Surgical Technique

Corset suture: A novel technique of overlay appositional continuous sutures with air tamponade for management of large acute corneal hydrops

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Management of large acute corneal hydrops (ACH) has always been a challenge. Various medical and surgical management options have been used, such as topical steroids, cycloplegics, antiglaucoma medications, antibiotics, Descemet's membrane reposition, and pre-Descematic sutures, for the management of acute hydrops, but have shown limited benefit. We hereby describe a novel technique of appositional continuous overlay sutures along with air tamponade for surgical management of corneal edema following large ACH. In this technique, the epithelium is scraped to visualize the stromal cleft, and then corneal marking is done to locate the suture placement site. Next, a continuous overlay, 10-0 nylon suture is passed in a crisscross fashion, just like the laces of a corset. A small paracentesis is made to lower the intraocular pressure. Stromal fluid is milked out using two iris spatulas, simultaneous suture tension adjustment is done, and the knot is secured. Appropriate anterior chamber tamponade is achieved using air, paracentesis is hydrated, and a bandage contact lens is applied. We noted complete resolution of corneal edema within 2 weeks of the procedure, with significant improvement in visual acuity.

Key words: Appositional suture, corneal hydrops, corset suture, overlay suture

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DOI: 10.4103/IJO.IJO_1006_23

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Acute corneal hydrops (ACH) is a rare complication of ectatic corneal disorders.[1,2] The pathogenesis is thought to involve stretching and rupturing Descemet's membrane (DM) and posterior stroma, with the resultant entry of the aqueous humor into the corneal stroma. This leads to the abrupt onset of pain, photophobia, and decreased vision.[3-5] Prolonged edema in large hydrops may lead to an increased inflammatory reaction and neovascularization, affecting the prognosis of subsequent transplantation procedures.[6-8]

Current modalities aim to achieve rapid resolution of corneal edema by DM reattachment using full-thickness or pre-Descematic sutures, with or without anterior chamber tamponade, using air or gas.[3-5,9-13] These modalities have their own shortcomings. Full-thickness sutures may result in wound leaks post surgery, increasing the risk of endophthalmitis and suture tract scars.[12,13] In corneas with large hydrops, stromal sutures have a risk of loosening and inadequate apposition of the DM tear. Pre-DM suture passage also becomes difficult due to the poor visibility of the anterior chamber in large ACH. To overcome these shortcomings, we proposed a novel technique of appositional overlay continuous sutures to bring torn DM edges close to each other along with air tamponade for the management of massive corneal edema following large ACH.

Material and Methods

We performed this technique on two large ACH patients who presented to us in June 2019 at our tertiary eye care services cornea department. The cases were managed using a novel corset suture technique. The study was approved by an institutional review board and followed the tenets of the Declaration of Helsinki. Informed consent was obtained. Both patients were asked for a detailed, relevant history. They underwent a complete ophthalmological examination, including best-corrected visual acuity (BCVA) measurement, slit-lamp examination, tonometry, and anterior segment optical coherence tomography (AS-OCT). Parameters such as DM break length, DM detachment depth, and initial corneal thickness were recorded preoperatively and postoperatively on each visit by using AS-OCT (Casia 2, Tomey Corp., Nagoya, Japan).

Technique

Under peribulbar anesthesia, first, the epithelium was removed over the hydrops area to aid visualization. The corneal surface

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Received: 17-Apr-2023 Revision: 09-Dec-2023
Accepted: 26-Dec-2023 Published: 08-Mar-2024

Cite this article as: Parmar GS, Agrawal A, Meena A, Mutha P, Gurnani B. Corset suture: A novel technique of overlay appositional continuous sutures with air tamponade for management of large acute corneal hydrops. Indian J Ophthalmol 2024;72:592-5.

was dried and marked with gentian violet to guide the passage of a 10-0 nylon continuous suture. Sutures were passed into the anterior stroma of the unaffected peripheral cornea, starting from the most proximal dot. This passage of 10-0 nylon suture creates a mesh of sutures over the edematous stroma. A small paracentesis was made, and the anterior chamber pressure was reduced. The intervening stromal fluid was milked out by ironing the edematous stroma from the periphery to the center by using two iris spatulas. The suture tension adjustment was done, and then knots were secured and buried. Finally, the anterior chamber was filled with an air bubble to achieve the appropriate tamponade [Fig. 1, Video 1]. After 15 minutes, air removal was done, leaving approximately 80% of the anterior chamber. A bandage contact lens was applied to the cornea at the end of the surgery.

The postoperative therapy consisted of 5% hypertonic saline eye drop (4 times a day) for 15 days, topical 0.5% moxifloxacin eye drop (4 times a day) for 15 days, and 1% prednisolone acetate (4 times a day) eyedrop, which was tapered over 4 weeks. Tablet acetazolamide 250 mg was used twice a day for 2 days. Suture removal was done at 4 weeks postoperatively.

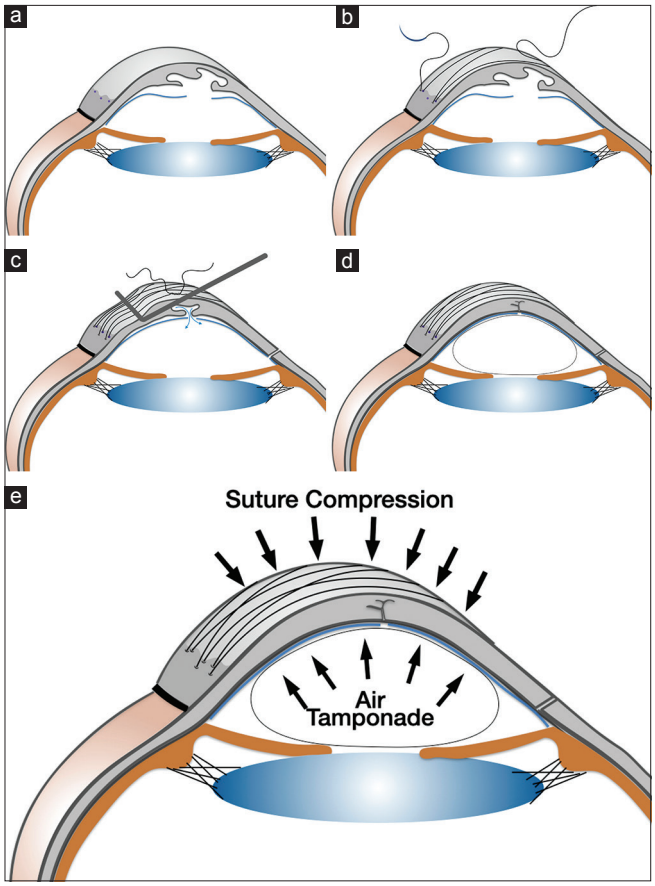

Figure 1: Schematic diagram showing surgical steps and mechanism of corset compression suture; (a) epithelial removal and marking of suture placement site; (b) placement of continuous 10-0 nylon suture in a crisscross manner (corset suture); (c) making of paracentesis with milking of stomal cleft (the direction of egress of fluid is shown by arrows); (d) a fully tightened corset suture with a buried knot (the complete closure of the stromal cleft and attached torn DM following air tamponade is visible); (e) illustration depicting the additive effect of compression suture and air tamponade resulting in a remarkable decrease in corneal edema and pachymetry

Results

Patient 1

A 15-year-old male complained of sudden vision diminution, pain, and redness in the left eye 8 days following blunt trauma. The BCVA was finger counting close to the face (FCCF) in the OS and 6/12 in the OD. Ocular examination revealed a presence of stage 2 KC in the OD according to the ABCD grading system using Oculus Pentacam (Oculus GmbH, Wetzlar, Germany).[14] In OS, there was the presence of corneal oedema that involved the central 8.5 mm of the cornea [Fig. 2e]. AS-OCT revealed that the length of DM separation was 4.82 mm, the depth of DM detachment was 0.69 mm, and the corneal thickness was 1.70 mm [Fig. 2a]. The corset suture with air tamponade was done as explained. No intraoperative complications were encountered. The post-operative decrease in corneal edema with an increase in corneal clarity was noticed. [Fig. 2f-h] Corneal thickness reduced to 682 µm at 4 hours [Fig. 2b] and 460 µm at 15 days [Fig. 2c] postoperatively, with a final corneal thickness of 476 µm [Fig. 2d], and BCVA improved to 6/18p on Snellen's visual acuity chart at 1 month postoperatively.

Patient 2

A 29-year-old male presented with sudden-onset painless diminution of vision in the OD for the past 13 days. He was a known case of stage 3 KC as per ABCD grading in the OS and had undergone deep anterior lamellar keratoplasty 3 months ago. The presenting BCVA was FCCF in OD and 6/9 in OS. On slit-lamp examination, there was a central corneal edema 94 of about 7 mm [Fig. 3e]. On AS-OCT, the size of the DM separation was 6.68 mm, the depth of the DM detachment was 1.62 mm, and the corneal thickness was 0.93 mm [Fig. 3a]. Post-intervention corneal thickness reduced to 604 µm with complete attachment of DM at 4 hours [Fig. 3b], 522 µm at 15 days [Fig. 3c], and 524 µm [Fig. 3d] at the end of 1 month. Corneal clarity increased as the thickness was reduced. [Fig. 3f-h] BCVA improved to 6/36 at postoperative 1 month. No complications were noted.

Discussion

Visual loss due to corneal edema in ACH is severe and may last for 5–36 weeks.[1,2] A rupture of DM along with the posterior-most stromal layer (Dua's layer) is decisive for corneal hydrops to occur.[5]

Basu *et al*. stated that the resolution of corneal hydrops by C_3F_8 gas tamponade seemed to involve two stages: reattachment of the DM to the posterior stroma and endothelial migration over the gap between the two broken ends of the DM.[15] Thus, all surgical modalities aim to hasten DM reattachment by air or gas tamponade and bring off torn edges of the posterior stroma or Dua's layer by pre-DM suture or full-thickness compression suture.

Recently, García-Albisua *et al*.[13] showed that the mean corneal edema resolution time by using a sole full-thickness suture was 4 weeks, with 3 (17.6%) out of 17 patients developing deep neovascularization and the same proportion having a positive Seidel test postoperatively. Earlier, Rajaraman *et al*.[11] had shown that combining intracameral C_3F_8 with compression

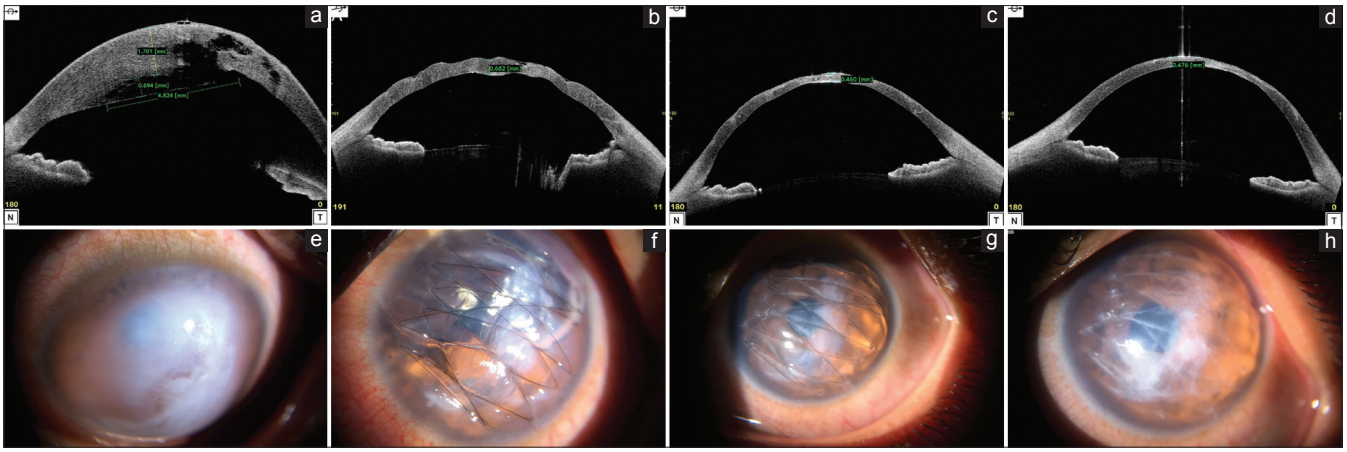

Figure 2: Anterior-segment optical coherence tomography and slit-lamp photograph of patient 1. (a and e) preoperative fluid cleft is visible; (b and f) 4 hours postoperative images, showing well-attached Descemet's membrane and marked decrease in corneal edema. Bumps (arrow) in corneal curvature are due to compression by suture; (c and g) decrease in bumps corresponds to a reduction in corneal thickness at 15 days post intervention; (d and h) 1-month postoperatively after suture removal, the cornea shows scarring

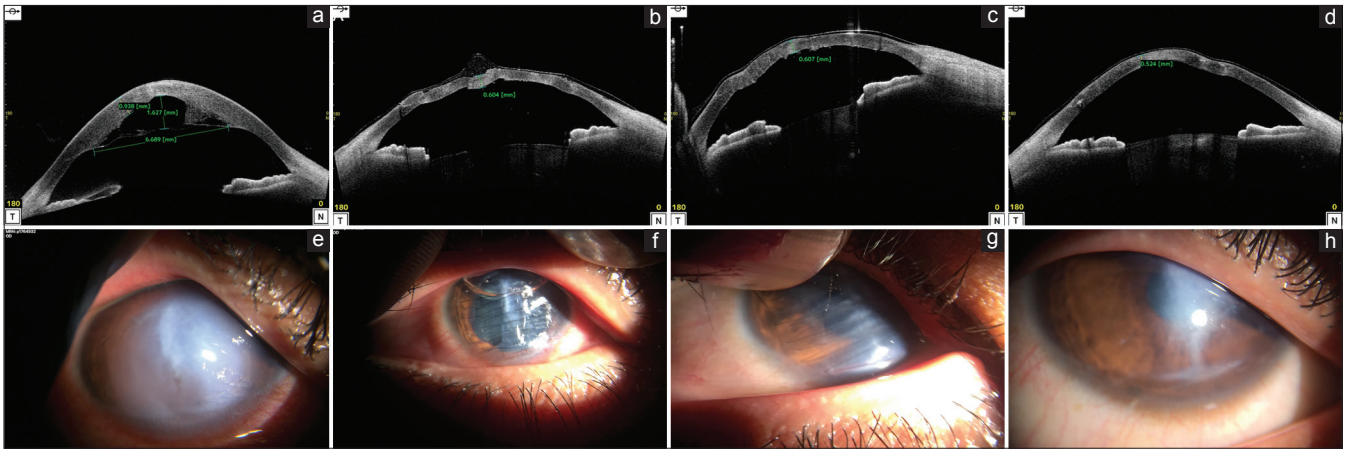

Figure 3: Clinical and anterior-segment optical coherence tomography photographs of the second patient are depicted in (a and e) at the time of presentation, (b and f) 4 hours after the intervention; (c and g) 15 days after the intervention; (d and h) 1 month post suture removal

full-thickness sutures over the hydrops area dramatically reduced the resolution of edema to 8.8 ± 4.9 days. In contrast, our technique showed faster resolution of corneal stromal edema, beginning at 4 hours, with a near total resolution within 24–48 hours. The compressive effect of the continuous overlay suture can be noted by the change in the cornea's contour (bump) [Fig. 1b], produced due to tension applied by the suture, visible throughout the thickness of the cornea in 4 hours postoperative AS-OCT images. These bumps resolve over 15 days as corneal edema reduces. The strength of the normal compact corneal stroma through which corset sutures are passed provides greater compressive force compared to full-thickness sutures passed through the loose edematous stroma.

Our technique is inspired by the corset used to shape the body by applying compression. We propose this innovative technique to manage keratoconus patients presenting with acute hydrops. Passage of the suture in the anterior normal corneal stroma gives the advantage of ease in performing the procedure. The number of suture bites depends on the size of the DM tear. Roughly one bite on each side suffices for a 1-mm tear. The risk of endophthalmitis, loosening of the suture, positive Seidel test, and a full-thickness stromal scar can be avoided by the passage of the overlay suture. Being a continuous property of corset suture has several advantages: first, uniform tension along the DM tear can be ensured easily by redistribution of sutures and hence the closure of the DM tear; second, a single knot is present, which makes it easy to secure and bury; and third, easy suture removal in the postoperative period. The absence of a full-thickness corneal scar may help with deep anterior lamellar keratoplasty once corneal hydrops resolve. In both cases, the corneal edema started to subside 4 hours after surgery, and by the 15th day, it had completely disappeared. The BCVA of both patients also improved significantly.

In both of our patients, there was some scarring at the level of Bowman's membrane along the suture line after suture removal [Fig. 1d]. This might be the result of pressure from the corset suture exerting on Bowman's membrane. We observed that this technique is extremely effective in the rapid resolution of edema without any unusual complications in corneas with large ACH. This technique can be used in all acute hydrops cases, especially in DM tears larger than 5 mm. The limitation

of our study is the small number of patients. Furthermore, the follow-up period was relatively short, and the possibility of long-term complications may not have been ruled out.

In conclusion, novel corset overlay continuous suture and air tamponade may become valuable tools in managing large ACH, leading to faster resolution of edema and better visual outcomes.

Acknowledgement

Department of Cornea and Refractive Services, Sadguru Netra Chikitsalya and Postgraduate Institute of Ophthalmology, Jankikund, Chitrakoot, India.

Financial support and sponsorship: Nil.

Conflicts of interest: There are no conflicts of interest.

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