Comparison of outcomes of idiopathic macular holes treated by vitrectomy with air or silicone oil tamponade based on the hole size

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Abstract

- **AIM:** To compare the efficacy of vitrectomy combined with air or silicone oil in the treatment of idiopathic macular hole (IMH).

- **METHODS:** According to the results of high-definition optical coherence tomography (HD-OCT), 75 cases (75 eyes) of IMH in stage II-IV (Gass stage) in the General Hospital of Chinese PLA from January 2017 to December 2019 were collected for this retrospective study. The best corrected visual acuity (BCVA) and minimum diameter of IMH (MMHD) were measured. Eyes underwent vitrectomy combined with internal limiting membrane peeling operation, and were divided into disinfection air group (30 eyes) and silicone oil group (45 eyes) according to the intraocular tamponade. For MMHD≤400 μm (MMHD1), there were 23 eyes in air group and 16 eyes in silicone oil group. For MMHD>400 μm (MMHD2), there were 7 eyes in air group and 29 eyes in silicone oil group. One month after surgery, the closure rates of IMH and BCVA were compared and analyzed. According to HD-OCT, the closure shape was graded with A (bridge closure) and B (good closure).

- **RESULTS:** The closure rates of air group and silicone oil group were 86.67% and 95.56% respectively with no significant difference (P>0.05). For MMHD1, those of air group and silicone oil group were 95.65% and 100% respectively with no significant difference (P>0.05); For MMHD2, those of air group and silicone oil group were 57.14% and 93.10% respectively, and those of the silicone oil group were higher than the air group (P<0.05). There was no significant difference in the closure shape grade between MMHD1 air group and silicone oil group (P>0.05). The proportion of Grade B in MMHD2 silicone oil group was higher than that in the air group (P<0.05). BCVA of each group after operation was better than that before operation, and there was no significant difference between air group and silicone oil group. While among them, MMHD1 air group was better than silicone oil group (P<0.05), and there was no significant difference between MMHD2 air group and silicone oil group (P>0.05).

- **CONCLUSION:** For smaller IMH (≤400 μm), the efficacy of vitrectomy combined with air should be considered better than silicone oil; for larger IMH (>400 μm), the efficacy of silicone oil may be better than air.

- **KEYWORDS:** idiopathic macular hole; vitreoretinal surgery; silicone oil; air

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INTRODUCTION

Macular hole is a full-thickness tissue defect in the retinal neuroepithelial layer of the macular region, which can cause visual loss, visual distortion and other clinical manifestations. Clinical treatment are mainly vitrectomy and internal limiting membrane peeling combined with different intraocular tamponade[1-2]. Expansile gas is the favorite tamponade, but due to some incidents of infection in China in recent years, it could not be obtained stably clinically. In fact, disinfected air usually has excellent effect on idiopathic macular hole (IMH) in some situations[3-5], but in the meantime there are still a lot of failed reports[6-7], whose main cause is due to the insufficient duration. So sometimes silicone oil is needed to be used. But because of the well-known side effects and limitation, it is often hard to make a choice between disinfected air and silicone oil. There are few articles comparing the effects of air and gas on IMH surgery, but articles about air vs silicone
oil has not been found. At present, there is no clear guidance for these two tamponades, and the choice relies mainly on the experience of the operators. In this study, we tried to explore the rule and compare the effects of them according to the closure rates, the closure shape, complications, and the improvement of vision.

**SUBJECTS AND METHODS**

**Ethical Approval** All patients’ data and essential information were retrieved from medical records during the period from January 2017 to December 2019 in the Ophthalmology Department of Chinese PLA General Hospital. All the patients had been given explanation and signed informed consent before every operation under the supervision by the Medical Management Division of the hospital. And tenets of the Declaration of Helsinki were adhered to for this study.

Inclusion criteria: 1) macular full-thickness hole with stage II or above by optical coherence tomography (OCT) measurement; 2) course of disease ≤2y. Exclusion criteria: 1) refractive stromal opacity affecting fundus examination or treatment; 2) history of ocular trauma, surgery or intraocular injection; 3) patients with refractive power <−6.00 D or axial length>26 mm; 4) patients with previous vitreoretinal surgery; 5) patients with optic neuropathy; 6) patients with heart, lung, liver, kidney dysfunction or other intolerable surgical treatments; 7) patients with incomplete key follow-up records. All patients underwent best corrected visual acuity (BCVA), intraocular pressure (IOP), slit lamp microscope, fundus color photography and macular OCT examination.

**RESULTS**

Totally 75 patients (75 eyes) with IMH who underwent vitrectomy combined with internal limiting membrane peeling were included in this study. There were 21 males and 54 females with the average age of 61.2±8.1y. The courses of disease ranged from two weeks to 24mo. The average course was 3.8±7.2mo.

In the air group, there were 8 males and 22 females with the average age of 63.1±9.6y and the average course of 3.6±8.5mo. In the silicone oil group, there were 13 males and 32 females with the average age of 58.7±7.0y and the average course of disease of 4.0±6.5mo. There was no significant difference in age and course of disease between the two groups (all P>0.05). In the range of MMHD ≤400 μm (MMHD1) there were 23 eyes in air group and 16 eyes in silicone oil group; the average of MMHD were (277.6±43.9) and (303.4±43.1) μm respectively; there was no statistical difference (P>0.05). In the range of MMHD>400 μm (MMHD2) there were 7 eyes in air group and 29 eyes in silicone oil group; the average of MMHD were (491.6±70.8) and (525.4±103.6) μm respectively; the average of BCVA were 1.23±0.46 and 1.27±0.50 respectively; there was no statistical difference (P>0.05). In MMHD1, IMHs were closed in 43 eyes out of 45 eyes in silicone oil group; the average of BCVA were 1.25±0.32 and 1.40±0.39 respectively; there was no statistical difference (P>0.05).

One month afteroperation, IMHs were closed in 26 eyes out of 30 eyes in air group, and the closure rate was 86.67%. IMHs were closed in 43 eyes out of 45 eyes in silicone oil group, and the closure rate was 95.56%. There was no significant difference in IMH closure rate between the two groups (P>0.05). In MMHD1, IMHs were closed in 22 eyes out of 23 eyes in air group, and the closure rate was 95.65%; IMHs were
all closed in 16 eyes in silicone oil group, and the closure rate was 100.0%, there was no significant difference between the two groups ($P>0.05$). In MMHD2, IMHs were closed in four eyes out of seven eyes in air group (57.14%), and in 27 eyes out of 29 eyes in silicone oil group (93.1%), so the silicone oil group showed a better result than the air group ($P<0.05$). The closure rate of MMHD1 in air group was higher than that of MMHD2 ($P<0.05$), while the closure rate of different MMHD didn’t exist significant difference in silicone oil group ($P>0.05$), but the rate of absolute value in MMHD1 was higher than that in MMHD2 (Table 1).

One month after operation, there was no significant difference in closure grade between MMHD1 air group and silicone oil group ($P>0.05$), but the proportion of Grade B in MMHD2 silicone oil group was higher than that in air group ($P<0.05$; Table 2).

The postoperative BCVA of the air group, the silicone oil group and the subgroup according to the MMHD were improved compared with the preoperative (all $P<0.05$). There was no significant difference in the postoperative BCVA between the overall air group and the overall silicone oil group, while the MMHD1 air group was better than the silicone oil group ($P<0.05$), and there was no significant difference between the MMHD2 air group and the silicone oil group ($P>0.05$; Table 3).

According to the literature, ocular hypertension (OHT) has been defined as a postsurgical IOP>21 mm Hg or an increase of $>10$ mm Hg over the IOP baseline[10], and ocular hypotony has been defined as a postsurgical IOP≤7 mm Hg[11]. There were seven eyes (15.56%) with ocular hypotension in silicone oil group and none in air group. Under the treatment with captopril hydrochloride and brinzolamide eye drops, all the IOP returned to normal within one week. There were two eyes (6.7%) with ocular hypotony in the air group, but without retinal nor choroidal detachment.

One month after the operation, there was no significant change in the lens of all eyes in the air group, but the lens opacity of three eyes deteriorated in the silicone oil group. No serious complications such as endophthalmitis occurred in all cases.

Table 1 The overall closure rate of IMH and the closure rate in different sizes of IMH 1mo after surgery %

<table>
<thead>
<tr>
<th>Groups</th>
<th>Eyes</th>
<th>Overall closure rate</th>
<th>MMHD1 closure rate</th>
<th>MMHD2 closure rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>30</td>
<td>86.67</td>
<td>95.65</td>
<td>57.14</td>
</tr>
<tr>
<td>Silicone oil</td>
<td>45</td>
<td>95.56</td>
<td>100</td>
<td>93.10</td>
</tr>
</tbody>
</table>

*The difference between silicone oil group and air group was statistically significant ($P<0.05$); *The difference between MMHD1 and MMHD2 under the same tamponade was statistically significant ($P<0.05$).

**DISCUSSION**

The closure of macular hole is mainly due to the release of traction in the vertical and tangential directions[12], and the top pressure of tamponade on the neuroepithelium at the edge of the hole[13]. It is generally considered that inert gas is a relatively ideal tamponadematerial because of its long duration effect and few side effects[14-15]. However, in recent years, most of Chinese medical institutions lack of inert gas because of infection and related problems. So, the surgeons could only choose between disinfected air and silicone oil.

In this retrospective study, there was no difference in the overall closure rates of IMH between air group and silicone oil group. Venkatesh et al[16] studied various quantitative parameters of IMH by observing pre- and post-operative OCT images, and found a significant negative correlation of IMH closure with MMHD. Similarly, we found that the closure rate of MMHD1 in air group was higher than that of MMHD2; although there was no difference in silicone oil group between MMHD1 and MMHD2, MMHD1 was higher than MMHD2 in absolute value. Furthermore, we subdivided MMHD and compared air group with silicone oil group again. There was no significant difference in MMHD1 closure rates between the two groups; the closure rate of MMHD2 silicone oil group was higher than that of air group. The results showed that the two tamponades both have satisfactory closure effects for smaller IMH, and there was little difference between them; for larger IMH, the closure rate of silicone oil was obviously higher than that of air.

There are many factors influencing IMH closure, including macular choroidal thickness and blood supply[17], duration of IMH[18], MMHD and other parameters of IMH[19]. But for the...
air group was better than silicone oil group, but significant difference was not found in MMHD2 between the two tamponades. There are many determinants of visual acuity after IMH surgery. For the comparison of air and silicone oil, the main factors are the closure rate, closure shape and complications[26-27]. There was no significant difference in the closure rate and shape between the two MMHD2 groups. The difference of BCVA was mainly due to the complications of silicone oil, such as complicated cataract and secondary glaucoma. In addition, the side effects of silicone oil on visual acuity include promoting preretinal proliferation and even causing macular fold[28]. Besides, there are many reports about the damage of optic nerve and optic chiasm caused by silicone oil drops[29]. In our study, the silicone oil group was better than the air group in terms of the closure rate and closure shape in MMHD2 because of the better efficacy of continuous top pressure. But at the same time, the complications of silicone oil offset those advantages.

As a result, there was no significant difference in BCVA between the two MMHD2 groups. Through this study, it can be concluded that for smaller IMH, choosing air can obtain better vision with similar closure rate, and relieve patients from pain and complications; for larger IMH, choosing silicone oil can achieve better closure efficacy with similar postoperative vision. Except for the size of IMH, age, axial length, epiretinal membrane, etc[30-32], may be the influenced factors to the closure of IMH. It has to say that was a defect in this research. And if the observation elements were extended, that would be more complete.

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Conflicts of Interest: Yin L, None; Liu AQ, None; Jin X, None; Jia L, None; Wang FX, None.

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