

Surgical Removal of the Internal Limiting Membrane for the Treatment of a Macular Hole

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Background: To evaluate the efficacy of internal limiting membrane (ILM) peeling in the treatment of a macular hole.

Methods: The ocular evaluation included Snellen visual acuity, a slit-lamp examination, indirect ophthalmoscopy, and contact lens biomicroscopy. The macular holes were confirmed using a Watzke-Allen slit beam test. Surgery consisted of a standard 3-port vitrectomy under local anesthesia. The vitreous was removed, and the macular ILM was peeled by creating a small opening and a tear in the ILM with a bent 22-gauge needle around the inner margin of the vascular arcade. The ILM flap was then grasped with end-gripping forceps, and a circular capsulorrhexis maneuver was initiated. Next, gas-fluid exchange and internal tamponade with 10% C3F8 were performed, followed by postoperative face-down positioning.

Results: Thirty-six eyes in 36 patients with idiopathic macular holes from stages 2 to 4 were included. The average follow-up time was 8.9 months. The holes were completely closed in 33 eyes (92%), and visual acuity was improved in 26 eyes (72%). Ten eyes were pseudophakic, 24 of the 26 phakic eyes had an increased density of the cataract after surgery, which was not detected in 2 cases. One of the patients had vitreous hemorrhage and hyphema; no retinal detachment or retinal tear was found in this study.

Conclusion: Surgery for macular holes using ILM peeling has a high anatomical and functional success rate.

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Key words: macular hole, internal limiting membrane peeling.

There was no effective treatment of macular holes until the early 1990s. In 1991, Kelly and Wendel reported the successful closure of a macular hole with the use of pars plana vitrectomy with gas-fluid exchange.⁽¹⁾ Since then, the results of hole closure and visual improvement have greatly advanced.

Autoserum has been used as an adjuvant to create a permanent seal at the edge of the holes.⁽²⁻⁴⁾

The internal limiting membrane (ILM) is the basement membrane of Muller cells.⁽⁵⁾ It may be involved in the pathogenesis of disorders affecting the vitreomacular interface, including the epiretinal

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membrane, vitreomacular traction, and macular holes.⁽⁶⁻⁸⁾ According to the pathogenesis, surgical peeling of the internal limiting membrane ensures complete removal of the overlying epiretinal membrane adjacent to the macular hole.⁽⁹⁾ Tangential macular traction is simultaneously relieved. Some reports also demonstrated that a vitrectomy with macular ILM removal and gas injection is a more-effective surgical procedure for healing a macular hole.⁽⁹⁻¹¹⁾

In this study, we report on the surgical results of a prospective series of 36 consecutive eyes of idiopathic full-thickness macular holes. All eyes underwent a complete vitrectomy and removal of the macular internal limiting membrane. At the end of the surgery, vitreous cavity was filled with 10% C3F8 and followed by face-down positioning.

METHODS

Patients who had developed stage 2, 3, or 4 macular holes and who desired to achieve closure of the macular holes were considered for entry into this study. The preoperative best-corrected visual acuity of all patients was equal to or worse than 20/50. The ocular evaluation included Snellen visual acuity, a slit-lamp examination, indirect ophthalmoscopy, and contact lens biomicroscopy. The macular holes were confirmed using the Watzke-Allen slit beam test. The stage of the hole was determined by contact lens biomicroscopy. The following criteria were monitored preoperatively: age, gender, refraction, best-corrected Snellen visual acuity, and the presence of posterior vitreous detachment. The following were recorded intraoperatively: the presence of posterior vitreous detachment, the presence of an epiretinal membrane, and intraoperative complications.

Surgery for macular holes consisted of a standard pars plana surgical technique with a 3-port system under retrobulbar anesthesia. After removal of the central vitreous, suction was increased (to 300 mmHg), and the vitrectomy probe was used to identify the posterior hyaloid. When the probe adjacent to the optic disc engaged the posterior vitreous, we elevated the probe and separated the vitreous from the inner retinal surface, producing posterior vitreous detachment. The detachment of the hyaloid from the retina was confirmed by the appearance of a floating Weiss' ring. We removed as much of the vitreous as

possible to create room for the tamponade gas.

For ILM peeling, the tip of a disposable 22-gauge needle was bent to form a small hook. We used this hook to create a small opening and tear in the ILM around the inner margin of the vascular arcade (Fig. 1A). The tear was sometimes enlarged with a Tano diamond dusted scraper (Fig. 1B).⁽¹²⁾ Then, the tear of the internal limiting membrane was

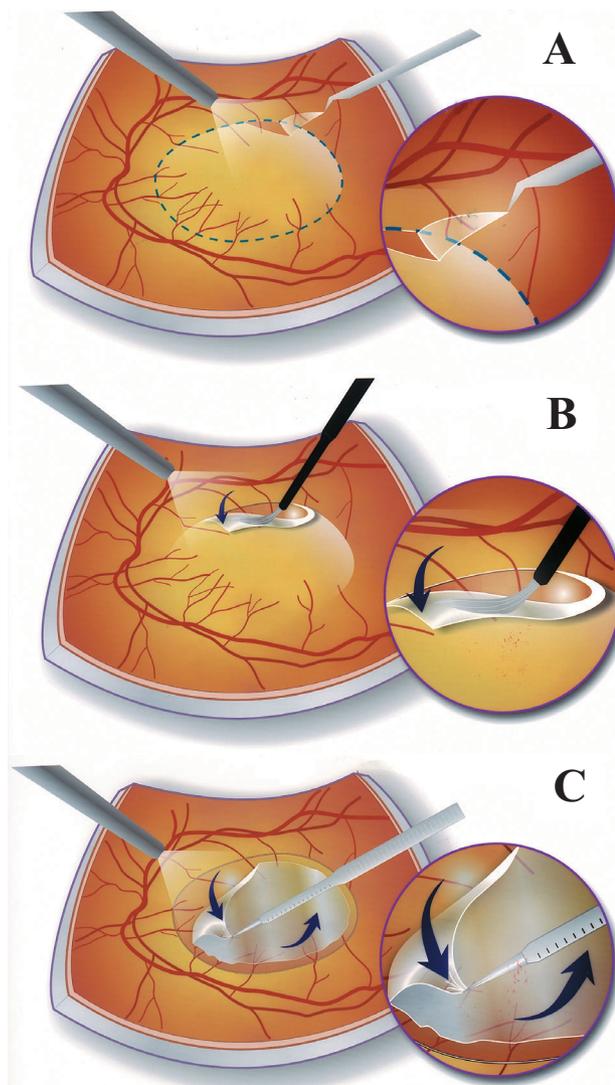


Fig. 1 (A) The bent tip of a 22-gauge needle served as a hook to create a small opening and tear in the ILM around the inner margin of the vascular arcade. (B) The tear was enlarged with a Tano diamond dusted scraper. (C) The tear of the internal limiting membrane was grasped with 25-gauge end-gripping forceps, and a circular fashion maneuver was initiated.

grasped with 25-gauge end-gripping forceps, and a circular fashion maneuver was initiated (Fig. 1C). The ILM flap sometimes tore during the maneuver; if this occurred, we engaged the margin of the ILM again with or without using the Tano diamond dusted scraper and completed the procedure. The ILM was usually removed from an area extending to the vascular arcade of the macula.

The entire retina was examined with a wide-angle lens for iatrogenic retinal breaks or detachment. If breaks or lattices were found, photocoagulation was applied to prevent further complications. Air-fluid exchange with filtered room air was performed after photocoagulation. The openings of the sclera were closed with scleral plugs, and another 10 min was allowed to elapse before aspirating the residual vitreous fluid. The air-filled vitreous cavity was flushed with 20 ml of 10% C3F8, followed by postoperative face-down positioning for 7 days. Patients were examined on postoperative days 1, 7, and 21, and monthly thereafter.

RESULTS

In total, 36 eyes in 36 patients (21 women and 15 men, aged from 42 to 78 years) with macular holes from stages 2 to 4 were included. In these patients, 5 eyes contained stage 2, 16 eyes contained stage 3, and 15 eyes contained stage 4 macular holes. All complained of decreased vision, and were diagnosed as having idiopathic macular holes. The average postoperative follow-up time was 8.9 (range, 6 to 14) months. The removed specimens were examined by electron microscopy to confirm that the specimen was indeed consistent with the retinal ILM. A photograph by electron microscopy showed a smooth vitreal surface and an irregular outer surface (Fig. 2). This demonstrated that the tissue removed during the operation was the retinal ILM.

The hole closed as early as 7 days after surgery (Fig. 3). The hole was successfully closed with a single surgery in 33 eyes (92%), and visual acuity improved in 26 eyes (72%). Final visual acuity was unchanged in 5 eyes (14%) with successful hole closure. The other 5 eyes (14%) had worse visual acuity as compared to the preoperative vision, including 2 with unsuccessful hole closure (Fig. 4). These 2 eyes for which the procedure was unsuccessful were



Fig. 2 Photograph by transmission electron microscopy of peeled specimens demonstrating the characteristic of ILM, the smooth vitreal surface, and irregular outer surface. (magnification, \times 2500)

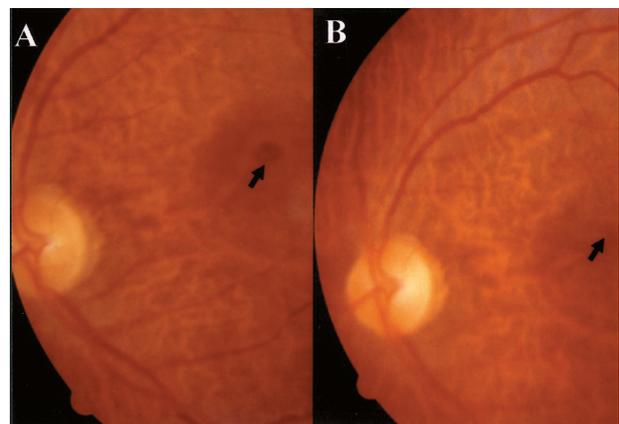


Fig. 3 Lane A. Preoperative full-thickness macular hole. Lane B. The hole closed 7 days after surgery. An air-bubble can still be seen at the top of the photograph. Arrows indicate foveal sites.

stage 4 macular holes. Ten eyes were pseudophakic; 24 of the 26 aphakic eyes had increased opacity of the cataract after surgery. One of the patients developed vitreous hemorrhage and hyphema postoperatively, but no retinal tears or detachment occurred in this study.

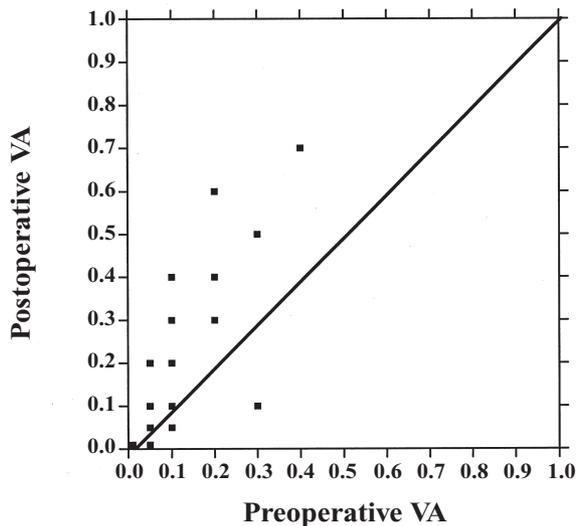


Fig. 4 Final visual acuity in 36 eyes after ILM peeling for macular holes. The visual acuity improved in 72% of eyes after surgery. *VA: visual acuity.

DISCUSSION

The formation of idiopathic macular holes was suggested by Gass in 1988 to be the result of tangential traction on the fovea.^(13,14) After this important observation, retinal surgeons focused on closure of macular holes by removing the posterior cortical vitreous.^(6,7,15,16)

In 1991, Kelly and Wendel reported a 58% success rate in closure of macular holes by the use of pars plana vitrectomy with gas-fluid exchange.⁽¹⁾ The success rate improved from 60% to 80% in the past decade with more-aggressive membrane peeling and long-term gas tamponade.^(1,11,17,18) The closure rate was even claimed to be 100% after the introduction of ILM peeling.⁽¹⁹⁻²²⁾ The purpose of this study was to report our initial experience and results of intraoperative ILM peeling in idiopathic macular

holes. The rate of hole closure was 92% in this study, which is comparable with a similar study.⁽¹⁹⁻²²⁾ Seventy-two percent of patients had better visual acuity after surgery. The improvement in visual acuity was less than that of other reports. The preoperative visual acuity and the stage of the hole are factors which influence final visual acuity.⁽²³⁻²⁵⁾

The possible role of the ILM in the formation of macular holes is uncertain, but it may be a passive element. The most-recent hypothesis by Gass suggests a primary role of degeneration of the Muller cone-vitreous cortex interface followed by glial migration, proliferation, and contraction.⁽²⁶⁾ The ILM is the basement membrane of Muller cells and may provide a barrier function, excluding retinal glial elements from its inner surface. The ILM may play a part in tangential surface traction after initiation of a hole. The exact pathogenesis of macular holes is still being debated.

Recently, indocyanine green (ICG) has been used to stain the ILM during an operation because the ILM is not easy to identify under surgical microscopy. The reported study showed that ICG did facilitate peeling of the ILM during the operation. They also claimed there was no evidence of ICG toxicity.⁽²³⁾ However, apprehension about ICG toxicity to the retina was reported. An animal study showed that ICG can damage the morphology and function of the retina at certain concentrations.⁽²⁷⁾ In this study, we show successful ILM peeling without ICG staining.

Some reports have suggested that an adjuvant including autologous serum, platelets, or a plasma-thrombin mixture can help improve the results of macular hole surgery.^(22,28,29) Another study showed that there is no strong evidence that adjuvant therapy used at the time of surgery results in improved surgical outcomes.⁽³⁰⁾ In this study, we used no adjuvant during the operation. We believe that the surgery itself and membrane peeling of the ILM will produce sufficient cytokines to seal the holes. Our anatomic success rate was no lower than those of previous studies using adjuvant therapy.^(31,32)

The final visual acuity of this study was no better than those of similar previous studies.^(10,23,24) The main reasons were the postoperative cataract formation and the fact that 42% of the eyes were stage 4 macular holes. Some of the previous studies simul-

taneously performed cataract and macular hole surgery. The visual acuity will certainly improve in some patients even without macular hole surgery. In this study, cataracts in 24 of the 26 aphakic eyes increased in opacity after the surgery. In addition, stage 4 macular holes are usually associated with a less-favorable anatomic and visual prognoses due to long-term macular hole duration. These factors will definitely affect the postoperative visual acuity.

In conclusion, this study demonstrates our ability to peel the ILM without the aid of ICG staining, and that surgery of macular hole with ILM peeling has a high anatomical and functional success rate.

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用內限膜(Internal Limiting Membrane)剝離術來治療黃斑部裂孔

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背景： 內限膜是視網膜上的一層基底膜，與黃斑部裂孔的病灶形成有關。本研究目的在評估內限膜剝離術對黃斑部裂孔的治療效果。

方法： 每位病人在手術前的視力用Snellen視力表來詳細評估。使用細隙燈，及間接眼底鏡來檢查整個眼球的狀況，並使用Watzke-Allen試驗來證實黃斑部裂孔的病灶。在黃斑部裂孔手術方面，使用標準三孔玻璃體切除術並在局部麻醉下來進行。首先，玻璃體儘可能切除後，在內限膜上用22號的彎針頭產生一個小裂孔，再利用鑷子將內限膜整個撕離視網膜，其範圍在黃斑部外圍血管的內側，以同心圓方式撕離。之後，再行氣液交換，並使用10% C3F8氣體來填充玻璃體腔，在術後要求病人必須維持臉部朝下的姿勢。

結果： 包括從第二期到第四期裂孔共有36隻原發性黃斑部裂孔的患眼，平均追蹤時間共8.9個月。10位病人是人工晶體的病眼，其餘26隻病眼中，有24位在術後有白內障更混濁的情形。術後共有33隻病眼(92%)黃斑部裂孔完全癒合，並且有26隻(72%)眼睛視力有改善。其中有一隻眼睛術後有前房及玻璃體出血的情形，但並沒有發生視網膜剝離或裂孔的併發症。

結論： 用內限膜剝離術來治療黃斑部裂孔，無論在眼球的解剖上或功能上都有很高的成功率。

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關鍵字： 黃斑部裂孔，內限膜剝離。