ANTERIOR LENS CAPSULE IN THE MANAGEMENT OF CHRONIC FULL-THICKNESS MACULAR HOLE

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Purpose: To report the use of anterior lens capsule flap transplantation in two cases with chronic full-thickness macular hole (MH).

Methods: Case series.

Results: Two cases of chronic MH with a new treatment approach were reported. In the first case, a 66-year-old man presented with a chronic idiopathic MH in the left eye for 2 years. Presenting visual acuity was hand motion. The patient underwent phacoemulsification and vitrectomy with anterior lens capsule flap transplantation in the MH. At 5 months postoperatively, the visual acuity was 20/200 with MH closure. In the second case, a 68-year-old woman presented with decreased visual acuity for 2 years. Her visual acuity was hand motion in the right eye. The patient underwent phacoemulsification and vitrectomy with anterior lens capsule flap transplantation in the MH. Visual acuity improved to 20/400 with reduction in the MH diameter. Vision and MH diameter remained stable over 5 months postoperatively.

Conclusion: Lens capsular flap transplantation is useful in closing chronic MH in the short term.

REFERENCES

Pars plana vitrectomy with posterior hyaloid removal, internal limiting membrane (ILM) peeling, and gas tamponade has become the standard surgical treatment technique for full-thickness macular hole (MH). Although the closure rate of idiopathic MH may reach 90% or higher, approximately 10% of cases do not resolve after vitrectomy.¹ Some have cautioned against surgery for chronic MH because of poor visual prognosis and anatomical failure, and other studies reported improved vision in up to 70% of patients.² Michalewska et al³ initially reported the inverted ILM flap technique for large MH and MH in highly myopic eyes with poor prognosis for closure after a single procedure. Modifications to the original inverted ILM flap technique have been described. In the temporal inverted ILM flap technique, a 2-disk diameter ILM is removed from the temporal side of the fovea and inverted to cover the MH, leaving the nasal ILM in place.³ This technique may decrease the risk of surgical trauma and dissociated optic nerve fiber layer appearance with the same anatomical and functional results compared with the original inverted ILM flap technique.³

The physiologic lens capsule is a basement membrane for lens epithelial cells and is composed mainly of proteins, such as Collagen IV, heparan sulfate proteoglycan, and fibronectin.⁴ ⁵ The thickness of the human anterior lens capsule increases with age from approximately 15 μm to 20 μm.⁴ ⁵ A recent study demonstrated that lens capsular flap transplantation with ILM peeling may close the MH and improve
visual outcomes in the majority cases of refractory MH. We report two cases of chronic MH in which anterior lens capsule flaps were injected into the hole without ILM peeling to achieve hole closure.

Surgical Technique

Conventional phacoemulsification was performed with brilliant blue dye to stain the lens capsule. A standard 23-gauge pars plana vitrectomy was performed. The capsular flap was harvested from the anterior lens capsule. The anterior capsule was used as the free flap. The flap was created and trimmed so that is was a little larger than the MH and was injected within the hole with a modified 23-gauge needle (Figure 1). No effort was made to select a specific side of the flap to place against the retinal pigment epithelium. The flap was aspirated into the 23-gauge needle (Figure 2) and was then gently grasped for delivery into the vitreous cavity through a 20-gauge trocar. With the tip of the needle, the edge of the hole was gently lifted to create a space for leaving the flap toward the base of the hole. The flap was then released from the needle and allowed to gently settle on the posterior retinal surface without any effort. Proper position was secured by trapping the edge of the MH and was removed, and fluid–air exchange was performed. The intraocular pressure was maintained at 30 mmHg, and fluid was aspirated slowly. Complete fluid–air exchange did not affect the position of flap once it was in place. Proper position of the flap is indicated by the blue spot at the MH at the end of the surgery (Figure 3). Gas tamponade was performed with 20% sulfur hexafluoride (SF6). Patients were asked to remain prone or maintain a head down position for 1 week.

Case Reports

Case 1

A 66-year-old man was referred for metamorphopsia and decreased vision in his left eye for 2 years. The best-corrected visual acuity was hand motion. Any history of ocular or systemic disease was negative. Result of anterior segment examination was unremarkable. Fundoscopy indicated a MH in the left eye, and the posterior vitreous was attached. Spectral-domain optical coherence tomography (OCT) (Spectralis, Heidelberg Engineering, Inc, Heidelberg, Germany) indicated a full-thickness Stage III MH with perifoveal cysts and a base diameter of 905 μm (Figure 4A). One month after the initial evaluation, the patient underwent phacoemulsification and 23-gauge pars plana vitrectomy combined with anterior lens capsule flap insertion into the MH in the left eye. Spectral-domain OCT indicated that the flap covered the MH and remained in position at 1 week postoperatively (arrows, Figure 4B). By 2 weeks postoperatively, both edges of the MH had progressed centrally with the formation of a thick wall beneath the flap and smaller perifoveal cysts (Figure 4C). At Week 4 of MH closure, a partial defect remained in the inner segment/outer segment line (Figure 4D). At postoperative Week 5, the defect in the inner segment/outer segment line resolved, and best-corrected visual acuity improved to 20/200 (Figure 4E).

Case 2

A 68-year-old woman was referred with a chief complaint of decreased visual acuity in the right eye for 2 years. The best-corrected visual acuity was hand motion. Fundus examination indicated a full-thickness MH in the right eye, with posterior vitreous detachment. Spectral-domain OCT indicated a full-thickness Stage IV MH (Figure 5A). The patient underwent phacoemulsification and 23-gauge pars plana vitrectomy combined with anterior lens capsule flap transplantation into the MH. Spectral-domain OCT indicated that the flap covered the MH and remained in position (yellow arrows) at 1 week postoperatively (Figure 5B). By 2 weeks postoperatively, both edges of the MH had progressed centrally with the formation of a thick wall beneath the flap (Figure 5C). At Week 4 of MH closure, a partial defect in the inner segment/outer segment line remained (Figure 5D). At 5 weeks postoperatively, the defect in the internal retinal layers resolved, and best-corrected visual acuity improved to 20/400 (Figure 5E).

Fig. 1. A front (A) and side (B) view of 23-gauge modified needle. A 23-gauge needle was modified by using a blade breaker or needle holder to bend the needle tip and cut it to decrease edge sharpness while holding the bevel up. Then, the tip was bent 30°.
Discussion

Vitrectomy with or without ILM peeling is commonly used to treat MH, and although the closure rate is high, persistent MH remains a problem in chronic cases. Insertion of ILM free flap into the hole has been advocated to facilitate hole closure in refractory cases. However, the technique of peeling the peripheral ILM may be surgically challenging in cases that have undergone previous ILM peeling within the arcade or when only shreds of ILM can be obtained. Additionally, the ILM fragments tend to float into the vitreous cavity, and the flap can be easily lost during manipulation.

Recently, Chen and Yang published a case series of persistent MH where anterior or posterior lens capsule fragments were plugged into the MH for closure. In our technique described here, the placement of the crystalline lens anterior capsule flap seems to provide an alternative for the treatment of chronic MH.

The advantages of our technique compared with that of Chen and Yang are that the removal of ILM is not necessary, a complete flap is used that can be easily visualized during follow-up by OCT, and a modified 23-gauge needles allows placement in the bed of the MH edge without stopping infusion during the implant, ensuring that it will remain in place postoperatively.

The anterior lens capsule is an avascular basement derived from the ectoderm, whereas the sclera is derived from the mesoderm. These tissues are derived from different blastoderms and do not adhere to each other. The anterior lens capsule is autologous; it contains no living immunogenic cells, and hence, tissue rejection should not occur.

Lee et al reported that the permeability of Bruch membrane was similar to human anterior lens capsule. The permeability of the anterior lens capsule combined with its cell growth promoting properties indicates that the anterior lens capsule is a promising replacement for Bruch membrane.

The encouraging results of the two cases documented in this series are the result of the following properties of the anterior capsule: 1) fibronectin may serve more so as a cell signaling molecule rather than as a structural component of basement membranes. It has been proposed that fibronectin may play a role in lens wound healing and posterior capsule opacification because it is released from lens epithelial cells; 2) the capsule is also considered a reservoir for growth factors that contribute to lens development. Growth factors sequestered in the lens capsule must be
released before binding to their respective cell membrane receptors. Matrix metalloproteinases, which have endopeptidase activity, combined with tissue inhibitors of metalloproteinases regulate the release of growth factors from basement membranes and participate in basement membrane remodeling; Collagen IV is ubiquitous in basement membranes, including the lens capsule. Collagen IV forms an

Fig. 4. A. Spectral-domain OCT of a Stage III MH. B. A week after the surgery demonstrate that the flap remain in place within the hole (arrows). C. Two weeks after the surgery, MH edges are closer; note absorption of the perifoveal cyst. D. The hole closed 3 weeks postoperatively, and best-corrected vision improved from hand motion to 20/400. E. Spectral-domain OCT 4 weeks postoperatively indicates MH closure; the size of MH was comparatively smaller than preoperatively. Best-corrected vision improved to 20/200 (Stage III MH).

Fig. 5. A. Spectral-domain OCT of a Stage IV MH. B. One week postoperatively, the flap remains steady inside the hole (arrow). C. Two weeks postoperatively, MH edges are closer. The size of the MH was comparatively smaller than preoperatively. D. The hole closed at 3 weeks postoperatively (right). E. Macular hole closure at 4 weeks. Visual acuity improved to 20/400 (Stage IV MH) 2 months postoperatively.
integrated network within the laminin scaffold, providing the required strength and stability and can contribute to the absorption of perifoveal cysts; and 4) the human anterior capsule is a potential scaffold for ex vivo expansion of limbal epithelial cells, a crucial tool for ocular surface reconstruction.

We believe that these properties allow the anterior capsule to theoretically provide a scaffolding or template for fibroglial proliferation to repair MH without ILM removal. A possible mechanism for this procedure that cause MH closure include relief of traction (anterior and posterior) and stimulation of fibroglial proliferation to plug the hole. Histopathologic evidence indicates hyperplastic retinal pigment epithelial cells and fibroglial cells associated with spontaneous MH closure.

The limitations of this report are the small number of patients, short-term follow-up, and lack of a control group with MH and cataract surgery alone or MH surgery alone. However, this is the first case series using anterior lens capsule to treat persistent MH without removing ILM. We found that the capsular lens flap is useful in closing chronic MH. In addition, our technique and instrumentation is a promising method to transplant tissue into focal retinal defects, which may play a role in treating other disorders with tissue transplant of retina or retinal pigment epithelium under the retina. A prospective study with a larger number of patients and longer follow-up is necessary to further establish the advantages of this technique and determine whether there are long-term complications.

**Key words:** anterior lens capsule, chronic macular hole, vitrectomy, internal limiting membrane peeling, gas tamponade.

**References**