Macular Hole Surgery Sans Gas

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Introduction

Macular holes affect one in every 1,000 individuals, 72% of them are women between 60 and 70 years of age with a bilaterality ranging between 6 and 22%. Eyes with idiopathic macular hole have reduced vision, secondarily to the loss of tissue, cystic retinal changes, detachment of the retinal ring surrounding the hole and photoreception degeneration. In 1988, Gass described the pathogenesis of idiopathic macular hole, considering tangential vitreoretinal traction as the cause. Also in 1988, Smiddy et al performed this surgery without being able to define the usefulness of vitrectomy and due to the progression of lens sclerosis and potential retinal complications; concluded that conservative management in this stage would be a better option. Subsequently, studies were made in patients with stage 3 or 4 idiopathic macular hole in which pars plana vitrectomy with removal of the posterior vitreous and tamponade with expandable gas induced a healing of the macular hole in 58-97% of cases, with visual improvement between 42 and 85%.

The first report of successful macular hole surgery was published by Kelly and Wendel in 1991. In recent years, a number of authors have attributed increased success rate of surgery to the use of healing adjuvants (autologous serum, transforming growth factor α, platelets or thrombin), the initial stage and duration of macular hole.

The surgical technique necessitates post operative face down posturing in order to achieve effective tamponade of the macular hole. Indeed, there is evidence to suggest that longer duration of intraocular gas tamponade may have a favorable effect on the outcome of macular hole surgery.

Although 2 studies have reported comparable results with no face-down posture and four days of posture postoperatively, most studies advocate strict face-down posturing for at least one week after surgery as this is believed to be an important factors in closure of the hole. Because of this, macular hole surgery has been restricted to patients who are able to comply with the postoperative face-down posturing.

A number of patients however are unable to maintain posture because of positioning difficulties due to neck, back, spine, chest, other diseases or social reasons. This study reviews our experience of macular hole surgery without gas tamponade in a consecutive series of 25 patients and presents the results of a comparative analysis of patients undergoing macular hole surgery with and without postoperative gas tamponade.

Clinical Objective

To study whether gas tamponade was necessary to improve anatomic and functional outcomes in macular hole surgery.

Materials and Methods

This was a comparative case control study in which a retrospective analysis of 50 patients who underwent macular hole surgery at our centre between 2007 and 2009 June. They were divided into 2 groups. Group I which included 25 patients in whom surgery was
performed with intra operative gas tamponade and Group II which included 25 patients without gas tamponade. In both groups ILM peeling had been performed intraoperatively.

The inclusion criteria comprised patients between 50 and 80 years of age, males and females with macular hole diagnosed and evaluated based on clinical features, digital fluorescein angiogram and Optical Coherence Tomography (OCT) scan of stage 3 and 4 with a duration of greater than 6 months.

The exclusion criteria were vitreous or retinal pathology, aphakia, uveitis, glaucoma, corneal pathology, high myopia and previous vitreoretinal surgery. In all cases, a detailed evaluation was made, including assessment of visual acuity, slit lamp evaluation, assessment of lenticular changes, non contact tonometry and indirect ophthalmoscopy. All patients also underwent digital fluorescein angiography, fundus imaging and OCT Scan.

Infusion of air-perfluoropropane gas ($C_3F_8$) mixture at a non-expansible concentration of 17%. A thorough examination of 360° of the peripheral retina was performed with indirect ophthalmoscopy and scleral indentation. The sclerotomies were then closed.

**Post operative management**

The post operative visits were scheduled on day 1, weekly for the 1st 1 month and then monthly for the second, fourth, sixth and 12th months. The post operative evaluation comprised of best corrected visual acuity, non contact tonometry, slit lamp evaluation (to evaluate the condition of the cornea, lens, macular hole), indirect ophthalmoscopy and presence of complications, if any. OCT scans were performed on the 1st, 6th and 12th month after the procedure.

**Results**

The study included 50 eyes of 50 patients, 17 males and 33 females, between 52 and 80 years of age with an average of $61.4 \pm 11.9$ years. (Table: 1)

The pretreatment best corrected visual acuity ranged from 6/9 to counting fingers at half meter distance. The post operative visual acuity ranged from 6/9 to hand movements.

Distribution of the sample patients according to duration of the macular hole is shown in table 2. 32 % of the patients had a duration of < 5 months while 42 % between 5-8 months and 26 % of the patients had macular holes of more than 9 months duration.

The average duration of holes prior to surgery was $6.9 \text{ m} \pm 5.6 \text{ m}$.

58 % of the patients had a macular hole size of > 400 micrometre while 42 % had macular hole sized < 400 micrometers (Table 3)

Associated findings included cystoid macular edema (CME) 6 %, epiretinal membranes (ERM) 22 %, subretinal fluid (SRF) 4 % and Berlin’s edema 2 %. 56 % of the cases with macular hole did not have any other associated findings. One patient had an associated peripheral hole which was laser intraoperatively.

Retinal tears and postoperative retinal detachments are the most serious posterior segment complications and they occurred in 12 % of cases (Table 4) 88 %

**Surgical Technique**

Three port pars plana vitrectomy was performed by the same vitreoretinal surgeon (Dr. M C), with separation and removal of the posterior cortical vitreous after staining and demarcating it with triamcinolone acetonide. The internal limiting membrane was lifted, torn from the retinal surface by blunt dissection employing the technique of maculorhexis and peeled with a forceps. In patients whom gas tamponade was performed, a fluid / air exchange was done with...
of patients did not encounter any intra operative problems.

36 % of the patients underwent staining of the internal limiting membrane (ILM) with indocyanine green dye while 4 % of the ILM was stained with brilliant blue green (BBG) and 60 % with trypan blue dye.

50 % of the patients underwent perfluoropropane ($C_3F_8$) injection following ILM peeling while the remaining 50 % did not received any gas.

Patients who received $C_3F_8$ gas underwent post operative positioning for a period of 3 weeks. (6 hrs / day X 1 week ; 4 hrs / day X 2nd week ; and 2 hrs / day in the 3rd week). They were instructed to maintain face-down posture for the prescribed duration and to sleep on either sides avoiding supine position.

In 80 % of the patients in both the groups, the macular hole closed completely while the hole remained open in 20 % of the cases in both groups (Table 5)

Post operative complications included cataract in 40 % of patients who underwent macular hole surgery with gas and only 8% in those without gas. Glaucoma was encountered in 4 % of patients with gas while none of the patients in the other group developed glaucoma.

| Table 5. Distribution of the sample patients according to closure. |
|-------------------------|-------------------------|
| Closure | Without gas | Count | Percent | With gas | Count | Percent | Total | Count | Percent | \( \chi^2 \) | p |
| closed | 20 | 80.0 | 20 | 80.0 | 40 | 80.0 | 0 | 1.000 |
| open | 5 | 20.0 | 5 | 20.0 | 10 | 20.0 |
**Discussion**

The rate of closure of idiopathic macular hole depends on many factors like size of the hole (measured by OCT scan), duration of symptoms, ILM peeling, type of tamponade used (air, SF6, C3F8, silicone oil) and length of face-down positioning (2 weeks, 1 week, 5 days, 1 day or more).

Majority of the surgeons use gas tamponade. A 2006 survey by Mittra and Pollack showed that 63 % of surgeons use C3F8 while 33 % use SF6 as 6 weeks of visual disturbances with C3F8 is disabling for most patients. The patient compliance to postoperative positioning is also poor as indicated in a patient survey conducted by the AAO (Pollack J,S, Packo, J 2000). Only 3 % (4 weeks), 8 % (3 weeks), 63 % (2 weeks) and 25 % (1 week) compiled with the postoperative positioning.

So if buoyancy of the gas is small and the patients are generally unable to comply with the positioning, then what are we positioning for? A metanalysis of relevant studies on shortened post operative positioning is given below (Table 6).

Park in 1999 conducted a study in 58 patients with macular hole and concluded that 91 % of the macular holes closed with gas tamponade and positioning for 4 days.

Isomac in 2002 studied the effect of C3F8 tamponade and 1 day post operative positioning in 21 eyes with recent onset macular holes which also had a hole closure rate of 91 %.

Sato in 2003 also attained 91 % hole closure rate with air tamponade and 1 day face down positioning in a case series of 23 patients with small macular holes.

Krohn in 2005 studied 24 eyes with full thickness macular hole who underwent pars plana vitrectomy along with C3F8 tamponade and 3 days post operative face down positioning and showed that 87.5 % of the macular holes closed well while Wockens in 2006 achieved 95 % closure rate (21 eyes case series) with C3F8 gas tamponade and 3 days face down positioning.

Toruambe in 1997 achieved 79 % closure rate with C3F8 tamponade alone without any face down positioning, while Simcock in 2001 with C3F8 tamponade alone achieved 90 % closure rate.

Tranos and Merkur in 2007 used C3F8 alone for tamponade and had a hole closure rate of 88 % and 92 % respectively.

Thus smaller, recent holes will likely close with ILM peeling and minimal or no positioning (as long as patient avoids the supine position). Most holes will close with ILM peeling, SF6 gas and 1 day of positioning. For chronic or larger holes or if there are doubts regarding the patients ability to position, 3 or more days of face down positioning or C3F8 gas can be considered.

Clinical studies have shown that small holes that are of recent onset will have high success rates using almost any technique. Tadayoni et al (Br J Ophthalmol 2006) has shown that 100 % hole closure can be obtained for holes < 400 micrometre, with or without ILM peel.

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**Table 6. Metanalysis of published articles on MHS with shortened duration of posturing.**

<table>
<thead>
<tr>
<th>STUDY</th>
<th>PATIENT</th>
<th>SIZE/DURATION</th>
<th>GAS</th>
<th>POSITION</th>
<th>CLOSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK 1999</td>
<td>58</td>
<td>ALL</td>
<td>AIR</td>
<td>4 DAYS</td>
<td>91 %</td>
</tr>
<tr>
<td>ISOMAC 2002</td>
<td>21</td>
<td>RECENT</td>
<td>C3F8</td>
<td>1 DAY</td>
<td>91 %</td>
</tr>
<tr>
<td>SATO 2003</td>
<td>23</td>
<td>SMALL</td>
<td>AIR</td>
<td>1 DAY</td>
<td>91 %</td>
</tr>
<tr>
<td>KROHNS 2005</td>
<td>24</td>
<td>ALL</td>
<td>C3F8</td>
<td>3 DAYS</td>
<td>87.5 %</td>
</tr>
<tr>
<td>WICKENS 2006</td>
<td>21</td>
<td>ALL</td>
<td>C3F8</td>
<td>3 DAYS</td>
<td>95 %</td>
</tr>
</tbody>
</table>

**Table 7. Hole Closure Rates for macular holes without positioning**

<table>
<thead>
<tr>
<th>STUDY</th>
<th>PATIENT</th>
<th>SIZE/DURATION</th>
<th>ILM</th>
<th>GAS</th>
<th>POSITION</th>
<th>CLOSURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TORNABE</td>
<td>33</td>
<td>20 % CHRONIC</td>
<td>-</td>
<td>C3F8</td>
<td>NONE</td>
<td>79 %</td>
</tr>
<tr>
<td>SIMCOCK</td>
<td>20</td>
<td>STAGE II/III</td>
<td>-</td>
<td>C2F6</td>
<td>NONE</td>
<td>90 %</td>
</tr>
<tr>
<td>TRANOS</td>
<td>16</td>
<td>ALL</td>
<td>+</td>
<td>C3F8</td>
<td>NONE</td>
<td>88 %</td>
</tr>
<tr>
<td>MERKUR</td>
<td>72</td>
<td>RECENT</td>
<td>+</td>
<td>C3F8</td>
<td>NONE</td>
<td>92 %</td>
</tr>
</tbody>
</table>
100 % closure could be obtained with ILM peel in macular holes > 400 micrometre while only 73 % of the macular holes closed without ILM peel.

Although ILM peel remains controversial, most surgeons peel ILM for idiopathic holes. ILM peeling allows for complete removal of perifoveal vitreous traction.

Most surgeons use C$_3$F$_8$ for gas tamponade. However 6 weeks of visual disturbance with C$_3$F$_8$ is disabling for most patients.

The buoyant pressure and interfacial tension of the gas tamponade reattaches retina. C$_3$F$_8$ allows for 2-3 weeks of contact between hole and gas if supine position is avoided. Longer acting gas allows for more leeway in positioning. Shorter acting gas requires more positioning to achieve hole / gas contact as bubble dissipates. Positioning may actually be more critical as the bubble dissipates.

Hole closure rates for macular holes without positioning has been studied by several workers and the results show that it does not affect closure rate or functional outcomes (Table: 7)

The anatomic and functional outcomes in macular hole surgery are similar irrespective of whether intraoperative gas tamponade was used or not in the present study. Face down positioning is burdensome for the patient with reported side effects like ulnar neuropathy.

We decided to conduct our study without gas to tamponade the macular hole in 20 consecutive cases of idiopathic 3 and 4 macular holes and compared our results with our own series where C3F8 was used for postoperative tamponade. The rate of hole closure was similar in both groups, with the added advantage of fewer complications in the group where gas was not used. The patients were also saved from the discomfort of postoperative positioning, lesser progression of cataract and negligible postoperative glaucoma. However for repeat procedures and large chronic holes, tamponade should still be considered.

References