3A), with a mean spherical equivalent of less than a quarter of a diopter (0.21 ± 0.31D). For cylinder, 86.27% of eyes had refractive astigmatism within ≤0.50D and 100% were ≤1.00D (Figure 3B), with a mean value of 0.34 ± 0.27 D. Our mean rotational stability was 1.18 ± 1.35 degrees and all eyes had a rotation of ≤5 degrees. Bascaran et al[6] analyzed the stability of the lens in 48 eyes with six months of follow-up and found that UDVA was 20/40 or better in 88.1% of eyes and 20/25 or better in 61.9%, with CDVA being 20/40 or better in 100% of eyes and 20/25 or better in 90.2%. Our values were 100% in both cases (see Figure 1). These authors also reported that the mean refractive cylinder

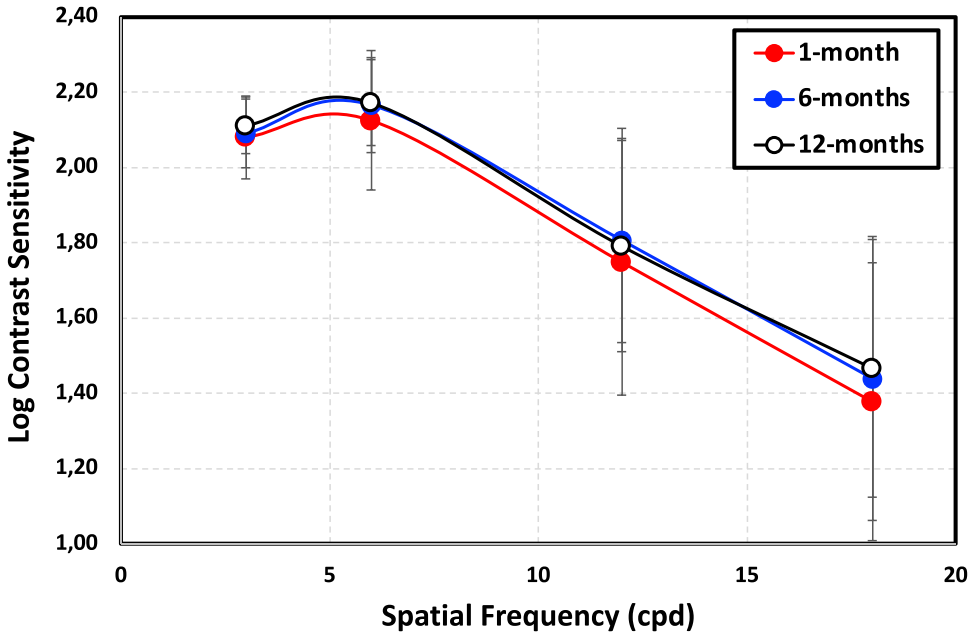

Figure 5 Log contrast sensitivity value as a function of spatial frequency (cycles per degree) at one, six and 12 months post- surgery.

decreased significantly from –2.23 ± 1.72D before to –0.43 ± 0.53D after surgery ($p < 0.05$) and the mean IOL axis rotation was 4.42 ± 4.31 degrees (ranging from 0 to 16 degrees), with 86% of lenses being rotated <10 degrees. Our mean refractive cylinder at this follow-up was less, namely 0.26 ± 0.27D, and our mean rotation was 0.82 ± 1.14 degrees with 100% of eyes with a rotation ≤5 degrees. Bascaran et al[6] concluded that this lens was predictable and effective with good rotational stability, although they implanted lenses with a higher cylindrical power than us (up to 6.50D) and eyes with axial lengths up to about 28 mm. The range of the preoperative sphere varied from –12.50 to 7.00D, with a mean value of 3.29 ± 2.58D. Specifically, as indicated in that publication, the longer the eye, the bigger the capsular bag,[31–33] the lower the friction and the greater the risk of rotation.[34] Consequently, their series presented a myopic tendency, with a mean IOL power of 18.81 ± 3.77D (range: 4.50 to 25.00D), which could account for part of the reported rotation. On the other hand, if the IOL is too big in relation to the capsular bag, then stretching and distortion of the capsular bag,[35] and decentration of the IOL, occurs.

Mencucci et al[8] analyzed the outcomes of this lens postoperatively up to 6 months in a small sample of 20 eyes. These authors included eyes with a higher axial length, since this study was done specifically in myopic eyes, and aimed to assess the refractive results and, specifically, the rotational stability and its correlation with refractive sphere, axial length and WTW diameter. They found mean UDVA and CDVA values of 0.09 ± 0.04 logMAR (range: 0.02 to 0.15 logMAR) and 0.04 ± 0.03 logMAR (range: 0.00 to 0.07 logMAR), respectively. Our mean values were slightly better: 0.05 ± 0.09 logMAR (range: –0.16 to 0.30) and 0.01 ± 0.06 logMAR (range: –0.16 to 0.10), respectively. Moreover, the mean sphere and cylinder found by these authors were –0.43 ± 0.22D (range: –0.75 to 0.00D) and –0.53 ± 0.32D (range: –1.25 to 0.00D), respectively. Again, our mean values were better (about 0.25D). As regards stability, Mencucci et al found a mean IOL rotation of 3.00 ± 1.69 degrees, with 90% of eyes within ±5 degrees. Similarly, 100% of eyes with a rotation ≤5 degrees. As noted by these authors, myopic eyes tend to have a larger capsular bag than emmetropic eyes,[32] thus resulting in a greater risk of early IOL rotation. However, there is some controversy[8] regarding the possible relationship between axial length and IOL rotation and, indeed, these authors found no correlation between the IOL rotation and axial length ($p > 0.2$) or WTW diameter ($p > 0.19$). The main limitation of their study was the small range of axial lengths included (25 to 27 mm), although they also supported the effectiveness and safety of the lens during this period.

Miháltz et al[14] was the only study with the same follow-up as us (12 months) and with a similar axial length (21.13 to 26.82 mm) and corneal astigmatism range (from 1.00 to 3.96D). These authors analyzed 59 eyes and found a mean

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Table 2 Studies Reporting Data for the AT TORBI Intraocular Lens. Author (Type of Study), Year of Publication, Sample, Maximum Follow-Up, Age, Preoperative Spherical Equivalent, Corneal Astigmatism, Sphere and Cylinder Intraocular Lens Powers and Axial Length. Mean, Standard Deviation and Range

Author (Type of Study)	Year	Eyes	Follow-Up (Months)	Age (Years)	Spherical Equivalent (D)	Corneal Astigmatism (D)	Spherical IOL Power (D)	Cylinder IOL Power (D)	Axial Length (mm)
Ale et al[5] (Retrospective)	2012	36	NR	79.3±5.5 (69 to 90)	NR	3.11 ± 1.62 (1 to 4.75)	NR	NR	NR
Bascaran et al[6] (Prospective)	2013	48	6	71.70±8.45 (40 to 82)	3.29±2.58* (7 to −12.50)	2.35±0.95 (NR)	18.81±3.77 (4 to 25)	2.81±1.26 (1 to 6.50)	23.40±1.21 (21.36 to 27.98)
Scialdone et al[7] (Prospective)	2013	36	3	69.9±8.8 (48 to 83)	NR	2.6±1.3 (1 to 5.4)	18.5±3.6 (9.5 to 24.3)	NR	23.5±1.0 (21.5 to 25.3)
Mencucci et al[8] (Prospective)	2014	20	6	66.45±5.65 (60 to 76)	−7.10±1.78 (NR)	−2.35±0.59** (−1.50 to −3.50)	11.88±2.22 (8.50 to 16)	2.65±0.83 (1.50 to 5)	26.11±0.68 (25.03 to 27.00)
Krall et al[9] (Prospective)	2015	88	3	64.1±19 (38 to 84)	−2.09±4.95 (5.88 to −16.50)	−2.19±1.39** (0 to −7)	17.37±5.38 (3.5 to 28)	2.93±1.41 (1 to 9.5)	23.99±1.82 (20.83 to 29.60)
Kretz et al[10] (Retrospective)	2015	41	3	63±NR (50 to 75)	−2.40±NR (6.12 to −14)	−1.70±NR** (−0.25 to −7.00)	NR	NR	NR
Mayer et al[11] (Prospective) *(2 corneal marking Methods)*	2017	57	3	66.5±NR (45 to 85)	−0.50±1.20 (NR) -0.70±1.60 (NR)	−2.20±0.65** (NR) -2.40±0.78** (NR)	NR	NR	23.13±1.67 (NR) 22.98±1.88 (NR)
Kern et al[12] (Prospective) *(2 calculation methods)*	2018	64	NR	66.0±16.7 (37 to 92)	−1.90±5.15 (8.60 to −16)	−2.32±1.39** (−0.25 to −6)	NR	NR	24.31±2.09 (20.84 to 30.94)
Seth et al[13] (Prospective)	2018	21	3	57.9±10.9 (NR)	NR	1.87±1.01 (1.07 to 4.91)	20.12 ±2.83*** (NR)	NR	23.08±1.25 (NR)
Miháltz et al[14] (Prospective)	2018	59	12	66.83±11.54 (NR)	−0.71±3.51 (5.87 to −12.25)	2.06±0.64 (1 to 3.96)	19.84±3.66 (11.5 to 28)	2.41±0.88 (1 to 5)	23.29±1.19 (21.13 to 26.82)
Kim et al[15] (Prospective)	2019	19	3	71.16±8.52 (54 to 87)	0.47±1.94 (3.50 to −3.88)	1.78±0.81 (0.75 to 3.75)	19.16±1.49 (16 to 22.50)	2.37±0.96 (1.50 to 5.50)	23.42±0.62 (21.83 to 24.18)

Zhu et al[16] (Prospective)	2020	31	3	61.90±10.90 (NR)	NR	2.12±0.79 (NR)	NR	NR	27.86±2.48 (NR)
Lesieur[17] (Retrospective)	2020	393	1	76.1±8.6 (46 to 95)	NR	1.24±0.77 (0.50 to 6.38)	19.78±3.56 (1.50 to 30.00)	1.60±0.83 (1.0 to 5.50)	23.64±1.28 (20.66 to 31.60)
Levron et al[18] (Retrospective) *(2 groups: anterior keratometry and total keratometry)*	2021	158 79	1	74.98±9.09 (NR) 74.39±8.58 (NR)	NR	1.56±0.59 (NR) 1.56±0.63 (NR)	18.48±4.47 (NR) 17.82±3.93 (NR)	1.78±0.74 (NR) 1.96±0.83 (NR)	23.83±1.46 (NR) 23.92±1.45 (NR)
Yao et al[19] (Retrospective)	2021	102	1	63.1±13.0 (26 to 86)	NR	2.08±0.77 (1.08 to 4.07)	NR	NR	26.43±2.65 (21.71 to 34.60)
Ma et al[20] (Prospective) *(CTR and NCTR)*	2023	185 177	3	68.67±10.65 (NR) 64.71±10.72 (NR)	NR	1.83±0.75 1.88±0.74	NR	NR	24.86±2.29 (NR) 26.36±2.66 (NR)
Ma et al[21] (Prospective)	2023	328	3	65.49±12.71 (16 to 89)	NR	1.80±0.75 (NR)	NR	NR	25.29±2.45 (21.26 to 33.08)
Sun et al[22] (Prospective)	2023	39	3	66.69±7.98 (46 to 80)	NR	2.04±0.80 (NR)	18.52±3.17 (NR)	2.75±1.03 (NR))	23.68±0.91 (NR)
Current (Prospective)	2024	51	12	75.28±7.06 (56 to 87)	1.40±1.10 –0.75 to 3.50	1.57±0.67 1.02 to 3.98	22.68 ±1.18*** (21.00 to 25.00)	1.90±0.87 (1.00 to 5.00)	22.90±0.63(21.46 to 24.34)

Notes: *Sphere; **cylinder; ***Spherical equivalent IOL power.
Abbreviations: IOL, intraocular lens; NR, not reported; CRT, capsular tension ring; NCTR, without capsular tension ring.

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UDVA of 0.03 ± 0.13 logMAR and a mean CDVA of –0.04 ± 0.09 logMAR. Our mean values were 0.06 ± 0.11 and 0.00 ± 0.08 logMAR, respectively. The UDVA and CDVA were 0.1 logMAR or better in 88% and 98% of eyes, respectively, and we found that 94.12% of eyes had a cumulative CDVA of 0.1 logMAR or better (20/25 or better, see Figure 1). Miháltz et al reported a mean spherical error of –0.51 ± 0.58D (range from –1.50 to 1.00D), and 58% of the eyes in their study obtained a postoperative spherical equivalent within ±0.50D. Our mean spherical equivalent was 0.21 ± 0.31D, with 92.16% of eyes within ±0.50D. The mean axial rotation at one year was 3.0 ± 2.26 degrees, and in our case, it was 1.18 ± 1.35 degrees. The mean spherical IOL power in the former study was 19.84 ± 3.66D (ranging from 11.50 to 28.00D) and the cylindrical IOL power was 2.41 ± 0.88D (ranging from 1.0 to 5.0D), which differ from our mean values (see Table 1). These authors concluded that emmetropia could be achieved with this lens given its high degree of rotational and centration stability. Specifically, for the rotational stability, we would like to point out that 1 degree of misalignment of the toric IOL corresponds to a 3.3% loss in its cylinder.[36] In our case, we have found that the IOL lost, on average, 3.89% of its power due to a mean rotation of 1.18 degrees after 12 months. Consequently, the mean rotation we obtained in our series was negligible and clinically insignificant. This result confirms that the rotational stability of the IOL was excellent in the hyperopic eyes included in our analysis. This also correlates with the correction of astigmatism given the concentration of the dots in Figure 4 postoperatively around the center of the graph (0,0), which represents an eye free of astigmatism. Based on the American National Standards Institute[37] scale, the stability of the IOL was defined as the axial excursion thereof at three months postoperatively, with a rotation angle change of ≤5 degrees in at least 90% of eyes at consecutive follow-up visits at least three months apart. Sun et al[22] also analyzed this lens in 39 eyes for three months post-implantation and indicate that the IOL design is the main factor affecting its stability. The lens column of plate-haptic toric IOLs has a double-sided design, and there is no gap between the lens haptics. The plate-haptic toric IOL is fixed by the capsular bag via the four haptics of the IOL, which increases the friction area between the lens and the capsular bag, thereby reducing the effects of capsular bag compression and rotation. These authors also indicated that there are two position holes at the corner of the lens and the lens epithelial cells migrate through them, thus improving its stability. They compared this plate haptic lens with a C-loop haptic lens and found that the longer the axial length and the larger the WTW, the greater the likelihood that the C-loop haptic toric IOL becomes unstable, while the plate-haptic toric IOL is relatively stable Our results also revealed good contrast sensitivity outcomes during the follow-up of the study (from 1 to 12 months).

There were some limitations in our study. Thus, although the sample size seemed sufficient, it is nevertheless limited; therefore, a larger sample of eyes is desirable in order to confirm our results in eyes with different degrees of hyperopia and astigmatism. In addition, our analysis only considers this model of lens, therefore the performance of other lenses, with a different haptic design or material, in this type of patient may be different. As such, future studies should also include more lenses available on the market.

Conclusions

Our results show that, when implanted in hyperopic and astigmatic eyes with cataracts, the AT TORBI 709M IOL offers excellent visual performance in terms of visual acuity and contrast sensitivity, with good refractive outcomes and excellent rotational stability. In conclusion, the use of this lens in this type of eye can be considered an excellent choice.

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