Microincisions in cataract surgery

Reductions in incision size lower than 1.8 mm may not be beneficial

By Prof. İzzet Can, MD

Spanning 45 years, the history of the phacoemulsification surgery might well be briefly depicted as the 'gradual decrease of incisions'. However, when we hear the term 'small incision' what mostly comes to mind as a benefit is merely, the reduction of surgical-induced astigmatism (SIA). Although, at the same time small incision means shortened wound closing and visual recovery time, less peroperative (e.g., expulsive haemorrhage) and postoperative complications (e.g., wound closure problems, anterior chamber inflammations and risk of endophthalmitis).[1–3] In addition, small incision serves to preserve prolate shape and biomechanics of the cornea, which are key factors in achieving postoperative quality of vision.[4] As a result of cataract surgery advances (i.e., leaving the cornea in a nearly neutral state both astigmatically and aberrationally) the use of premium intraocular lenses (IOLs) for the correction of presbyopia, astigmatism and spherical aberration has been made feasible. Therefore, in the future, customized IOLs should definitely only be used with cornea-preserving surgical techniques.

Today four fundamental controversies continue in the area of microincisional cataract surgery. 1) Which technique is more efficient, functional and safer: biaxial or microcoaxial? 2) How safe are clear corneal incisions (CCIs) with the gradually decreasing sizes? 3) Are microincision IOLs as successful as conventional intracapsular IOLs? 4) To what end it is meaningful for the incisions getting smaller and smaller? To find the answers to these questions we performed a series of prospective studies over the course of the last five years.

Biaxial or micro-coaxial?

Quickly glancing at the current literature, one might realize that the cataract authors are mostly appertains to either the biaxial or the coaxial camp. Each of which have published numerous papers in favour or against one of these techniques. Our first study,[5] examining the techniques in scope of clinical efficacy and safety, was the first in the literature to compare the three methods concurrently: standard coaxial, microcoaxial and biaxial completed with 2.8, 2.2 and 1.8 mm incisions respectively.

Biaxial technique was found to be significantly better in peroperative measures such as effective phaco time and delivered phaco power, whereas IOL implantation through 1.8 mm biaxial incisions was detected to be more time-consuming. While more central corneal thickness increases were measured in the microcoaxial group on the postoperative 1st day, shorter visual recovery times were established in the biaxial group (Figure 1). It was obvious that the findings in favour of the biaxial technique were associated with dynamics of anterior chamber fluid, and that irrigation performed in this technique has a role by shifting into an attractive force from the repulsive one with respect to the attractive-repulsive force balance. Nevertheless, it should be also emphasized that if a torsional technology had been used in the study instead of longitudinal technology used in coaxial and micro-coaxial phaco groups, a better anterior chamber fluid dynamics might have been obtained owing to decreased repulsive forces and increased attractive forces, as well as probably better clinical outcomes in coaxial techniques associated with decreased turbulence. However, SIA values in this study were found to be 0.45, 0.24 and 0.13 D, respectively, which showed the strong correlation with incision sizes and proved that the smaller the incision, the better the result.

In short...

When biaxial and micro-coaxial techniques were compared, though biaxial technique appeared to be clinically superior, these finding might have seemed to change if microcoaxial technique had been performed with torsional or elliptical technology. Comparative assessment of safety of incision site and healing processes demonstrated superiority of microcoaxial technique to some extent. In spite of having an overall diameter of 10.5–11.0 mm, microincisional IOLs provide comparable efficacy, functionality and safety to conventional IOLs, thanks to their creative designs. Moreover, they also offer premium lens characteristics. Current data on the extent of diminution of incision size showed that an incision size of 1.80 mm appeared to be the magical number as it absolutely elicits neutral results in scope corneal aberrations.

Are small incisions safe?

Shortly after Fine's description[6] and introduction in 1992, sutureless self-sealing CCIs had rapidly become very popular and the most commonly used type.[7] Despite there being many published favourable studies, this type of incision always remained to be a focus of concern, especially as a risk factor of endophthalmitis.[8] Debates and doubts were boosted further by the facts that the sizes of surgical instruments used with these smaller incisions haven't kept up with the decreasing sizes of CCIs proportionally, they have well-known unfavourable mechanic and thermal effects inside the incisions and, furthermore, there is a sleeveless phaco tip (preferred in biaxial technique). Authors belonging to the coaxial camp published a number of *in vitro* studies suggesting lack of safety for biaxial incisions.[9–13] But the introduction of anterior segment-ocular coherence tomography (AS-OCT) has started an important era for *in vivo* evaluation of wound sites, especially over the last five years.[14–19] Early publications were mostly static evaluations over incision architecture with time-domain OCT technology.

In our 2011 study,[20] where we used Fourier domain OCT, that is faster and has higher resolution, we aimed at putting forward not only incision architectures, but also dynamic changes by time, the effects of incision enlargement and the probable reasons for complicated incision closure cases, in which we performed either biaxial (1.2–1.4 mm) or micro-coaxial (1.6–1.8 mm) techniques.

Even though there were no statistical differences, micro-coaxial incisions were found to be longer, more slanted and had more arcuate configuration, meaning they demonstrate a safer early recovery model and also the incision site was found to be thinner when compared with the biaxial group (Figure 2). It was observed over time that all of the incision's lengths became smaller, incisions' angles lessened and became flatter and mostly turned into a linear model from a rather arcuate model (Figure 3). It was demonstrated that stromal hydration performed at the end of the surgery decreased endothelial gap rates and increased Descement's membrane detachment, and postoperatively a reduced intraocular pressure was well correlated with the emergence of incision site problems.

Are microincisional IOLs safe?

Microincisional IOL (MICS IOL) means an IOL that can be inserted through <2.0 mm incisions. Because lenses may undergo permanent structural and optical alterations while being inserted through such small incisions, they are manufactured with a size of 10.5–11.0 mm instead of 12.0–12.5 mm like standard intracapsular lenses. Yet, it is not uncommon to speculate that this may lead to unfavourable conditions such as intracapsular destabilization, decentralization and tilting of the lens due to the relatively small

Figure 2: Incision configurations on the first postoperative day. (a) Arcuate incision configuration in a microcoaxial case. (b) Linearincision configuration in a biaxial case. (From: *I Can et al., J. Cataract Refract. Surg., 2011;**37**:490–500.*)

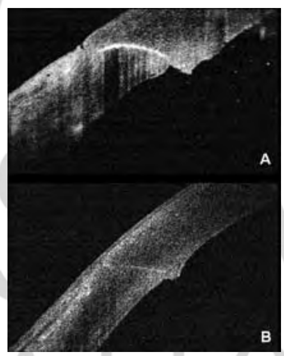


Figure 1: Visual recovery time; that is, time to best visual acuity postoperatively. (From: *I Can et al., J. Cataract Refract. Surg., 2010;**36**(5):740–746.*)

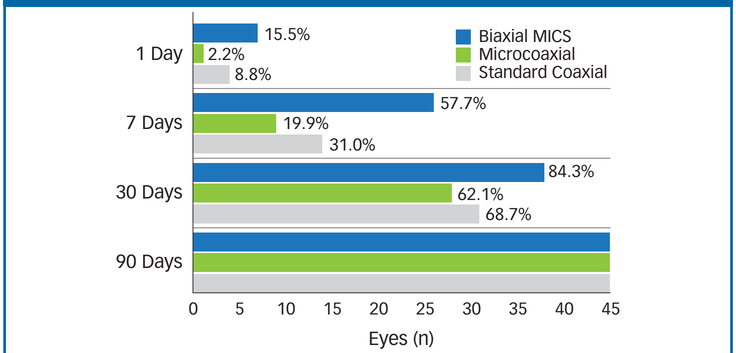
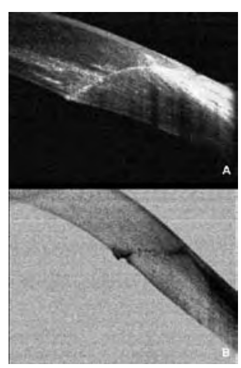


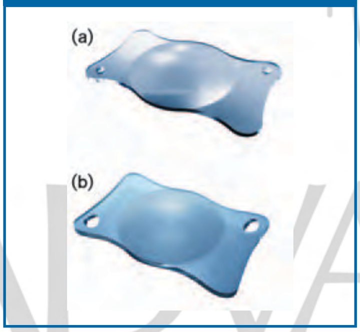
Figure 3: Alteration in incision configuration in the late postoperative period on AS-OCT. (a) Arcuate configuration in a biaxial case on the first postoperative day. (b) Linear configuration in the same case 30 days postoperatively. (From: *I Can et al., J. Cataract Refract. Surg., 2011;**37**:490–500.*)



IOL sizes according to the lens capsule. Furthermore, another potential problem that comes to mind is the inreased risk of posterior capsule opacification as a result of these lenses. Because of these reasons MICS IOLs also remained to be an issue of debate, which was investigated by us with two different studies.

In our first study,[21] we implanted Akreos MI-60 (Bausch + Lomb, Rochester, New York, USA) lenses, a monofocal, hydrophilic, aspheric lens with an innovative design of 4 haptics, in 100 eyes through, on average, 1.82 mm incisions. This MICS IOL gave perfectly good results by means of vision acuity and quality and also centralization.

Figure 4: (a) Acri.Lisa 366 D IOL, (b) Acriva Reviol MFM 611 IOL (From: *I Can et al., J. Cataract Refract. Surg., 2012;**38**:60–67.*)



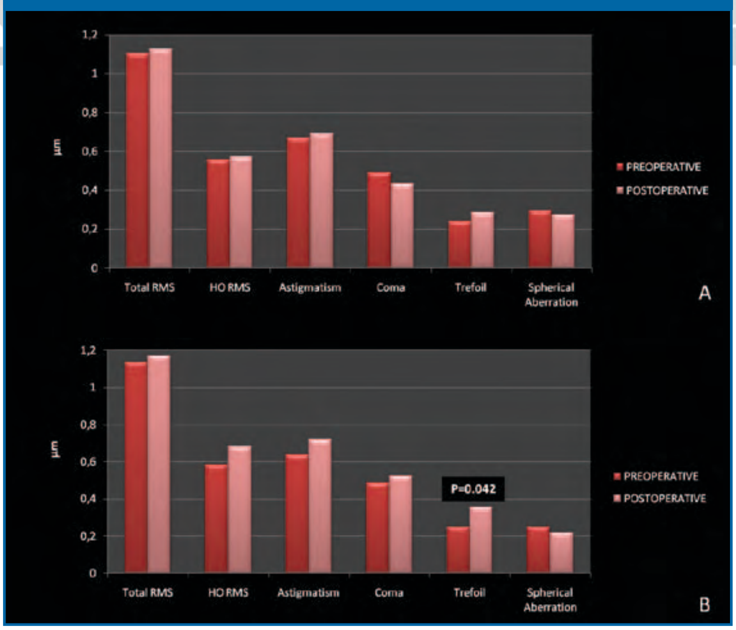
In our second study,[22] we examined two different but similarly designed multifocal MICS IOLs (Figure 4). We found that both Acri-Lisa 366 D (Carl Zeiss Meditec AG, Berlin, Germany) and Acriva Reviol MFM 611 (VSY Biotechnologies, Istanbul, Turkey) lenses provide 100% spectacle independence for near and far, and also for intermediate distance with the Acriva Reviol lenses as well. Both studies have shown us that the disadvantages previously seen with smaller lens size was overcome by the 4 point supported innovative design of these lenses, revealing why all IOLs remained perfectly centralized.

How small is meaningful?

If the problem had only been just SIA, based on the literature data indicating 2.2 mm and below incisions leads approximately 0.25 D. of SIA,[5,21,23] we might have answered the question that 2.2 mm was the meaningful minimum limit for astigmatically neutral incisions. It may even have been asserted that incisions might be kept wider because steep on-K corneal incisions would show some benefits in the scope of some degree of SIA neutralization. However, if the aim is to perform surgeries without altering corneal shape to benefit from small incisions such as using customized IOLs in the future, which will fix individual's aberrations one-to-one, other higher order aberrations (HOA), besides of astigmatisms, should also be considered.

A literature search revealed that the effects of cataract incisions on HOAs have been studied from early 2000 so far, yet the data about very small incisions were very limited. Our related study upon this subject was recently published[24] where we comparatively examined an equal number of cases operated with either biaxial or micro-coaxial techniques, performed with the average incisions sizes of 1.80 and 1.89 mm respectively.

Figure 5: Preoperative and postoperative RMS values of corneal aberrations. (a) Biaxial microincision cataract surgery group, (b) microcoaxial cataract surgery group. (From: *I Can et al., Curr. Eye Res., 2012;**37**(1):18–24.*)



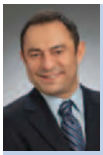
All corneal aberrations in Zernike polynomial were calculated, the difference between postoperative and preoperative aberrations was studied for each Zernike term and vectorial magnitudes were computed disclosing the surgical alteration and both magnitude and orientation of induced aberration and its association to the incision site was examined in non-rotational symmetrical aberrations (astigmatism, coma and trefoil).

In-group comparisons of techniques showed no difference between preoperative or postoperative phases in biaxial technique possessing a mean 1.80 mm incision, whereas micro-coaxial group with mean 1.89 mm incisions demonstrated a significant postoperative increase in vertical trefoil and vertical coma. When these two techniques were compared for surgery-induced aberrative changes, primary trefoil in microcoaxial group was found to be statistically higher (Figure 5). Another significant finding is that SI Trefoil in microcoaxial group was overtly and significantly compatible with incision axes.

All in all, based on these facts, if not being too assertive we could say that, to operate without eliciting corneal aberrations, the ideal incision width is somewhere between 1.80–1.89 mm and that ≤1.8 mm incisions are most probably completely aberration-free. Surgical intervention ensuing further reduction in size of incisions seems to have no purpose, particularly if it creates additional risks.

References

1. İ Can and B. Bostancı Ceran, *Ophthalmology International*, 2011;**6**:74–79.
2. J. Alió, J.L. Rodriguez-Prats and A. Galal, *Curr. Opin. Ophthalmol.*, 2006;**17**:80–93.
3. J.M. Osher and R.H. Osher. The Transition towards smaller and smaller incisions. In: Minimizing incisions and maximizing outcomes in cataract surgery. Alio JL and Fine IH (eds) Berlin, Springer, 2010; Chap 1: 5–11.
4. B. Elkady *et al.*, *J. Cataract Refract. Surg.*, 2008;**34**:40–45.
5. İ Can *et al.*, *J. Cataract Refract. Surg.*, 2010;**36**(5):740–746.
6. I.H. Fine, *Ocular Surgery News*, 1992;**10**:38–39.
7. D.V. Leamin, *J. Cataract Refract. Surg.*, 2002;**28**:1681–1688.
8. T. Wallin *et al.*, *J. Cataract Refract. Surg.*, 2005;**31**:735–741.
9. J.P. Berdahl and J.J. DeStafano, *J. Refract. Cataract Surg.*, 2007;**33**:510–515.
10. D. Gajjar *et al.*, *J. Cataract Refract. Surg.*, 2007;**33**:2129–2134.
11. S.R.K. Johar *et al.*, *J. Cataract Refract. Surg.*, 2008;**34**:670–676.
12. M.R. Praveen *et al.*, *J. Cataract Refract. Surg.*, 2008;**34**:1007–1012.
13. L.F. Torres *et al.*, *J. Cataract Refract. Surg.*, 2006;**32**:1820–1826.
14. I.H. Fine *et al.*, *J. Cataract Refract. Surg.*, 2007;**33**:94–97.
15. J.M. Schallhorn *et al.*, *J. Cataract Refract. Surg.*, 2008;**34**:1561–1565.
16. S. Dupont-Monod *et al.*, *J. Cataract Refract. Surg.*, 2009;**35**:444–450.
17. B. Elkady *et al.*, *J. Cataract Refract. Surg.*, 2009;**35**:466–474.
18. Y. Xia *et al.*, *Acta Ophthalmol.*, 2009;**87**:764–768.
19. A. Behrens *et al.*, *J. Refract. Surg.*, 2008;**24**:46–49.
20. İ Can *et al.*, *J. Cataract Refract. Surg.*, 2011;**37**:490–500.
21. İ Can *et al.*, *J. Cataract Refract. Surg.*, 2010;**36**(11):1905–1911.
22. İ Can *et al.*, *J. Cataract Refract. Surg.*, 2012;**38**:60–67.
23. S. Masket, *Ophthalmol. Times*, 2006;**31**:41–42.
24. İ Can *et al.*, *Curr. Eye Res.*, 2012;**37**(1):18–24.



Author
Professor İzzet Can, MD, is the director of the Ophthalmology Department, Bozok University Medicine Faculty, Yozgat, Turkey. He may be reached by E-mail: izzetcan@yahoo.com
Prof. Can has no financial or proprietary interest in any material or method mentioned.