

# Outcomes of Surgical Treatment for Retinal Detachment Resulting from Macular Hole in Highly Myopic Eyes

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## ABSTRACT

**Purpose:** To determine the type and outcome of surgery for retinal detachment resulting from macular hole in highly myopic eyes.

**Methods:** This retrospective analysis was performed on the medical records of highly myopic patients who underwent surgery for retinal detachment (RD) resulting from macular hole at Labbafinejad Hospital, Tehran-Iran from 1992 to 2001. Variables included age, gender, number and type of operations, visual acuity before and after the procedures and surgical success rate.

**Results:** Overall, 28 eyes of 27 patients (26 female and one male) with mean age of  $59.8 \pm 11$  years were included. Mean follow-up was 17.3 (range 3-72) months. Mean axial length was  $29 \pm 2.74$  mm (range: 24 to 35 mm) and mean degree of myopia was  $-16.4 \pm 3.1$  D (range -10 to -22 D). Posterior staphyloma was present in 20 eyes (71%). Seven eyes had undergone failed scleral buckling as the primary procedure prior to referral. Intravitreal SF<sub>6</sub> injection was the primary procedure in 12 eyes with localized detachments; the retina became attached in 5 (41.6%) of these eyes, however redetachment occurred in 7 (58.4%) eyes. Overall, 23 eyes (including 7 failed scleral buckling cases, 7 redetachments following SF<sub>6</sub> injection and 9 cases of primary surgery) underwent vitrectomy with use of high viscosity silicone oil. No major complications occurred during the operations. Overall, final anatomical success was 92.9% and visual improvement occurred in 85.7% of the eyes.

**Conclusion:** In highly myopic eyes with RD due to macular hole, less invasive procedures such as SF<sub>6</sub> injection seem to be appropriate for eyes with localized detachment. In cases of total or subtotal RD and posterior staphyloma, pars plana vitrectomy and silicone oil tamponade seem to be the preferred procedure.

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## Introduction

Highly myopic eyes may develop retinal detachment (RD) resulting from macular hole especially when accompanied by a posterior staphyloma<sup>1</sup>. The pathogenesis of this condition as well as its treatment is controversial. Current treatment options for RD resulting from macular hole include injection of an expansible gas with or without laser therapy around the macular hole<sup>2</sup> with or without pars plana vitrectomy. More recently vitrectomy accompanied by epiretinal membrane removal has been described.<sup>3</sup> Pars plana vitrectomy has replaced the older macular scleral buckling

techniques and led to improvement in anatomical and visual outcomes.<sup>4</sup> Pars plana vitrectomy relieves vitreous traction on the macula precluding need for sealing the macular hole by buckling or laser therapy. However, highly myopic eyes with posterior staphylomas and extensive areas of choroidal and retinal pigment epithelial atrophy may not respond to such treatment.<sup>5</sup> It appears that long term internal tamponade with silicone oil would be beneficial in these eyes.

The present study was aimed to determine the anatomic and visual results of surgical procedures performed for retinal detachment resulting from macular hole in highly myopic eyes based on medical records at Labbafinejad Medical Center, Tehran, Iran from 1992 to 2001.

## Methods

A retrospective analysis was conducted on records of all patients undergoing surgery for RD resulting from macular hole in highly myopic patients referred to Labbafinejad Medical center affiliated to Shaheed Beheshti Medical University, Tehran, Iran during a ten-year period (1992-2001). Selection criteria included myopia greater than -10 D, absence of proliferative vitreoretinopathy grade C (PVR-C) and no previous history of trauma. Eyes with retinal breaks other than macular holes were excluded from the study.

Medical records including admission notes, operative records and postoperative visits were reviewed. Variables including age, gender, involved eye, amount of myopia and axial length, presence of posterior staphyloma, extent and duration of detachment, type and number of procedures, follow-up period, visual acuity before and after operation and anatomical reattachment were collected and analyzed statistically. Statistical analysis methods included paired t-test, Fisher's exact test and chi-square. For the purpose of statistical analysis, visual acuity of counting fingers was considered equivalent to 2/100, the ability to detect hand movement as 2/1000 and light perception as 1/1000.

## Results

Overall, 28 (12 right and 16 left) eyes of 27 (26 females and one male) patients met the inclusion criteria and the records were reviewed and analyzed. Mean age was  $59.8 \pm 11$  years (range 35-75 years). All patients had history of progressive visual deterioration for several years with sudden loss of vision due to RD. None of the patients had history of trauma, previous vitreoretinal surgery, cystoid macular edema or any other condition predisposing to macular hole formation except for high myopia.

Mean axial length and mean amount of myopia (spherical equivalent) were  $29.1 \pm 2.7$  mm (range 24-35 mm) and  $-16.4 \pm 3.1$  diopter (range -10 to -22 D) respectively. Spherical equivalent refractive error was -10 to -14.5 D in 25%, -14.5 to -18.5 D in 50% and -18.5 to -22 D in 25% of the eyes. In cases which refraction and axial length measurement was not feasible due to RD or presence of silicone oil, the fellow eye was used to make these measurements.

The retinal detachment was localized to the posterior pole in 10, subtotal in 8 and total in 10 eyes. Posterior staphyloma involving the macula and the optic nerve was present in 20 eyes (71%) and multiple macular holes were present in one eye (3.5%). No vitreous traction was noted in any eye during the preoperative examination. Mean interval between RD and first procedure was  $2 \pm 2$  months (range 2 days to 7 months) and mean follow-up period was 17.3 months (range 3-72 months).

Three different interventions were performed as the primary procedure. The first group included 7 eyes (25%) all of which were referred due to recurrent RD starting from the posterior pole after an encircling scleral buckle (#276), fixed 7-16 mm from the limbus. All these eyes underwent

pars plana vitrectomy and silicone injection. The second group comprised of 12 eyes (42.9%), which underwent intravitreal injection of 0.5ml 100% SF6 and anterior chamber tap as the primary procedure followed by prone positioning. The third group included 9 eyes (32.1%) in which the initial procedure included insertion of an encircling band, pars plana vitrectomy, removal of the posterior hyaloid and silicone oil injection.

When the first intervention was not successful, the second operation involved standard pars plana vitrectomy accompanied by an encircling band, silicone oil injection and cataract extraction in phakic eyes. Overall, 3 eyes had undergone cataract surgery before retinal detachment and the remaining 25 eyes were phakic. Phakic eyes requiring vitrectomy at any stage of management underwent lens extraction at the same session. Laser therapy was also performed on eyes with lattice degeneration. In case of silicone oil related complications the oil was removed via the limbus using standard techniques.

**Table 1** Patient characteristics

Eye	Age	RD Duration	Myopia(D)	A-Pd(mm)	VA pre	VA final	PS	Extent of RD	F/U(m)	Re-op	Final AS
1	64	1	-19	31.5	HM	1/100	+	S	6	-	ON
2	59	1	-18	29	2/100	5/100	+	L	7	+	ON
3	55	3	-17	31	1/100	2/100	+	L	9.5	+	ON
4	72	7	-15.5	28	HM	1/100	-	S	23	-	ON
5	73	7	-18	29.5	HM	1/100	+	T	11	-	ON
6	50	0.6	-20	32.5	1/100	5/100	+	L	8	+	ON
7	50	0.8	-16	30.5	HM	5/100	+	S	17	+	ON
8	47	4.5	-14.5	27	2/100	6/100	-	T	20	-	ON
9	54	0.3	-14	27.4	HM	20/200	+	S	16	+	ON
10	57	2.5	-12	26	HM	6/100	-	T	72	+	ON
11	60	1	-18	31.5	HM	2/100	+	T	57	+	ON
12	75	1	-16	-	2/100	3/100	+	S	42	+	ON
13	73	3.5	-20	-	HM	1/100	+	L	12	+	ON
14	67	0.6	-14	27	HM	1/100	+	S	9	+	OFF
15	58	0.1	-22	33	1/100	6/100	+	L	54	-	ON
16	42	3.5	-14	27.5	2/100	20/200	-	L	58	+	ON
17	35	1	-22	35	HM	3/100	+	S	12	+	ON
18	60	0.6	-15	26.75	1/100	2/100	-	T	6	-	ON
19	68	1	-28	29.5	1/100	3/100	+	S	4	-	ON
20	73	5	-10	24	LP	LP	-	T	3	-	OFF
21	73	5	-17	-	1/100	1/100	+	T	6	+	ON
22	58	1.5	-12.5	25	HM	7/100	-	T	13	+	ON
23	55	3	-18	32	4/100	4/100	+	S	4.5	+	ON
24	57	1	-16	-	HM	HM	-	T	3	+	ON
25	70	0.3	-10	26	HM	2/100	+	L	3	+	ON
26	42	0.6	-18.5	28.88	4/100	2/100	+	L	3	-	ON
27	53	0.6	-19	30.5	HM	2/100	+	T	3	+	ON
28	75	0.3	-15	28.5	1/100	2/100	+	L	3	+	ON

RD=retinal detachment, A-P d=anterior posterior diameter, VA=visual acuity, HM=hand motion, LP=light perception, PS=posterior staphyloma, L=localized, S=subtotal, T=total, F/U=follow-up, m=month, Re-op= reoperation, AS=anatomical status

Anatomical success was defined as stable retinal re-attachment (posterior to the buckle effect in case of an encircling element) at final visit and was achieved in 26 eyes (92.8%). In these eyes anatomical

success was achieved with one, two, three and four procedures in 11 (42.3%), 12 (46.1%), 2 (7.6%) and one (3.8%) eye. Two patients refused to undergo reoperation despite lack of anatomic success.

Of the first subgroup of seven eyes (with previously failed scleral buckling performed elsewhere) which underwent pars plana vitrectomy and silicone oil tamponade, 6 eyes underwent the procedure once and one eye was reoperated leading to retinal attachment in all 7 eyes.

In the second subgroup of 12 eyes that underwent SF6 injection as the initial intervention, 5 eyes required no further treatment, however the remaining 7 eyes required pars plana vitrectomy and silicone oil injection leading to successful retinal re-attachment in all eyes with no need for reoperations.

In the third subgroup of 9 eyes that underwent pars plana vitrectomy and silicone oil injection as the initial procedure, retinal reattachment was achieved in 6 eyes. The operation was not successful in three eyes. Two eyes underwent reoperation and anatomical success was accomplished in one, however the other eye developed redetachment after the second operation (the patient refused a third intervention). The other patient refused any operation after the first operation was unsuccessful. Thus the results of pars plana vitrectomy and silicone injection were superior to SF6 injection ( $p= 0.008$ ).

Our results indicate no significant correlation between single-procedure anatomical success rate and extent of RD ( $p=0.6$ ) or presence of posterior staphyloma ( $p=0.28$ ). Silicone oil was removed from 4 of 23 eyes after an average period of 12.3 months. Redetachment occurred in one eye after silicone removal in which the retina was successfully reattached after a second session of pars plana vitrectomy and silicone injection. Retinotomy was performed due to PVR in one eye in the second operation, in two eyes in the third operation and in one eye in the fourth operation.

Overall 12 of 28 eyes underwent a single operation, of these only one eye developed redetachment and the patient refused a second operation. Another eye developed a localized RD anterior to the buckle effect as a result of PVR after 8 months which remained stable throughout the study (this eye was also considered a case of anatomical success).

Preoperative and postoperative visual acuity of 1/10 to 1/100 was present in 46.4% and 92.9% of the eyes, respectively ( $P<0.0001$ ) [table 2]. Comparison of visual acuity before and after the procedure(s) revealed that 24 eyes (85.7%) showed visual improvement, however 4 (14.3%) eyes had no improvement after the operation(s), but visual acuity did not decrease in any eye. Age ( $p=0.01$ ) and preoperative visual acuity ( $p=0.01$ ) were correlated with postoperative visual acuity but the extent of detachment ( $p=0.11$ ) and interval between RD to surgery ( $p=0.19$ ) were not.

**Table 2** Visual acuity before and after operation

Visual acuity	2/1000-1/100	1/100-1/10
Before operation	15 (53.6%)	13 (46.4%)
After operation	2 (7.1%)	26 (92.9%)

Mean preoperative intraocular pressure (IOP) was  $10.6\pm 4.5$ mmHg, which increased to  $15.1\pm 3.6$ mmHg at the last visit ( $p<0.001$ ). Elevated IOP was managed medically in three eyes, however two eyes did not respond to medical therapy and required further procedures to control IOP. The remaining 23 eyes were stable and required no treatment with IOP in the normal range.

No significant intraoperative complication was observed. However, complications that occurred during the follow-up period included silicone oil emulsification (11 eyes), hyphema (3 eyes), optic atrophy (3 eyes), spontaneously resolving vitreous haemorrhage (2 eyes), persistent glaucoma (2 eyes), orbital cellulitis and buckle infection each in one eye.

## Discussion

The great majority of patients in this study (26 of 27) were female which may indicate the higher incidence of RD due to macular hole in highly myopic eyes in females. The overall success rate of the operations was 92.9% and visual improvement was observed in 85.7% suggesting myopic degeneration. Adequate visual acuity for performing daily activities was achieved in all patients with a successful operation and did not change during the study period. More than one operation was needed to attach the retina in 17/28 (60%) eyes.

In eyes that underwent pars plana vitrectomy, silicone oil tamponade (5000 cs in most cases) was used. In the past, silicone tamponade was applied permanently for patients with RD resulting from macular hole.<sup>6-10</sup> We also intended to retain the silicone oil for as long as possible. The lens was removed during vitrectomy due to the high prevalence of cataract progression after vitrectomy and silicone oil injection in myopic patients.<sup>11</sup>

Pre-operative examination revealed no vitreous traction on the macula in any eye. Spontaneous and complete posterior vitreous detachment is common in high myopic eyes. In Miyake's study, no evidence of vitreous traction was reported.<sup>4</sup> In Machemer and Gonvers study, no vitreoretinal traction was reported in the preoperative assessment, however during vitrectomy, vitreous strands adherent to the retina were reported in 4 of 6 patients.<sup>12</sup>

Macular photocoagulation was not performed in any eye in our study. When the retina is attached, the macula normally remains attached without applying laser treatment. Kreissig<sup>13</sup> and Miyake<sup>4</sup> used argon or krypton laser and achieved results similar to studies with no laser application.<sup>12</sup>

Retinal detachment is rare in eyes with macular hole (0.6%) unless in high myopia (up to 10%). This higher rate might be due to presence of a posterior staphyloma or chorioretinal atrophy and disturbances in retinal pigment epithelium. These factors may result in fluid flow and subsequent retinal detachment.<sup>14</sup> Some studies suggest that the vitreous traction in highly myopic eyes may cause macular hole and RD.<sup>15</sup> In a study conducted on 209 eyes with myopic macular hole, rate of RD was 97.6% with myopia greater than 8.25 D, 96% in eyes with posterior staphyloma and 8.2% in eyes without a posterior staphyloma.<sup>16</sup>

Treatment of RD resulting from macular hole has been controversial. Before the introduction of pars plana vitrectomy, conventional treatment included macular buckle and retinopexy of the macular hole using cryotherapy, diathermy or photocoagulation.<sup>18-21</sup> Many of these techniques incur considerable complications such as extensive scar formation in the macula followed by reduction in visual acuity.<sup>20-22</sup> Apart from complications, the techniques were not effective in highly myopic eyes with chorioretinal atrophy or posterior staphyloma, because lack of retinal pigment epithelium in affected regions reduces normal retinal adhesion.<sup>5,23</sup> In addition retinal adhesion may be overcome with opposite tension resulting from posterior staphyloma (in such instances the retina is not flexible enough to follow posterior scleral ectasia).<sup>12</sup> In the current study, scleral buckling had been performed elsewhere in seven eyes with no peripheral holes and the retina redetached in all cases. In certain cases, RD in eyes with myopic macular hole may be treated using air or gas tamponade.<sup>12</sup> This technique is less effective in eyes with chorioretinal atrophy and posterior staphyloma.<sup>12</sup> Rosenberg was the first to use tamponade with air and trans-scleral diathermy.<sup>24</sup> Norton performed the same technique using SF<sub>6</sub>.<sup>25</sup> Kreissig used SF<sub>6</sub> and various types of perfluorocarbon gases<sup>26-28</sup> for closure of macular holes without drainage of subretinal fluid and achieved success in 15 of 16 eyes.<sup>13</sup> In our study, intravitreal injection of SF<sub>6</sub> in 12 eyes led to anatomic success in 5(41.6%). Temporary tamponade with intravitreal gas is not recommended in eyes which proliferative tissue

has resulted in macular hole formation. In such cases, the most efficient treatment is pars plana vitrectomy and removal of vitreous traction bands.<sup>29</sup>

Our single operation success rate with primary pars plana vitrectomy and silicone oil injection, was 67%. Recurrent RD has been reported 7-78 months after operation in myopic eyes with macular hole.<sup>30</sup> To prevent redetachment in eyes with chorioretinal atrophy or posterior staphyloma, Gonvers and Wolfensberger recommended weak laser photocoagulation around the macular hole with long-term silicone tamponade.<sup>31</sup> They have reported success rate of 91% with silicone tamponade for three months. Peeling of vitreous remnants or the internal limiting membrane has been described as an adjunct to vitrectomy. Ishida et al has reported successful retinal attachment in all eyes with epiretinal membrane peeling.<sup>15</sup> Other adjuncts to vitrectomy include cyanoacrylate tissue adhesive<sup>32</sup>, autologous platelet concentrate<sup>33</sup>, autologous serum<sup>34</sup>, thrombin-activated fibrinogen<sup>35</sup> and recombinant transforming growth factor- $\beta$ <sup>36</sup>, however these methods need further investigation.

In conclusion, retinal detachment associated with myopic macular hole may be managed with expansile gas (such as SF<sub>6</sub>) injection in localized cases. For the treatment of more extensive and complicated detachments with posterior staphyloma, pars plana vitrectomy with long term silicone oil tamponade is recommended.

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