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Research

Comparison of Two Different Techniques in Macular Hole Surgery: 12-month Results of Clinical Practice

Makula Deliği Cerrahisinde İki Farklı Tekniğin Karşılaştırılması: 12 Aylık Klinik Uygulama Sonuçları

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ABSTRACT

Objective: To examine and compare the outcomes of complete internal limiting membrane (ILM) peeling and inverted ILM flap techniques in patients with idiopathic full-thickness macular holes.

Methods: Sixteen eyes of 16 patients operated on with the standard complete ILM peeling technique were included in group 1, and 12 eyes of 12 patients who had vitrectomy with the inverted ILM flap technique were included in group 2. Baseline and postoperative month 3, 6, and 12 best-corrected visual acuity (BCVA) data and spectral-domain optical coherence tomography (OCT) images were examined. Macular hole closure, foveal contour formation, ellipsoid zone integrity on OCT images, and BCVA improvement were analyzed.

Results: The macular hole closure rate was 62.5% in group 1 and 91.7% in group 2, but the difference between the groups was not significant (p=0.18). An improvement was seen in BCVA after surgery in group 1, but the difference was not significant compared with the pre-operative BCVA (p=0.28). In group 2, the improvement from baseline BCVA at postoperative month 12 was significant (p=0.016).

Conclusion: The macular hole closure rate was over 90% in the eyes that were operated on with the inverted ILM flap technique. BCVA was improved after surgery in both groups, and a significant improvement from baseline BCVA was seen at postoperative month 12 with the inverted ILM flap technique.

Keywords: Internal limiting membrane peeling, inverted internal limiting membrane flap, macular hole, optical coherence tomography, visual improvement

ÖZ

Amaç: İdiyopatik tam kat makula deliği olan bireylerde tam iç limitan membran (İLM) soyulması ve ters İLM flep tekniklerinin sonuçlarını incelemek ve karşılaştırmaktır.

Gereç ve Yöntem: Standart İLM soyma tekniği ile ameliyat edilen 16 hastanın 16 gözü grup 1'e, ters İLM flep tekniği ile vitrektomi uygulanan 12 hastanın 12 gözü grup 2'ye alındı. Başlangıç ve ameliyat sonrası 3. ay, 6. ay ve 12. ay en iyi düzeltilmiş görme keskinliği (EİDGK) verileri ve spektral-domain optik koherens tomografi (OKT) görüntüleri incelendi. Makula deliği kapanması, foveal kontur oluşumu, OKT görüntülerinde elipsoid zon bütünlüğü ve EİDGK'deki iyileşme analiz edildi.

Bulgular: Makula deliği kapanma oranı grup 1'de %62,5 ve grup 2'de %91,7 idi; ancak gruplar arasındaki fark anlamlı değildi (p=0,18). Grup 1'de cerrahi sonrası EİDGK'de iyileşme görüldü ancak ameliyat öncesi EİDGK ile karşılaştırıldığında fark anlamlı değildi (p=0,28). Grup 2'de, postoperatif 12. ayda, başlangıca göre EİDGK'deki iyileşme anlamlıydı (p=0,016).

Sonuç: Ters İLM flep tekniği ile opere edilen gözlerde makula deliği kapanma oranı %90'ın üzerinde idi. Ameliyattan sonra her iki grupta da EİDGK düzeldi ve ters İLM flep tekniği ile postoperatif 12. ayda başlangıca göre EİDGK'de anlamlı bir iyileşme görüldü.

Anahtar Kelimeler: İnternal limitan membran soyma, ters internal limitan membran flebi, makula deliği, optik koherens tomografi, görsel iyileşme

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INTRODUCTION

Full-thickness macular hole (FTMH) is a defect of retinal tissue on the macula that especially affects the foveola and fovea (1). Macular holes are usually idiopathic, and women in the 7th and 8th decades are more commonly affected (2-4). Tangential or anteroposterior traction of the posterior cortical vitreous on the fovea is accepted to be the cause of idiopathic FTMHs (1,3-6).

In 1991, Kelly and Wendel (7) used modern vitrectomy techniques for the treatment of idiopathic FTMH and reported that the macular holes closed in 58% of their patients. Since then, with advances in surgery such as the internal limiting membrane (ILM) peeling technique during vitrectomy, the macular hole closure rate has increased to over 90% (8-13).

Michalewska et al. (14) showed that the results obtained with the inverted ILM flap technique in large macular holes (≥400 µm) were more satisfactory than those obtained with the complete ILM peeling technique. With the inverted ILM flap technique, covering the macular hole with the inverted ILM flap allowed early closure of the hole. Thereafter, they also reported nearly 100% anatomical success in myopic macular holes using the same technique (15).

Functional improvement was associated with the integrity of the ellipsoid zone (EZ) and the external limiting membrane (ELM) (16-20). Optical coherence tomography (OCT) has been found useful in the detailed analysis of macular holes before surgery and in the evaluation of both anatomical closure and integrity of the retinal layers that affect the visual prognosis after surgery (16).

In this study, we aimed to examine and compare the surgical and functional results of these two techniques in eyes with idiopathic FTMHs.

METHODS

We performed this retrospective, observational study at University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital Ophthalmology Clinic after obtaining approval from the Clinical Researches Ethics Committee (decision no: 2020-02-15, date: 20.01.2020). The study adhered to the tenets of the Declaration of Helsinki and we obtained informed consent from all participants.

The records of the patients who underwent surgery with the diagnosis of idiopathic FTMH between January 2015 and January 2021 were retrospectively evaluated. FTMHs with retinal detachment, patients with lamellar, traumatic, or myopic macular holes, history of uveitis, glaucoma, or any other retinal diseases, previous ocular surgery except phacoemulsification, and less than 12 months follow-up were excluded.

The patients were examined in two groups. Group 1 included patients who were operated on with the standard complete ILM peeling technique; group 2 included patients who had pars plana vitrectomy (PPV) using the temporal inverted ILM flap technique.

Age, gender, operated eye, axial length of the eye, lens status, and detailed ophthalmological examination data of both groups were obtained from patient records. Baseline and postoperative month 3, 6, and 12 best-corrected visual acuity (BCVA) data were recorded, and the logarithm of minimal angle of resolution (logMAR) values were used for statistical analysis.

Spectral-domain OCT device (RTVue-100, Optovue Inc., Fremont, US) images in the patient records were analyzed at baseline and at postoperative months 3, 6, and 12. The minimum macular hole diameter was measured from the baseline OCT image. Postoperative month 3, 6, and 12 OCT images were examined to analyze macular hole closure, foveal contour formation, and EZ integrity (Figure 1).

The same experienced vitreoretinal surgeon (U.O.) performed a standard 3-port 23-gauge PPV. Patients with cataracts underwent combined PPV, phacoemulsification, and intraocular lens implantation surgery. In both groups, a mixture of brilliant blue G and trypan blue (Membrane Blue Dual, DORC, Netherlands) was used to stain ILM and then aspirated with a backflush needle. The epiretinal membranes were peeled away before ILM.

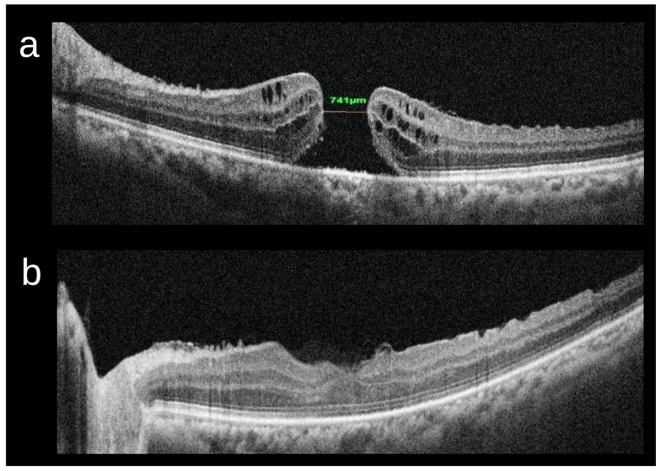

Figure 1. a) Preoperative spectral-domain optical coherence tomography (SD-OCT) image of a patient with a minimum 741 µm macular hole diameter. b) Postoperative month 12 SD-OCT image of the same patient who was operated on with the inverted internal limiting membrane flap technique. Macular hole was closed. Foveal contour formation and the integrity of both the external limiting membrane and the ellipsoid zone could be seen

In the ILM peeling group, ILM was removed completely by approximately 2 disk diameters around the macular hole in a circular pattern using ILM peeling forceps. In group 2, ILM peeling was performed in a manner similar to the study of Michalewska et al. (14). After inverting the ILM flap, the macular hole was covered with this, and an air-fluid exchange and then a 20% SF6 gas-air exchange were performed. After surgery, maintaining a prone position for at least three days was advised to all subjects.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS), version 21.0 (SPSS, Inc, Chicago, IL, USA). The distribution of the data was evaluated using the Kolmogorov-Smirnov test. Parametric data were analyzed using Student's t-test and One-Way repeated ANOVA. Analysis of the non-parametric data and comparison of the groups were performed using the Mann-Whitney U test. The baseline characteristics of age between the groups were compared using an independent t-test, and gender was compared using the chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

Twenty-eight patients who underwent surgery for FTMH were included in this retrospective and observational study. There were 16 eyes of 16 patients that were operated with the standard complete ILM peeling technique in group 1 and 12 eyes of 12 patients that were operated with the inverted ILM flap technique in group 2. The baseline characteristics of patients in both groups are given in Table 1.

Phacovitrectomy was performed in 3 eyes (18.75%) in group 1 because of lens opacification in the baseline examination, and vitrectomy alone was performed in all eyes in group 2. No major complications were seen in both surgical procedures, but 1 eye in group 1 and 3 eyes in group 2 required cataract surgery during the follow-up. In all 4 eyes, cataract surgery was performed 10 months after vitrectomy, and no complications were observed.

The macular hole closure rate was 68.75% at postoperative month 3 and 56.25% at postoperative month 6 in group 1, whereas it was 91.7% at postoperative months 3 and 6 in group 2. The foveal contour formation rate was 68.75% at postoperative month 3 and 56.25% at postoperative month 6 in group 1, whereas it was 91.7% at postoperative month 3 and 83.3% at postoperative month 6 in group 2. Restoration of the EZ rate was 50% at postoperative month 3 and 43.75% at postoperative month 6 in group 1, whereas it was 58.3% at postoperative month 3 and 41.7% at postoperative month 6 in group 2. Surgical and functional results of the groups at postoperative month 12 are given in Table 2.

BCVA was 0.98±0.46 logMAR units at postoperative month 3 and 0.86±0.50 logMAR units at postoperative month 6 in group 1, whereas it was 0.80±0.35 logMAR units at postoperative month 3 and 0.78±0.37 logMAR units at postoperative month 6 in group 2. An improvement was seen in BCVA after surgery in group 1, but the difference was not significant compared with the pre-operative BCVA (p=0.28). In group 2, the improvement from baseline BCVA at postoperative month 12 was found significant (p=0.016). Figure 2 shows the changes in BCVA (logMAR) from baseline to 12 months postoperatively for both groups.

DISCUSSION

The results of our study showed a macular hole closure rate of over 90% in patients who had vitrectomy with the

Table 1. Baseline characteristics

Variables	Group 1 (n=16) ILM peeling technique	Group 2 (n=12) Inverted ILM flap technique	p-value
Age (mean ± SD)	69.2±4.8	67.2±5.3	0.29[t]
Gender (female/male)	11/5	6/6	0.44[x²*]
Eye (right/left)	10/6	6/6	0.78[x²**]
Lens (phakic/pseudophakic)	11/5	8/4	0.90[x²]
Axial length (mm) (mean ± SD)	23.20±0.69	23.28±0.84	0.48[m]
Minimum hole diameter (µm) (mean ± SD)	468.63±181.97	520.67±170.39	0.48[m]
Foveoschisis (n)	16	11	0.42[x²]
Preoperative BCVA (logMAR) (mean ± SD)	1.02±0.42	1.02±0.38	0.43[m]

[t]: Independent t-test, [x²]: Chi-square test, [x²*]: Chi-square test (Fisher's Exact test), [x²**]: Chi-square test (Yates' correection), [m]: Mann-Whitney U test
ILM: Internal limiting membrane, SD: Standard deviation, BCVA: Best-corrected visual acuity, logMAR: Logarithm of minimal angle of resolution

Table 2. Results of the groups at postoperative month 12

Variables	Group 1 (n=16) ILM peeling technique	Group 2 (n=12) Inverted ILM flap technique	p-value
Hole closure rate (%)	62.5%	91.7%	0.18[x²]
Foveal contour formation (%)	68.8%	91.7%	0.35[x²]
Restoration of ellipsoid zone (%)	43.8%	58.3%	0.70[x²]
Mean BCVA logMAR (mean ± SD) /median	0.84±0.53	0.78±0.47/0.70	0.23[m]

[x²]: Chi-square test; [m]: Mann-Whitney U test
ILM: Internal limiting membrane, BCVA: Best-corrected visual acuity, SD: Standard deviation, logMAR: Logarithm of minimal angle of resolution

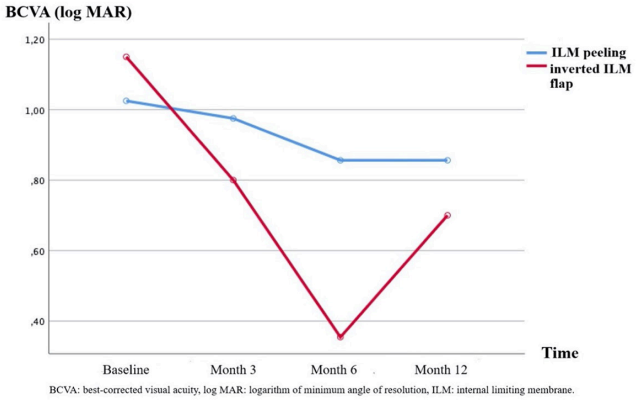

Figure 2. Changes in best-corrected visual acuity (BCVA) from baseline to 12 months postoperatively for both groups. An improvement was seen in BCVA after surgery in both groups. In group 1, the difference in BCVA from baseline to postoperative month 12 was not significant (p=0.28). The improvement in BCVA from baseline to postoperative month 12 was found significant in group 2 (p=0.016)

inverted ILM flap technique, whereas it was 62.5% in patients who underwent vitrectomy with the complete ILM peeling technique. Michalewska et al. (15) were the first to use the inverted ILM flap technique in patients with large idiopathic FTMHs and reported a 98% macular hole closure rate while it was 88% in patients who had surgery with the standard complete ILM peeling technique. In addition, recent studies have shown that the inverted ILM flap technique is more efficient than the complete ILM peeling technique, especially in myopic holes and large (>400 µm) FTMHs (14,21-23). In their retrospective study, Rizzo et al. (21) examined the results of two techniques involving large patient groups and found that the anatomical success rate of the inverted ILM flap technique was 95.6% and that of the ILM peeling technique was 78.6% in large macular holes (p=0.001). They also reported an 88.4% anatomical success rate with the inverted ILM flap technique and a 38.9% rate with the ILM peeling technique in patients with myopic holes (p=0.001). In our study, the mean axial length of patients was 23.20±0.69 mm in group 1 and 23.28±0.84 mm in group 2. The minimum baseline hole diameter was 468.63±181.97 µm in in patients who underwent surgery with the complete ILM peeling technique and 520.67±170.39 µm in in patients who underwent surgery with the inverted ILM flap technique. Although it appeared larger in the inverted ILM flap technique group, the difference in the baseline minimum macular hole diameter between the groups was not significant (p=0.48). Despite having a higher macular hole closure rate with the inverted ILM flap technique (91.7%), the difference from the complete ILM peeling technique (62.5%) was not significant (p=0.18). We suggest that the difference may be significant with larger groups, as in the study by Rizzo et al. (21).

Previous studies have shown that the evaluation of the integrity of EZ, ELM, and outer segments of foveal cone photoreceptors on OCT images is important in the determination of visual recovery after macular hole surgery (17,20,24). In addition, it was suggested that the restoration of the foveal retinal tissues might continue over time, and because of this process, postoperative BCVA might improve during the follow-up period (25). Ooka et al. (20) studied 43 eyes of 43 patients at months 1, 3 and 6 after macular hole surgery and found that the correlation of BCVA and foveal sensitivity with defects on both EZ and ELM were significant at all postoperative exams.

It is known that the proliferation of Müller cells is activated by the inverted ILM flap tissue. The restoration of the outer retinal tissues was induced by the activated Müller cells, and as a result, both the macular hole closure rate and the final BCVA improved (14,26). A meta-analysis by Shen et al. (23) comparing the efficacy of two surgical techniques in large macular holes showed a significant improvement in BCVA at postoperative month 3 in patients who had vitrectomy with the inverted ILM flap technique compared with patients who underwent complete ILM peeling surgery (p<0.00001). However, the difference in BCVA between the groups was not significant during the longer follow-up period. Silva et al. (27) reported the 8-year experience results of their retrospective study analyzing EZ recovery and improvement in BCVA after macular hole surgery with the inverted ILM technique. They showed that 80% of their patients had ≥0.3

logMAR units of BCVA improvement, and the final BCVA in the patients with closed holes after surgery was better in eyes that had good EZ integrity than in eyes with EZ defects (p=0.003). In our study, the foveal contour formation rate at postoperative month 12 was higher (91.7%) in subjects who underwent vitrectomy with the inverted ILM flap technique than in those who underwent vitrectomy with the standard ILM peeling technique (68.8%). Restoration of the EZ was seen in 58.3% of the subjects who underwent surgery with the inverted ILM flap technique and in 43.8% of the eyes who underwent surgery with the standard ILM peeling technique at postoperative month 12. BCVA improved in both groups after surgery, and the final BCVA was 0.84±0.53 logMAR units in group 1 and it was 0.78±0.47 logMAR units in group 2. We believe that despite the improvement, these relatively low final visual acuity results might be related to the relatively low EZ restoration rates. The improvement from baseline to 12^{th} months after surgery was only significant in the inverted ILM flap technique group (p=0.016). We suggest that the small sample size of our study could affect these results and that different results may be obtained with larger groups. In addition, we think that the improvement in BCVA may continue over time by the restoration of the EZ, as shown in previous reports (14,26).

Cataract progression can be seen after vitreoretinal surgery, and combined phacovitrectomy can be considered in phakic patients (27). In this study, cataract surgery was required for one eye in group 1 and three eyes in group 2 during the follow-up period after vitrectomy.

This study had several limitations. First, this was a retrospective study, and the sample size of the groups was small. This could affect the power of our results; therefore, a prospective study including larger patient groups is necessary to confirm the findings of this study. Another limitation is that the 12-month follow-up time could be inadequate and more informative results could be obtained after a longer follow-up period. Lastly, phacovitrectomy was performed for only 3 eyes in group 1, and in the follow-up period, cataract surgery was needed for four eyes. Considering that combined surgery for the phakic eyes could affect the postoperative recovery process.

CONCLUSION

In conclusion, both surgical techniques could be performed for treating FTMHs without any complications. Similar to the previous studies, the macular hole closure rate was over 90% in the eyes that were operated on with the inverted ILM flap technique. BCVA was improved after surgery in both groups, and a significant improvement from baseline BCVA was seen at postoperative month 12 with the inverted ILM flap technique. OCT could be accepted as a useful device for both diagnosis and follow-up of patients and could provide predictive data about the anatomical and functional healing process.

ETHICS

Ethics Committee Approval: Ethical approval was obtained from the University of Health Sciences Türkiye, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Researches Ethics Committee (decision no: 2020-02-15, date: 20.01.2020).

Informed Consent: We obtained informed consent from all participants.

Authorship Contributions

Surgical and Medical Practices: Ö.P.A.A., İ.U.O., Concept: Ö.P.A.A., O.S., İ.U.O., Design: Ö.P.A.A., O.S., İ.U.O., Data Collection or Processing: O.S., S.Z., Analysis or Interpretation: Ö.P.A.A., S.Z., Literature Search: Ö.P.A.A., Writing: Ö.P.A.A.

Conflict of Interest: No conflict of interest was declared by the authors.

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