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IP International Journal of Ocular Oncology and Oculoplasty

Journal homepage: https://ijooo.org/

Original Research Article

Intraoperative partial thickness compression suturing for descemet's membrane detachment: A Novel technique

Anuradha Raj[1]*, **Rajnish Raj**[2]

[1]*Dept. of Ophthalmology, All India Institute of Medical Sciences, Bathinda, Punjab, India*
[2]*Dept. of Psychiatry, Government Medical College and Rajindra Hospita, Patiala, Punjab, India*

ARTICLE INFO

Article history:
Received 12-03-2024
Accepted 08-04-2024
Available online 03-05-2024

Keywords:
Descemet's membrane
Ultrasonographic biomicroscopy
Compression suturing
Descemetopexy

ABSTRACT

Aim: To evaluate the efficacy of partial thickness transcorneal compression suturing with air desmetopexy in descemet's membrane detachment (DMD) during cataract surgery

Materials and Methods: This is a retrospective review of records of patients who were managed for non-planar DMDs during phacoemulsification or small incision cataract surgery with partial thickness suturing with air descemetopexy in virgin eyes.

Results: A total of fifteen cases were identified including 11 females and 4 males with average age of 67 years. All patients involved in the study underwent uneventful cataract surgery. All 15 cases involved in the study with DMD during cataract surgery were caused by intra-operative trauma during different instrumentations. Five cases had peripheral DMDs and ten cases had central DMDs. The average size of non-planar DMD was 4 mm. Ten cases had DMDs with scrolled margins. Eight patients achieved the best corrected visual acuity (BCVA) of 6/6 at the end of one month with clear corneas. Descemet's membrane (DM) got completely attached at two weeks follow-up. The suture removal was done approximately after one month of follow-up.

Conclusions: Partial thickness transcorneal compression suturing with air desmetopexy in non-planar DMD is very helpful in recovering traumatic corneal edema during cataract surgery.

1. Introduction

Descemet's membrane (DM) is a thin, homogenous, and strong specialized basement membrane composed of endothelial cells in the cornea. It is also known as posterior elastic lamina which plays a vital role in the maintenance of corneal transparency. Its thickness varies with age between 3 microns at birth to 10-12 microns in young adults. This layer shows resistance to trauma, chemical agents, infection and pathological insults. It tends to regenerate when destroyed. Normally the DM is in a state of tension, when detached or torn and it curls inwards on itself. This eventually leads to overlying stromal hydration, edema and opacification.Visual acuity is significantly affected if the central cornea gets involved.[1] Small descemet's membrane detachment (DMD) resolves spontaneously but untreated larger DMD can lead to bullous keratopathy with eventual visual loss. DMD has been reported in 43% of cataract surgeries.[2]Most of the DMDs are small in size and peripheral in location at the site of corneal incisions which resolve without any intervention. The central cornea is involved in 0.5% of cases. In the case of large DMDs, 8% subsequently require keratoplasty to regain visual acuity.[3–5]

With the advent of clear corneal incisions in advanced cataract surgical procedures, most surgical manipulations are done at the edge of the DM, thus increasing the chances of DMD.

* *Corresponding author*.
E-mail address: dranuradha_sagar@yahoo.com (A. Raj).

https://doi.org/10.18231/j.ijooo.2024.006

In cases of acute hydrops or tear in the DM, Dua's layer, and endothelium allow seepage of the aqueous into the corneal stroma, leading to corneal edema.[6,7] Large-sized descemet tears take a few months to resolve corneal edema or may require keratoplasty.[8] Longer duration of edema leads to corneal vascularization which can increase chances of graft rejection if keratoplasty is done in such cases.

Conservative management of DMD takes a longer duration of two to four months for spontaneous resolution of edema. Large tears may take even longer and eventually require keratoplasty. If corneal edema stays for a longer duration, it increases the chances of corneal vascularization, which further increases the chances of graft rejection in subsequent keratoplasty.[9]

The healing in cases of small tears happens by the sliding of the endothelial cells to cover the small defect, while in large DMDs with rolled edges, DM first attaches to the posterior stroma and then endothelial cells spread over the gap between the two broken edges.[10]

Suturing helps to decrease the gap between torn edges of the descemet's tear, which aids in faster absorption of the stromal fluid by the endothelial pump mechanism. The compression suturing apposes the DM against the stroma and it shows a similar effect to the belt buckle or encirclage.[11] Compression effect is created by the perpendicular sutures to DM tear or split similar to the principles of corneal tear repair. Both partial and full-thickness compression sutures with descemetopexy, are very effective for the management of acute hydrops in keratoconus.[11,12] We hereby report a technique of partial-thickness compression suturing with air descemetopexy for DMD during cataract surgery.

2. Materials and Methods

A retrospective review was performed for the cases of DMD following phacoemulsification or small incision cataract surgery which were managed intraoperatively.

2.1. Inclusion criteria

All nonplanar > 1mm size both peripheral and central DMD cases managed during phacoemulsification or small incision cataract surgery with partial thickness suturing and descemetopexy with air were included in the study. All eyes included were virgin eyes.

2.2. Exclusion criteria

Any cases with any corneal ectasia, history of refractive surgery or cases with intraoperative complications such as posterior capsular tear or vitreous loss were excluded from the study,

The records of DMDs were noted as planar or non-planar as the planar DMD was defined as the separation of membrane 1 mm or less from its overlying stroma and on the contrary, the non-planar detachments were those in which there was more than 1 mm separation of the DM from its corresponding stroma.[13]

Based on the location of DMD, they were further subdivided into

1. Peripheral detachment which extended from the periphery and did not involve the central 3 mm zone of the cornea.
2. Central was considered if any part of DMD was falling in the central zone of 3 mm in diameter.

The timing and etiology of DMD were also noted such as at the time of making corneal sections, main entry or side ports, at the time of irrigation and aspiration or at the time of intraocular lens (IOL) insertion.

The site of DM tear was identified during the cataract surgery and suturing was done simultaneously at the respective step of the surgery. Before starting the suturing, the anterior chamber (AC) was filled with air to identify the air leakage on crossing the DM while suturing by the exit of the bubble from the needle tract.

2.3. Partial thickness compression suturing technique

As soon as the DMD was observed during surgery, the air bubble was injected in the AC against the DMD and external flattening or ironing of the cornea was done with iris repositor or back side of the canula to provide sandwiching to the DMD from the outside and inside the AC (Figure 1a). The suturing was performed with Monofilament 10-0 nylon sutures with the spatulated needle. The tip of the needle was passed through the stroma in a perpendicular direction to the DMD. The needle was placed perpendicular to the corneal surface and rotated through the intended area of DMD along the curve with as much as possible perpendicular orientation till the needle exited the cornea outside (Figure 1b). The sutures were taken across the area of DMD with normal margins on both extremes of DMD. The AC was inflated with air at all points of time while suturing and external corneal tapping or ironing was done to flatten the detached DM against the stroma. During the suturing proper care was taken to not to touch the DM and AC entry was avoided at all points of time. The peripheral part of DMD was sutured first followed by the central part of the cornea. The number of the sutures was according to the extent and size of the DMD. The sutures were taken optimally tight if they loosened intraoperatively and were revised accordingly. Intra-operatively the knots of the sutures were trimmed short and buried in superficial stroma. The merocele sponge was used to ensure the water tightness of the compression sutures. At the time of closure, a single full chamber air bubble was injected in all the cases to compress the DM from the endothelial side against the corneal stroma (Figure 1c). Proper care was taken not to keep the raised IOP while closure. A bandage contact lens

(BCL) was placed if required. After one hour of surgery, all patients were monitored for raised IOP. Only one patient got raised IOP to the tune of 28mmHg and that patient was started on Brimonidine and timolol combination, Rest had normal IOP.

3. Results

3.1. Demographics

A total of fifteen cases were identified including 11 females and 4 males. The average age was 67 (range 64-79) years. All patients involved in the study underwent uneventful cataract surgery on virgin eyes. All cases got foldable IOL implanted in the capsular bag.

3.2. Mechanism of DMD

All 15 cases involved in the study with DMD during phacoemulsification were caused by intra-operative trauma during the instrument insertion into a corneal wound either with a sinskey hook, IOL dialer, Irrigation or aspiration cannula or tip of the phacoemulsification probe during nucleotomy (Table1).

3.3. Location of DMD

3.3.1. Peripheral DMD

Five cases of peripheral DMD (not involving the visual axis) were recorded

3.3.2. Central DMD

Ten cases of central DMD (involving the visual axis) were identified.

The average size of non-planar DMD was 4 mm. 10 cases had DMD with scrolled margins.

3.4. Post-operative monitoring and treatment

On the first postoperative day the best corrected visual acuity (BCVA), intraocular pressure (IOP), Anterior segment optical coherence tomogram (AS-OCT), slit lamp examination (SLE) were done for all the cases. All the cases showed corneal edema at the site of the DMD. These patients were started with topical antibiotics and steroids (Moxifloxacin 0.5%+ Prednisolone acetate 1%) eight times daily, Sodium chloride five times daily and antiglaucoma and cycloplegics if required. Two patients got raised IOP with mild anterior uveitis which resolved at the end of one week. These patients were followed up on one week, two weeks and one month for BCVA, IOP, and SLE to observe the resolution of the corneal edema (Figure 2). AS-OCT was done in all the cases to observe the status of DM (Figure 3).

Eight patients achieved a BCVA of 6/6 at the end of one month. The rest of the seven patients got BCVA to the tune of 6/9. The astigmatism was noticed in most of the cases to the tune of the Spherical equivalent of 0.5 Diopter (D). In two cases it came out to be 1D where DMD was central and 4 mm in size. The corneas were clear in all the cases except two cases where very faint nebulomacular opacification of the cornea was observed. In all the cases DM was attached at 2 weeks. The sutures were removed one month after AS-OCT ensuring the complete attachment of DM.

4. Discussion

This case series highlights the varied presentations of DMD that were encountered during phacoemulsification surgery in patients more than 60 years of age. All were caused by instrumentation injuries occurring during surgery.

Mackool and Holtz classified Detachments as planar (DM and stromal separation less than 1 mm) and non-planar (DM and stromal separation greater than 1 mm). It was suggested that planar detachments may spontaneously resolve while non-planar detachments were less likely to reattach.[13] They didn't include the size or location of the detachment. Assia et al reported that larger detachments are more likely to involve the visual axis and non-planar. In this study all the DMDs were non-planar. The concept of a scrolled versus non-scrolled DMD has also been introduced by Assia et al.[14]

A non-scrolled detachment may spontaneously reattach if observed for an adequate duration. While these classification systems provide clinicians with guidance on the likelihood of spontaneous reattachment, they do not provide guidelines to determine whether surgical intervention is indicated or the timing for intervention. Modern-day cataract surgery in many ways can be considered a refractive procedure, with high patient expectations for rapid visual recovery.[15]

A DMD carries the risks of delayed visual rehabilitation as well as bullous keratopathy, which can cause pain and increase the risk of microbial keratitis and corneal scarring. Thus, prolonged observation of a central, planar detachment may not be ideal, highlighting the limitations of the existing classification systems and the need to modify it to better reflect the management strategies available to clinicians.

Samarawickrama et al proposed the classification of DMD into two categories: peripheral and central. Peripheral DMDs are small, with minimal central corneal edema and therefore conservative management can be adopted. They reported that the observation up to three months, balances the risks of surgical intervention against the risks associated with prolonged corneal edema. Early intervention was advocated in cases of DMD involving the central visual axis for the apposition of the DM to the overlying stroma. Air tamponade by using a 100% air fill for 10 minutes, followed by an air-fluid exchange leaving 80% residual air, dilating the pupil (to avoid pupil block) and positioning the patient supine for 2 hours was advised by Samarawickrama et al. Despite the size or position of the DMD, the

Table 1: Baseline demographics and characteristics of detacheddescemet's membrane (DMD)

S.No.	Age /Sex	Location of DMD	Timings of DMD	Size of nonplanar DMD (mm)	Scrolled / Non scrolled	BCVA 1 day	BCVA 1 Month	Time taken for resolution of corneal edema (weeks)
1	65/F	Central	IOL dialing	5	Non-scrolled	3/60	6/9	2
2	67/M	Central	IOL dialing	4	Scrolled	6/60	6/9	2
3	78/F	Central	Nucleotomy	4	Scrolled	3/60	6/9	2
4	68/F	Peripheral	I &A	4	Non-scrolled	6/36	6/6	2
5	75/F	Peripheral	Side port hydration	4	Scrolled	6/24	6/6	1
6	76/F	Central	Nucleotomy	3	Scrolled	6/24	6/6	2
7	79/F	Peripheral	I &A	3	Non-scrolled	6/36	6/6	1
8	79/M	Central	Nucleotomy	3.5	Scrolled	6/60	6/6	2
9	76/M	Peripheral	I &A	2.5	Non-scrolled	6/18	6/6	1
10	75/M	Peripheral	Side port hydration	3	Scrolled	6/18	6/9	1
11	69/F	Central	I &A	3	Scrolled	6/24	6/6	2
12	65/F	Central	IOL dialing	4	Non-scrolled	6/60	6/9	1
13	64/F	Central	I & A	2.5	Scrolled	6/18	6/6	2
14	72/F	Central	I & A	3.0	Scrolled	6/24	6/9	2
15	71/F	Central	Nucleotomy	3.0	Scrolled	6/24	6/9	2

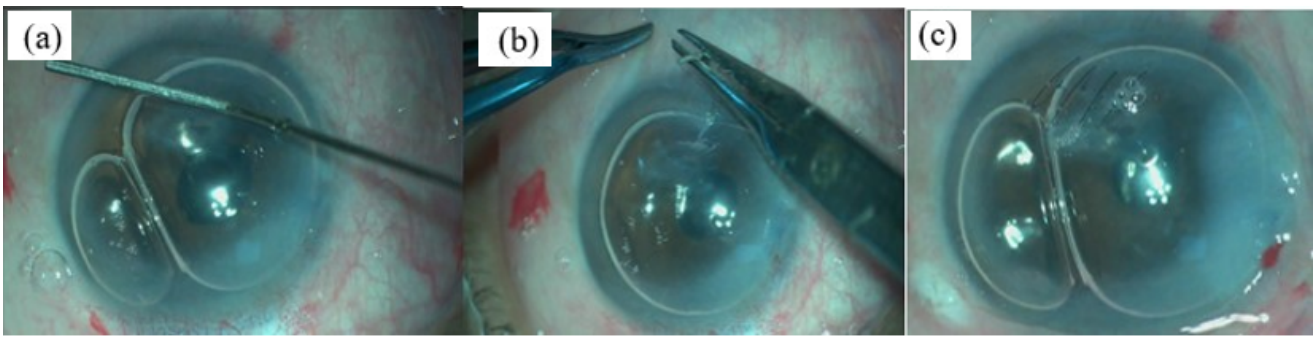

Figure 1: (a): Showing ironing of the cornea from the epithelial side against the air bubble at the site of descemet's detachment; **(b):** Demonstrating passing the needle perpendicular to the corneal surface; **(c):** Showing closure with air-filled anterior chamber.

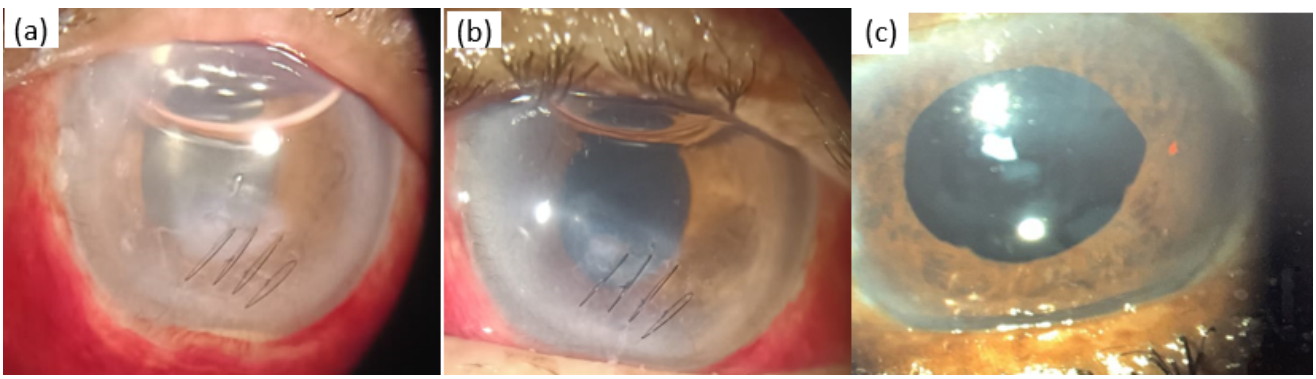

Figure 2: (a): Showing Sutured DMD with diffuse corneal edema on the first postoperative day; **(b):** Demonstrating reduced corneal edema on the second postoperative day; **(c):** Showing clear cornea with a faint nebulomacular corneal opacity at one-month follow-up

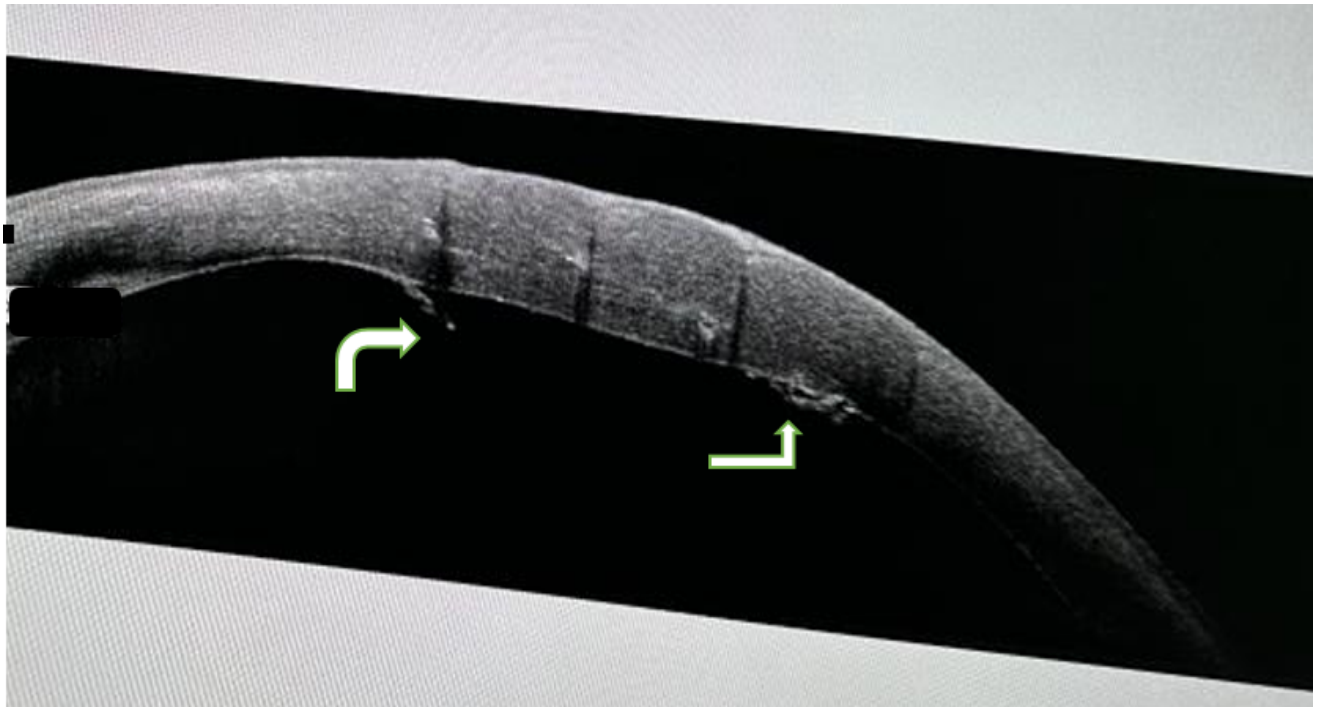

Figure 3: Showing healed Descemet's membrane under the suture tracts with arrows showing the area of primary descemet's detachment.

degree of endothelial cell trauma was a better prognostic indicator of the likelihood of irreversible corneal edema from endothelial cell failure.[16]

Scheimpflug and high-resolution optical coherence tomography imaging is a handy tool in helping to delineate the extent of the DMD.[17]

Partial-thickness compression sutures without descemetopexy can be a choice for acute hydrops in keratoconus. It would eliminate the possible adverse effects of full-thickness sutures and full chamber air.[17]

This novel partial-thickness compression suturing technique is of paramount importance in managing intraoperative non-planar DMDs which reduces the chances of corneal decompensation with bullous keratopathy.

5. Limitations

This is a pilot study with a very small sample size. The intraoperative DMD can be better monitored with intraoperative optical coherence tomography(iOCT) which was not available to us. We couldn't show the extent of intraoperative DMD as it was managed at the time of observation. The specular microscopy was not done as it was not available. All these patients had corneal degeneration which indicates poor endothelial pump function.

6. Strength of the Study

This was a very gentle technique of suturing and all these cases were more than 1mm size DMD which if left alone can lead to corneal decompensation. We got very good results without any kind of abnormal astigmatism. All patients in this series were more than 60 years of age which indicates poor endothelial cell reserves and poor endothelial pump. The corneal topography was also done which was unremarkable.

7. Conclusion

Partial thickness compression suturing with air desmetopexy in non-planar DMD is very helpful in the recovery of traumatic corneal edema during cataract surgery. It can avoid the complication of bullous keratopathy which eventually requires corneal transplantation. Prompt intraoperative recognition and its simultaneous management accelerates the resolution of corneal edema and enhances visual outcome.

8. Conflict of Interest

The authors declared no potential conflicts of interest

9. Source of Funding

No financial support.

10. Acknowledgment

Acknowledge my patients for their cooperation.

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Author biography

Anuradha Raj, Professor & HOD https://orcid.org/0000-0002-1142-0540

Rajnish Raj, Professor & HOD

Cite this article: Raj A, Raj R. Intraoperative partial thickness compression suturing for descemet's membrane detachment: A Novel technique. *IP Int J Ocul Oncol Oculoplasty* 2024;10(1):30-35.