IJMA

International Journal of Medical Arts

VOLUME 6, ISSUE 5, MAY 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Ophthalmology]

Original Article

Effect of Square-Edge versus Round-Edge Foldable Intraocular Lens in Prevention of Posterior Capsule Opacification

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Article information

Received: 06-04-2024

Accepted: 07-05-2024

DOI: 10.21608/IJMA.2024.281856.1953.

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Citation: Azzam HAAA, Abdelgawad AA, Sakr AM. Effect of Square-Edge versus Round-Edge Foldable Intraocular Lens in Prevention of Posterior Capsule Opacification. IJMA 2024 May; 6 [5]: 4415-4420. doi: 10.21608/IJMA.2024.281856.1953.

ABSTRACT

Background: The most common consequence following cataract extraction is posterior capsule opacification [PCO], which can occur in as many as half of cases.

Aim of the work: To research the impact of folding intra-ocular lens design - square-edge versus round-edge - in preventing PCO.

Patients and Methods: The ophthalmology department of Al-Azhar University Hospitals was the site of this prospective comparative interventional study. The study involved 40 eyes of patients with cataracts who fulfilled specific selection criteria. Eyes were grouped into: Group A [20 eyes] received hydrophilic round-edge foldable intraocular lenses [IOLs], and Group B [20 eyes] received hydrophilic square-edge foldable IOLs. Patients were followed up for 9 months to evaluate PCO development.

Results: Five cases [25%] in group A and 2 cases [10%] in group B developed PCO at 9 months, with no statistically significant difference between the two groups [P = 0.212]. However, only one case in each group required Nd:YAG laser capsulotomy. The two groups did not differ significantly statistically regarding best-corrected visual acuity [P = 0.391] or uncorrected visual acuity [P = 0.981].

Conclusion: At 9 months, there was no substantial variation in PCO development or in the time of first PCO appearance. In eyes implanted with round or square-edged hydrophilic IOLs, there was no significant association with visual acuity.

Keywords: Capsule Opacification; Cataract Extraction; Intraocular Lenses.

INTRODUCTION

One of the leading causes of blindness globally is cataract [1]. Worldwide, the most common surgical procedure for cataracts nowadays is phacoemulsification, followed by the implantation of Intraocular lens [IOL] [2].

With a frequency of as high as fifty percent, posterior capsule opacification [PCO] appears as the most common consequence following cataract extraction [3]. Although neodymium-doped yttrium aluminum garnet [Nd:YAG] laser capsulotomy is effective in treating PCO, it does come with its own set of risks when it comes to the vitreous and retina. Because of this, avoiding or postponing PCO should be a top priority during cataract surgery [4].

Clearly, lens epithelial cells [LECs] proliferation on the posterior capsule surface is impeded by an acute capsular bend. Contact inhibition of migrating LECs can be induced by an IOL with pointed edges producing a discontinuous capsular bend, irrespective of the material composition of the lens [5]. Using a square-edge foldable IOL with optimum posterior capsule polishing and perfect capsulo-rhexis might lead to minimal PCO and perfect long-term results. Since phacoemulsification has been widely practiced in Egypt, it can be linked to PCO, leading to treatment costs and other drawbacks. This research was conducted to evaluate the incidence and grades of PCO after implantation of square-edge versus round-edge foldable IOLs.

This study aimed to search the effect of design of foldable IOL square-edge versus round-edge on the prevention of PCO.

PATIENTS AND METHODS

This prospective, comparative interventional research was conducted on 40 patients [23 males and 17 females; age range [48-78]] at the Ophthalmology department, Al-Azhar University Hospitals. The research involved 40 eyes of cases with cataracts who fulfilled specific criteria for selection. Eyes were grouped into: Group [A]: [20 eyes] received hydrophilic round-edge foldable IOLs [Optima Aspheric, Optima Co.], and Group [B]: [20 eyes] received hydrophilic square-edge foldable IOLs [Ray One Aspheric, Rayner Co.].

Inclusion criteria: Age from 40 years to 80 years old, types of cataracts: nuclear, cortical, or posterior sub-capsular; and uneventful cataract surgery [phaco-emulsification] with IOL in the bag.

Exclusion criteria: Congenital, developmental, or traumatic cataracts, eventful cataract surgery, and uncontrolled systemic conditions.

Data collection: The patient underwent complete ophthalmological examination, including visual acuity using Snellen chart, external inspection, pupillary examination, extraocular movements, conjunctival examination, corneal examination, anterior chamber evaluation, lens examination using Slit lamp examination, and IOP measurement using Goldmann applanation tonometry and investigational studies.

Surgical techniques: Using [Oertli CR3 with SPEEP Phaco Machine Cataract surgery was done, making continuous circular curvilinear rhexis, excellent polishing for anterior and posterior capsules, and centralized foldable IOL implantation in bags.

Steps of the technique

A local anesthetic was used, and the procedure included capsulorhexis, hydrodissection and hydro-delineation, phacoemulsification, irrigation and aspiration, polishing of the capsules, and putting in an intraocular lens to be centralized in the bag, final lavage and finally stromal hydration.

Postoperative care: Postoperative medications were administered, such as antibiotics and anti-inflammatory eye drops. The patient was instructed on postoperative care, including proper use of eye drops, limitations of physical activities, and follow-up appointments.

Outcome Measurements and Follow-Up

Routine post-operative follow-up at 1 day, 1 week, 3 weeks, and the final results at the 9th month. At each follow-up visit, BCVA, IOP, fundus examination, grades, and type of PCO were assessed by slit lamp photography using CANON 200d [24.1MP] 3x optical zoom system.

Retroillumination images of the posterior capsules from all patients were evaluated following the grading criteria established by **Congdon** [6]: grade 0 indicating the absence of posterior capsule opacification [PCO], with no opacity present or only appearing on the peripheral capsule; grade 1 denoting wrinkling or limited opacity within a circle of 4 mm in diameter centered on the visual axis, where the posterior polar retina remained clearly visible; grade 2 representing central or paracentral opacity more severe than grade 1, slightly affecting the detailed observation of the

macula but not impeding the assessment of the cup/disc ratio; grade 3 indicating central or para-central opacity more severe than grade 2, resulting in challenges in ascertaining the cup/disc ratio; grade 4 mirroring the characteristics of grade 3 but hindering fundus observation, possibly rendering it difficult or impossible. In cases of disputed grades, a senior ophthalmologist reassessed the images for consistency. Illustrative examples of various PCO grades can be found in Figure [1].

Ethical Consideration: Every single patient who participated in this study gave their written consent. Approval of the research was obtained from the Ethical Committee of the Faculty of Medicine of Al-Azhar University before the start.

Statistical analysis: The data that was collected was then evaluated using software and was input into the statistical package for the We used the social sciences SPSS-20 [SPSS-20 Inc., Chicago, Illinois, USA for statistical analysis] software for further examination. While frequency was used to summarize qualitative data, descriptive data was organized in accordance with mean, SD and range for continuous data. We deemed results significant in statistics if the p-value was less than 0.05. Statistical tests used for the comparison including the student "t" test and the chi-square test [X2].

RESULTS

In terms of statistical significance, the two examined groups showed no variation in sex and age [P = 0.749, 0.912, respectively] [Table 1].

Regarding PCO at the 9th month and PCO grade, the two examined groups showed no statistically significant variation [P = 0.212, 0.571, respectively] [Table 2].

All patients in both groups with PCO underwent the same surgical technique of continuous circular capsulorhexis [CCC] [Table 3].

For Nd:YAG requirement, the two examined groups showed no statistically significant variation [P = 1] [Table 4].

Statistical analysis indicated no substantial distinction between the two datasets in terms of visual acuity and IOP. Concerning BCVA, the p-value was 0.391, and for UCVA, it was 0.981 between the two groups [P = 0.549, respectively] [Table 5].

Statistical analysis revealed no significant differences between the two datasets in terms of visual acuity. For BCVA, the p-value was 0.391, and for UCVA, it was 0.981 [Table 6].

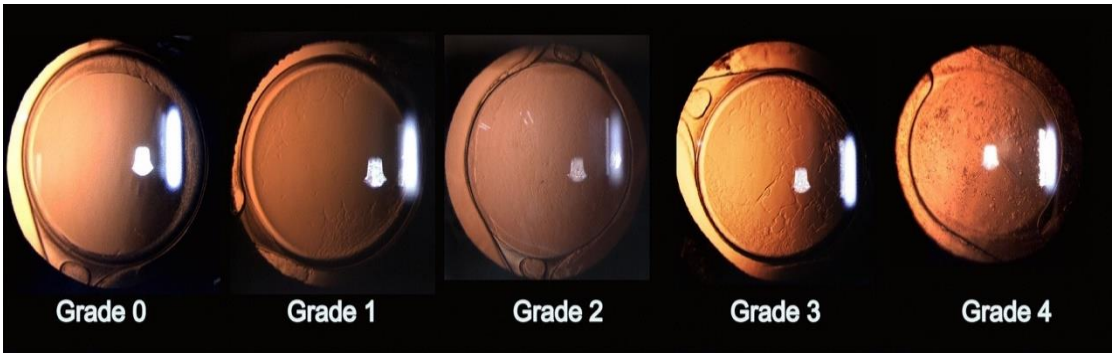

Figure [1]: Grades of PCO [6]

Table [1]: Demographic characteristics among the research population

	Group A [n = 20]	Group B [n = 20]	Test	p
	n [%]	n [%]		
Sex				
Male	11 [55%]	12 [60%]	X^2 = 0.102	0.749
Female	9 [45%]	8 [40%]		
Age [years]				
Mean ± SD.	62.9 ± 7.28	63.15 ± 6.93	t = -0.111	0.912
Median [IQR]	62.5 [56.75 - 68.25]	63 [59.75 - 66]		
Range [Min-Max]	27 [48 - 75]	29 [49 - 78]		

Table [2]: PCO presence and grade among the study population at 9th month

	Group A [n = 20]	Group B [n = 20]	Test	p
	n [%]	n [%]		
Posterior capsule opacification [PCO] at 9th month			X^2 = 1.558	0.212
Yes	5 [25%]	2 [10%]		
No	15 [75%]	18 [90%]		
PCO grade			X^2 = 1.12	0.571
Grade 1	3 [15%]	2 [10%]		
Grade 2	1 [5%]	0 [0%]		
Grade 3-4	1 [5%]	0 [0%]		

Table [3]: Operation technique among study population with PCO

	Group A with PCO [n = 5]	Group B with PCO [n = 2]	Test of Sig.	p
	n [%]	n [%]		
Operation technique			X^2 = **0**	**1**
Continuous circular capsulorhexis [CCC]	5 [100%]	2 [100%]		

Table [4]: Nd:YAG laser capsulotomy requirement among the study population at 9th month

	Group A [n = 20]	Group B [n = 20]	Test of Sig.	p
	n [%]	n [%]		
Nd:YAG laser capsulotomy requirement at 9th month			X^2 = **0**	**1**
Yes	1 [5%]	1 [5%]		
No	19 [95%]	19 [95%]		

Table [5]: Baseline Ocular features among the study population

	Group A [n = 20]	Group B [n = 20]	Test of Sig.	p
	n [%]	n [%]		
Visual acuity			t = 0.055	0.956
Mean ± SD.	1.1 ± 0.29	1.1 ± 0.29		
Median [IQR]	1.1 [0.9 - 1.23]	1.1 [0.8 - 1.3]		
Range [Min-Max]	1.2 [0.6 - 1.8]	0.8 [0.7 - 1.5]		
IOP [mm Hg]			t = -0.605	0.549
Mean ± SD.	17.34 ± 1.95	17.66 ± 1.34		
Median [IQR]	17.1 [15.88 - 18.45]	17.35 [16.77 - 18.55]		
Range [Min-Max]	8.3 [14.6 - 22.9]	4.7 [15.3 - 20]		

Table [6]: Follow-up Visual Acuity among the study population at 9th month

	Group A [n = 20]	Group B [n = 20]	Test	p
	n [%]	n [%]		
BCVA			t = -0.868	0.391
Mean ± SD.	0.23 ± 0.03	0.24 ± 0.04		
Median [IQR]	0.22 [0.21 - 0.25]	0.26 [0.21 - 0.28]		
Range [Min-Max]	0.13 [0.18 - 0.31]	0.13 [0.16 - 0.29]		
UCVA			t = 0.024	0.981
Mean ± SD.	0.5 ± 0.06	0.5 ± 0.07		
Median [IQR]	0.49 [0.47 - 0.53]	0.5 [0.49 - 0.55]		
Range [Min-Max]	0.22 [0.39 - 0.61]	0.29 [0.3 - 0.59]		

DISCUSSION

The leading cause of complications after primary cataract surgery is PCO. Complications can occur, despite the effectiveness of Nd:YAG laser capsulotomy in treating PCO. Cystic macular edema and an elevated risk of retinal detachment is among them [7].

Participants in Group A [48-75 years, avg. age: 62.9 ± 7.28 years] and Group B [49-78 years, avg. age: 63.15 ± 6.93 years] showed no significant age difference [P = 0.912] or gender distribution variance [P = 0.749]. Our findings are consistent with those of **Rehan *et al.*** [8]. The study included 56 eyes from 56 individuals, with an average age of 57.31 ± 11.01 years in the

Square-edge of Lens group [29 eyes from 29 individuals], and an average age of 58.04 ± 18.84 years in the Round-edge Foldable Intraocular Lens group [27 eyes from 27 patients; P = 0.860]. The Round-edge Foldable Intraocular Lens group had a higher percentage of female participants compared to the Square-edge group [64.4%], but this gender distribution difference was not statistically significant [P = 0.054].

There was no significant variation observed between the two groups studied in terms of PCO [P = 0.212] and PCO grade [P = 0.571]. Our findings align with those of **Rehan *et al.*** [8]. They noted significant static variation between the two groups in the onset of PCO development postoperatively. However, there was no significant static correlation found between the onset of PCO and other variables.

In contrast, our results diverge from that of **Haripriya *et al.*** [9], who reported lower PCO scores in eyes with SE-PMMA IOLs compared to contralateral RE-PMMA eyes at each follow-up visit [P < 0.05]. Within group B, eyes implanted with SE hydrophobic acrylic IOLs exhibited higher PCO scores compared to those with SE-PMMA IOLs, except for the 1- and 3-year follow-up visits. While PCO scores reached a plateau for SE-PMMA IOLs by the fourth year and for SE hydrophobic acrylic IOLs by the fifth year, the PCO scores of RE-PMMA IOL eyes continued to increase steadily annually, persisting up to the ninth year of follow-up [P < 0.05].

Our results indicate that all patients with PCO in both groups underwent the same surgical technique involving continuous circular capsulorhexis [CCC]. Our findings are consistent with those of **Auffarth *et al.*** [10], who examined 53 eyes from 46 patients who underwent cataract surgery and were implanted with an Acrysof IOL 34.2 ± 4.3 months later. After three years, the average PCO value in the entire optic area was 0.22 ± 0.21. On average, the overlap between capsulorrhexis and Acrysof IOL optics was 40.5% and 12.4%, respectively. The degree of overlapping showed a negative correlation with PCO levels [r = 0.69, P = 0.001].

Our results revealed a requirement for Nd:YAG laser capsulotomy within the study population. Concerning Nd:YAG requirements, no significant statistical variation was observed between the two tested groups [P = 1].

Our findings align with those of **Rehan *et al.*** [8], who compared YAG laser posterior capsulotomies between the two groups under study. The necessity for Nd:YAG capsulotomy was not statistically significant over the 24-month follow-up period.

In a study by **Cheng *et al.*** [11], various intraocular lenses constructed from acrylic, PMMA, hydrogel, silicone, and other materials were investigated. Different designs with both sharp and rounded edges were also examined. The results indicated that lenses made of acrylic or silicone were more effective in reducing the need for Nd:YAG laser capsulotomy and posterior capsule opacification [PCO] compared to lenses made of PMMA or hydrogel. Furthermore, lenses with sharp optic edges outperformed those with rounded edges in reducing PCO and Nd:YAG laser capsulotomy rates.

The study found similar average visual acuity [VA] in Group A [0.6-1.8, average ± SD: 1.1 ± 0.29] and Group B [0.7-1.5, average ± SD: 1.1 ± 0.29], with no significant difference [P = 0.956]. Intraocular pressure [IOP] in Group A [14.6-22.9, average ± SD: 17.34 ± 1.95] and Group B [15.3-20, average ± SD: 17.66 ± 1.34] did not show substantial variation between groups [P = 0.549].

Our findings are consistent with those of **Hayashi *et al.*** [12], who reported no significant static change in visual acuity when comparing eyes implanted with rounded-edge and sharp-edge acrylic intraocular lenses [IOLs] over a two-year postoperative period.

Our results demonstrated the follow-up visual acuity [VA] among the study population. The best-corrected visual acuity [BCVA] in Group A ranged from 0.18 to 0.31 with an average ± SD of 0.23 ± 0.03, while in Group B, the BCVA ranged from 0.16 to 0.29 with an average ± SD of 0.24 ± 0.04, showing no statistically significant variation between the two groups [P = 0.391]. Our findings are consistent with those of **Auffarth *et al.*** [10]. They observed that after three years, there was no significant static variation in BCVA between eyes implanted with silicone IOLs and those with acrylic IOLs [median Snellen BCVA: 20/20 for both groups, P = 0.71].

There was no significant static variation in corrected visual acuity among the groups since the BCVA impairment caused by posterior capsule opacification [PCO] was not present in either

group. It was noted that having a sharp-edge IOL significantly enhances contrast sensitivity and glare sensitivity compared to a rounded-edge IOL [13].

A limitation of this study is the small sample size and the relatively short postoperative follow-up period. It is recommended to conduct studies with larger sample sizes and for longer post-operative follow-up periods to evaluate the prevention of PCO after cataract surgery using square-edge versus round-edge IOLs.

Conclusion: when comparing eyes implanted with hydrophilic IOLs that were round or square-edged, there was no significant static variation in PCO development at 9 months, and no significant correlation with the general condition was observed.

Financial and Conflict of Interest: Nil

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IJMA

International Journal of Medical Arts

VOLUME 6, ISSUE 5, MAY 2024

P- ISSN: 2636-4174
E- ISSN: 2682-3780