Surgical Technique

A Novel Technique of Modified Continuous Blanket Suture for Amniotic Membrane Fixation in Severe Ocular Surface Diseases

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The human amniotic membrane (AM) transplantation (AMT) has been widely used to treat various ocular surface diseases (OSDs) because of its unique properties. The firm fixation of the AM to the ocular surface is a prerequisite for providing a stable basement membrane for epithelial cell migration and propagation before complete epithelialization is achieved. The literature describes several techniques to fix the AM. Traditional suture techniques for AM fixation are the interrupted suture, a continuous (or running) suture, or a combination of these techniques. Recently, sutureless techniques, such as tissue adhesives and diverse ring-AM complexes, have been introduced and tested in different studies. Cautery was also used in pterygium surgery. However, there are a number of complications and inherent drawbacks associated with those fixation methods, especially in cases of severe OSD. In severe patients, the AM could dissolve or be lost early because of serious inflammation. Some patients may need repeated AMT. Thus, it is necessary to develop new AM fixation techniques to overcome these drawbacks.

Since 2002, we have routinely used a modified continuous blanket suture (MCBS) technique to anchor the AM in more than 300 cases with various OSDs. In this article, typical cases are presented to demonstrate the application of these new techniques in different zones of ocular surface defects caused by severe OSD.

Methods

This study was approved by the review ethics committee of the Eye Hospital of Wenzhou Medical College, and all of the subjects or their legal guardians signed their written informed consent to participate.

The AM was thawed and trimmed to fit the size and shape of the lesion. The amnion patch was used to cover the entire ocular surface of all of the severe lesions, with the epithelial surface side up. The AM was sutured to the perilimbal episclera and to the bulbar conjunctiva using 2 circumferential 10-0 nylon sutures in the manner described here (Figure 1).

The first needle entered from the limbus at 9 o’clock (right eye) or 3 o’clock (left eye), passed through the episclera, and then exited from the bulbar conjunctiva at 2 to 3 mm. The suture was made...
perpendicular to the limbus in a radial fashion. The end was tied but not cut to allow for making the last knot. The second needle was also inserted from the limbus to the bulbar conjunctiva, as previously described. Rather than being tied, the distal end of the suture was passed down through the trailing end of the first knot, creating a T shape, with the horizontal line facing the limbus. The subsequent needles were inserted in a similar fashion. The AM was then flattened with a suture. The MCBS was run through the limbus for 360°, and 10 to 12 stitches were made. In the end, the last knot was tied with the trailing end of the first. Using this MCBS technique, the continuous blanket suture can form 2 to 3 loops around mass lesions for corneal and conjunctival defects (Video).

Results
Five representative patients were selected to evaluate the application and efficacy of these new techniques in detail. Their clinical characteristics are summarized in the Table.

Patient 1
A 54-year-old man experienced a liquid aluminum splash to the left eye, resulting in a severe thermal burn (grade III) with eyelid swelling, diffuse conjunctival congestion with chemosis, 360° limbal and conjunctival ischemia, and a large corneal epithelial defect with opaque stromal edema (Figure 5A). Visual acuity (VA) had decreased to hand movement/10 cm. Amniotic membrane transplantation with MCBS was performed after the necrotic tissues were removed (Figure 5B). Two weeks postoperatively, the patient had

Figure 2. Amniotic Membrane Transplantation for Fornix Reconstruction

A. Amniotic membrane transplantation for fornix formation was performed in a patient with an acute thermal burn (copper). B. Eight weeks after surgery, the lesions were restored and a functional fornix was obtained.

Figure 3. Amniotic Membrane Transplantation for a Traumatic Corneal Defect Without Perforation

A. A deep corneal stromal defect occupying more than 90% of the corneal thickness developed in the patient’s right eye as a result of hot scrap iron. B and C. Multilayer amniotic membranes were stacked to fill the stromal defect, 2 more pieces of amniotic membrane patch were anchored as a bandage using modified continuous blanket suture, and a simple shoelace suture was used. D. Complete epithelialization was observed within 3 weeks postoperation. A whitish scar tissue without neovascularization was observed in the corneal lesion.
obtained complete epithelialization and symptomatic relief. The superior cornea was relatively clear (Figure 5C). Four weeks after transplantation, AM dissolution was observed. The eye was quiet, with a stable and intact corneal epithelial surface. Superficial vessels were seen only around the peripheral cornea in the nasal quadrant (Figure 5D). At the end of the patient’s 6-month follow-up, his VA had improved to 20/40.

Patient 2
A 79-year-old man said he had foreign body sensation and the presence of an increasing claret mass in his left conjunctiva for the past year. His VA had decreased to 20/50, with a dense cataract in the involved eye. Examination revealed an elevated claret lesion nearly 360° around the limbus, except at the 3-o’clock region and the nasal bulbar conjunctiva (Figure 6A). Based on the pathologic biopsy results indicating conjunctival intraepithelial neoplasia, the lesion involving the conjunctival with a 2- to 3-mm lesion-free margin and corneal tissue was removed. A few interrupted 10-0 nylon sutures were placed to anchor the dissociated conjunctival margin to the shallow sclera. The AM was applied with the epithelial surface facing up to cover the whole cornea, the entire denuded conjunctiva, and part of the temporal bulbar conjunctiva. Finally, an amnion patch was secured first to the perilimbal sclera and then to the bulbar conjunctiva using MCBS, as just described (Figure 6B). Eight days later, corneal epithelialization and conjunctival vascularization were achieved (Figure 6C). Two months after AMT, the ocular surface reconstruction was completed, and the patient’s VA had improved to 20/30 (Figure 6D). There were no signs of recurrence 4 years after tumor excision.

Patient 3
In a 52-year-old woman, necrotic scleritis developed 2 weeks after pterygium surgery, with bare sclera in the right eye. The patient was treated with topical antimicrobial and prednisolone therapy for 2

Table. Clinical Data for 5 Patients Who Underwent AMT

<table>
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<th>Patient/Sex/Age, y</th>
<th>Eye</th>
<th>Diagnosis</th>
<th>Stage</th>
<th>Previous Therapy</th>
<th>Visual Acuity Before AMT</th>
<th>Visual Acuity After AMT</th>
<th>Follow-up, mo</th>
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<td>CB</td>
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<td>LP/10 cm</td>
<td>LP/10 cm</td>
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<td>4</td>
</tr>
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</table>

Abbreviations: AMT, amniotic membrane transplantation; CB, chemical burn; CIN, conjunctival intraepithelial neoplasia; CUP, corneal ulcer with perforation; ET, epithelialization time; F, female; HM, hand motion; LP, light perception; M, male; NS, necrotizing scleritis; OD, right eye; OS, left eye; PED, persisting epithelial defect; PS, pterygium surgery; TB, thermal burn.

A, Before surgery, the patient presented with a severe thermal burn with sclera perforation 2 weeks after injury. B and C, After 3 unsuccessful sclera sutures and 1 unsuccessful conjunctival autograft, the patient underwent amniotic membrane transplantation surgery with sclera graft. D, Four weeks after surgery, the amnion was removed along with the conjunctival epithelialization. Finally, ocular surface reconstruction was achieved.

Figure 4. Slitlamp Photographs Illustrating the Amniotic Membrane Sutured to the Perilimbal Episclera and the Conjunctiva Covering the Entirety of the Lesion Sites and Part of the Nasal Corneal Surface
weeks without any improvement. Examination revealed a large area of deep scleral ulceration with exposed uvea extending 2- to 3-mm posterior from the limbus between the 1-o’clock and 4-o’clock positions, surrounded by active conjunctival inflammation (Figure 7A).

\[\text{Figure 5. Slitlamp Photographs of Patient 1 (Thermal Burn), Who Underwent Amniotic Membrane Transplantation Using Modified Continuous Blanket Suture}\]

\[\text{Figure 6. Slitlamp Photographs of Patient 2, With Amniotic Membrane Covering a Large Defect Following the Excision of Conjunctival Intraepithelial Neoplasia}\]

B-scan ultrasonic tomography showed choroidal detachment in the inferotemporal quadrant. The VA deteriorated to 20/200.

During surgery, the necrotic scleral tissue was removed and replaced with a preserved sclera graft (Figure 7B). A conjunctival au-
togram was then made. Because the conjunctiva could only cover parts of the sclera graft, an amnion patch was fixed to the normal perilimbal episclera and to the bulbar conjunctiva using MCBS (Figure 7C). Complete epithelialization occurred in 3 weeks. All of the patient’s symptoms were eased 1 month after the surgery. No complications were found at the 2-year follow-up visit; the right eye was quiet, and VA remained stable at 20/67 (Figure 7D).

Patient 4
A 42-year-old man experienced a hot aluminum splash to the left eye, resulting in severe thermal burns (grade IV), VA deterioration to 20/500, and a shortened lower fornix. Treatment involved AMT combined with fornix formation. The AM was used to cover the entirety of the ocular surface lesions up to the lid, and it was anchored to the perilimbal episclera using MCBS for 360° from the 3-o’clock position. The suture proceeded down to the fornix with 1 or 2 bites, rather than being tied. The AM was anchored in the fornix using MCBS to the episclera and the tarsus alternately. To ensure a completely horizontal line for the T suture placement to induce a deeper fornix, the needle entered from the fornix basement and exited at the episclera or the tarsus. In the end, the edge of the AM was secured to the skin surface of the lower palpebral margin using a 10-0 nylon suture placed in the MCBS manner (Figure 8A).

Three months after surgery, fornix reconstruction was obtained (Figure 8B). At the end of 2 years of follow-up, the patient’s VA improved to 20/50, with a correction of +5.00−9.00 × 150. The ocular surface was stable, and complete epithelialization was achieved, although a small symblepharon formed at the 6-o’clock and 7-o’clock positions. Ultimately, the patient successfully regained a fornix with favorable anatomy and normal function.

Patient 5
A 51-year-old man had developed a 2-mm-diameter spontaneous, sterile central corneal fistula in his right, silicone-oil dependent eye...
with calcified band keratopathy, and silicone oil had leaked from the corneal fistula. The intraocular pressure was Tn-3, and the VA was light perception. With these abnormalities, the patient was a poor candidate for conventional corneal transplantation. He was initially treated with conjunctival autograft to tamp and cover the ulcer; however, after 2 weeks, the patient showed no response to the treatment (Figure 9A).

Multiple layers of AM patches were stacked one above the other to fill the corneal defect, and a double application of AM was made. The inner layer was cut to larger than the corneal ulcer to cover both the ulcer zone and the nearby healthy tissue. The outer layer was then laid over the entire cornea and secured using MCBS and a 10-0 nylon suture. The suture end was not tied to permit the use of a simple shoelace suture as a bandage to press the AM into the corneal fistula zone. The last knot was tied with the first knot (Figure 9B).

Three weeks after AMT, the deep amniotic pieces were incorporated into the corneal stroma. The perforation site of the right cornea was sealed (Figure 9C). The intraocular pressure had recovered to within a normal range. Seven months later, the cornea was healing well, with no thinning of the graft-host junction at the site of the previous corneal fistula. During the 2-year follow-up, corneal perforation did not recur. Nevertheless, the severity of the initial injury led to a less fortunate outcome, with an opaque and vascularized cornea in the right eye (Figure 9D).

### Discussion

Amniotic membrane transplantation has been found to be a safe and effective treatment modality for OSDs. Meticulous membrane fixation high on the ocular surface is technically challenging. Various surgical techniques have been developed to fix the AM. The conventional suture techniques mainly include interrupted suture, running suture, or a combination of both. Although these techniques have been successfully used for several ophthalmic applications, complications are usually inherent. Patches can fall off early because of membrane shrinkage and movements of the eye and palpebral tertia. Too many suture ties can incite tissue growth, thereby inducing a granulomatous foreign body reaction and patient discomfort. Surgery-induced astigmatism is always seen. Additionally, the freshly epithelialized surface can be reinjured by AM sliding. Recently, tissue adhesives and a polymethylmethacrylate ring–AM complex have been reported in the management of OSDs. However, despite several advantages over the use of sutures, tissue adhesive use presents several inherent complications and drawbacks.

We first used the MCBS technique to anchor AMs in 2002 to secure the AM patch more firmly and for a longer period. Our clinical results suggest that this technique has advantages over traditional suture methods in terms of patch security and postoperative comfort. For example, MCBS could tightly attach the membrane to the ocular surface with little or no movement, which could minimize postoperative management. Because the sutures are placed into the conjunctiva in cases of cornea diseases, trace scarring from sutures can be avoided and surgery-induced astigmatism can be minimized. The MCBS method leads to rapid reconstruction of the ocular surface and provides a surface conducive to further procedures such as autolimbal and allolimbal transplantation and keratoplasty. It can prolong the residual time of AM above the eye and can improve the melting and absorption times of the AM without using a bandage contact lens. Consequently, all membranes remain intact until the ocular surface completely re-epithelializes.

The MCBS technique allows a deeper fornix to be obtained during fornix reconstruction. Compared with previous techniques, the amnion was anchored more firmly and with a better aesthetic ap-
pearance when attached to the tarsus than on the skin surface of lid margin. In addition, a simple shoelace suture can be applied easily and quickly using this modified fixation method to produce a multilayered membrane for filling corneal ulcers with or without perforation.18

In conclusion, AMT with MCBS is an effective surgical modality for managing severe OSDs. This simple suture method allows the convenient manipulation of the AM patch, which could promote the clinical use of AMT and prepare the eye for subsequent corneal transplantation. However, limitations regarding this study remain, and further comparisons of this modified surgery technique with traditional AMT suturing techniques and prolonged follow-ups would provide better insights.

REFERENCES