INTRAOCULAR LENSES

Single versus three piece acrylic IOLs

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Which haptic design is better?

Since their clinical introduction 10 years ago, hydrophobic acrylic IOLs have gone on to become the most popular foldable IOL category worldwide. According to the annual Leaming surveys of the American Society of Cataract and Refractive Surgery membership, hydrophobic acrylic has been the most preferred IOL material since 1998, and was favoured by 63% of respondents in the 2002 poll.[1] This sustained popularity undoubtedly results from the excellent track record enjoyed by the first hydrophobic acrylic model—the three piece Alcon AcrySof—in terms of safety, biocompatibility, and capsular opacification.[2–6]

While some initially thought that the universally observed reduction in posterior capsule opacification (PCO) with this lens was mainly because of the acrylic material,[7 8] subsequent studies have shown that it is the truncated edge of the IOL that is the primary factor.[9–14] The sharp posterior edge is able to indent the posterior capsule, forming a mechanical barrier to posterior lens epithelial cell (LEC) migration.[9] Nishi *et al* demonstrated in rabbit experiments that if the edge of the AcrySof IOL was rounded the PCO advantage was lost.[10] Furthermore, they demonstrated that any IOL with a squared edge, regardless of material, was able to inhibit LEC migration in rabbits by forming this ''capsular bend.''[11] Abela Formanek *et al* and Auffarth *et al* subsequently confirmed this finding in prospective clinical trials.[12 13] Finally, Buehl and co-authors conducted a prospective trial of 53 patients who each received AMO Sensar hydrophobic acrylic IOLs with or without a square edge in alternate eyes.[14] The eyes receiving the truncated edge model developed less PCO at 1 year. Since the patient variables and the IOLs were otherwise identical, the barrier effect of the IOL edge was clearly more important than the acrylic material in preventing PCO.

The potential optical tradeoffs of a squared IOL edge have also been well documented. Ray tracing studies have shown that the symptoms of arcuate light flashes at night are the result of edge reflections from peripheral sources of light.[15–18] In addition, the high refractive index of the material led to the original AcrySof IOLs having a flattened anterior curvature. This could result in both external and internal reflections and dysphotopsias.[19]

In 2000, Alcon introduced a significantly different design—the single piece AcrySof. Having moulded and floppier haptics permits this IOL to be more easily injected through a small incision. Reduced wound size is particularly important for clear corneal cataract incisions. While the square edge design was maintained, modifications to reduce the aforementioned dysphotopsias were incorporated. The single piece models featured a frosted edge and a steeper anterior curvature—changes that have since been made to the three piece AcrySof models as well. In the brief ensuing period, the single piece AcrySof has become the most popular foldable IOL in the United States, where it accounts for 80% of total AcrySof sales. In Europe, 50% of Alcon's AcrySof sales are the one piece models.

In this issue of the *BJO* (p 000), Nejima and co-authors address an important and practical clinical question—namely, is the one piece AcrySof equal to the three piece model in terms of centration, tilt, and opacification of the anterior or posterior capsule? Theoretically, these are the parameters that would most likely be affected by changing the haptic design.

Given the enormous popularity and rapid adoption of the single piece AcrySof model, there is surprisingly little in the ophthalmic literature that addresses these questions.

Two rabbit studies of single piece acrylic IOLs from David Apple's group indicated that the truncated edge provided an excellent PCO barrier in spite of the one piece design and the elimination of any haptic angulation.[20 21] This is pertinent because there is no posterior edge present where each thick haptic emerges from the optic. However, Nishi's rabbit studies of the single piece AcrySof raised concerns that PCO will be more likely with this design.[22]

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Recent clinical studies have shown that shrink wrapping of the capsular bag around the IOL optic is an important mechanism or prerequisite for creating the LEC blocking capsular bend.[23 24] Naturally, a truncated edge accentuates this capsular indentation. However, even without a sharp IOL edge (for example, AMO SI-40), enough of a capsular bend can form because of this tight ''shrink wrap'' effect. Furthermore, the anterior and posterior capsules first make contact peripherally. This adhesion then progresses centripetally towards the optic, which becomes hermetically sealed.[23] Nishi and Nishi postulate that the bulky size of the single piece haptic may prevent peripheral contact between the anterior and posterior capsule from developing in some cases. Histopathologically, this was observed in rabbit eyes where abundant PCO developed.[22]

In the first clinical comparison of the two AcrySof designs, Wallin and co-authors published a retrospective study of 75 patients.[25] Approximately half had received the single piece AcrySof, and half the original three piece AcrySof. Visual acuity, refractive stability, and centration were similar in the two groups. However, the single piece IOLs were associated with more PCO, less anterior capsule opacification (ACO), and fewer dysphotopsias. YAG capsulotomy was more frequent in the single piece IOL group, but the incidence did not reach statistical significance in this small study. This is the only comparative study so far to evaluate and confirm that the newer design modifications succeed in reducing dysphotopsias.

Da Reitz Pereira and co-authors also reported on a comparison of the two AcrySof IOL designs at the most recent annual meeting of the American Academy of Ophthalmology.[26] Theirs was a retrospective study of 418 eyes, of which 230 received the single piece AcrySof, and 188 received the three piece AcrySof. They found a statistically higher number of patients requiring YAG anterior capsulotomy for anterior capsule contraction syndrome (3% versus 0%), despite the same surgical technique and initial capsulorhexis diameter. Although the incidence of significant capsulophimosis was still low, this study suggests that the reduced tensile strength of the floppy, single piece haptics may not resist capsular contracture as well. This may be an important consideration in eyes at higher risk of capsulophimosis, such as those with psuedoexfoliation, diabetes, or weakened zonules.[27–29]

The study by Nejima and co-authors represents the first prospective, randomised comparison of the single piece and three piece AcrySof IOLs. The investigators sought to evaluate potential differences in IOL decentration, tilt, ACO, and PCO in 20 bilaterally implanted patients. Implanting the two designs in alternate eyes of the same patient eliminated patient co-variables and selection bias. The use of sophisticated, objective measurements with masked technicians further improved the validity of the results.

While there was no statistically significant difference in PCO measurements, there was a trend towards greater PCO in the single piece AcrySof group. Furthermore, only 16 patients were examined at the final 18 month visit. The authors speculate as to why PCO could be higher with the single piece design, but correctly point out that the sample size and follow up period of their study are clearly insufficient to make a definitive PCO comparison.

In summary, the rabbit studies of Nishi, the retrospective study of Wallin, and the current prospective study of Nejima collectively raise some suspicion that the single piece AcrySof design may not have the same PCO advantage as the traditional three piece AcrySof design, despite the presence of a truncated edge on both models. A larger study population followed prospectively for at least 2–3 years may be necessary to prove whether the designs are equally protective against PCO. As we seek to further improve IOL technology, we must remember that lenses of an identical material, but with different designs cannot be assumed to produce the same clinical results. Now that the single piece design has already overtaken the three piece design in popularity, further comparative studies are warranted to evaluate whether one haptic design is superior to another.

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