

Anatomical Outcomes of Surgery for Idiopathic Macular Hole as Determined by Optical Coherence Tomography

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Objectives: To determine the rate of anatomical closure of idiopathic macular holes undergoing vitreous surgery with respect to preoperative horizontal diameter as determined by optical coherence tomography (OCT) and to correlate postoperative visual acuity, duration of symptoms, and late reopening with initial idiopathic macular hole diameter by OCT.

Materials and Methods: Forty eyes of 40 patients with an idiopathic macular hole were examined with OCT before and after vitreous surgery. All eyes were treated with pars plana vitrectomy, peeling of posterior cortical vitreous, and dilute perfluoropropane or sulfur hexafluoride gas. Face-down positioning was maintained for 7 to 14 days.

Results: Twenty-two (92%) of 24 eyes with a preoperative idiopathic macular hole diameter smaller than 400 μm measured by OCT attained anatomical closure following surgery. Anatomical closure was observed in 9 (56%) of 16 eyes with a macular hole diameter of 400 μm or larger measured by OCT ($P=.02$). The median postoperative visual acuity improvement was 4 Snellen lines in the 31 eyes achieving anatomical closure and no change

in the 9 eyes not achieving anatomical closure ($P<.001$). Late macular hole reopening at longer than 6 months occurred in 3 (10%) of 31 eyes with an initially closed macular hole. This event was observed only in macular holes 400 μm or larger measured by OCT. The preoperative macular hole diameter ($P=.02$) and duration of symptoms ($P=.02$) were factors predictive of anatomical closure of the macular hole postoperatively.

Conclusions: The postoperative closure of idiopathic macular holes following vitreous surgery was related to the preoperative macular hole diameter determined by OCT, with lesions smaller than 400 μm demonstrating higher success rates. A trend toward greater visual acuity improvement was demonstrated for idiopathic macular holes smaller than 400 μm . Late reopening was only seen in macular holes that were 400 μm or larger measured by OCT. Preoperative analysis and measurement of idiopathic macular holes with OCT may help delineate postoperative expectations for successful anatomical closure of the macular hole, visual acuity, and long-term closure.

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IDIOPATHIC MACULAR holes have received great attention over recent years owing to the improved ability to surgically achieve anatomical closure and regain visual function in many cases.¹ Several authors²⁻⁴ have reported significantly higher rates of anatomical closure and visual rehabilitation in patients with stage 2 macular holes compared with larger, stage 3 or 4, macular holes. The staging of macular hole lesions in these studies has largely been based on clinical biomicroscopic evaluation before and after vitreous surgery as well as grading of fundus photographs.^{3,4}

Clinical observations based on biomicroscopic observation suggest evolution of macular holes through several stages as proposed by Gass.⁵⁻⁸ A macular hole may start as a foveal detachment

(stage 1) and progress to a small ($<400\text{-}\mu\text{m}$) full-thickness macular hole (stage 2) then enlarge to a stage 3 lesion ($\geq 400\text{-}\mu\text{m}$). When a complete posterior vitreous detachment is present, the macular hole is defined as stage 4. Surgical intervention for stage 1 macular holes may not improve the natural history of these lesions due to spontaneous resolution in some eyes.⁹ However, vitrectomy with removal of posterior cortical vitreous, complete air-fluid exchange followed by injection of a dilute concentration of a long-acting inert gas, accompanied by face-down positioning appears to be effective in closing full-thickness macular holes.¹⁻⁴

Recent attempts to use imaging techniques such as the confocal scanning laser tomograph and the scanning laser ophthalmoscope to predict visual outcome

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MATERIALS AND METHODS

A retrospective review between July 1994 and February 1999 of all eyes with an idiopathic macular hole that were examined preoperatively and postoperatively by OCT by the Vitreoretinal Service of the New England Eye Center, Boston, Mass, was performed. Only eyes diagnosed as having an idiopathic macular hole were included in this study. Patients with previous and/or coexisting conditions such as intraocular inflammation, ocular trauma, and retinal detachment were excluded.

Patients received a complete ophthalmic examination including the following: complete medical and ophthalmic history, best-corrected Snellen visual acuity, Amsler grid testing, intraocular pressure measurement, slitlamp biomicroscopy, indirect ophthalmoscopy, and fundus photography. Optical coherence tomographic equipment used to obtain fundus images has previously been described by Puliafito et al.¹³ and Hee et al.¹⁴ The lateral resolution is limited by pixel size and determined to be 30 μm for acquisition of a 3-mm foveal scan performed in a radial fashion centered on the fovea. Each patient was examined with OCT by an experienced examiner through a dilated pupil and confirmed to have a full-thickness macular hole. An idiopathic macular hole was defined by OCT as a full-thickness defect of neurosensory retina overlying the retinal pigment epithelium and choriocapillaris reflection. Macular holes were measured in the least horizontal diameter by OCT (the shortest distance across the full-thickness defect was defined as the size of the macular hole). Fixation was maintained and readings were repeated if any question of deviation arose. Fellow eyes were also examined.

Informed consent was obtained prior to surgical intervention in all patients after the risks and benefits were reviewed. All surgical procedures were performed by 1 of 3 surgeons (J.S.D., E.R., or C.A.P.) between July 1994 and February 1999. The surgical technique consisted of standard 3-port pars plana vitrectomy, peeling of the posterior cortical hyaloid, air-fluid exchange, and injection of either 15% perfluoropropane (25 cases) or 25% sulfur hexafluoride (15

cases). No attempt was made to remove the internal limiting membrane. Eight cases included the use of intraoperative autologous serum placed in the bed of the macular hole. Patients were instructed to maintain strict face-down positioning for 7 to 14 days. Patients were examined postoperatively at day 1, 1 week, 1 month, 6 months, and when clinically indicated. Postoperative OCT was obtained when the gas bubble was absorbed superior to the macular region to confirm macular hole closure and on or after 6 months of follow-up.

Anatomical surgical success was clinically defined as apposition of the macular hole edges and absence of subretinal fluid cuff. Anatomical success determined by OCT was restoration of full- or partial-thickness retinal reflection over the retinal pigment epithelium and choriocapillaris reflections. Visual success was an improvement of 2 Snellen lines or more with best-corrected visual acuity or potential acuity meter. Postoperative evaluation of closure by clinical examination and OCT, late reopening, intraoperative complications, and macular hole formation in fellow eyes was performed on all patients.

The principal outcome of this study was anatomical closure of the idiopathic macular hole. Parameters of interest included age, sex, serum use, intraoperative gas, preoperative macular hole diameter, preoperative visual acuity, and length of symptoms. For regression analyses, macular hole diameter was dichotomized as stage 2 (macular hole diameter $<400 \mu\text{m}$) or stage 3 (macular hole diameter $\geq 400 \mu\text{m}$). Length of symptoms was dichotomized as long (≥ 6 months) or short (<6 months) duration.

A secondary outcome of this study was visual acuity. Snellen visual acuities were converted to logMAR equivalents for statistical analysis. Univariate and multivariate logistic regression analyses were performed. A 2-sided *P* value of .05 was regarded as statistically significant. Variables were included in the multivariate logistic regression model using a stepwise procedure based on the Akaike Information Criterion.¹⁶ Statistical analysis of the data was performed using SAS (SAS Institute, Cary, NC) and S-PLUS (Insightful Corporation, Seattle, Wash).

suggest a correlation between macular hole size and visual recovery.¹⁰⁻¹² These studies demonstrated significant variability in visual recovery based on preoperative volume and depth of macular holes. This study used optical coherence tomography (OCT) to measure preoperative macular hole size and correlated this with the postoperative rate of anatomical closure. To our knowledge, this is the first such study to use OCT in this manner.

Optical coherence tomography is a noninvasive diagnostic imaging technique that can help diagnose and quantify macular disease, including idiopathic macular hole.^{13,14} Optical coherence tomography is analogous to ultrasound B-scan except that since light rather than sound is used, a higher resolution is obtainable. Owing to the precise resolution of OCT, with an axial definition of 10 μm and a transverse resolution of 30 μm for a 3-mm scan, it may be a valuable tool to track anatomical features of idiopathic macular holes longitudinally over time. Re-

cently, OCT has been used to better establish the sequence of events to macular hole formation. Anteroposterior forces due to vitreofoveal traction that result in intraretinal splitting and subsequent full-thickness macular hole have been documented longitudinally by OCT.¹⁵

In this study, OCT was used to document preoperative full-thickness macular hole size. Preoperative macular hole size was then correlated with the anatomical success rate of surgery. Evaluation of the anatomical success rate between macular holes smaller than 400 μm and macular holes larger than or equal to 400 μm was performed to allow for comparison between macular hole stages as defined by the widely accepted Gass classification. Visual outcome and duration of symptoms were also correlated with preoperative macular hole size as determined by OCT. Late reopening, defined as opening of a macular hole that had been closed for 6 months or longer, in relation to initial preoperative OCT measurement was also examined.

Demographics of 40 Patients With Idiopathic Macular Hole Undergoing Vitrectomy Surgery*

Patient No./ Age, y/Race/Sex	Eye	Preoperative Status		Postoperative Status		Intraocular Gas Used	Serum Use	Length of Symptoms, mo
		Hole Diameter, μm	Visual Acuity	Status of Hole	Visual Acuity			
1/41/W/F	OD	70	20/50	Closed	20/30	15% C ₃ F ₈	-	1.5
2/61/W/F	OS	80	20/80	Closed	20/30	15% C ₃ F ₈	-	2
3/77/W/M	OS	100	20/70	Closed	20/50	25% SF ₆	-	6
4/74/W/F	OS	140	20/400	Closed	20/30	15% C ₃ F ₈	-	2
5/72/W/M	OD	140	20/70	Closed	20/50	15% C ₃ F ₈	+	2
6/53/W/F	OD	140	20/400	Closed	20/400	25% SF ₆	-	6
7/70/W/F	OD	150	20/60	Closed	20/30	15% C ₃ F ₈	-	1
8/73/W/F	OD	160	20/70	Closed	20/40	25% SF ₆	-	2
9/54/W/F	OD	160	20/70	Closed	20/25	15% C ₃ F ₈	+	12
10/68/W/F	OS	180	20/200	Closed	20/50	15% C ₃ F ₈	-	2
11/54/W/F	OD	210	20/200	Closed	20/30	15% C ₃ F ₈	+	1.5
12/67/W/M	OS	220	20/60	Closed	20/30	25% SF ₆	-	3
13/74/W/F	OS	230	20/100	Closed	20/60	15% C ₃ F ₈	-	3
14/44/W/M	OD	230	20/100	Closed	20/40	25% SF ₆	-	4
15/67/W/F	OS	230	20/400	Closed	20/40	25% SF ₆	+	4
16/62/W/F	OD	290	20/100	Closed	20/30	15% C ₃ F ₈	-	1
17/65/W/F	OS	290	20/100	Closed	20/60	25% SF ₆	-	0.5
18/62/W/M	OD	290	20/70	Closed	20/50	15% C ₃ F ₈	-	6
19/50/W/F	OS	330	20/80	Closed	20/40	15% C ₃ F ₈	-	5
20/63/W/F	OS	330	20/100	Closed	20/25	25% SF ₆	-	2
21/63/W/F	OD	330	20/200	Closed	20/60	25% SF ₆	-	3
22/85/W/F	OD	350	20/100	Open	20/400	15% C ₃ F ₈	-	8
23/80/W/F	OD	370	20/100	Open	20/200	25% SF ₆	+	6
24/61/W/M	OS	380	20/80	Closed	20/30	15% C ₃ F ₈	-	12
25/70/W/M	OS	420	20/200	Closed	20/50	15% C ₃ F ₈	+	3
26/40/W/F	OS	420	20/70	Closed	20/25	25% SF ₆	-	2
27/43/W/F	OD	430	20/400	Open	20/400	15% C ₃ F ₈	-	3
28/67/I/M†	OS	460	20/70	Closed	20/30	15% C ₃ F ₈	-	1
29/58/W/F	OS	460	20/50	Open	20/50	25% SF ₆	-	12
30/71/W/F†	OD	470	20/200	Closed	20/70	15% C ₃ F ₈	-	6
31/63/W/F	OS	490	20/100	Closed	20/60	15% C ₃ F ₈	-	4
32/51/W/F	OD	510	20/100	Open	20/80	25% SF ₆	-	5
33/49/W/F	OS	520	20/200	Closed	20/60	15% C ₃ F ₈	-	6
34/79/W/F	OD	530	20/400	Open	20/400	15% C ₃ F ₈	-	12
35/64/W/M†	OD	550	20/400	Closed	20/40	15% C ₃ F ₈	+	4
36/59/W/F	OD	560	20/200	Open	20/80	15% C ₃ F ₈	-	6
37/71/W/F	OS	560	20/400	Open	20/400	25% SF ₆	-	18
38/74/W/F	OD	600	20/100	Closed	20/60	15% C ₃ F ₈	-	7
39/58/W/F	OD	710	20/400	Closed	20/400	15% C ₃ F ₈	-	12
40/53/W/F	OD	810	20/200	Open	20/200	25% SF ₆	+	10

*W indicates white; I means person from India; C₃F₈, perfluoropropane; SF₆, sulfur hexafluoride; minus sign, no adjuvant autologous serum used; and plus sign, intraoperative use of adjuvant autologous serum.

†Patient with late reopening of an initially closed macular hole.

RESULTS

The clinical characteristics and demographics of the patients are included in the **Table**. There were 31 women (78%) and 9 men (22%), with a median age of 65 years (age range, 40-85 years). Twenty-two right eyes (55%) were included. Preoperative macular hole diameter ranged from 70 to 810 μm , with a median of 330 μm .

The range of preoperative visual acuity was 20/50 to 20/400, with a median of 20/100. In 40% (16/40) of eyes, the macular hole diameter was larger than or equal to 400 μm . Eyes with macular hole diameter larger than or equal to 400 μm had poorer preoperative visual acuity (median, 20/200) than eyes with macular holes smaller than 400 μm (median, 20/100) ($P = .04$, Wilcoxon rank sum test). Twenty-five of the 40 eyes received 15% per-

fluoropropane, and the remaining 15 eyes received 25% sulfur hexafluoride. Adjuvant autologous serum was used in 8 cases (20%).

The median length of visual symptoms, such as metamorphopsia, blurring, or scotoma, was 4 months with a range of 2 weeks to 1½ years. Eyes with macular hole diameter larger than or equal to 400 μm had a longer length of visual symptoms (median, 6 months) than eyes with macular holes smaller than 400 μm (median, 3 months) ($P = .02$, Wilcoxon test). Sixteen eyes had symptoms lasting at least 6 months. Of these 16 eyes, 7 had macular hole diameters smaller than 400 μm , and 9 had macular hole diameters larger than or equal to 400 μm .

Twenty-two (92%) of 24 eyes with an idiopathic macular hole smaller than 400 μm as determined by preoperative OCT achieved anatomical closure after 1 sur-

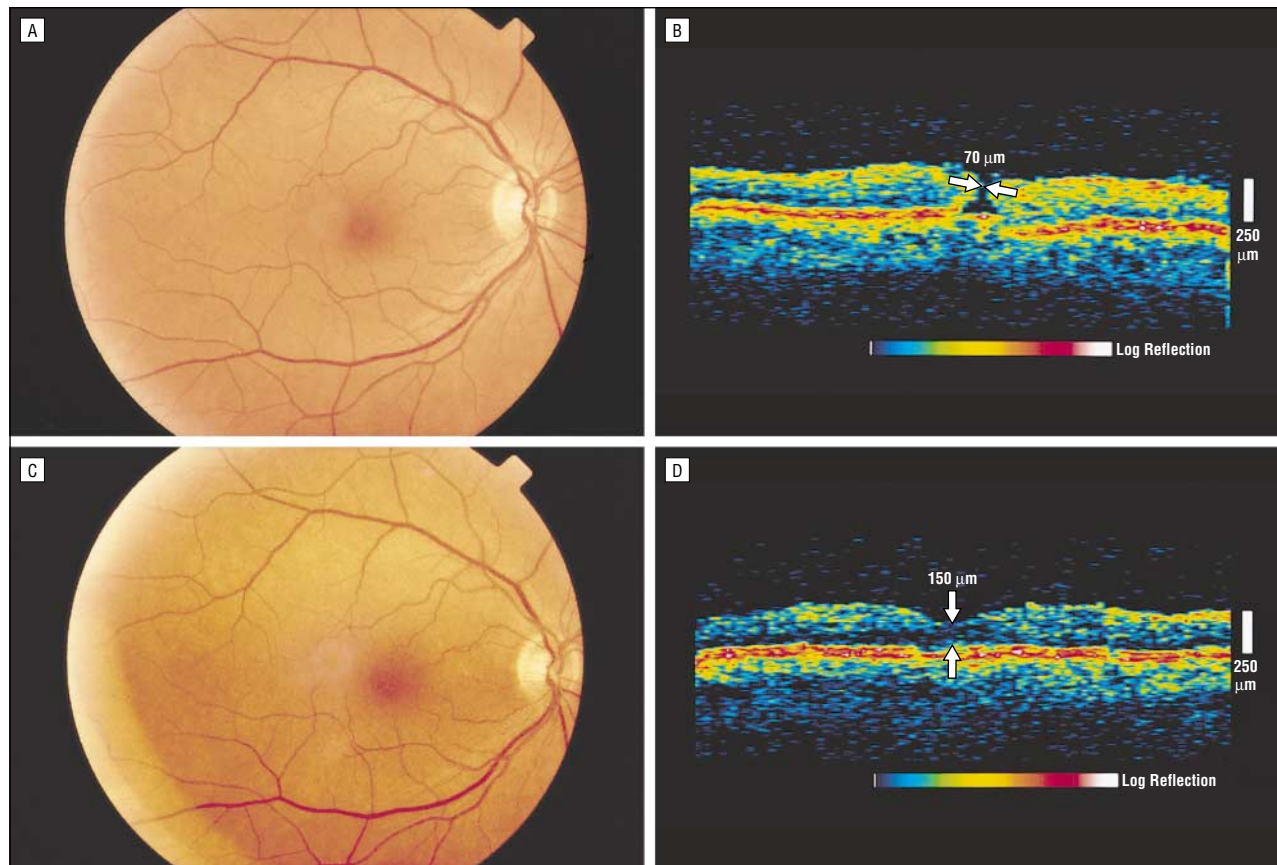


Figure 1. Fundus photograph (A) and optical coherence tomographic (OCT) image (B) of preoperative full-thickness idiopathic macular hole measuring 70 μm in horizontal diameter. Postoperative fundus photograph (C) showing clinical anatomical closure confirmed by the OCT image (D) showing reapposition of retinal tissue at the site of previous idiopathic macular hole.

gical intervention. **Figure 1** shows a patient with a full-thickness macular hole measuring 70 μm in horizontal diameter on preoperative OCT that was successfully closed with vitreous surgery. For the subgroup of macular holes measuring larger than or equal to 400 μm on OCT, anatomical closure was observed in 9 (56%) of 16 eyes. **Figure 2** shows a patient with a macular hole measuring 560 μm on preoperative OCT that was successfully closed with vitreous surgery.

In univariate logistic regression analyses, anatomical closure was associated with macular hole diameters smaller than 400 μm ($P = .02$) and with a length of visual symptoms for less than 6 months ($P = .02$). In a multivariate logistic regression analysis, the associations between anatomical closure and both a macular hole diameter smaller than 400 μm and a length of visual symptoms less than 6 months remained statistically significant ($P = .043$ and $P = .043$, respectively). Other variables such as age, sex, serum use, and gas injection were excluded from the model based on the Akaike Information Criterion model selection criterion. All 9 eyes in male subjects achieved anatomical closure, while 9 (29%) of 31 eyes in female subjects did not achieve anatomical closure ($P = .09$, Fisher exact test).

Overall, a median postoperative visual acuity improvement of 3 Snellen lines was observed ($P < .001$, Wilcoxon signed rank test), resulting in a median postoperative visual acuity of 20/50. The median postoperative

visual acuity improvement was 4 Snellen lines in the 31 eyes achieving anatomical closure and no change in the 9 eyes not achieving anatomical closure ($P < .001$, Wilcoxon rank sum test). For eyes with macular holes smaller than 400 μm , the median postoperative visual acuity improvement was 3 Snellen lines; in eyes with macular holes larger than or equal to 400 μm , the median visual acuity improvement was 2.2 Snellen lines ($P = .27$, Wilcoxon rank sum test). The median visual acuity improvement in eyes with a length of visual symptoms less than 6 months was 3.8 Snellen lines compared with an improvement of 0.8 Snellen lines in eyes with visual symptoms for at least 6 months ($P = .003$, Wilcoxon rank sum test).

Visual improvement of 2 or more Snellen lines was recorded in 26 (84%) of 31 eyes in which anatomical closure was achieved; 1 of 9 eyes in which anatomical closure was not achieved experienced a visual improvement of 2 or more Snellen lines ($P < .001$, Fisher exact test). Seventeen of the 31 eyes achieving anatomical closure had a final visual acuity of 20/40 or better; none of the eyes in which anatomical closure was not achieved had a final visual acuity of 20/40 or better ($P = .005$, Fisher exact test).

Late reopening of an initially closed macular hole after 6 months occurred in 3 (10%) of 31 eyes between 8 to 18 months (median, 14 months) postoperatively. The initial preoperative diameter in these 3 eyes by OCT was 460, 470, and 550 μm .

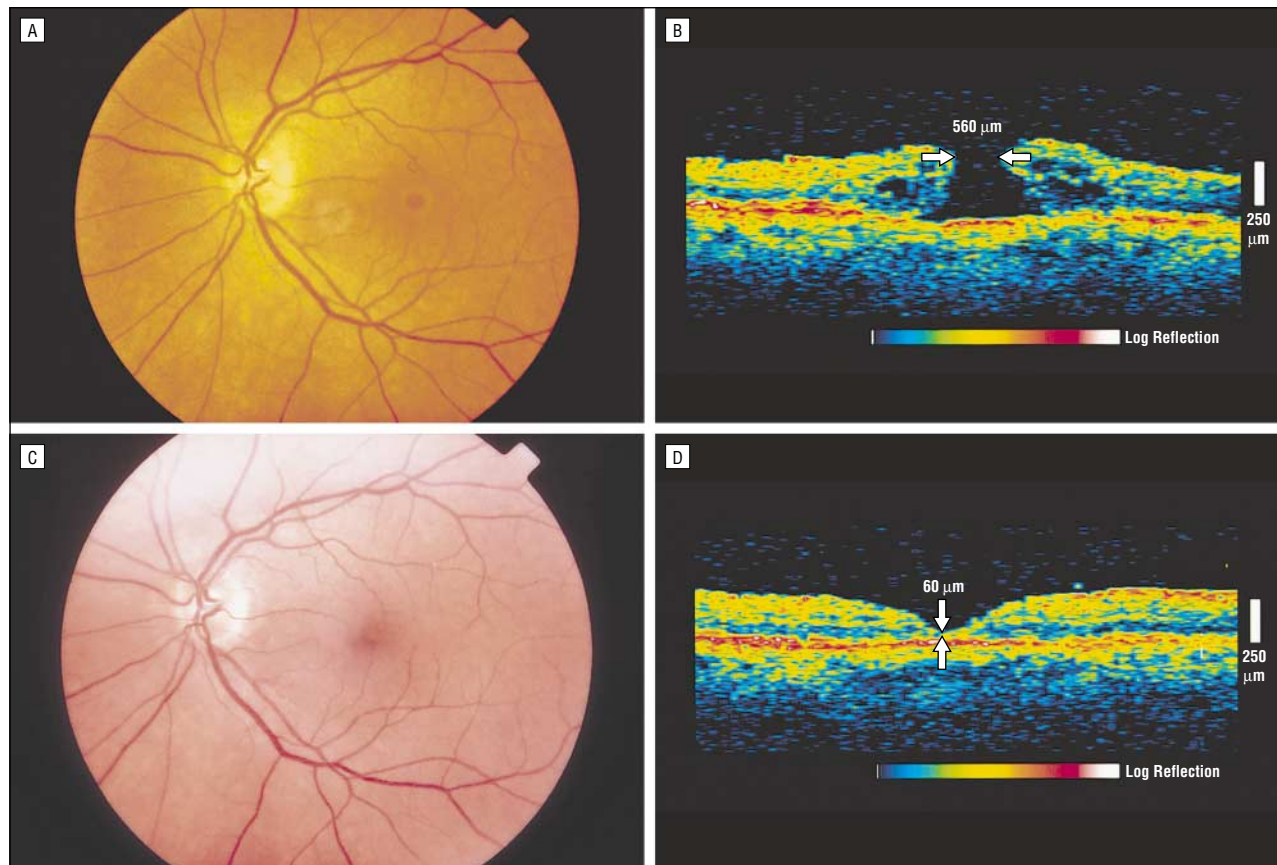


Figure 2. Fundus photograph (A) showing a larger idiopathic macular hole with surrounding cuff of subretinal fluid. Optical coherence tomographic (OCT) image (B) shows the 560- μm defect with adjacent thickening of the neurosensory retina. Eight months after undergoing surgery the 560- μm macular hole appears to be closed on clinical examination and on the fundus photograph (C). The OCT image (D) shows restoration of retinal tissue overlying the choriocapillaris reflection.

Progression of nuclear sclerosis or posterior capsule opacification occurred in all patients after the initial macular hole surgery. Two patients had postoperative intraocular pressures above 30 mm Hg on postoperative day 1 and were treated with aqueous suppressants. Four of the patients had a history of or developed a macular hole in the fellow eye. Seven patients received either intraoperative cryotherapy or endolaser to treat a retinal tear.

COMMENT

Surgical treatment of idiopathic macular holes has given vitreoretinal surgeons and patients an option for visual recovery for this once untreatable condition. Although often effective, there is controversy regarding the pathogenesis, surgical timing, verification of macular hole closure, visual recovery, and long-term complications.

Some conditions such as epiretinal membrane, lamellar hole, cystoid macular edema, and macular degeneration may be misdiagnosed on occasion as a full-thickness macular hole on biomicroscopic evaluation.^{17,18} Optical coherence tomography has been used successfully to demonstrate these entities and differentiate them from idiopathic full-thickness macular hole.^{13,14} Confirmation of the diagnosis, monitoring longitudinally over time, and unequivocal documentation of anatomical success or failure are possible with OCT.

Timing of surgical intervention, depending on idiopathic macular hole staging, size, and duration has shown correlation in success rate and visual recovery.² Preoperative staging has been traditionally based on the classification system proposed by Gass,⁵ judging macular hole diameters on clinical and photographic evaluation using the peripapillary vein as 125 μm in diameter as a reference. Stage 2 idiopathic macular hole closure based on this system has been reported in more than 90% of the selected cases.² The measurement of macular hole size in these previous studies was performed biomicroscopically, without the use of OCT. The use of OCT may allow better quantification of macular hole diameter, as OCT measurements are reproducible with a transverse resolution of 30 μm . Furthermore, OCT measurements do not rely on the assumption that a landmark peripapillary vein, which may vary in size between individuals, is 125 μm .

In this study, 22 (92%) of 24 macular holes smaller than 400 μm were successfully closed as determined by OCT. The anatomical closure rate decreased to 56% for idiopathic macular holes equal to or larger than 400 μm in diameter. We suggest that it is possible to use these results to predict rates of anatomical closure after surgery. Some studies have demonstrated that a smaller preoperative idiopathic macular hole size attains a higher rate of closure with surgical intervention.² This study uses OCT to quantify a measurement at which the success rate

appears higher. Four hundred microns was chosen to allow for comparison between macular hole staging as defined by the Gass classification. Clinicians may use the results of this study to more accurately predict postoperative expectations for initial and long-term anatomical closure.

Ryan and Gilbert² reported that shorter duration of macular hole presence had a better prognosis for closure and visual rehabilitation, separating the groups into symptoms less than 6 months and those longer than 6 months. In a natural history study of idiopathic macular hole, it was found that 34% of macular holes increase in size and 45% experience a loss of 2 or more Snellen lines during a follow-up period of 1 to 6 years.¹⁹ In this study, all successfully closed macular holes smaller than 400 μm by OCT had a short duration of symptoms of less than 6 months (median, 3 months) with the exception of 1 patient.

Optical coherence tomography may allow the physician to discuss the rate of possible success if intervention occurs in a timely fashion. Ophthalmologists are more likely to refer patients with macular hole symptoms at an earlier time owing to the success rates of surgery. Optical coherence tomography can provide valuable information in these earlier onset macular holes, many of which will be of smaller diameter.

In this study, 78% of eyes had an improvement of 2 Snellen lines or better. Although a trend toward greater visual acuity improvement was noted in the group of eyes with macular holes smaller than 400 μm than the group of eyes with macular holes larger than or equal to 400 μm (mean of 3 Snellen lines vs 2.2 Snellen lines), this did not reach statistical significance ($P = .27$, Wilcoxon rank sum test). This finding may reflect the fact that visual acuity was performed with a Snellen letter chart and without the benefit of a standardized refraction protocol. Additionally, other tests of visual function such as the Bailey-Lovie Word Reading test, that was found to have a significant benefit from macular hole surgery when other tests of visual function such as the Early Treatment Diabetic Retinopathy Study chart had only a marginal benefit from surgery in other studies, were not used in this study.³ Furthermore, the effect of cataract was not accounted for in this study as visual acuity data were a secondary outcome; the primary objective of this study was to correlate preoperative macular hole size with the rate of anatomical closure following vitreous surgery.

Complications of vitreous surgery for idiopathic macular holes include retinal tears, visual field defects, cataract formation, and late macular hole reopening. Late reopening of initially closed macular holes has been reported to occur in approximately 5% to 9.5% of eyes in previous studies.²⁰⁻²² Late macular hole reopening in this study occurring after 6 months of successful repair was seen in 10% of eyes. Preoperative macular hole size in these eyes measured by OCT was 460, 470, and 550 μm , respectively. Two of 3 underwent successful second pars plana vitrectomy. A larger sample size may reveal a lower rate of macular hole reopening, but this study suggests that macular holes with a greater horizontal diameter are at increased risk for late reopening.

Surgical intervention with a standard 3-port vitrectomy and injection of long-acting intravitreal gas, in combination with proper face-down positioning, has proven effective in attaining closure of idiopathic macular holes. Recent multicenter prospective studies have questioned the efficacy of adjuvants in surgical management and visual recovery of idiopathic macular holes.^{23,24} Six (75%) of the 8 patients receiving intraoperative adjuvant autologous serum in our series had closed macular holes. As only 5 of the 22 macular holes smaller than 400 μm in diameter that were successfully closed received adjuvant serum, we believe that idiopathic full-thickness macular holes smaller than 400 μm in diameter by OCT are likely to be successfully closed without adjuvant serum owing to their smaller size. Since the mechanism of closure by vitrectomy and gas injection is not completely known, it is possible that relieving traction from the posterior hyaloid surgically and preventing vitreous fluid from entering the macular hole via a gas bubble may be sufficient for successful closure.

Limitations of this study are based in its retrospective nature and sample size. The lack of a standardized refraction protocol limits the interpretation of visual acuity data. Although close attention was given to standardization of image acquisition, patient tracking of the scanning probe can result in an overestimate of macular hole size.¹⁴ Although reproducible, OCT is limited in the lateral resolution by pixel size, 30 μm , for acquisition of a 3-mm foveal scan in this study. Consideration of these factors should be made when applying these results to clinical situations.

CONCLUSIONS

Preoperative measurement of idiopathic macular hole diameter with OCT may help delineate postoperative expectations for successful initial anatomical closure of the macular hole, successful long-term closure and possibly visual function. Stage 2 macular holes, smaller than 400 μm in diameter as measured by OCT, had a greater likelihood of successful postoperative closure than stage 3 or 4 macular holes equal to or larger than 400 μm in diameter. There was also a trend, although this did not reach statistical significance, toward better postoperative visual acuity in the subgroup of eyes with stage 2 macular holes. Additionally, late reopening of macular holes in this study occurred only in the subgroup of eyes with preoperative macular hole diameters larger than 400 μm . When used in conjunction with careful clinical observation, OCT may be used to confirm the diagnosis of macular hole, verify results of surgery, and predict in which patients vitrectomy surgery will more likely be successful based upon preoperative quantitative measurement of macular hole diameter.

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