MACULAR HOLE REPAIR WITH LIMITED NONSUPINE POSITIONING

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Purpose: To assess the surgical success rates of modern macular hole repair with elimination of face down positioning.

Methods: A review of data for 72 eyes (from 102 consecutive cases) with idiopathic macular holes treated surgically between 1998 and 2004 was performed. Exclusion criteria consisted of macular hole for >1 year or of unknown duration and macular holes from secondary causes. All patients were evaluated and surgically managed by one surgeon (R.T.).

Results: Average preoperative best spectacle corrected visual acuity (BSCVA) was 20/170 (6/51). Six patients had a grade II hole, 60 patients had a grade III hole, and 6 patients, had a grade IV hole. Anatomical success was achieved in 92% of cases with 1 operation, and the average postoperative BSCVA was 20/46 (6/14). Six patients required additional surgical management to achieve anatomical success with an average postoperative BSCVA of 20/55 (6/16.5). The postoperative BSCVA improved an average of 5.7 lines from baseline.

Conclusion: Favorable anatomical and BSCVA outcomes were achieved with the elimination of face down positioning in the postoperative period. Additional benefits are an increase in patient acceptance and compliance and the number of patients eligible for the procedure.

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With the advancement of our understanding of idiopathic macular hole pathogenesis, a previously untreatable disease has become increasingly amenable to surgical repair. Despite our advances, many questions still remain unanswered regarding patient selection, predictors of outcome, optimal surgical technique, and postoperative measures.

Significant interest and excitement arose in 1988 when Gass[1] proposed his hypothesis on the pathogenesis of idiopathic macular holes, staging criteria, and guidelines for feasibility studies. Closure rates of 58% were seen in the initial pilot study by Kelly and Wendel[2] in 1991. A subsequent follow-up study by Wendel et al[3] on 170 eyes saw an increased closure rate of 73%. Their technique involved pars plana vitrectomy, removal of the posterior perifoveal cortical vitreous, epiretinal membranectomy (when present), and gas–fluid exchange. At least 1 week of strict occiput up postoperative positioning was used in their series. With the recent introduction of internal limiting membranectomy, with theoretical release of all posterior cortical vitreous traction vectors, we have begun to question the optimal length of postoperative positioning while maintaining current surgical success rates.

Recently, Park et al[4] reported a 91% closure rate using internal limiting membranectomy and 4-day prone postoperative positioning. Reports of other studies, with small sample sizes, using internal limiting membranectomy in their surgical procedure dis-

closed no appreciable difference in surgical closure and postoperative visual acuity between 2 weeks, 1 week, 4 days, and 1 day of prone positioning.[4–8] Despite these studies, many patients are asked to assume a supine position for 1 week to 3 weeks postoperatively. We present a retrospective case series of 72 eyes whereby patients were restricted only from lying supine for a period of 24 hours. They were not required to assume any face down positioning in the postoperative period.

Patients and Methods

This series included 98 consecutive patients (102 eyes) with idiopathic macular holes that were surgically managed from March 1998 to February 2004. All patients were evaluated and managed by one surgeon (R.T.). Exclusion criteria consisted of macular holes for >1 year or of unknown duration, macular holes from secondary causes (trauma, chronic cystoid macular edema, myopia, etc), prior attempts at surgical repair, and incomplete patient data. Thirty eyes (28 patients) met exclusion criteria. Twenty-four eyes had chronic macular holes for >1 year or of unknown duration, one eye developed a macular hole secondary to chronic diabetic macular edema, and five eyes lacked postoperative visual acuity data.

A chart review was conducted for the remaining 72 eyes of 70 patients. Questionnaires were sent to all referring ophthalmologists and optometrists concerning the immediate preoperative best spectacle corrected visual acuity (BSCVA) and the BSCVA achieved during the first postoperative year for the 72 eyes included in the study.

The surgical procedure involved clear corneal cataract extraction and intraocular lens implantation in all phakic patients before standard three-port pars plana vitrectomy. Core vitrectomy followed by the surgical creation of a posterior hyaloid detachment was performed on all eyes. Scleral depression for 360° was used to cut vitreous toward the peripheral base. "Wide" internal limiting membrane (ILM) peeling was then performed in all cases as follows (Fig. 1). Intraocular forceps were used to engage and peel any epiretinal membrane over the macular region with intraocular forceps. A tiny ILM flap was then created with the intraocular forceps. ILM peeling was then typically continued by engaging the flap with a blunt membrane pick. The pick was swept with side-to-side movements toward the macular hole. The ILM was then released 360° around the macular hole. Next, the ILM was removed with intraocular forceps. Normally, ILM peeling extended nasally to the optic nerve, inferiorly to the arcades, and then ≈2 disk diameters
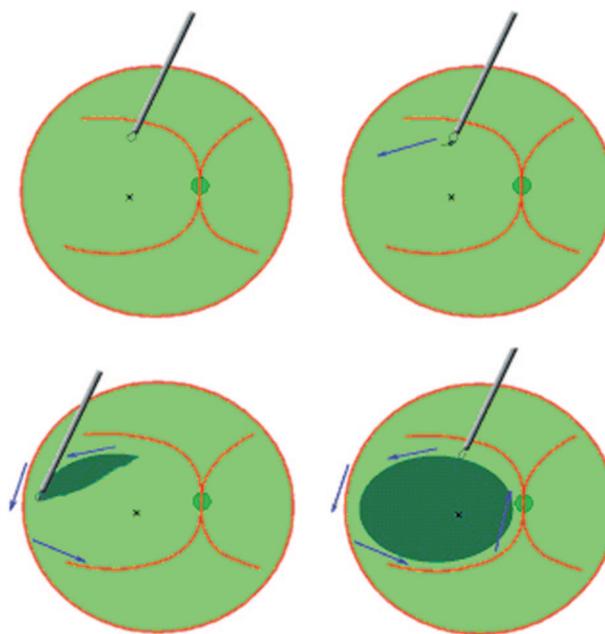
Fig. 1. "Wide" internal limiting membrane (ILM) peeling. The ILM is engaged just within the superotemporal arcade, superior to the macular hole. The ILM is peeled temporally approximately twice the disk–fovea distance, inferiorly just within the arcades, and nasally toward the optic nerve and finally completed superiorly.

temporal to the macular hole. In those cases where a pick was not able to identify a clean plane between the ILM and the underlying retina, ILM peeling was completed by grasping the ILM flap with forceps and peeling the ILM in a "capsulorhexis" fashion. ILM peeling was performed without the aid of indocyanine green dye or triamcinolone acetonide. Immediately after ILM peeling, the retinal surface was observed to be whiter. Small retinal hemorrhages were typically seen throughout the macular region.

The peripheral retina was then examined with 360° of scleral depression, and any induced peripheral retinal tears were treated prophylactically with argon laser photocoagulation or cryotherapy. Air–fluid exchange was performed, and double-filtered 12% C_3F_8 was injected. The patient was instructed only to avoid supine positioning for the first 24 hours. Apart from this, there were no restrictions in positioning. Patients were advised that face down positioning was not required.

All cases of persistence or recurrence of macular holes were managed with repeated injection of 12% C_3F_8 and subsequent face down positioning for 24 hours postoperatively. After this period, there were no restrictions on patient positioning.

Results

Chart review of 102 consecutive cases (102 eyes of 98 patients) revealed 30 eyes that were not eligible for

Table 1. Background Data

Average age (y)	72
Age range (y)	46–82
Males, no.	23
Females, no.	49
Right eyes, no.	45
Left eyes, no.	27
Average time (d) to closure	63
Ophthalmology referral, no.	20
Optometry referral, no.	52

the study: 24 had chronic macular holes for >1 year or of unknown duration, 1 developed a macular hole secondary to chronic diabetic macular edema, and 5 lacked postoperative visual acuity data. Of the five eyes with incomplete data, four were closed with one procedure, and one required further surgical management for anatomical success. The following results are for the remaining 72 eyes of 70 patients.

Demographic data for patients meeting eligibility criteria are listed in Table 1. Fifty-six eyes underwent combined phacoemulsification with clear corneal cataract extraction and macular hole repair. The average duration from confirmation of the diagnosis to surgery was 63 days. The average preoperative BSCVA was 20/84 (6/25), 20/175 (6/53), and 20/262 (6/78) for grade II, grade III, and grade IV macular holes, respectively. The combined preoperative BSCVA was 20/170 (6/51). Six patients had a grade II hole, 60 patients had a grade III hole, and 6 patients had grade IV hole consistent with Gass' classification scheme.

Anatomical success was achieved in 92% (66 of 72) of eyes with 1 operation and in 100% with additional surgery. The average postoperative BSCVA (after anatomical success) was 20/34 (6/10) for grade II, 20/45 (6/14) for grade III, and 20/74 (6/22) for grade IV macular holes. The average postoperative BSCVA for all patients was 20/46 (6/14). Five of six patients had anatomical closure after further management with an average postoperative BSCVA of 20/56 (6/17). One patient required a third procedure for anatomical success and had a postoperative BSCVA of 20/50 (6/15). All patients who did not have anatomical success with one operation had grade III macular holes at baseline. The average postoperative improvement in BSCVA from baseline for all patients was 5.7 lines. Two patients saw no benefit in postoperative visual acuity. No patient lost visual acuity from baseline. No appreciable baseline or postoperative differences were found between patients undergoing combined cataract extraction and macular hole repair and those undergoing isolated macular hole repair (Table 2).

Two patients sustained multiple small inferior retinal tears intraoperatively and were treated with a scleral buckling procedure using a number 240 encircling band at the time of the primary operation. The postoperative BSCVA was 20/30 (6/9) and 20/40 (6/12) in these two patients. No further surgery was required in either patient.

Intraoperatively, no macular tears were encountered during ILM peeling. It was common to encounter intraretinal perimacular hemorrhages during the procedure, but all resolved rapidly in the early postoperative phase with no appreciable sequelae.

Discussion

Careful observational work by Gass[1] from 1988 onward led to his hypothesis of tangential traction of the premacular cortical vitreous in macular hole development. He theorized that tangential traction on the macula led to foveal detachment, retinal thinning, and the formation of an operculum that enlarged by the centrifugal retraction of retinal receptors.[9] Controversy exists regarding the etiology of the tangential traction force, but fluid movements in the premacular liquefied vitreous pocket may play a key role in premacular cortical vitreous shrinkage and/or remodeling.[10] Histopathologic examination of vitrectomy specimens discloses native vitreous collagen with rare fragments of ILM. Most specimens lack photoreceptor elements, further supporting this hypothesis.[11] Optical coherence tomographic data have also provided evidence of perifoveal hyaloid detachment and vitreofoveal traction early in macular hole development. In addition, a potential role for anteroposterior traction vectors in the initiation of macular holes with disrup-

Table 2. Baseline and Postoperative VA Results According to Macular Hole Grade and Surgical Procedure Performed

| Grade | No. of Eyes, Preoperative VA | | No. of Eyes, Postoperative VA | |
	CE-MHR	MHR	CE-MHR	MHR
II	6, 20/84 (6/25)	—	6, 20/34 (6/10)	—
III	45, 20/169 (6/51)	15, 20/193 (6/58)	45, 20/71 (6/21)	15, 20/39 (6/12)
IV	5, 20/276 (6/83)	1, 20/200 (6/60)	5, 20/73 (6/22)	1, 20/80 (6/24)

VA, visual acuity; CE-MHR, combined clear corneal cataract extraction and macular hole repair; MHR, macular hole repair.

tion and opening of the foveal floor to create full-thickness macular holes has been demonstrated in some studies.[12–15]

The initial pilot study by Kelly and Wendel[2] stirred great interest in the vitreoretinal community regarding the possibility for surgical management of this entity. With initial anatomical success rates of 58%, much effort was directed toward adjuvants to help seal the macular defect and improve anatomical success.[16–24] Subsequent experience revealed internal limiting membranectomy to offer similar if not improved results without the need for adjuvants.

The optimal postoperative management for patients after modern macular hole repair is not known. Postoperative face down positioning has been considered important for surgical success.[2,16–24] The role of postoperative face down positioning is to maintain contact of the gas bubble against the macular hole, therefore promoting closure. With ILM peeling and the release of all posterior cortical vitreous traction vectors, we have begun to question the optimal length of postoperative positioning. Our patients were only limited to nonsupine positioning during the first 24 hours postoperatively, and despite this minimal positioning restriction, our outcomes compare favorably with the anatomical closure rates and postoperative BSCVA reported in the literature.

Thirty cases (28 patients) in this series met exclusion criteria. Twenty-four cases were excluded secondary to macular holes for >1 year. Because initial success rates seem dependent on the duration of the macular defect,[3,25] we believe that macular holes of longer duration would require separate investigation. Cases of macular holes of unknown duration were also excluded in our study. Although some of these patients may represent recent-onset macular holes, it was impossible to discern these patients from the binocular patients with chronic macular holes who only became acutely symptomatic when the dominant eye was covered. Finally, despite all attempts at collecting patient information, five cases lacked postoperative visual acuity data. Fortunately, the anatomical success data were available, with four of the five macular holes closed with one procedure and one requiring a second procedure for anatomical success. These cases were excluded from the statistical analysis in this series.

Combined cataract surgery and macular hole repair was performed on all phakic patients (n = 56) in our series. The incidence of postoperative cataract progression after macular hole repair has been reported to be as high as 80% at 6 months postoperatively.[26] We thought that the combined procedure was most beneficial to the patient because of the high incidence of postoperative visually significant cataracts, delay in

visual rehabilitation for most patients, morbidity of a second procedure, and potential reopening of the macular hole with cataract surgery.

Continued visual improvement has been observed in patients with successful macular hole repair beyond 1 year postoperatively.[27] Much of the initial improvement is likely due to the management of subsequent cataract formation and/or posterior capsule opacification. The continued visual improvement has been demonstrated by scanning laser ophthalmoscopic testing. Hypothesized mechanisms include regenerative capabilities of the central nervous system, Stiles–Crawford effect, and continued centripetal repositioning of retinal photoreceptors.[28] In this study, the peak BSCVA during the first postoperative year was used as our main outcome to allow for improved macular function and avoid the temporary effects of posterior capsule opacification.

We believe that the high surgical success rate demonstrated in our series, despite limited positioning requirements and a predominance of grade III macular holes, was likely due to the surgical technique (wide ILM peeling with intraocular gas tamponade) and limited duration of the macular hole. Limitations of our study include small numbers, lack of a comparison group, and data limited to a single surgeon. A final limitation was the selection of a long-acting gas (12% C_3F_8) as our tamponade agent during this series, resulting in a prolonged rehabilitation period for the patient. With the favorable results of this study, we hope to look at alternative tamponade agents such as 5% C_3F_8, SF_6, or air to reduce postoperative morbidity in the future.

In conclusion, favorable results in surgical success rates and visual outcomes were achieved with the elimination of face down positioning. The benefits are faster postoperative rehabilitation and return to work, increased number of patients eligible for surgery, as well as improved patient acceptance of the procedure.[29]

References

1. Gass JDM. Idiopathic macular senile hole. Its early stage and pathogenesis. Arch Ophthalmol 1988;106:629–639.
2. Kelly N, Wendel RT. Vitreous surgery for idiopathic macular holes. Results of pilot study. Arch Ophthalmol 1991;109:654–659.
3. Wendel RT, Patel AC, Kelly NE, et al. Vitreous surgery for macular holes. Ophthalmology 1993;100:1671–1676.
4. Park DW, Sipperley JO, Sneed SR, et al. Macular hole surgery with internal limiting membrane peeling and intravitreous air. Ophthalmology 1999;106:1392–1397.
5. Sato Y, Isomae T. Macular hole surgery with internal limiting membrane removal, air tamponade, and 1-day prone positioning. Jpn J Ophthalmol 2003;47:503–506.

6. Isomae T, Sato Y, Shimada H. Shortening the duration of prone positioning after macular hole surgery—comparison between 1-week and 1-day prone positioning. Jpn J Ophthalmol 2002;46:84–88.

7. Nagata A, Horiguchi M, Kojima Y, Sugino T. Macular hole surgery with internal limiting membrane removal and minimized face-down positioning. Atarashii Ganka (J Eye) 1999; 16:1425–1428.

8. Tornambe PE, Poliner LS, Grote K. Macular hole surgery without face-down positioning. Retina 1997;17:179–185.

9. Gass JD. Reappraisal of biomicroscopic classification of stages of development of a macular hole. Am J Ophthalmol 1995;119:752–759.

10. Kishi S, Hagimura N, Shimizu K. The role of the premacular liquefied pocket and premacular vitreous cortex in idiopathic macular hole development. Am J Ophthalmol 1996;122:622–628.

11. Smiddy WE, Michels RG, Green WR. Morphology, pathology, and surgery of idiopathic vitreoretinal macular disorders. A review. Retina 1990;10:288–296.

12. Gaudric A, Haouchine B, Massin P, et al. Macular hole formation: new data provided by optical coherence tomography. Arch Ophthalmol 1999;117:744–751.

13. Chauhan DS, Antcliff RJ, Rai PA, et al. Papillofoveal traction in macular hole formation: the role of optical coherence tomography. Arch Ophthalmol 2000;118:32–38.

14. Tanner V, Chauhan DS, Jackson TL, Williamson TH. Optical coherence tomography of the vitreoretinal interface in macular hole formation. Br J Ophthalmol 2001;85:1092–1097.

15. Johnson MW, Van Newkirk MR, Meyer KA. Perifoveal vitreous detachment is the primary pathogenic event in idiopathic macular hole formation. Arch Ophthalmol 2001;119: 215–222.

16. Glaser BM, Michels RG, Kuppermann BD, et al. Transforming growth factor-beta 2 for the treatment of full-thickness macular holes. A prospective randomized study. Ophthalmology 1992;99:1162–1173.

17. Lansing MB, Glaser BM, Liss H, et al. The effect of pars plana vitrectomy and transforming growth factor-beta 2 without epiretinal membrane peeling on full-thickness macular holes. Ophthalmology 1993;100:868–872.

18. Smiddy WE, Glaser BM, Thompson JT, et al. Transforming growth factor-beta 2 significantly enhances the ability to flatten the rim of subretinal fluid surrounding macular holes. Preliminary anatomic results of a multicenter prospective randomized study. Retina 1993;13:296–301.

19. Liggett PE, Skolik DS, Horio B, et al. Human autologous serum for the treatment of full-thickness macular holes. A preliminary study. Ophthalmology 1995;102:1071–1076.

20. Gaudric A, Massin P, Paques M, et al. Autologous platelet concentrate for the treatment of full-thickness macular holes. Graefes Arch Clin Exp Ophthalmol 1995;233:549–554.

21. Korobelnik JF, Hannouche D, Belayachi N, et al. Autologous platelet concentrate as an adjunct in macular hole healing: a pilot study. Ophthalmology 1996;103:590–594.

22. Wells JA, Gregor ZJ. Surgical treatment of full-thickness macular holes using autologous serum. Eye 1996;10:593–599.

23. Ezra E, Aylward WG, Gregor ZJ. Membranectomy and autologous serum for the retreatment of full-thickness macular holes. Arch Ophthalmol 1997;115:1276–1280.

24. Paques M, Chastang C, Mathis A, et al. Effect of autologous platelet concentrate in surgery for idiopathic macular hole: results of a multicenter, double-masked, randomized trial. Platelets in Macular Hole Surgery Group. Ophthalmology 1999;106:932–938.

25. Ryan EH Jr, Gilbert HD. Results of surgical treatment of recent-onset full-thickness idiopathic macular holes. Arch Ophthalmol 1994;112:1545–1553.

26. Cheng L, Azen SP, El-Bradey MH, et al. Duration of vitrectomy and postoperative cataract in the vitrectomy for macular hole study. Am J Ophthalmol 2001;132:881–887.

27. Leonard RE 2nd, Smiddy WE, Flynn HW, Feuer W. Long-term visual outcomes in patients with successful macular hole surgery. Ophthalmology 1997;104:1648–1652.

28. Sjaarda RN, Frank DA, Glaser BM, et al. Assessment of vision in idiopathic macular holes with macular microperimetry using the scanning laser ophthalmoscope. Ophthalmology 1993;100:1513–1518.