Stage III macular hole surgery

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Abstract

Twelve macular holes in 12 patients underwent a pars plana vitrectomy and epiretinal membrane resection with intravitreal gas tamponade for repair of their macular holes. The patients had stage III macular holes and had previously undergone a normal fundus-copic examination within 2 years. The patients have been followed for a mean of 14 months (range 12-18 months) postoperatively. The results show that visual acuity improvements were not seen until at least 6 months after surgery if the hole was closed successfully. Seven holes were closed (58.3%) and all improved their best corrected visual acuity by more than two Snellen lines. In the five eyes that did not demonstrate hole closure (41.6%), one eye improved by two lines as well. The other four eyes remained at their preoperative acuity. One eye developed a dialysis which responded to a fluid air exchange and cryopexy (8.3%). Three eyes developed minimal lenticular opacities during the follow up period (25%). One eye demonstrated an altered perifoveal pigment epithelium perhaps related to intraoperative light toxicity. Macular hole surgery can restore some central acuity even in patients with longstanding holes.

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The aetiology of macular holes has been debated for a long time. Theories of anterior posterior vitreous traction as the aetiology for these holes have been replaced by the tangential traction theory as proposed by Gass.^{1,2} Chronic cystoid macular oedema, myopic degeneration, and trauma will also produce a macular hole.^{1,3} Irrespective of the theory, the doctrine has been advanced that once a through and through macular hole is present, no therapy is possible. The patient has thus effectively surrendered his or her central acuity forever. Kelly and Wendel, however, suggested that the retina around the macular hole can be reattached in approximately 58% of cases with an improvement in the central acuity.⁴

We assessed the efficacy of this procedure in patients who had a longstanding full thickness macular hole (stage III), as described by Gass,¹ a full thickness retinal hole principally involving the foveolar region. The hole usually measures 500 µm in diameter and is associated with a rim of sensory retinal detachment. We wanted to know if these patients were able to attain any form of central acuity even though the macular hole had been present for more than 1 year.

Patients

Patients with a unilateral stage III idiopathic macular hole were chosen for this study if they

met several criteria. The patient had to be able to comprehend instructions and carry them out without the need for constant supervision. The macular hole in each case was less than 24 months old but more than 12 months old. Their best corrected Snellen visual acuity had to be 20/200 or worse. The fellow eye had to be free of any stages of macular hole formation. The patients all noted a central scotoma and had metamorphopsia. They could map out their scotomas and distortions on an Amsler grid. Patients with stage IV macular holes who met these criteria were very few in number and so were excluded from consideration in this study. All patients were free of any prior intraocular surgery and had minimal refractive errors ranging from -1.00 sphere to +1.50 sphere.

Ten women and two men met the above criteria and were entered into the study. Their ages ranged from 55 to 85 years (mean age 64.1 years). Preoperative and postoperative best corrected Snellen acuities were recorded for each patient. Fluorescein angiograms, fundus photographs, and Humphrey central fields were performed preoperatively and postoperatively.

Surgery was carried out under local anaesthesia using 2% xylocaine, 0.75% bupivacaine, and hyaluronidase. The anaesthetist administered neuroleptics and the patient was given an O'Brien block and retrobulbar block. In this fashion, anaesthesia and akinesia were attained.

Using a standard three port technique, a complete pars plana vitrectomy was performed. All the cortical vitreous was removed. A 20 gauge bent needle was used to pick the cortical vitreous at the edge of the optic disc; alternatively, a silicone tube with suction looking for the 'fish strike sign' as described by Kelly and Wendel.⁴ The retina around the macular hole was dissected free of delicate epiretinal membranes. Most membranes could be readily identified; however, we found it necessary to use a membrane scratcher (manufactured by the Dutch Ophthalmic Research Center, DORC) around the edges of the hole. Delicate epiretinal membranes were identified and removed with intra-

Table 1 Pre and postoperative acuities in patients with macular holes

Patient	Age of macular hole (months)	Pre-op acuity	Post-op acuity	Follow up (months)
1*	14	15/400	20/80	13
2*	16	15/400	20/100	13
3*	16	15/400	20/100	18
4*	13	20/400	20/80	12
5*	13	20/400	20/50	12
6*	15	20/400	20/70	14
7*	14	20/200	20/40	13
8	13	15/400	15/400	14
9	15	15/400	15/400	13
10	12	20/400	20/400	13
11	14	20/400	20/200	15
12	16	20/300	20/300	16

*Successful cases.

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Figure 1 (A) This preoperative photograph demonstrates a macular hole in a patient with a visual acuity of 20/400 (patient 5). (B) The preoperative fluorescein angiogram demonstrates the typical pseudofluorescence of a macular hole (patient 10). The postoperative angiogram remained unchanged.

Fig 1A

Fig 1B

ocular forceps. A complete fluid air exchange was performed with removal of the subretinal fluid under the edges of the macular hole. We were careful to dry completely the macular hole. An exchange of air for a minimally expandable concentration of 20% sulphur hexafluoride was performed. The patient was positioned face down as much as possible for the following week in order to reappose the perifoveal rim of tissue. A topical mydriatic (1% atropine) was given twice daily and a combination antibiotic steroid drop was administered four times daily.

The patients were examined 1 week, 2 weeks, and monthly thereafter until the last patient had been followed for at least 12 months. The best corrected visual acuities were followed as well as any complications or adverse effects of surgery. The best corrected visual acuities were documented by an independent optometrist who was aware that the patients had a macular hole.

Results

The visual acuities in this group of patients ranged from 20/200 to 15/400. All patients demonstrated a rim of detached retina around their stage III macular hole. Seven of the 12 eyes had successful closure of their macular hole (58.3%) (Table 1). In these patients the acuities ranged from 20/40 to 20/100 (Figs 1 and 2). An improved visual acuity was not seen until the sixth month postoperative visit or later. Two eyes have developed mild posterior subcapsular cataracts from this group (16.6%) after the third month visit. One patient (8.3%) developed a dialysis at the first month examination. A fluid

air exchange with 20% sulphur hexafluoride and cryoretinopexy successfully reattached the retina. Fortunately, the dialysis occurred in the nasal quadrant and did not affect the acuity. One eye (8.3%) developed a perimacular pigment disturbance which was most likely related to light toxicity. The acuity in this patient was 20/70 with an attached retina (Fig 3). The macular thresholds (Humphrey) improved in the patients who had successful surgery; however, the fields remained the same in the unsuccessful cases. Figure 4 illustrates the improvement seen in patient 4 who, over 12 months, improved from a preoperative acuity of 20/400 to 20/80.

The preoperative fluorescein angiogram demonstrated the classic findings of a macular hole in this series. Fig 1B demonstrates the hyperfluorescence corresponding to the area of the hole. Postoperatively, the angiograms were unchanged in the failed cases; however, the successful cases showed an enlarged hypo-fluorescent foveal region (Fig 2B). In the successful cases, the edges of the original hole were difficult to detect.

Five eyes did not demonstrate total readherence of the macular hole. It was apparent by the time that the gas reabsorbed that the hole would not flatten. These eyes did not experience any problems during surgery. No aetiology could be established for their failure. One eye did improve from 20/400 to 20/200 despite failure of the macular hole to close completely. The visual acuities in the other four failed eyes improved to the preoperative levels and remained at that level throughout the follow up period. One of these eyes also developed a posterior subcapsular lens

Figure 2 (A) After 13 months, the visual acuity is 20/50 (patient 5). (B) The postoperative angiogram looks normal; however, the avascular zone appears to be questionably enlarged. This may represent the altered capillary bed around the hole secondary to the intraoperative manipulation (patient 5).

Fig 2A

Fig 2B

Figure 3 Although this patient attained a postoperative acuity of 20/70, these pigment changes are apparent. They may represent light toxicity which suggests that the surgeon must be cautious in using too much illumination or placing his light source too close to the macula (patient 4).

opacity, bringing the total to three for the entire series (25%) over the follow up period.

Discussion

Although this is a small pilot series, the results suggest that even in patients with a macular hole present for longer than 12 months, vitreous surgery may produce a successful outcome. We opted not to include patients with prior intraocular surgery or even moderate amounts of myopia because both of these entities can produce a hole. It was our desire to keep the group homogeneous and therefore make an observation on a group of patients with an idiopathic stage III hole. Our results parallel those of Kelly and Wendel in that both series reported an anatomical success rate of 58%. Indeed, we found that the better acuities were always correlated with the successful reattachment of the perifoveal tissue. An improved acuity, however, was not seen until the patient had been followed for at least 6 months and five of the seven successfully reattached eyes did not improve until the eighth postoperative month. When precisely this improvement occurs is unknown. We postulate that at some point around 6 to 8 months retinal function improves enough to produce some amount of central acuity. Guyer and coworkers may have explained this by their observation that there is a variable amount of photoreceptor degeneration in the region surrounding a

macular hole.⁵ Since the acuities do not improve for at least 6 months, it may take a long time to regenerate some photoreceptors in the perifoveal region or, alternatively, many of these receptors do not totally degenerate when the fluid accumulates under the perifoveal rim.⁶ As suggested by Glaser and coworkers, visual improvement may depend on preservation of the neurosensory elements both during the detachment period and vitrectomy procedure.⁷

The improved macular thresholds seen in the successful cases, suggests that there is indeed an improvement in some type of central acuity perhaps related to a decrease in the anatomical size of the central defect. Microperimetry with a scanning laser ophthalmoscope may shed some light on the extent of resolution of the preoperative scotoma size after successful surgery. A decrease in the scotoma may also explain why the acuity improves after successful surgery. We speculate that the scotoma size will be observed to be smaller and that the central macular thresholds will be higher after surgery.

Why some cases resulted in total reapposition while others failed remains unclear. We did not see any significant preoperative differences between successful and unsuccessful results. The factors of patient age, age of macular hole, amount of subretinal fluid, the amount of scotoma, the extent of metamorphopsia, or the values of preoperative macular thresholds did not predict the outcome. All the cases underwent identical surgery with two important considerations. Initially, a complete pars plana vitrectomy was performed. A core vitrectomy will not suffice because it will not remove the tangential traction that may be originating outside the posterior pole. This means that all the cortical vitreous must be identified and removed.⁸ Secondly, care was taken to remove all the epiretinal membranes which insert on the edges of the macular hole. If this is not done, the hole will remain open and will not settle. Kelly and Wendel postulate that some epiretinal membrane fibres may grow around the edges of the hole onto the surface of the outer retinal layers.⁴ We found that gentle retinal manipulation with a membrane scratcher helped identify the fine epiretinal membranes inserting at the rim of the

Figure 4 (A) The preoperative Humphrey macular field shows decreased macular thresholds (patient 1). (B) After surgery, this patient has improved from 20/400 to 20/80. The fields have improved. Microperimetry may have a role in delineating when the central acuity begins to return in these patients.

Fig 4A

Fig 4B

macular hole. It is possible that chemical agents such as the transforming growth factor β or even cyanoacrylate glue may compensate for incomplete traction release. Incomplete removal of these membranes may prevent the complete reapposition of the perifoveal rim. To ensure success, Schocket and coworkers⁹ have even used laser photocoagulation to treat macular holes. Using this type of therapy obliterates the neurosensory tissue that the surgery is striving to preserve. Unless the patient develops ectopic fixation away from the laser scars, central acuity will not be restored.

One failed case demonstrated an improved acuity to 20/200 from a preoperative acuity of 20/400. A possible explanation for this improvement may lie in the above hypothesis that enough tangential traction was released to improve slightly the acuity without totally flattening the perifoveal rim of tissue.

The complications from macular hole surgery include cataract, retinal detachment, and glaucoma from intraocular gas use. We had one retinal detachment in this group and it responded to a pneumatic correction. Had it not succeeded, a reoperation with a scleral buckle would have been necessary. One of our patients demonstrated a pigment change near the fovea which we assume to be related to light toxicity or possibly a result of inadvertent retinal touch during surgery (Fig 3). This particular case was treated early in the series and it demonstrates that prolonged exposure or too intense a light source can be detrimental. The patient in this case had a successful outcome and the postoperative acuity was 20/70.

Typically, these older patients have a certain amount of lenticular opacity before surgery which is accelerated with vitreous surgery and intraocular gas. Three eyes have developed mild posterior subcapsular changes. Although the opacities have not progressed and do not interfere with their acuities at this point in their follow up, the lenticular changes may require surgery at some point. The patients should be made aware of this fact. An increase in lenticular nuclear sclerosis is commonly seen after vitreous surgery

for macular pucker. We did not assess this since we did not have a way of standardising the measurements. In a larger series, it may be possible to detect if there is a difference in the type of lenticular opacities produced by these two different surgical procedures.

Certainly, the fresh macular hole will apparently benefit from surgery as aptly demonstrated by Kelly and Wendel⁴ and Glaser *et al.*⁷ This small series suggests that the older macular hole deserves surgical consideration. Both the visual acuity and the central field can improve if the surgery is successful. Despite the reservations expressed by Fine¹⁰ based on available statistics for the development of macular holes in the fellow eye, improvements in both surgical techniques and improved materials (such as transforming growth factor β or cyanoacrylate glue)^{7,11} may make the benefits of surgery greatly outweigh the risks. Although the visual acuity improved to 20/70 or better in only three of the seven anatomically attached cases (42.8%), this series suggests that further investigations into macular hole surgery are warranted.

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