Comparison of clinical efficacy: Nd:YAG laser rates after implantation of AcrySof® SN60WF, Akreos® AO-MI60 and Hoya® YA-60BB

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Received 4 April 2012; accepted 17 July 2012
Available online 22 April 2013

Summary
Purpose. — To compare Nd:YAG laser rates following implantation of AcrySof® SN60WF (Alcon), Akreos® AO-MI60 (Baush & Lomb), and Hoya® YA-60BB (Hoya) intraocular lenses.
Methods. — This retrospective study was conducted at three French centers with each implanting at least two of the three implants. Included patients had undergone uncomplicated cataract surgery with at least 3 years of follow-up. Records of patients implanted with one of the three IOL’s were drawn randomly from the surgical logs. Postoperative data were obtained from the medical records of either the surgeon or the referring physician. Time elapsing until Nd:YAG laser was analysed using Kaplan-Meier survival curves.
Results. — Three hundred eyes were implanted (AcrySof® 126, Akreos® 89, and Hoya® 85). AcrySof® recipients were the youngest (AcrySof® 72.1, Akreos® 76.4, and Hoya® 75.2 years of age; P = 0.0007). The sex ratio was 4:6 male:female. Follow-up was longest for Hoya eyes (AcrySof® 29.4, Akreos® 24.6 and Hoya® 34.6 months; P = 0.0002). Eyes implanted with AcrySof® had 1.74 times less chance of Nd:YAG laser treatment than Hoya eyes (P = 0.0327) and 3.50 times less than Akreos® eyes (P < 0.0001). The results remained unchanged when the analysis
was restricted to events in the first 24 months (Risk Ratios: Hoya® = 2.64; P = 0.02; and Akreos® = 4.22; P = 0.0001). Adjustment on unbalanced confounding variables did not alter the results.

Conclusions. — Eyes with AcrySof® implants required significantly fewer Nd:YAG laser capsulotomies than those with Hoya® and Akreos® implants and were therefore less subject to Nd:YAG laser treatment complications, thus ensuring better vision at the lowest cost.

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Introduction

Cataract is the leading cause of blindness worldwide, e.g., cataract in at least one eye affects an estimated 20.5 million Americans (17.2%) aged more than 40 years [1–3]. Surgery is the only effective cataract treatment and is one of the most frequent surgical procedures in Western developed countries [1,2]. In France, more than 650,000 cataract operations were performed in 2010 and approximately 11% of patients older than 45 years were aphakic [3]. Cataract surgery, today, is a common surgical procedure for which surgeons have several different intraocular lens types at their disposal [2,5].

The most frequent post-surgical complication is posterior capsule opacification (PCO), which affects about 20% of patients within 3 years after surgery [2,6,7]. Other complications in patients without ocular co-morbidities or diseases, that could influence healing or cause post-surgical complications, are far rarer (<5%) [2].

The occurrence of PCO depends on several factors, including the surgical technique and the type of intraocular lens (IOL) implanted [6]. Lens geometry plays an important role in the occurrence of PCO especially the lens edge shape, with PCO less frequent in patients given square-edged lenses rather than curved-edges [8–10]. Fewer studies exist for other geometric parameters such as angle and lens design (monobloc or three-piece) and their conclusions are contradictory [11–16]. However, numerous other studies have demonstrated that lens material is a factor affecting the incidence of PCO, with PCO more frequent with hydrophilic acrylic lenses rather than hydrophobic acrylic, silicone or phenylmethylmethacrylate (PMMA) lenses [17–21]. This was confirmed by a recent Cochrane Review [22] showing significantly higher PCO rates following hydrogel IOLs compared to other materials. Conversely, PCO rates were significantly lower for:

- IOLs with sharp posterior optic edges relative to round edged IOLs;
- IOLs placed in the capsular bag rather than the sulcus;
- and eyes with small versus large capsulorhexis. There were no significant differences between single and three-piece IOLs.

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Researchers [23] evaluated intraindividual differences in posterior capsule opacification and visual performance with AcrySof® SN-60WF and Hoya® AF-1 YA-60BB IOLs. The results showed significantly greater PCOs after the Hoya IOL than the AcrySof® IOL. In addition, the study showed statistically significant differences of both high and low contrast visual acuity in favour of eyes implanted with the AcrySof® IOL. Haptics might have influenced the development of PCO.

Posterior capsule opacification can be treated by cutting a hole in the posterior lens capsule with a Nd:YAG laser (Neodymium:YAG laser capsulotomy). However, the procedure can lead to complications, such as: IOL damage, intraocular pressure elevation, glaucoma, retinal hemorrhage, Elschnig pearls, iris at, vitreous prolapse, corneal damage, vitritis, iris damage, pupillary block, hyphema, cystoid macular edema, retinal detachment, IOL subluxation, and localised endophthalmitis exacerbation [24–38]; with associated costs in all cases [39].

The aim of the present study in everyday practice at ophthalmology clinics in France was to compare Nd:YAG laser rates after implants of three recent IOLs: AcrySof® SN-60WF (Alcon Inc, TX, the USA), Akreos® AO-MI60 (Baush&Lomb Inc, NY, the USA) and Hoya® YA-60BB (Hoya Corp., Japan).

Methods

All procedures adopted the tenets of the revised Declaration of Helsinki. Approval for this retrospective analysis was obtained from the Conseil National de l’Ordre des médecins, and did not require Review Board submission.

This retrospective, multicentre study was conducted at three ophthalmology centres across France. To enable a differentiation between centre and IOL effects, selected centres used at least two different types of IOL amongst those under investigation. Other centre inclusion criteria included accessibility to patients’ medical records and follow-up data.

The three IOLs studied (Table 1) were AcrySof® SN-60WF, Akreos® AO-MI60, and Hoya® YA-60BB. Two IOLs were made from hydrophobic acrylic (AcrySof® and Hoya®) and the third from hydrophilic acrylic (Akreos®). All three had square edges, but differed in geometry (monobloc or multipiece), optic diameter, and angle (no angle or 10° C angle).

Study inclusion criteria sought patients (either sex and any race) with age-related cataract, older than 50 years on the day of surgery (performed before January 2008), and treatment by posterior chamber IOL implantation with phaco-emulsification. The minimum follow-up duration was initially fixed at 36 months and reduced to 24 months when difficulties were encountered at finding patients with Akreos IOLs. The study excluded cases with complications during surgery (posterior capsule rupture, capsulorhexis tearing, hyphema, endophthalmitis), eye co-morbidities that would compromise visual outcome, i.e. uveitis, previous history of uveitis, high myopia (axial length ≥26 mm), combined surgery, post-traumatic cataract, glaucoma, and ARM.

As a preliminary step, each centre compiled a list, from its operating theatre register, of patients undergoing cataract surgery before January 2008. Patients’ identities were made anonymous and files were sequenced according to the date of surgery. Patients’ files were then drawn randomly from the database, without replacement, according to a predefined randomisation list stratified by centre and IOL type. Files on approximately 100 patients were obtained per IOL type. The randomisation list was generated by SAS program version 9.2 (SAS Institute; Cary; North Carolina, USA) [40].

Medical records of selected patients were examined by both a clinical research assistant and the investigator to verify that they fulfilled the inclusion and exclusion criteria. Patients who did not do so were replaced by the next patient on the randomisation list, with the same type of implant. Data collected from the medical records comprised: patient characteristics, type of lens implanted, visual acuity before and after the operation, post-surgical complications, laser Nd:YAG capsulotomy after IOL implantation, complications linked to laser Nd:YAG treatment, and the date of the last patient visit. If follow-up data were missing the investigator contacted the patient and/or the referring ophthalmologist (by telephone or post) to obtain the missing information.

Statistical analyses were performed with the statistical software package SAS version 9.2 (North Carolina, USA). All statistical tests were interpreted with an alpha risk of

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Lens properties.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AcrySof® SN-60WF</td>
</tr>
<tr>
<td>Material</td>
<td>Hydrophobic acrylic</td>
</tr>
<tr>
<td>Design</td>
<td>Monobloc</td>
</tr>
<tr>
<td>Edges</td>
<td>Square</td>
</tr>
<tr>
<td>Optical diameter (mm)</td>
<td>6</td>
</tr>
<tr>
<td>Total diameter (mm)</td>
<td>13</td>
</tr>
<tr>
<td>Angle (degrees)</td>
<td>0</td>
</tr>
<tr>
<td>A-constant</td>
<td>118.7</td>
</tr>
<tr>
<td>Depth of anterior chamber (mm)</td>
<td>5.37</td>
</tr>
</tbody>
</table>

PMMA: phenylmethylmethacrylate; NA: not available.
Table 2 Patient characteristics at inclusion according to type of lens.

<table>
<thead>
<tr>
<th></th>
<th>AcrySof® SN-60WF</th>
<th>Akreos® AO-MI60</th>
<th>Hoya® YA-60BB</th>
<th>Total n=300</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (%)</td>
<td>39.2</td>
<td>32.6</td>
<td>40</td>
<td>37.5</td>
<td>NS</td>
</tr>
<tr>
<td>Mean age (years) ± SD</td>
<td>72.1 ± 9.1</td>
<td>76.4 ± 8.4</td>
<td>73.8 ± 6.9</td>
<td>74.2 ± 8.7</td>
<td>0.0007</td>
</tr>
<tr>
<td>Patients with treated intraocular hypertension (%)</td>
<td>0</td>
<td>2.3</td>
<td>0</td>
<td>0.7</td>
<td>NS</td>
</tr>
<tr>
<td>Patients with an associated ocular pathology likely to affect vision (%)</td>
<td>15.9</td>
<td>22.5</td>
<td>10.7</td>
<td>16.4</td>
<td>NS</td>
</tr>
<tr>
<td>Patients with diabetes (%)</td>
<td>8.7</td>
<td>13.4</td>
<td>12.9</td>
<td>11.3</td>
<td>NS</td>
</tr>
<tr>
<td>Contralateral eye previously operated (%)</td>
<td>20.8</td>
<td>24.4</td>
<td>11.1</td>
<td>19.2</td>
<td>NS</td>
</tr>
<tr>
<td>Mean visual acuity before surgery ± SD</td>
<td>0.5 ± 0.2</td>
<td>0.5 ± 0.2</td>
<td>0.4 ± 0.1</td>
<td>0.5 ± 0.2</td>
<td>NS</td>
</tr>
</tbody>
</table>

SD: standard deviation; NS: not significant.

5% (two-sided). Variables concerning group comparability at the time of intervention were analysed using classical statistical tests, i.e. qualitative data were compared by the Chi² test or Fisher’s exact test when the theoretical number was less than 5; and quantitative data by Student’s t-test or analysis of variance when distributions were close to normal (Kolmogorov-Smirnoff test not significant). When distributions were not normal, non-parametric tests were applied (Mann-Whitney U test, Kruskal-Wallis test). The primary analysis was performed with Kaplan-Meier survival curves. The critical end event was laser Nd:YAG capsulotomy. The Log-Rank test was used to determine the statistical significance of any difference observed. Cox’s model was applied to adjust rates with regard to characteristic differences between patient groups.

Results

Three hundred patients met the inclusion criteria and were implanted with one of the studied IOLs (AcrySof® n=126, Akreos® n=89, and Hoya® n=85).

Table 2 shows an overall sex ratio of four males:six females, approx. The mean age of patients treated with AcrySof® (72.1 years) was significantly (P=0.0007) lower than those of Hoya® (73.8) and Akreos® (76.4). Few patients (0.7%) were treated for high intraocular pressure, 16.4% had eye co-morbidities, and 11.3% diabetes (no significant difference between IOLs), and 19.2% of patients had undergone a contralateral eye operation for cataract. Mean visual acuity before surgery was comparable between the treatment groups (0.4 - 0.5 decimals).

The mean follow-up duration (Table 3 and Fig. 1) was longer after Hoya® (34.6 months) than AcrySof® (29.4) or Akreos® (24.6) IOLs (P=0.0002).

Reasons for Nd:YAG laser treatment were similar for all three IOL groups, decreased visual acuity and patients’ complaints (Table 4). The delay between IOL implantation and Nd:YAG laser treatment was significantly (P=0.01) shorter for Akreos® than for AcrySof® or Hoya®. Although mean visual acuity (decimals) was initially better (P=0.0001) in PCO patients receiving AcrySof® (0.7), compared to Hoya® and Akreos® (0.5), the response to Nd:YAG laser intervention was similar, or better (i.e. 0.9 cf. 0.8).

Table 5 hazard ratios show that the probability of Nd:YAG laser treatment following AcrySof® was less than with Akreos® (3.502–4.223) and less than for Hoya® (1.739–2.691). The results remained unchanged after adjusting for length of follow-up and thereby support the robustness of our findings.

Table 3 Posterior capsular opacification and Nd:YAG laser need.

<table>
<thead>
<tr>
<th></th>
<th>AcrySof® SN-60WF</th>
<th>Akreos® AO-MI60</th>
<th>Hoya® YA-60BB</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean duration of follow-up post-surgery (months) ± SD</td>
<td>29.4 ± 14.7</td>
<td>24.6 ± 11.1</td>
<td>34.6 ± 19.3</td>
<td>0.0002</td>
</tr>
<tr>
<td>Mean visual acuity after surgery ± SD</td>
<td>0.9 ± 0.1</td>
<td>0.8 ± 0.2</td>
<td>0.9 ± 0.2</td>
<td>0.0001</td>
</tr>
<tr>
<td>Nd:YAG laser at one year (%)</td>
<td>1.7</td>
<td>12.1</td>
<td>3.0</td>
<td>&lt; 0.0002</td>
</tr>
<tr>
<td>Nd:YAG laser at two years (%)</td>
<td>10.3</td>
<td>36.0</td>
<td>24.9</td>
<td></td>
</tr>
</tbody>
</table>

SD: standard deviation; NS: not significant.
Discussion

This study compared incidence rates of Nd:YAG laser capsulotomy following implants of three square-edged monofocal IOLs, approximately 2 years after cataract surgery. The principal IOL differences involved materials and haptics. According to this retrospective case-record analysis the probability of a Nd:YAG laser intervention following AcrySof® SN-60WF implants is about 1.7 less than with Hoya® YA-60BB or 3.5 less than with Akreos® AO-MI60 implants.

Several studies have compared hydrophobic acrylic lenses with hydrophilic acrylic lenses and most have concluded that the PCO incidence is significantly higher after hydrophilic lenses. A retrospective study followed-up 705 patients for a mean duration of 23 months and found a Nd:YAG laser capsulotomy incidence rate of 7.6% with patients given hydrophilic lenses (XL-Stabi) compared to 2.7% given hydrophobic acrylic AcrySof® SA-60AT (P = 0.004) [18]. Another retrospective study followed 105 patients for 18 months and reported Nd:YAG laser capsulotomy rates of 24.4% with hydrophilic lenses versus 8.9% after AcrySof® SA-60AT (P = 0.03) [19]. A randomised clinical trial implanted 95 patients with a different IOL in each eye, followed them for 2 years and found that 28% of eyes given a hydrophilic

Table 4 Reasons for Nd:YAG capsulotomies and outcomes.

<table>
<thead>
<tr>
<th>Reasons for undergoing laser Nd:YAG</th>
<th>AcrySof® SN-60WF</th>
<th>Akreos® AO-MI 60</th>
<th>Hoya® YA-60BB</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased visual acuity (%)</td>
<td>46.4</td>
<td>57.5</td>
<td>32.4</td>
<td>NS</td>
</tr>
<tr>
<td>Patient complaint (%)</td>
<td>28.6</td>
<td>25.0</td>
<td>10.8</td>
<td>NS</td>
</tr>
<tr>
<td>Mean delay between surgery and laser Nd:YAG (months) ± SD</td>
<td>28.7 ± 14.0</td>
<td>20.4 ± 9.6</td>
<td>27.4 ± 13.2</td>
<td>0.01</td>
</tr>
<tr>
<td>Visual acuity before Nd:YAG laser (/10)</td>
<td>0.7 ± 0.2</td>
<td>0.5 ± 0.2</td>
<td>0.5 ± 0.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Visual acuity after Nd:YAG laser</td>
<td>0.9 ± 0.1</td>
<td>0.8 ± 0.3</td>
<td>0.8 ± 0.2</td>
<td>NS</td>
</tr>
</tbody>
</table>

SD: standard deviation; NS: not significant.

Table 5 Hazard ratio (HR) estimates (CL 95% and P-values).

<table>
<thead>
<tr>
<th>Time limits</th>
<th>AcrySof® SN-60WF</th>
<th>Akreos® AO-MI60</th>
<th>Hoya® YA-60BB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis without adjustment, no time limit</td>
<td>Ref</td>
<td>3.502[2.124; 5.776]&lt;0.0001</td>
<td>1.739 [1.046; 2.889] 0.03</td>
</tr>
<tr>
<td>Analysis with adjustment, no time limit</td>
<td>Ref</td>
<td>3.555[2.083; 6.065]&lt;0.0001</td>
<td>1.804 [1.072; 3.036] 0.03</td>
</tr>
<tr>
<td>Analysis without adjustment, at 24 months</td>
<td>Ref</td>
<td>4.223 [2.028; 8.794] 0.0001</td>
<td>2.637[1.197; 5.810]0.0162</td>
</tr>
<tr>
<td>Analysis with adjustment, at 24 months</td>
<td>Ref</td>
<td>3.889 [1.806; 8.375] 0.0005</td>
<td>2.691 [1.209; 5.988] 0.0153</td>
</tr>
</tbody>
</table>
lens required Nd:YAG laser treatment, compared to 2% given the hydrophobic acrylic AcrySof® SA-60AT lens (P < 0.0001) [17]. Our Nd:YAG laser incidence rate with AcrySof® was similar to that reported [41] in a cohort of 12,419 consecutive patients.

Similar results were obtained by a European study that followed 1525 patients for a mean duration of 3.2 years and reported Nd:YAG laser incidences rates of 16.2% (n = 426) after a silicone lens, 19.3% (n = 384) after a phenylmethylmethacrylate (PMMA) lens, and 31.1% (n = 294) after a hydrophilic acrylic lens, in contrast to 7.1% (n = 421) after a hydrophobic acrylic lens (P < 0.001) [20]. A more recent trial [42] randomised 63 patients to receive a hydrophilic IOL (Meridian® HP60M) in one eye, and an hydrophobic IOL (AcrySof® SA-60AT) in the other eye, and noted a statistically significant higher capsulotomy rate with the hydrophilic IOL, compared to the hydrophobic IOL. With a similar experimental design [43] reported more frequent capsulotomy after the hydrophilic Akreos® Adapt IOL (16%) than the hydrophobic AcrySof® (0%). This was supported by a recent meta-analysis [44] who showed that hydrogel IOLs tend to have higher PCO scores than other materials. Our present results with the hydrophilic IOL Akreos® AO-MI60, compared to hydrophobic AcrySof® SN-60WF and Hoya® YA-60BB, agree with the latter study. Our results are therefore consistent with a "consensus" amongst ophthalmologists that the material used to make IOLs is an important factor, which must be taken into account during lens selection.

A clinical interpretation of the present PCO differences between AcrySof® and Hoya® IOLs, is less straightforward since the materials were rather similar, i.e. hydrophobic. As all three IOLs in our study were also square-edged this would imply that other factors influenced the low rate of PCO with AcrySof®. The present three lenses also differed in other respects, i.e. optic diameter and angle. Researchers [22] used a randomised, controlled trial to compare AcrySof® SN-60AT IOL (not quite the same as AcrySof® SN-60WF) with Hoya® AF-1 YA-60BB, and found that AcrySof® produced less PCO and better visual performance than Hoya AF-1 YA-60BB® and attributed the differences to optic edge design.

Lastly, our "AcrySof®" Nd:YAG laser rate was similar to the one reported by other researchers who found a 10% Nd:YAG laser rate at 2 years [45] and the 8% rate 5 years after implantation published by other researchers [46].

Our findings further suggest that patients implanted with AcrySof® should experience fewer Nd:YAG laser adverse events and therefore better long-term vision. According to previous results [38], one retinal detachment per 265 patients can be avoided if the 3-year incidence rate of detachment attributable to Nd:YAG laser treatment is reduced from 20 to 5%. Also, fewer Nd:YAG laser interventions would avoid long-term medication for increased intraocular pressure, benefitting one per 237 patients. Hence, avoidance of Nd:YAG laser treatment is a significant factor for preserving patients’ vision. Also, Nd:YAG laser interventions impact on the overall cost of cataract surgery [39].

The main limitation to our study is its retrospective design frequently adopted by Nd:YAG laser studies [20,38,39,47-49]. However, in the case of Nd:YAG laser treatment a retrospective design is appropriate to conduct everyday practice studies, avoids the possible patient selection bias of clinical trials (samples different from the general population) and avoids observational bias (decision to perform Nd:YAG laser was not influenced by the survey). In addition, our patients were not assigned randomly to IOL implants, thereby allowing possible treatment preferences.

It should be noted, however, that no important imbalances were observed between our patient groups receiving different IOLs, other than age distribution, study follow-up, and reasons for capsulotomy. The lower average age of our patients given AcrySof® did not bias the outcome since younger patients are more prone to PCO [50]. Also, our findings are robust because different methods of adjustment led to very similar results.

In conclusion, our analyses conducted in everyday surgical practice, suggest that eyes implanted with AcrySof® SN-60WF required significantly less frequent capsulotomy than implants of Hoya® YA-60BB or Akreos® AO-MI60.

Disclosure of interest

A.M. Bourdiol Ducasse: declares free lectures to opticians for Hoya.

V. Guerzider, L. Velasque and M. Dominguez: declare that they have no conflict of interest concerning this article.

A. Lafuma and J. Robert: are employees of Cemka that received grants from Alcon for this study.

References


Nd:YAG laser rates after IOL implants


