Original Article

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Utility of Abraham Lens in YAG Laser Capsulotomy: A Prospective Study

Ophthalmology Section

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ABSTRACT

Introduction: Neodymium-doped Yttrium Aluminum Garnet (Nd: YAG) laser capsulotomy remains the safest treatment for Posterior Capsular Opacification (PCO). The use of capsulotomy lens has some benefits to offer especially when learning the procedure and in uncooperative patients. With changing curriculum in medical teaching which focusses more on practical aspects it will serve as an asset for the trainees. Even if not used routinely its importance cannot be altogether undermined.

Aim: To assess the utility of Abraham capsulotomy lens in YAG laser capsulotomy procedure and compare it with capsulotomy performed without lens.

Materials and Methods: This was a prospective, longitudinal study conducted in the Department of Ophthalmology, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India, from June 2020 to February 2021. A total of 79 patients who developed PCO after more than six months of cataract surgery and had decrease in visual acuity on Snellen's chart by two or more lines from baseline were included. Visual acuity, Intraocular Pressure (IOP) measurement, fundoscopy, Ocular Coherence Tomography (OCT) was done for Central Macular Thickness (CMT) in all patients at presentation, one and three months following YAG capsulotomy. Nd-YAG laser capsulotomy was then done with and without the use of Abraham's capsulotomy lens in two groups. Parameters such as visual acuity change, IOP, CMT, energy used in capsulotomy, type of PCO were then compared between the two groups. Independent t-test, repeated Analysis of Variance (ANOVA) and Spearman's correlation tests were used to analyse the data.

Results: Of the 79 patients, 40 underwent capsulotomy without the Abraham lens (Group 1) and 39 with Abraham lens (Group 2). Females were more than males in both the groups. The improvement in visual acuity was statistically significant in both groups. There was statistically significant difference in CMT in both groups at each visit. The average energy used for dealing with fibrous type of calcification was significantly more than that used in elsching pearls (13.96 mj). Complications like Intraocular Lens (IOL) pitting, raised IOP, cystoid macular oedema, uveitis and retinal detachment were encountered which were managed by appropriate medical and surgical therapy.

Conclusion: Use of capsulotomy lens decreases the amount of energy needed for capsulotomy and helps to stabilise the eye and to focus better especially for ophthalmologists in their initial training days.

Keywords: Academic training, Cataract, Complications, Neodymium-doped yttrium aluminum garnet laser, Visual acuity

INTRODUCTION

Cataract surgery has evolved from intracapsular cataract extraction to phacoemulsification and a more advanced procedure femtosecond laser surgery [1]. In the modern approach IOL is implanted in the capsular bag after extraction of all lens fibres. Patients undergoing these procedures have high expectations of good visual outcome. In uneventful cataract surgery results are mostly satisfying for both the patient and the treating physician. But with the intact lens capsule, the residual lens fibres that remain behind still have the potential to cause PCO. PCO is the most common delayed complication after cataract surgery [2]. The use of Nd-YAG laser for the treatment of PCO has been described since 1980's [3,4]. It is a very safe and effective method of restoring vision with minimal complications. The process can be carried out with the help of a capsulotomy lens called Abraham's lens or without it. Visual compromise due to PCO can be easily taken care of by a simple procedure which can be easily learnt by residents as well. While training the residents one should take proper care so that complications can be avoided. The study aimed to gauge the utility of Abraham lens as well the complications, if any, between the two alternatives used for capsulotomy (with lens and without lens). The outcome parameters were changes in ocular parameters visual acuity, IOP, CMT with relation to the energy used during capsulotomy or IOL used during surgery.

MATERIALS AND METHODS

This was a prospective, longitudinal study carried out in the Department of Ophthalmology, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India from June 2020 to February 2021.Institutional Ethical Clearance (IEC) was obtained (KIIT/KIMS/IEC/154/2019) and the study complied by the principles of Declaration of Helsinki. Patients recruited in the study had developed PCO after cataract surgery. Purposive sampling was done to recruit patients. Informed consent was obtained from all the participants.

Inclusion criteria: All patients who developed PCO after more than six months of cataract surgery and had decrease in visual acuity on Snellen's chart by two or more lines from baseline (visual acuity one month postcataract surgery) were included in the study.

Exclusion criteria: Patients who did not give consent, having significant pre-existing corneal or retinal diseases which hampered visual acuity were excluded from the study.

Comprehensive ophthalmological examination was carried out for all patients which included visual acuity, IOP measurement, fundoscopy, OCT for CMT in all patients at presentation. Nd-YAG laser capsulotomy was then done by one opthomologist for all study subjects after dilatation with topical eye drop containing 0.5% tropicamide and 0.5% phenylephrine hydrochloride. Pattern of capsulotomy was either circular or cruciate. When circular capsulotomy was done it was central and about three millimetres in size.

The patients were divided into two groups. Forty patients underwent capsulotomy without the use of Abraham's lens (Group 1) and 39 with the use of Abraham's lens (Group 2). The lens used in the study was manufactured by Ocular R. It has a black outline with an image magnification of 1.8x, a laser spot of 0.56x, contact diameter of 15.5 mm, and lens height of 16.5 mm. It has a 10 mm diameter with +66D magnifying button which enhances visualisation of the posterior capsule. Both circular and cruciate pattern capsulotomy was done in both groups and allocation of patients to groups was done randomly. Single pulse mode Nd-Yag laser was used for capsulotomy.

Total energy used was calculated by multiplying the energy (in milijoules) used in each shot with the total number of shots used. All patients were prescribed topical Non Steroidal Anti-Inflammatory Drugs (NSAIDs) for 15 days postcapsulotomy. The patients were again followed-up at one month and three months and comprehensive ophthalmological examination was carried out for all.

STATISTICAL ANALYSIS

Data was coded and recorded in the MS Excel spreadsheet program. Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM Corp.) was used for data analysis. Descriptive statistics were elaborated in the form of means/standard deviations and medians/IQRs for continuous variables, and frequencies and percentages for categorical variables. Data were presented graphically wherever appropriate for data visualisation using histograms /column charts for continuous data. For comparing continuous data, independent t-test to check for the significance between the two methods was used. The p-value <0.05 was considered to be statistically significant. Spearman's correlation test was used to find correlation between energy used in capsulotomy with the type of capsulotomy done and the type of IOL use.

RESULTS

A total of 79 patients were included in the study;40 patients underwent capsulotomy without lens (group 1) and 39 with the Abharam lens (group 2). The mean age group of patients in the former group was 66.6 years and the latter was 54.8 years. The numbers of female patients were more in both the groups as compared to males. The patients of group 1 presented much later (after three years postcataract surgery) as compared to the other group (one and a half years postcataract surgery). The mean visual acuity (in log mar) at baseline was better in patients who presented at an early date postsurgery 0.66±0.540 in group 1 and 0.68 ± 0.552 in group 2. The nature of PCO was fibrotic in majority of cases in both the groups. The mean CMT of both groups had statistically significant difference at baseline visit/first visit. The baseline demographic and ocular parameters are described in [Table/Fig-1].

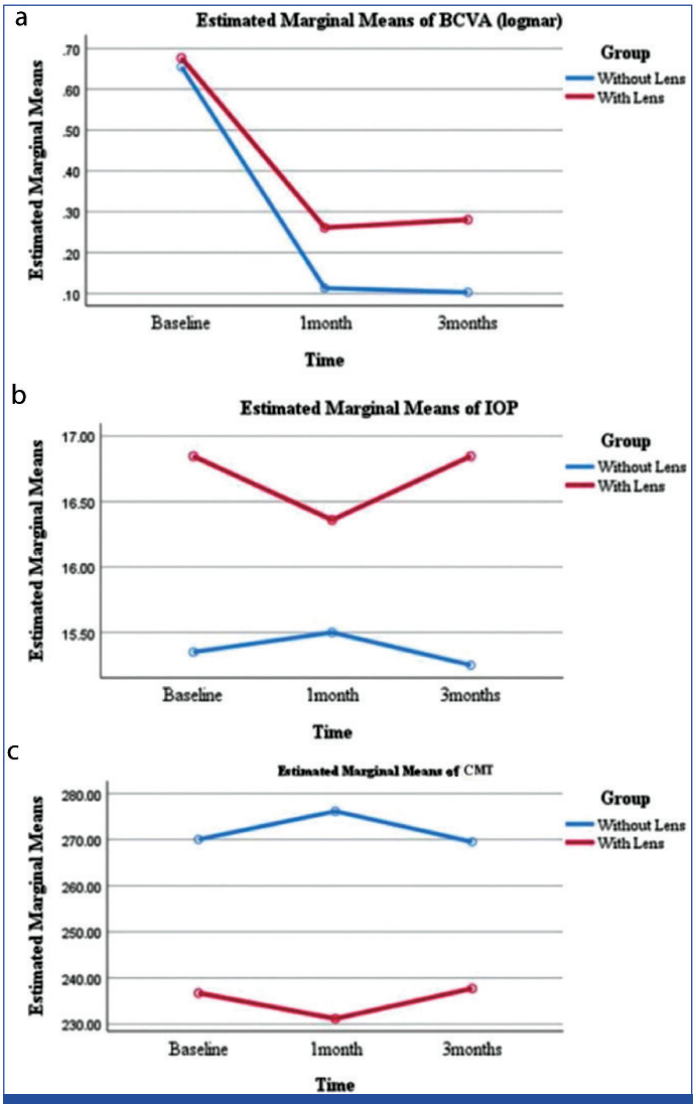
Parameters	Capsulotomy without lens (group 1)	Capsulotomy with lens (group 2)	p-value
Mean age (in years)	66.6	54.8	<0.001
Sex	Male-18 Female-22	Male-13 Female-26	0.288
Mean visual acuity (in log mar)	0.66	0.68	0.769
Mean intraocular pressure (in mmHg)	15.35	16.85	0.175
Mean central macular thickness (in µm)	270.05	236.74	<0.001
Mean duration after cataract surgery (in years)	3.4	1.5	<0.001
Type of lens	Hydrophobic-23 Hydrophilic-17	Hydrophobic-25 Hydrophilic-14	0.547
Type of posterior capsular opacification	Fibrotic- 24 Elschnig's pearls- 16	Fibrotic- 23 Elschnig's pearls-16	0.707

[Table/Fig-1]: Baseline values.

The pattern of capsulotomy done was circular in 50 patients and cruciate in 29 patients. The Best Corrected Visual Acuity (BCVA) improved significantly in both the groups at one month and three months follow-up. The improvement was statistically significant both with respect to time and when compared between patients over time in each group. This implied that visual acuity improved irrespective of the use of lens and was better in the group where lens was not used. Similarly, IOP and CMT also had significant difference between two groups at baseline and at three months follow-up [Table/Fig-2,3].

Time	Group	Parameters (Mean±Standard deviation)		
		BCVA (logmar)	AT/IOP	CMT
Baseline	1	0.66±0.33	15.35±3.13	270.05±28.62
	2	0.68±0.33	16.85±3.13	236.74±28.62
	p-value	0.769	0.041*	<0.001*
1 month	1	0.11±0.14	15.50±2.75	276.15±36.75
	2	0.26±0.14	16.36±2.75	231.18±36.75
	p-value	0.013*	0.175	<0.001*
3 months	1	0.10±0.13	15.25±2.80	269.53±29.10
	2	0.28±0.13	16.85±2.80	237.72±29.10
	p-value	0.004*	0.016*	0.017*

[Table/Fig-2]: Visual acuity, IOP and CMT at baseline and follow-up.
Independent t-test was used to compare these parameters between with and without lens;
*Statistically significant at p<0.05



[Table/Fig-3]: Trajectories of BCVA (logmar), IOP and MT over the time.

The IOP was raised after capsulotomy in four patients where it was done without lens and in just one patient postcapsulotomy where it was done with lens but analysis of all patients irrespective of

lens use at baseline, one and three months showed no significant change in IOP. Similarly, CMT measured at baseline and at one and three months respectively did not show any change though one case in each group was reported to have macular oedema.

The mean energy used in doing capsulotomy with the capsulotomy lens was 23.01 milijoules but decreased to almost half i.e 11.8 milijoules when Abraham's lens was used. Both circular and cruciate pattern of capsulotomy was done in patients of both groups. Correlation of the energy used during capsulotomy with and without lens was done with the type of IOL implanted (hydrophobic or hydrophilic) and with the pattern of capsulotomy. There was statistically significant association between the amount of energy used with the pattern of capsulotomy done lens (correlation co-efficient -0.095, p-value=0.046). It meant that the pattern of capsulotomy done did have a bearing on the total amount of energy used. On corelating the parameters at individual group level negative correlation was found between the pattern of capsulotomy done and the energy used in both the groups (Group 1- -0.245,Group 2- -0.417). This implied that cruciate pattern required less energy than the circular pattern. The values were statistically significant in the group where lens was used. There was no significant correlation between the amount of energy used and the type of IOL implanted either at group level or during comparison irrespective of lens use. The values are elaborated in [Table/Fig-4].

	Overall		Group 1 (without abraham lens)		Group 2 (with abraham lens)	
	Correlation	p-value	Correlation	p-value	Correlation	p-value
Energy requirement with pattern of capsulotomy	-0.095	0.046	-0.245	0.127	-0.417	0.008
Energy requirement with type of intraocular lens used	0.006	0.960	-0.209	0.197	0.041	0.806

[Table/Fig-4]: Correlation of energy used in capsulotomy with the pattern of capsulotomy and type of implanted intraocular lens.
Spearmann correlation test used

The PCO were of two types-fibrotic and Elschnig's pearls. While assessing the effect of the type of IOL on the type of PCO formed, it was found that there was no significant association between the two [Table/Fig-5].

Type of IOL	Type of PCO		p-value (Chi-square test)
	Fibrotic	Elschings pearls	
Hydrophobic	29 (61.7%)	19 (59.4%)	0.835
Hydrophilic	18 (38.3%)	13 (40.6%)	

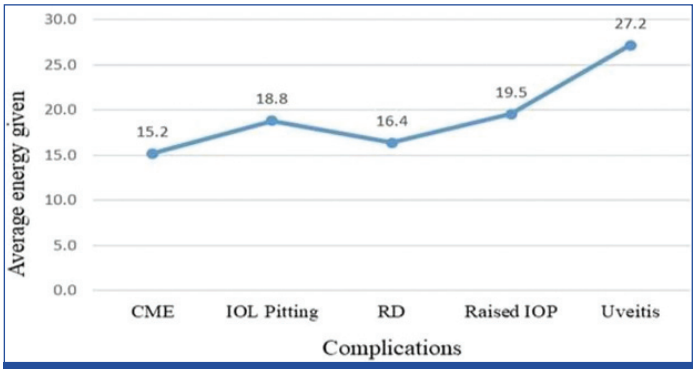
[Table/Fig-5]: Association between type of IOL and type of PCO.

On the other hand, energy used in dealing with fibrotic PCO's was significantly more than that needed to tackle the Elschnig's pearls. The mean energy used in PCO's which was fibrotic in nature was 19.94 milijoules and in Elschnig's pearls was 13.96 milijoules irrespective of the use of lens. On comparing the energy used to do capsulotomy in both types of PCO with or without Abraham lens, there was statistically significant probability values for both groups [Table/Fig-6].

	Overall (Irrespective of lens use)		GROUP 1(With capsulotomy lens)		GROUP 2 (Without capsulotomy lens)	
	Energy (in mj)	p-value	Energy	p-value	Energy	p-value
Fibrotic PCO	19.94±7.59	0.003	26.09±5.37	<0.001	13.51±2.41	<0.001
Elschnig's pearls	13.96±5.52		18.4±3.89		9.53±2.43	

[Table/Fig-6]: Comparison of energy used in different types of PCO.
Independent t-test was used

In the present study, patients presented with few complications which were medically managed and final visual acuity was not significantly affected. [Table/Fig-7] shows complications associated with the capsulotomy procedure in the present study. IOL pitting was seen in maximum six cases, five cases of raised IOP, two cases of uveitis, and cystoid macular oedema, and one case of retinal detachment was seen. All complications were seen in the group 1, except one case each of increased IOP and retinal detachment in the group 2. It was found that uveitis occurred in cases where maximum energy was used followed by secondary rise in intraocular pressure, IOL pitting, and macular oedema.



[Table/Fig-7]: Complications association with energy.
CME: Cystoid macular oedema; IOL: Intraocular lens; RD: Retinal detachment; IOP: Intraocular pressure

DISCUSSION

PCO is an opaque membrane which develops due to the proliferation of the retained lens epithelial cells following cataract surgery. It can develop after a period of few months to few years postcataract surgery [5,6]. Nd-YAG laser capsulotomy is a safe procedure that successfully restores vision without many complications [7]. It requires adequate precision and accurate focus to breach the posterior capsule so that vision is improved without giving rise to complications. Abraham lens is a contact lens that helps to focus better on the posterior capsule and keeps the eye steady during the procedure.

The present study shows mean age group of the patients at presentation to be between 50-70 years. This was expected as most cataract surgeries are performed in these age groups [8,9]. Number of female patients were more in both the groups. This late presentation of female sex might imply the variable need of visual clarity with regard to occupation or as per different vocational requirements of men and women. The mean time interval between surgery and presentation for capsulotomy ranged from 1.5 years to 3.3 years. The interval was shorter in the group of patients where lens was used. This was in accordance with the mean visual acuity at presentation which was better in patients who presented late. The time of presentation postsurgery was similar to several other studies where development of PCO was started as early as three months and was high during the five years postoperative period [5,10].

The development of PCO is also said to be linked with factors like the type of surgery and type of IOL used and the ocular parameters get influenced by the type of PCO that develops, the pattern of capsulotomy that is used and the amount of energy used to breach the posterior capsule. Primarily, equatorial epithelial cells are responsible for the formation of the pearls while anterior epithelial cells are responsible for fibrous PCO formation. Sometimes equatorial cells also can contribute to the formation of fibrous PCO especially in cases where cataract surgery has been delayed for several years [11]. With regards to the type of PCO encountered in present study, fibrotic PCOs were more in number than the Elsching pearls in both the groups.

Similar causes may have been associated in patients of this study too but there was not enough preoperative information on

cataract status of all the patients. Different studies have shown either fibrotic or elschnig pearls to be the predominant type but no specific factor has been described for such finding [12-15]. Other baseline parameters like IOP, CMT were within the normal range in all patients before the procedure implying no bias due to any other ocular pathology affecting the parameters postcapsulotomy.

The severity of visual symptoms do not always correlate with the degree of PCO. But there was significant improvement in the mean visual acuity postcapsulotomy. This finding has been consistent across several studies corroborating with findings of the present study [9,16]. Just like this study several other studies have reported this improvement in visual acuity irrespective of the shape of capsulotomy or energy used in doing capsulotomy [17,18]. Some patients complain of floaters postcapsulotomy where the detached posterior capsule flap floats in the vitreous. In this study, there were no such encounters because the capsulotomy opening was central and about three millimetres in size. Most importantly, though the use of lens did improve the accuracy of the shots specially while doing circinate pattern, it did not have any significant contribution in the improvement in visual acuity.

Mainly two types of capsulotomy techniques were used in the present study- circular and cruciate. Circular technique means to make a central hole in the posterior capsule and cruciate pattern involves making a cross pattern with the laser which then allows the resultant capsule to retract. Studies have reported that energy required to make a circular opening was higher than cruciate but it does not affect the resultant visual acuity or IOP and CMT significantly. It was similar to findings of the present study [19,20]. Studies which did report changes in visual acuity or complications may be due to the significantly higher energy levels in doing circular capsulotomy [21]. As far as the type of IOL used is concerned studies have shown that incidence of PCO with hydrophobic IOLs is lesser as in comparison with hyphophilic ones [5,22-24]. But Borkenstein AF and Borkenstein EM did find that hydrophobic IOLs, which underwent more damage and fraying than hydrophilic ones [25]. But none of these factors were significantly altered by the use of capsulotomy lens.

As discussed earlier, the present study had more fibrous types of PCO's than pearls. The energy used to cut the fibrous PCO's was more than that used for pearls in present study in both the groups. The usage of lens decreased the amount of energy used to cut the PCO. This was in accordance with another study [15].

The most important aspect was the occurrence of complications postcapsulotomy which are mostly because of high levels of energy used or as a result of faulty technique. Increased IOP, uveitis, vitritis, cystoid macular oedema, corneal injury, IOL dislocation, and even retinal detachment have been reported as complications associated with YAG capsulotomy [26-28]. Baring two, all of the complications in the present study occurred when capsulotomy was done without capsulotomy lens. IOL pitting was the most common complication followed by raised IOP. This may be due to incorrect focusing, patient non compliance and release of pigments, and subsequent inflammation during the procedure. The increase in IOP was transient and was medically managed. Development of CME is linked to energy levels used in the procedure causing vitreous damage and/or traction [29,30]. But in a study by Steinhert RF et al., the energy levels as risk factor for CME development have been excluded [31]. Similarly in the present study though energy used was low in these cases, some patients were diabetic as well which could have contributed to the development of CME. The energy used was maximum in the patients with uveitis followed by raised IOP which is selfexplanatory. One case of retinal detachment was reported where capsulotomy was done with lens. This may have been caused because of an inadvertent peripheral retinal break induced by capsulotomy or vitreous displacement causing traction postcapsulotomy. Incidence of retinal detachment is low after capsulotomy and preexisting high myopia could be a contributory factor in this particular case [31,32]. What is relevant to the present study was that the use of capsulotomy lens prevented mainly the IOL pitting.

All the studies done with related to the formation of PCO and the effects of capsulotomy have findings which largely corroborate with the findings of the present study. A larger sample size would have helped to get a more elaborate picture. Moreover all the cases in the present study were done by a single experienced consultant which masked the importance of using a capsulotomy lens in beginners. Not many studies have evaluated the parameters giving importance to the use of capsulotomy lens.

Dickerson DE et al., had elaborated the pros and cons of using a lens during capsulotomy but they had used an iridotomy lens as against capsulotomy lens used in the present study [33]. The study was in agreement with other observation that lens does help in accurate focusing of the laser and stabilisation of the eye. This indeed helps in minimalising a lot of complications. A lot of new and progressive changes are being incorporated in the teaching curriculum, both at undergraduate and postgraduate level. Competency-based models for teaching focus more on the practical aspects. Hence, one must need to adopt techniques which ensure proper training of students without compromising patient safety and vision at the same time. Use of capsulotomy lens is like revisiting the old lanes of ophthalmic practices but with a renewed purpose of better training.

Limitation(s)

The present study was limited by factors such as small sample size and a shorter follow-up period. Longterm follow-up with a larger group may shed some light on the effect of Yag capsulotomy over CMT and IOP in the long run. Considering recent educational curriculum changes putting more emphasis on practical and hands on knowledge, it can give safer avenues for resident training programmes.

CONCLUSION(S)

With advancement in surgical techniques and growing expectation of patients several measures are being routinely taken to prevent the formation of PCO like better hydrodisection, through cortical wash, use of good quality IOL and ensuring good contact of IOL surface with the posterior capsule. But for cases where PCO does develop, YAG capsulotomy remains the best option. As per present study findings, it can be summarised that the use of lens mainly helps decrease the amount of energy used to cut the PCO. It also helps the ophthalmologists in the early training period for better focusing and stabilisation of eye. It can also be used by all in patients where compliance is an issue. The use of capsulotomy does help in better training and control over the procedure. Hence, its importance can't be ignored altogether and it can be an useful tool during the early training period.

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