의학석사 학위논문

전층 황반원공의 치료로서의 위쪽 내경계막 피판 덮힘술 (Superior Inverted Internal Limiting Membrane Flap Technique)의 효용성

2017 년 10 월

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의학과 안과학

최세랑

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지도교수 박 규 형

이 논문을 의학석사 학위논문으로 제출함

2017 년 **10** 월

서울대학교 대학원

의학과 안과학

최 세 랑

최세랑의 석사 학위논문을 인준함

2017 년 **12** 월

위 원 장 김 태 우 (인)

부위원장 박 규 형 (인)

위 원 변 석 수 (인)

국문초록

목적: 전층 황반원공의 치료를 위한 수술로 위쪽 내경계막 피판 덮힘술의 효용성에 대해 분석하고자 한다.

대상과 방법: 400㎛ 이상의 직경을 가진 전층 황반원공 환자를 대상으로 황반원공 위쪽의 내경계막을 망막의 나머지층으로부터 반달모양으로 분리한 후 분리된 내경계막을 피판으로 이용하여 황반원공이 덮히도록 위치시키고 25% 육플루오르화황 가스를 안구 내로 주입하였다. 수술 후 환자들은 앉거나 엎드린 자세를 취하도록 교육하고 수술 후 시력 및 빛간섭단층촬영을 통한 황반원공의 닫힘 여부와 닫힌 모양, 외경계막의 결함 유무 등을 분석하였다.

결과: 23명의 환자가 연구에 포함되었고 황반원공의 평균 기저부 직경은 922.4±273.9㎛ 였다. 수술 후 시력은 수술 전 시력에 비해 유의하게 향상되었다. 모든 황반원공은 성공적으로 닫혔고 경과 관찰 기간 동안 황반원공의 재발도 확인되지 않았다. 황반원공의 닫힌 모양도 U자형이 82.6%로 가장 많았고 위경계막의 결함은 26.1%에서 관찰되었다.

결론: 위쪽 내경계막 피판 덮힘술은 환자가 엎드린 자세를 취하지 않아도 황반원공의 수술 후 성공적인 해부학적 닫힘에 도움이 될 수 있다.

주요어 : 내경계막 피판술, 황반원공, 유리체절제술

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목 차

표 목차

그림 목차

제 1 장 연구의 배경

제 1 절 연구의 배경

Vitrectomy for macular holes (MHs) has shown a high closure rate and evident vision improvement.[1-4] Many studies have shown that the removal of a membrane at the vitreoretinal interface in patients with idiopathic MH produced good functional and anatomical results.[4-7] Surgical treatment of MHs aims to relieve vitreofoveal traction because firm foveal vitreous adhesion, anteroposterior vitreomacular traction, and tangential traction are believed to be the main factors in the pathogenesis of MH.[2]

In 2010, Michalewska et al[8] suggested an inverted internal limiting membrane (ILM) flap technique for the treatment of idiopathic large MH. This technique prevented the postoperative flat-open appearance of MHs and improved the functional and anatomical results for MHs with a large diameter (>400 mm).[9] However, the spontaneous retroversion of the ILM flap, or even ILM flap loss, occurs in up to 14% to 20% of patients during fluid-air exchange.[8,10] Moreover, the patients have to mostly lie face down after the surgery. Recently published studies have introduced a modification of the classic inverted ILM flap technique.[11,12] In this procedure, ILM peeling was restricted to the temporal side of the fovea, and the MH was covered with the temporal ILM flap. These studies concluded that the new technique was as effective as the classic inverted ILM flap

technique for repairing large MHs. However, the temporal-side ILM flap could be difficult to keep in position because of the vector sum between gravity and the ILM tangential force.

Therefore, in the present study, we attempted a novel modification by changing the direction of the ILM flap to the superior side to decrease the need of staying prone after the surgery for patients who had difficulty maintaining this position. We investigated the efficacy and convenience of the superior inverted ILM flap technique for the treatment of large idiopathic fullthickness MH. To our knowledge, this is the first study reporting the surgical outcome of this modified technique.

제 2 장 연구의 내용

제 1 절 대상 및 방법

This retrospective study included patients with Stage 4 MH with a diameter > 400 mm, who underwent 23-gauge pars plana vitrectomy with superior inverted ILM flap peeling, between October 2015 and May 2016 at the Seoul National University Hospital. Patients with MH in high myopia and reopening of MHs were also enrolled. Eyes that had retinal detachment combined with MHs or any other vitreoretinal complication, including proliferative diabetic retinopathy or age-related macular degeneration, were excluded.

Surgical Technique: The Superior Inverted Internal Limiting Membrane Flap Technique

All of the surgeries were performed by one surgeon. First, 23-gauge pars plana vitrectomy with membrane peeling with indocyanine green staining was performed in all patients. If an epiretinal membrane was present, it was also peeled off. A contact lens was placed for macular surgery. End-gripping forceps were used to pinch and tear a flap of ILM to cover the MH. Indocyanine green-assisted semicircular ILM peeling was restricted to only the superior half of the MH, and the ILM was not removed completely from the retina during peeling. Then, the superior half of the ILM flap was inverted and the MH was adequately covered with this ILM flap. At the stage of fluid-air

exchange, the ILM flap position over the MH was confirmed. The suction produced by a backflush needle placed on the apex of the semicircular flap facilitated this affirmation. Indocyanine green staining was helpful for better visualization of the ILM flap position. All eyes were filled with 25% sulfur hexafluoride (SF6) gas for tamponade. The patients were not kept in strict all-day prone position postoperatively but were either in a sitting or prone position, although they were instructed to avoid a supine position.

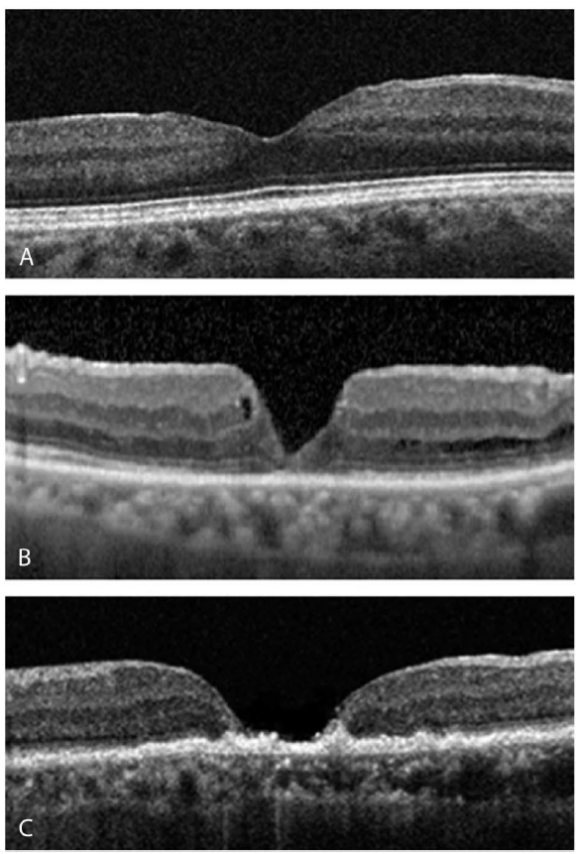
Outcome Measures

Preoperative ophthalmic findings, including age, best-corrected visual acuity, intraocular pressure (IOP), and measurements of slit-lamp biomicroscopy and funduscopy, were recorded. Spectral-domain optical coherence tomography (OCT) was performed to identify MHs. The minimum and base diameters of MHs were measured using Cirrus High-Definition OCT (Carl Zeiss Meditec, Dublin, CA) or Spectralis OCT (Heidelberg Engineering, Heidelberg, Germany).

Postoperatively, all patients underwent visual acuity measurement, tonometry, and slit-lamp biomicroscopy and fundoscopy. Optical coherence tomography was performed to determine the success of MH closure, the reoccurrence of MH, final foveal contour type (U-, V-, or W-type)(Figure 1), and the presence of external limiting membrane and/or ellipsoid zone defects. Best-corrected visual acuity was measured as decimal visual acuity and converted to logarithm of minimal angle of resolution according to the standard equation. The test of

normality was performed for analysis. A paired t-test was used to compare the preoperative and postoperative outcomes with a significance level set at P <0.05. We also used a multiple regression analysis to determine the factors significantly associated with final visual acuity. A P-value <0.05 was considered significant.

Figure 1. A. U-type: normal foveal contour; B. V-type: steep foveal contour; C. W-type: foveal defect of the neurosensory retina.



제 2 절 결과

Twenty-three eyes of 23 patients with full-thickness MHs were included in the study. They consisted of 18 women and 5 men with an average age of 64.4 ± 7.7 years. The mean follow-up period was 5.8 months (range, 2-9 months). The mean preoperative spherical equivalent was 21.4 ± 2.5 diopter and mean IOP was 16.7 mmHg ± 3.4 mmHg. Slit-lamp anterior segment examination of the included eye was unremarkable. Among the 23 eyes, 12 were phakic and 11 pseudophakic/aphakic. The mean minimum MH diameter was 525.2 ± 232.4 mm (range, 165-1,033 mm). The mean base MH diameter at the level of the retinal pigment epithelium was 922.4 ± 273.9 mm (range, 408-1,385 mm) (Table 1).

Anatomical Results

The MH was successfully closed in all eyes. No primary failure or recurrence was reported during the follow-up period even among patients with reoperation or old MH.

On spectral-domain OCT, the final U-shaped foveal contour type was achieved in 82.6% (19/23 eyes) of the patients and V-shape in 17.4% (4/23 eyes). None of the patients had the flat/open-type or flat/closed-type contour. The closure type was not related to postoperative visual acuity in this study (P = 0.704).

External limiting membrane defects were noted in 26.1% (6/23 eyes) of the patients, but the final visual acuity was not affected by the presence of external limiting membrane defects (P = 0.843). Ellipsoid zone defects were observed in 73.9% (18/23

eyes) of the patients and showed a correlation with the final visual acuity (P = 0.009).

Functional Outcomes

Preoperative visual acuity in the affected eye was 0.95 (20/180) ± 0.37 logarithm of minimal angle of resolution and improved significantly to a postoperative visual acuity of 0.48(20/59) ± 0.24 logarithm of minimal angle of resolution (P = 0.003) (Table 1). The postoperative visual acuity showed a statistically significant correlation with the minimum diameter of MH (P = 0.042) and preoperative visual acuity (P = 0.023). However, age (P = 0.375) and the base diameter of MH (P = 0.616) had no impact on the postoperative functional results.

Adverse Events

The most common complication after surgery was cataract formation (in 2 of 12 phakic eyes). One of these patients underwent cataract surgery after 5 months. Increased IOP was detected 1 month after surgery in one patient. The increased IOP was normalized after applying IOP-lowering medication for 1 month, without filtration surgery. No cases of primary failure and reopening of MH, retinal detachment, or posterior iris synechiae were observed during the follow-up period.

Table 1. Demographic Data

	Preoperation	Postoperation	*p* value*
Age, years	64.4 ± 7.7		
Male : Female	5:18		
The Follow-up period(range), months	5.8 (2-9)		
Minimal MH diameter, ㎛	525.2 ± 232.4		
Base MH diameter, ㎛	922.4 ± 273.9		
Visual Acuity, LogMAR	0.95 ± 0.37	0.48 ± 0.24	0.003
IOP, mmHg	16.7 ± 3.4	16.1 ± 0.7	0.411
Spherical equivalent, diopter	-1.4 ± 2.5	-2.2 ± 2.2	0.092

*P value is the statistical level between preoperative and postoperative data. A P value < 0.05 was considered significant. logMAR, logarithm of minimal angle of resolution.

제 3 절 고찰

After first introduced surgical intervention as a treatment for MH by Kelly and Wendel,[4] newly developed ILM peeling and inverted ILM flap were reported as a successful procedure. Michalewska et al[8] reported that MH closure rate was 98% when the inverted ILM flap technique was preformed and 88% of closure rate with ILM peeling. However, inner retinal defects, retinal pigment epithelium loss or alteration, even paracentral scotoma frequently took place in ILM-peeled eyes.[9,13-16] The inverted ILM flap loss or malposition and the potential damage to the retinal pigment epithelium at the base of the MH when tucking the ILM flap into the hole and late closure of MH could also have occurred after the inverted ILM flap technique.[17] A modified inverted ILM flap technique for MH, i.e., the temporal inverted ILM flap technique, has been reported recently.[11,12] This new technique could minimize the surgical trauma induced by ILM peeling by limiting the area of peeling. In addition to minimal trauma, these modified techniques are relatively easy to perform and do not cause ILM flap loss because the ILM is not totally removed; instead, only a part of it is removed and the flap is easier to place in the proper position without much manipulation. These studies demonstrated that the temporal inverted ILM flap technique could achieve closure rates and visual acuity improvements similar to the original inverted ILM flap technique. The superior inverted ILM flap technique that we used also has this fair benefit of minimal damage in that it did not require peeling off the entire ILM similar to the temporal inverted ILM flap technique.

The superior inverted ILM flap technique had several advantages

for MH repair. First, this technique showed excellent anatomical results. In our study, the success rate for primary closure of MH was 100% without reopening. This was a meaningful outcome because patients who underwent reoperation for MH reopening and those with old MH were also included in our study. We assumed that the stable superior inverted ILM flap position was the cause of higher success rate because the superior flap was an easier to maintain the flap position due to gravitation. Another anatomical success was achieved in a foveal contour type. Many studies concluded that the U-shaped closure was associated with postoperative functional outcomes.[10,18,19] In our study, the U-shaped foveal contour consist of 82.6%. This was a higher percentage than the reported 38.7% to 61.3% of the U-type foveal contour after vitrectomy for MH and 64% after temporal inverted ILM flap technique.[11,18-20] In addition, no W-shaped contours or flat/closed-type closures were found in any of our patients, even those with old and reopened MH. Morawski et al[21] concluded that the main mechanism leading to spontaneousMH closure is the bridging phenomenon, i.e., tissue formation in the outer nuclear layer. The higher frequency of the U-shaped contour type in our study could be attributed to this tissue bridge formed by the flap and the relatively smaller minimal diameters of MH in our study. Second, the need for a postoperative facedown posture is decreased with the superior location of the inverted ILM flap. The meta-analysis conducted by Hu et al[2] concluded that face-down posturing was an essential component for the success of the closure of MHs with diameters larger than 400 mm. However, most MHs occur in

elderly patients, most of whom seem difficult to maintain prone posturing due to low compliance. After this superior inverted ILM flap technique, the patients were not required to maintain a strict face-down position and allowed to keep the sitting position because of the superior flap position. This was advantageous to patients who could not lie face down because of psychological and/or physical problems. Third, there is also the clinical significance in that the ILM was not completely peeled off in this technique, ensuring enough ILM was left for future surgeries in case of reoccurrence of the MHs. A new flap will also provide a basement membrane substrate for tissue proliferation to repair reopened MHs.

This study has several limitations, most of which could be attributed to its retrospective design, the small number of included cases, and short-term follow-up duration. Also, preoperative and postoperative visual acuity measurements may have been interfered by the heterogeneous lens status (i.e., phakia, pseudophakia, or aphakia) in patients. The postoperative visual improvement in our study may have been underestimated due to cataract formation in some patients. Moreover, indocyanine green is known to be toxic to the retinal nerve fibers, retinal pigment epithelium, and optic nerve.[22-24] Although indocyanine green was used for visualizing the ILM flap in all our patients, we did not evaluate its toxicity.

In conclusion, the superior inverted ILM flap technique was an effective way for the repair of full thickness MHs. In addition, this can be considered in most patients because it does not require a strict prone position.

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Abstract

The Efficacy of Superior Inverted Internal Limiting Membrane Flap Technique for the Treatment of Full-Thickness Macular Hole

Se Rang Choi

Medical science, devision of Ophthalmology

The Graduate School

Seoul National University

Purpose: To investigate the efficacy of the superior inverted internal limiting membrane (ILM) flap technique for full-thickness macular holes(MH).

Methods: In patients having a full-thickness macular hole with a diameter >400㎛, semicircular ILM peeling limited to the superior half of the macula was performed and the MH was covered with the superior ILM flap. All eyes were filled with 25% sulfur hexafluoride gas for tamponade. The patients were not kept in strict prone position postoperatively, they were either in sitting or prone position. They underwent visual acuity (VA) measurement and optical coherence tomography postoperatively to evaluate the success of MH closure, type of MH closure (U-, V-, or W-type) and the presence of defects in the external limiting membrane (ELM) and ellipsoid zone (EZ).

Results: Twenty-three patients were enrolled. The mean base diameter of the MH was 922.4±273.9 ㎛. All patients had successful MH closure and none showed primary failure or recurrence during the follow-up period. A U-shaped foveal contour was achieved in 82.6%; ELM defects were noted in 26.1% and EZ defects in 73.9%. The postoperative VA improved significantly.

Conclusions: The superior inverted ILM flap technique offers good surgical results for MH surgery without strict postoperative prone position.

keywords : limiting membrane flap technique, macular hole,

vitrectomy.

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