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Original Article

Ophthalmology Section

Diagnosing Descemet Membrane Detachment in Patients Undergoing Cataract Surgery using an AS-OCT-based HELP Algorithm: A Prospective Cross-sectional Study

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ABSTRACT

Introduction: Descemet Membrane Detachment (DMD) is a rare complication of cataract surgery which is more likely to occur during the learning curve especially during surgical training in residency. There are various methods of diagnosing DMD using slit lamp biomicroscopy, Ultrabiomicroscopy (UBM) and Anterior Segment Optical Coherence Tomography (AS-OCT). AS-OCT can be utilised to confirm, classify DMD and decide the plan of management by using Height, Length, Extent and Pupil (HELP) algorithm. Descemetopexy is the gold standard treatment in the management of DMD. The management of DMDs usually depends upon the site and extent of the detachment. Prompt diagnosis and timely management, leads to a good functional and anatomical outcome.

Aim: To study the occurrence and management of DMDs during cataract surgeries using an AS-OCT-based HELP algorithm in a training hospital.

Materials and Methods: This prospective cross-sectional study, included 25 eyes of 25 patients, who underwent cataract surgery which resulted in DMD in Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli, Maharashtra, India, from June 2021 to December 2021. AS-OCT-based HELP algorithm was used for diagnosis and determining, whether medical management needs to be done or surgical management. Either medical or surgical management (Descemetopexy) was done in all the 25 eyes. All the study subjects were followed-up Postoperative Day (POD)- 1,7,30 for Descemet's Membrane (DM) reattachment. The outcome measures were successful DM reattachment and/or improvement in visual acuity by atleast two Snellen lines. Paired t-test was used to test the mean difference between LogMAR visual acuity values pre and postoperatively. The p-value <0.05 was considered as statistically significant.

Results: Out of 1008 cataract surgeries, 25 patients had DMD intraoperatively. The mean age of the patients was 61.12±7.29 years with a male:female ratio of 2:3. The most common surgery preceding DMD was Manual Small Incision Cataract Surgery (MSICS) (84%; n=21). The mean pre and postmanagement visual acuities were 0.96±0.445 and 0.215±0.196, respectively (p<0.0001). A successful DM reattachment was seen in 92% (n=23) with the first attempt. There was a statistically significant improvement in visual acuity after management (p<0.0001).

Conclusion: Management of DMD is crucial, as early diagnosis and treatment of patients with DMD leads to good visual outcome. AS-OCT-based HELP algorithm is very beneficial in the diagnosis of DMD. Descemetopexy is the gold standard in the management of DMD.

Keywords: Air bubble, Anterior segment optical coherence tomography, Descemetopexy, Perfluoropropane

INTRODUCTION

The DM is the basement membrane of corneal endothelium (8-10 micrometres thick). Along with the endothelium, it also helps in maintaining the corneal transparency [1]. DM plays an important role in various physiologic processes such as endothelial cell differentiation and proliferation, corneal hydration apart from providing structural integrity of the cornea. DM is firmly attached to the posterior corneal stroma by a narrow transitional zone of amorphous extracellular matrix known as the interfacial matrix. Thus, the rupture of the DM leads to penetration of aqueous humour into the corneal stroma leading to stromal oedema [1].

The DMD is a rare but serious and vision-threatening complication of cataract surgery which is more likely to occur during surgical training in residency [2]. Risk factors of DMD are categorised as preoperative patient related factors (old age, dense cataract, pre-existing weakness), intraoperative factors (blunt instrumentation, inadvertent damage by instruments) and postoperative factors (endothelial disorders, corneal ectatic disorders) [1].

There is possibility of occurrence of DMD following other intraocular surgeries such as- keratoplasty, trabeculectomy, peripheral iridectomy, cyclodialysis, laser sclerostomy and viscocanalostomy [3,4]. The DMD has been classified by several authors- Samuel classification, Mackool classification, Jacob classification and an AS-OCT-based HELP algorithm [1]. There are various methods of diagnosing DMD like slit lamp biomicroscroscopy, UBM and AS-OCT [5,6].

AS-OCT can be utilised to confirm, classify DMD and decide the plan of management [7,8] by using HELP algorithm [2,9]. Peripheral, small, subclinical DMDs resolve spontaneously. Larger, central DMDs if not managed promptly, may lead to fibrosis, decompensation and opacification of cornea [10].

Descemetopexy is the gold standard in the management of DMD. Other management options include mechanical tamponade, suture fixation, descemetotomy, interface drainage, and keratoplasty. However, the management of DMDs usually depends upon the site and extent of the detachment [11]. Prompt diagnosis and timely management leads to a good functional and anatomical outcome [12,13].

The present study was conducted in a training Institute, with the purpose of studying the occurrence and management of DMDs during cataract surgeries using an AS-OCT-based HELP algorithm. The primary objective of the study was to assess the site and extent of DMD using slit lamp biomicroscope and AS-OCT and to classify DMD using an AS-OCT-based HELP algorithm. The secondary objective was to determine the mode of intervention

using an AS-OCT-based HELP algorithm and to study the outcome in patients with DMD who were managed medically and following descemetopexy.

MATERIALS AND METHODS

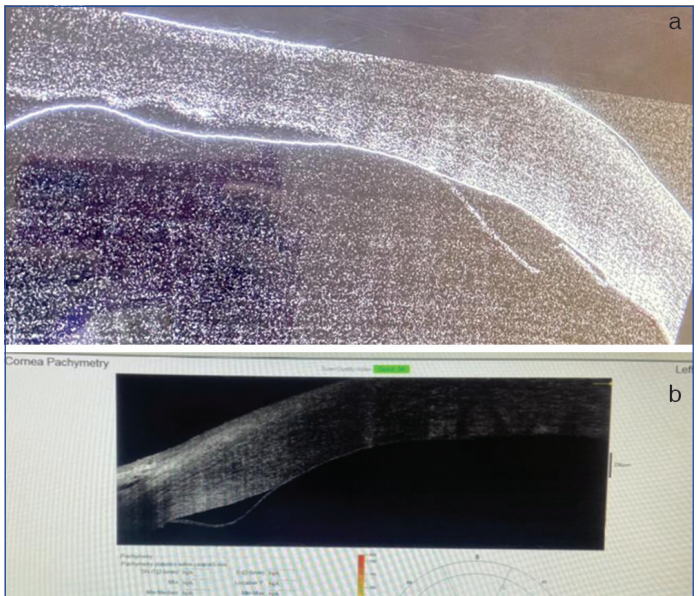
This prospective cross-sectional study, was conducted at a tertiary care hospital, Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli, Maharashtra, India, from June 2021 to December 2021. As DMD is a rare complication of cataract surgery, all patients who presented with the complication during the study period were taken as the sample population. All the study patients, who were willing to undergo descemetopexy were recruited after obtaining a proper written and informed consent. The study was conducted in accordance with the ethical standards of Declaration of Helsinki (Institutional Ethics Committee Number- IEC/447/21).

Inclusion criteria: All the patients, who have undergone cataract surgery either MSICS or phacoemulsification during the study period and have had DMD as an intraoperative complication during the cataract surgery, were included in the present study. All the consecutive patients fulfilling the inclusion criteria during the study period were included in the study.

Exclusion criteria: Traumatic DMDs, patients with pre-existing corneal pathologies and DMDs, which resulted after other intraocular surgeries, were excluded from the study.

Study Procedure

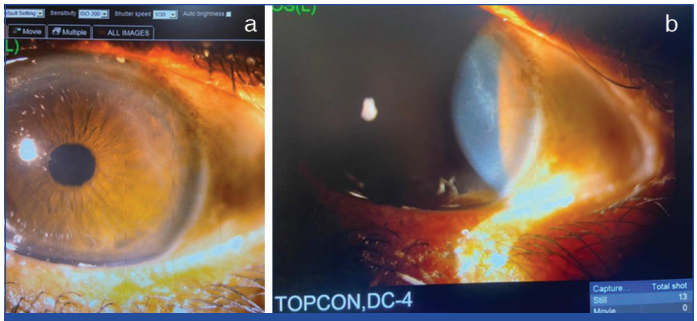
Detailed medical and ocular history including grade of cataract, surgical history- intraoperative details regarding the DMD parameters including the stage of cataract surgery at which DMD occurred were noted. All the study patients were subjected to comprehensive ophthalmic examination. Visual Acuity with best correction was recorded using Snellen's distance vision chart and later converted to log MAR scale for statistical analysis. Slit lamp examination was done in the immediate postoperative period and AS-OCT was done to confirm the existence of DMD. AS-OCT and slit lamp photograph was done in all the study patients [Table/Fig-1,2]. The mode of treatment- either medical management or surgical intervention of DMD was determined by using AS-OCT-based HELP algorithm, as per the discretion of the surgeon.



[Table/Fig-1a,b]: AS-OCT pictures showing DMD in study patients.

Medical intervention: Medical intervention was done using topical hyperosmotic drugs- 5% topical hyperosmotics 5 times/day, 1% topical steroids 2 hourly and 0.5% topical antibiotics 6 times/day for 7 days.

Surgical intervention: Surgical intervention was performed under an operating microscope, taking aseptic precautions using local or



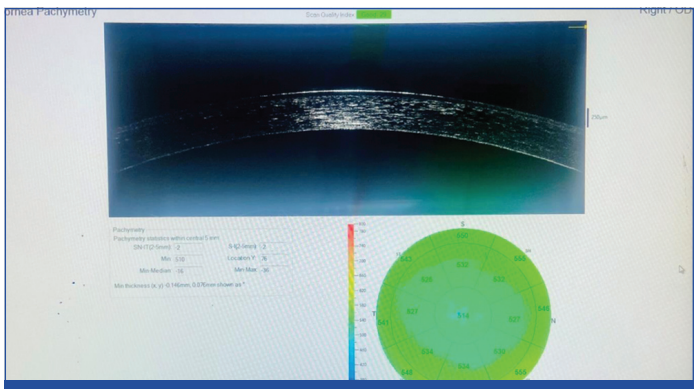
[Table/Fig-2a,b]: Slit lamp photographs of a study patient showing DMD during cataract surgery.

topical anaesthesia. In the present study, descemetopexy was done using 26 Gauge needle. Intracameral injection of either 0.3 mL of 100% sterile air or 0.1 mL of 14% C3F8 gas was used. Intracameral gas bubble was injected to an extent that it occupies 60-70% of the anterior chamber. All the descemetopexy procedures were performed by a single, experienced surgeon. In the immediate postoperative period, pupil was subsequently dilated using Topical Homatropine 2% eyedrops so as to prevent pupillary block and increase in Intra-Ocular Pressure (IOP). Postural positioning along with strict bed rest was given for atleast two hours, based on the site of DMD in all these 14 study patients, subsequent to surgical intervention [14,15].

Postintervention evaluation: On Postoperative Day (POD)-1, after the management of DMD, Best Corrected Visual Acuity (BCVA) was noted immediately. IOP was measured and any increase in IOP was managed using topical antiglaucoma medications. Reanalysis was done using slit lamp examination to assess the reattachment of DM. Slit lamp photograph was taken and AS-OCT was done in all the study patients, to confirm the reattachment of DMD [Table/Fig-3,4].

Patients were followed-up on POD-7 and 30 (one week and one month) postintervention, so as to assess the attachment of DMD.

[Table/Fig-3]: Slit lamp photograph of a study patient who underwent Descemetopexy using airbubble (Postoperative day-1).



[Table/Fig-4]: AS-OCT of a study subject showing DM reattachment postintervention. (Postoperative day-7).

Even after primary intervention, if there was persistent DMD which was visually significant, reintervention was arranged.

Success was defined as complete reattachment of DMD, as well as, improvement in Visual Acuity by atleast two snellen lines and failure as a persistent DMD either partial or complete.

STATISTICAL ANALYSIS

All statistical analyses were performed by IBM Statistical Package of Social Sciences (SPSS) version 26.0. Mean (standard deviation) or frequency (percentage) was used to describe the summary data. Paired t-test was used to test the mean difference between LogMAR visual acuity values pre and postoperatively. The p-value <0.05 was considered as statistically significant.

RESULTS

The present study included 25 eyes of 25 patients. All the characteristics of study patients with DMD as an intraoperative complication during cataract surgery are shown in [Table/Fig-5]. The male:female ratio of study patients was 10:15. The mean age of the patients in the present study was 61.12±7.29 years (range 50-79 years). Out of 25 eyes, 13 (52%) were right and 12 (48%) were left eyes in the present study.

Characteristics	Parameters	Number of patients, n (%)
Sex	Male	10 (40%)
	Female	15 (60%)
Age (in years)	50-59	10 (40%)
	60-69	11 (44%)
	70-79	4 (16%)
Laterality (eye)	Right	13 (52%)
	Left	12 (48%)
Type of cataract surgery	MSICS (Sclerocorneal tunnel)	21 (84%)
	Phacoemulsification (Clear corneal incision)	04 (16%)
Site of DMD	Central (Zone I)	4 (16%)
	Paracentral (Zone II)	8 (36%)
	Peripheral (Zone III)	13 (52%)

[Table/Fig-5]: Characteristics of study patients with DMD as an intraoperative complication during cataract surgery.

[Table/Fig-6] shows the presenting baseline Best Corrected Visual Acuity (BCVA) and Post Descemet Membrane Detachment (DMD) intervention BCVA of study patients.

Details about the paired samples statistics and paired samples test of all the study patients are seen in [Table/Fig-7].

Visual acuity	Baseline BCVA-Number of patients, n (%)	Post DMD intervention-Number of patients, n (%)
<1/60 to PL, PR*	03 (12%)	-
<3/60 to 1/60	05 (20%)	-
<6/60 to 3/60	06 (24%)	-
<6/18 to 6/60	09 (36%)	03 (12%)
6/12 to 6/9	02 (08%)	16 (64%)
6/6 to 6/9	-	06 (24%)

[Table/Fig-6]: Baseline Best Corrected Visual Acuity (BCVA) (before undergoing cataract surgery) and Post Descemet Membrane Detachment (DMD) intervention BCVA of the study patients.
*(Perception of light, Projection of rays)

In HELP algorithm, the DMD parameters were taken from AS-OCT. Based on the acronym, "HELP" components are height, extent, length and relation to pupil (with or without pupillary involvement) [Table/Fig-8,9]. These tables depict the parameters of DMD using HELP algorithm and the type of intervention done in these cases utilising AS-OCT-based HELP algorithm, respectively. Eleven cases (44%) were managed medically and 14 cases (56%) were managed surgically.

Height (in microns)	Extent	Length (in mm)	Pupil (involvement)
<100 (05)	Central 04	<1 (07)	Yes (4)
100-300 (17)	Paracentral 08	1-2 (09)	No (21)
>300 (03)	Periphery 13	>2 (09)	

[Table/Fig-8]: Characteristics of Descemet Membrane Detachment (DMD) based on HELP algorithm in study patients, who underwent cataract surgery (N=25).
Values presented as (n) from each variable

Type of intervention	No. of patients	Percentage
Medical	11	44%
Surgical	14	56%

[Table/Fig-9]: Showing details regarding the type of intervention done in study patients with Descemet Membrane Detachment (DMD) as intraoperative complication during cataract surgery.

In the present study, DMD cases with length less than 1 mm and height <100 microns in any zone; DMD cases with length 1-2 mm and height 100-300 µm in zone 2 and 3 and DMD cases with length >2 mm and height >300 µm long in zone 3- included 11 cases, in whom medical management was considered.

Whereas, in DMD cases with length 1-2 mm and height of 100-300 microns in zone 1 (for both with and without pupillary axis involvement, DMD >2 mm and height >300 µm long in zone 1 and 2)- included 14 cases, where surgical management was considered. Details regarding the type of intervention done in study patients with DMD as intraoperative complication during cataract surgery are shown in [Table/Fig-10]. Eleven (44%) cases the surgically intervention was done by using intracameral injection of 100% sterile air and in 3 (12%) cases, it was done by using intracameral injection of 14% C3F8 gas.

Whereas, [Table/Fig-11] gives us the details regarding reintervention performed in study patients.

Mode of intervention	No. of patients	Percentage
100% Sterile air	11	44%
14% C3F8	03	12%

[Table/Fig-10]: Details of surgical intervention done in study patients with DMD as intraoperative complication during cataract surgery (N=25).

Mode of reintervention	No. of patients	Percentage
C3F8	01	4%
20% C3F8 to 14% C3F8	01	4%

[Table/Fig-11]: Details of reintervention done in study patients with DMD (N=25).

Successful DM reattachment was seen in 23 out of 25 patients in the first attempt. It accounts to 92% (n=23). Whereas, DM reattachment was not successful in two patients in the first attempt accounting to 8% (n=2).

Paired samples statistics	Mean	Mean difference	N	Standard deviation	Standard error mean	95% Confidence interval of difference		t	Df (Degrees of freedom)	Sig. (2-tailed)
						Lower	Upper			
LogMAR VA Pre-op	0.962	0.748	25	0.445	0.089	0.581	0.914	9.273	24	0.0001***
LogMAR VA Post-DMD management	0.215		25	0.196	0.039					

[Table/Fig-7]: Statistical analysis of mean and standard deviation of visual acuity among all the study patients.
Paired samples statistics of all the study patients,*In the present study, significant improvement (decrease in mean) was observed between pre-op LogMAR and post DMD management LogMAR Visual Acuity.
***p-value in this study is 0.0001, p<0.05 was considered as statistically significant

Overall, there was an improvement in visual acuity after the management in the study patients [Table/Fig-12].

Management outcome	Number of patients	Percentage
Successful	23	92%
Unsuccessful	02	8%

[Table/Fig-12]: Outcome of all cases in the present study.

DISCUSSION

The DMD is a rare complication which can be encountered during cataract surgery. During cataract surgery, there is a possibility of DMD while using blunt instruments, excessive manipulation and instrumentation, misdirection of instruments, while injecting Ophthalmic Viscosurgical Devices (OVDs) [6,16] and inappropriate Intraocular Lens (IOL) insertion and soft globe [17,18]. Complications during surgeries like posterior capsular rupture, shallow anterior chamber or managing hard nucleus can also predispose to DMD. Pre-existing weak DM, due to congenital adhesion defects can also lead to spontaneous detachment even in case of an uneventful cataract surgery [2].

The present study includes 25 eyes of 25 patients. It was observed that the chances of DMD occurring after MSICS are more than that occurring after phacoemulsification in the present study which was similar to a study conducted by Odayappan A et al., [11]. The incidence is approximately 0.5% in phacoemulsification and approximately 2.6% in extracapsular cataract extraction. According to a study, visually significant DMD accounts to 0.044%, after phacoemulsification surgery in their study [11]. Marcon AS et al., have attributed increased referrals of DMD to the increasing use of clear corneal incisions [19]. The rate of DMD was higher in the study, as it's a training hospital. Odayappan A et al., suggested that the incidence of DMD was significantly more among surgical trainees than consultants, similar to the present study [11].

As early postoperative intervention results in better visual outcome, timely diagnosis of DMD is crucial. AS-OCT played a very important role in the present study in the diagnosis, evaluation of the extent and management of DMDs in patients, who underwent cataract surgery as slit-lamp evaluation of DMD was difficult in the immediate postoperative period due to corneal oedema [4,7]. Similarly, Moutsouris K et al., in their study suggested that, AS-OCT added diagnostic information in 36% of eyes, in whom examination was not possible by using slit-lamp biomicroscopy alone [20].

Kumar DA and Agarwal A, in their study proposed an AS-OCT-based HELP algorithm, for deciding the treatment plan [2]. This HELP algorithm has been utilised in the present study, to decide the plan of management in all the study patients.

Out of 25 study patients, no case of spontaneous reattachment was noted in the present study. Although there have been some reports of spontaneous reattachment of the DMD, most of the researchers recommend to treat it immediately, so as to save the patient's vision [3,6]. Medical management in 11 of the study patients was effective for small detachments in the present study. Odayappan A et al., Potter J and Zalatimo N in their studies, suggested that topical hyperosmotics and steroids were effective in reattachment of DMD by reducing stromal oedema [11,12].

Surgical intervention was considered for 14 patients in the present study. It included intracameral injection of 100% sterile air in 11 out of the 14 study patients and 14% isoexpansile perfluoropropane (C3F8 gas) in the rest three patients. In a study conducted by Odayappan A et al., Potter J and Zalatimo N, they found that large, central detachments were unlikely to resolve with topical medical treatment and required surgical intervention [11,12].

The efficacy of descemetopexy with intracameral injection of air or gases like 20% sulfur hexafluoride (SF6 gas) or 14% perfluoropropane (C3F8 gas) injection has been reported in severe cases [4,11,12].

In the present study, 11 out of 25 patients were surgically intervened by using intracameral injection of 100% sterile air i.e., pneumodescemetopexy. A retrospective study conducted by Einan-Lifshitz A et al., suggested that air was a better tamponading agent because it was a readily available and short-acting agent [21]. Chaurasia S et al., in their study reported successful attachment of DMD, using intracameral injection of sterile air in 13 out of 14 patients [22].

In the present study, three patients were managed surgically using intracameral injection of isoexpansile 14% C3F8 gas. Garg J et al., in their study suggested that early recognition of DMD and early descemetopexy with isoexpansile perfluoropropane has reasonably successful anatomical and functional outcomes [23]. There is no solid evidence reported, regarding which gas to be used for descemetopexy. Air is a safe, easily available, cheap and effective option for descemetopexy [24]. C3F8 or SF6 gases are considered only in cases of failed reattachment of DM with air bubble.

A 20% SF6 gas can be used for treating DMD as suggested by various reports [6]. In this study, none of the DMD patients were treated with 20% SF6 gas. Positioning and bed rest were advised to all the study patients. In a decubitus position, the bubble is more effective in sealing the site of DMD [16,25]. Bed rest should also be considered, as, decreased patient's activity could also contribute to successful DM reattachment [16].

Reintervention was performed in two out of 25 patients. In the first patient where, intracameral air was put initially during intervention but on follow-up, DMD was found to be persistent. So, reattachment was done using 14% C3F8 gas. In the second patient in whom initial intervention was performed using 20% C3F8 gas, lead to complications like raised IOP, leading to reintervention using 14% C3F8 gas.

Lucena Ada R et al., and Shah M et al., have reported success rates of 100% [26,27]. This difference may be attributed to their small sample size, which is similar to the present study. C3F8 might lead to complications to complications like endothelial dysfunction as it's toxic to corneal endothelium, raised IOP, pupillary block glaucoma, iris ischaemia due to compression of iris against the lens [23]. Eye ache, nausea, vomiting [24] might be noted in patients due to raised IOP (risk of damage to optic nerve). So, 10% C3F8 gas should be opted in patients with risk of glaucoma.

No patient in the present study underwent manual repositioning, trans-corneal suture fixation, perfluorocarbon liquid tamponade, descemetotomy, interface drainage for DMD [23]. Keratoplasty is considered as final line of management, in case of failed DM reattachments. In the present study, no case required keratoplasty, either. A total of 82 patients underwent keratoplasty in a study conducted by Einan-Lifshitz A et al., [21].

Early/prompt diagnosis of DMD was possible in study patients, who underwent cataract surgery using an AS-OCT. Efficient use of AS-OCT-based HELP algorithm was done in the management of DMDs in study patients, who underwent cataract surgery. The present study is a prospective study which has utilised on AS-OCT-based HELP algorithm. Very few studies are available which are prospective, and which have utilised this algorithm in the management of DMD.

Limitation(s)

Limitations of the present study include smaller sample size, shorter follow-up period (one month), lack of specular and pachymetry data and unequal distribution of cataract cases based on the type of surgery performed-MSICS and phacoemulsification. Other intraocular surgeries which might lead to DMD complication were also not studied, and assessment of endothelial toxicity of C3F8 gas couldn't be done in the present study.

CONCLUSION(S)

In this era, where postoperative patients expect best visual outcomes immediately, management of DMD is considered crucial, as early diagnosis and treatment of patients with DMD leads to good visual outcome. The present study highlights the importance of AS-OCT-based HELP algorithm in the treatment of DMD. Descemetopexy is the gold standard treatment in the management of DMD.

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