Visual Outcomes Following Macular Translocation With 360° Peripheral Retinectomy

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Objective: To evaluate visual outcomes following macular translocation with 360° peripheral retinectomy in patients with subfoveal choroidal neovascularization secondary to age-related macular degeneration.

Methods: In a prospective study, 15 consecutive patients with large subfoveal choroidal neovascularization underwent macular translocation with 360° peripheral retinectomy and silicone oil tamponade. Preoperative and postoperative photographs and fluorescein angiograms were obtained to evaluate lesion size and characteristics and translocation results. Standardized near and distance visual acuity and reading speed were measured preoperatively and 6 and 12 months postoperatively.

Main Outcome Measures: Changes in and final levels of near and distance visual acuity and reading speed.

Results: Median lesion size was 9 Macular Photocoagulation Study disc areas (range, 4-16 disc areas). In all patients, the fovea was successfully translocated off the subfoveal lesion. The median near visual acuity logMAR score (logarithm of the minimum angle of resolution) improved significantly from 0.54 units to 0.40 units (Snellen equivalent, 20/70 to 20/50; $P=.02$) at the 6-month follow-up and stabilized at 0.54 (12 months postoperatively; Snellen equivalent, 20/70). Seven (54%) of 13 patients and 7 (58%) of 12 patients achieved reading speeds of 70 words/min or greater at the 6-month and 12-month postoperative visits, respectively. Median preoperative distance visual acuity (20/100) was maintained at both the 6-month and 12-month examinations. No postoperative retinal detachments occurred in this series.

Conclusion: Macular translocation with 360° peripheral retinectomy and silicone oil tamponade stabilizes and can sometimes improve near and distance visual acuity and reading speed in patients with vision loss from subfoveal neovascular age-related macular degeneration.

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CHOROIDAL neovascularization (CNV) secondary to age-related macular degeneration (AMD) is a major cause of severe visual loss, including loss of reading ability.[1-3] Treatment options for subfoveal CNV are limited. Until the recent approval of photodynamic therapy, the only proven therapy for subfoveal CNV was focal laser photocoagulation.[2,4,5] The beneficial effect of laser treatment was restricted to patients with small, well-demarcated subfoveal lesions.[2] Thus, the majority of patients with subfoveal CNV were not eligible for laser treatment.[6,7] Furthermore, although laser treatment was effective in delaying large losses of visual acuity in certain patients, it usually did not allow patients to maintain the vision required for driving or reading.[2,3] Since its approval, photodynamic therapy has replaced laser photocoagulation as the recommended treatment for specified patients with subfoveal CNV.[8-10] Data from the Treatment of Age-Related Macular Degeneration With Photodynamic Therapy (TAP) Study and the Verteporfin in Photodynamic Therapy Study suggest that patients are candidates for photodynamic therapy if the lesion is predominantly classic or 100% occult with evidence of recent vision loss, especially if the lesion is smaller than 4 Macular Photocoagulation Study (MPS) disc areas or if the visual acuity is worse than 20/50.[8,9,11] Photodynamic therapy decreases the severity of vision loss but usually does not improve vision. Furthermore, many patients are ineligible for photodynamic therapy because of the size or characteristics of their subfoveal lesion.[8,9,11]

Macular translocation is a new surgical technique for the treatment of subfoveal CNV.[12,13] Originally described by Machemer and Steinhorst,[14] macular trans-

location moves the neurosensory retina away from the subfoveal abnormality to a new site of healthier retinal pigment epithelium and choriocapillaris with the goal of maintaining or recovering visual function. A theoretical advantage of macular translocation over current treatments is the preservation of foveal photoreceptor function. Initial case series of limited macular translocation and macular translocation with 360° peripheral retinectomy have demonstrated that central vision can be preserved or even improved in certain patients with subfoveal CNV secondary to AMD.[15-22]

The rate of retinal detachment and proliferative vitreoretinopathy has significantly decreased since the first report of full macular translocation by Machemer and Steinhorst.[14] Eckardt et al[16] have described a method of macular translocation involving 360° retinotomy and simultaneous muscle surgery to reduce postoperative torsional diplopia. Toth and Machemer[19] and Toth and Freedman[20] have recently published other modifications to the Machemer procedure.

The goal of this study was to evaluate visual outcomes in a prospective, standardized manner following macular translocation with 360° peripheral retinectomy and silicone oil tamponade. Primary outcome measures were changes in near visual acuity, reading speed, and distance visual acuity. A secondary goal was to examine whether lesion size, lesion characteristics, or duration of vision loss influenced final functional visual acuity.

METHODS

A prospective series of 15 consecutive patients with subfoveal CNV secondary to AMD underwent macular translocation with 360° peripheral retinectomy and silicone oil tamponade at the Duke University Eye Center, Durham, NC, between July 1,1999 and August 31, 2000. During this time period, additional patients underwent macular translocation with gas tamponade. Because of the different possible effects of tamponade, patients receiving gas tamponade were not included in this study and are being analyzed separately. In all patients, the surgery was performed by one of us (C.A.T.). The study protocol and consent were reviewed and approved by the Duke University Medical Center Institutional Review Board. The evaluation of the macular translocation with 360° peripheral retinectomy technique in the first 16 patients treated in the Duke study was previously reported.[20] This study summarizes the visual outcomes of the next 15 patients treated using modifications to the surgical technique as described by Toth and Freedman.[20]

Patients were eligible for the study if they met the following inclusion criteria: (1) age 55 years or older, (2) AMD with subfoveal CNV of any type, (3) best-corrected Snellen visual acuity between 20/50 and 20/400 in the surgically treated eye, and (4) maximum of 6 months of loss of central vision. Loss of central vision, as reported by the patients, occurred when they could no longer perform daily activities such as driving or reading. Patients were not excluded if they had evidence of macular atrophy, subretinal hemorrhage, or fibrosis. Exclusion criteria included (1) no light perception in either eye, (2) visual acuity of better than 20/50 in the fellow eye, (3) previous laser treatment of the center of the fovea in the surgically treated eye, (4) previous submacular surgery in the surgically treated eye, (5) severe diabetic retinopathy or previous laser treatment for diabetic macular edema or proliferative diabetic retinopathy in the surgically treated eye, (6) intraocular pressure of 30 mm Hg or more in the surgically treated eye, (7) ocular disease other than macular degeneration that would prevent the recovery of visual acuity after surgery (eg, severe amblyopia or previous vascular occlusion), and (8) a condition causing severe peripheral visual field loss in the fellow eye (eg, central retinal vein occlusion, chronic retinal detachment, or severe glaucoma).

All patients underwent a complete ophthalmologic examination preoperatively and 6 and 12 months postoperatively. At each visit, best-corrected distance visual acuity was measured using retroilluminated Bailey-Lovey charts with standardized refraction and visual acuity protocols adapted from the Submacular Surgery Trials.[23] Best-corrected near visual acuity was tested using a +2.50 diopter (D) add to the distance correction with a Rosenbaum near-vision card under standard lighting. Snellen visual acuities were converted into logMAR (logarithm of the minimum angle of resolution) units for statistical analysis. Evaluation of reading speed was performed in a standardized manner using Submacular Surgery Trials reading cards.[23] Subjective functional reading ability was ascertained by questioning patients on their ability to read newsprint with and without reading aids. Color stereo fundus photographs and fluorescein angiograms were also obtained preoperatively and 6 and 12 months postoperatively.

Macular translocation with 360° peripheral retinectomy was performed as described by Toth and Freedman.[20] After pars plana lensectomy and posterior capsulectomy for all phakic eyes, complete vitrectomy, posterior vitreous detachment, and shaving of the vitreous base were performed. Fluid was injected into the subretinal space in the inferonasal quadrant using a 36-gauge retinal needle. Detachment of the entire retina was completed via injection of additional subretinal fluid through a rounded, small-bore silicone cannula (Roundball; Alcon/Grieshaber, Schaffhausen, Switzerland). A 360° retinectomy was performed at the ora serrata, the retina was reflected, and the subfoveal lesion was removed. The neurosensory retina was then translocated superiorly off the subfoveal abnormality with a modified diamond-dusted soft silicone tip (surgeon-modified Tano Diamond-Dusted Membrane Scraper; Synergetics, Inc, St Charles, Mo) that was connected via short tubing to a syringe containing perfluorocarbon liquid. This instrument served as both a retinal manipulator and perfluorocarbon infuser. It was used to engage the posterior retina and slide it to its new location, followed immediately by infusion of perfluorocarbon liquid to hold the retina in its new position. After the new location of the fovea was confirmed, additional perfluorocarbon was added to flatten the retina out to the margins of the retinectomy. Laser photocoagulation was applied at the retinectomy margins while under perfluorocarbon liquid. A fluid to air to silicone oil exchange was then performed. Silicone oil was removed in a second operation an average of 7.5 weeks postoperatively (range, 4-10 weeks). Extraocular muscle surgery for torsional diplopia was performed at the time of oil removal in all eyes. A secondary acrylic intraocular lens was placed in the sulcus in aphakic eyes at the time of the oil removal.

Data were analyzed using SAS software, version 8.1 (SAS Institute, Inc, Cary, NC). Initially, descriptive statistics (mean, median, SD, and minimum and maximum values) were computed for continuous baseline and outcome data (age, duration of vision loss, lesion size, preoperative and postoperative visual acuities on logMAR derived from Snellen and on Early Treatment Diabetic Retinopathy Study (ETDRS) scales, and preoperative and postoperative reading speeds). Frequencies and percentages were obtained for categorical variables (sex, lesion size, and lesion type). Variables for change from preoperatively to 6 and 12 months postoperatively were created for ETDRS testing distance visual acuity, near visual acuity (logMAR), and reading speed. Correlations were obtained for selected variables.

Table 1. Patient Demographics*

Patient No./ Age, y/Sex	Eye	Lens Status	Duration of Vision Loss, wk	Lesion Size, MPS Disc Area	Type of Lesion by Relative Size of Components
1/72/M	OD	PCIOL	12	6	O
2/71/F	OD	NS	3	5	C>O
3/84/F	OD	PCIOL	2	6	B>C>O
4/76/M	OS	NS	6	4	O>B
5/71/M	OS	NS	14	6	O>C
6/74/M	OD	NS	12	16	B>C
7/81/F	OD	PCIOL	64	6	C>B
8/72/M	OD	NS	17	5	C>O
9/77/F	OS	NS	18	9	O>B
10/83/M	OD	PCIOL	24	12	O
11/71/M	OD	NS	7	16	O>C>B
12/81/F	OD	NS	4	16	B>O
13/76/M	OS	NS	13	9	O>C
14/75/F	OS	PCIOL	5	4	O
15/78/F	OD	NS	6	4	O

*MPS indicates Macular Photocoagulation Study; PCIOL, posterior chamber intraocular lens; NS, nuclear sclerotic cataract; O, occult choroidal neovascularization; C, classic choroidal neovascularization; and B, subretinal hemorrhage.

Subsequently, the significance of the changes in visual information (ETDRS testing, near visual acuity in logMAR units, and reading speed) was assessed using the Wilcoxon signed rank test. This test, which uses the ranks of the data instead of the data values themselves, assesses whether the median change from preoperative to postoperative measurements is significantly different from zero. This test was used instead of a paired *t* test because the distributions of the changes in visual acuities were not normally distributed.

After changes in visual acuities were evaluated, patient characteristics were examined to determine whether they were important in predicting the changes in acuities. Initially, selected variables were considered one by one in models as predictors (univariable analyses). Subsequently, they were considered simultaneously in models as predictors (multivariable analyses). Age, sex, preoperative vision, lesion size, and duration of vision loss were examined independently and together for their ability to predict changes in visual information. Linear models with these variables as predictors and the ranks of the changes at (6 and 12 months) in visual information variables as the dependent variables (to parallel the analyses of changes using ranks and described previously) were used to assess the significance of the predictors. In addition to this assessment, a similar analysis was carried out to assess predictors of 6-month and 12-month values of the visual outcomes.

RESULTS

Fifteen patients (15 eyes) participated in this study, and 8 (53%) were men (**Table 1**). Their ages ranged from 71 to 84 years (median age, 76 years). Duration of vision loss ranged from 3 to 64 weeks. One patient was included in the study despite having had vision loss for longer than 6 months. The smallest lesion measured 4 MPS disc areas,[1] and the largest was 16 MPS disc areas (median, 9 MPS disc areas). Most lesions (10 [67%] of 15) measured 6 MPS disc areas or larger (**Figure 1**). Of 15 eyes, 8 (53%) had a component of classic CNV (**Figure 2**), and 4 (27%) contained purely occult lesions. The fovea was successfully translocated off the subfoveal lesion in all 15 eyes (**Figure 3**). None of the patients in this series had undergone previous laser treatment or photodynamic therapy at the time of the translocation. All 15 patients had subfoveal CNV or a disciform scar in the fellow eye. Median visual acuity of the fellow eye was 20/400 (range, 20/64 to 20/1280). Ten eyes (67%) were phakic and underwent pars plana lensectomy at the time of the macular translocation.

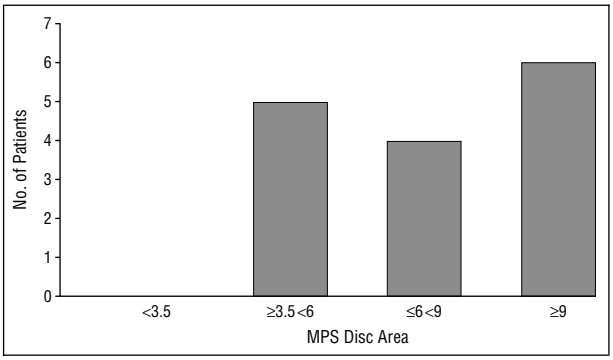

Figure 1. Choroidal neovascularization lesion size. The median lesion size was 9 Macular Photocoagulation Study (MPS) disc areas. Most lesions (10/15 [67%]) measured 6 MPS disc areas or larger.

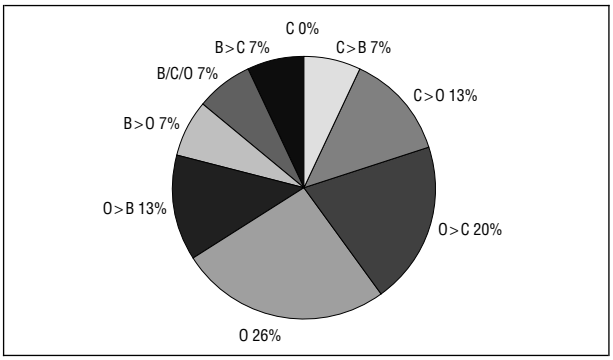

Figure 2. Type of lesion by relative size of components. Eight (53%) of 15 eyes had a component of classic (C) choroidal neovascularization, and 4 (27%) contained purely occult (O) lesions. B indicates subretinal hemorrhage.

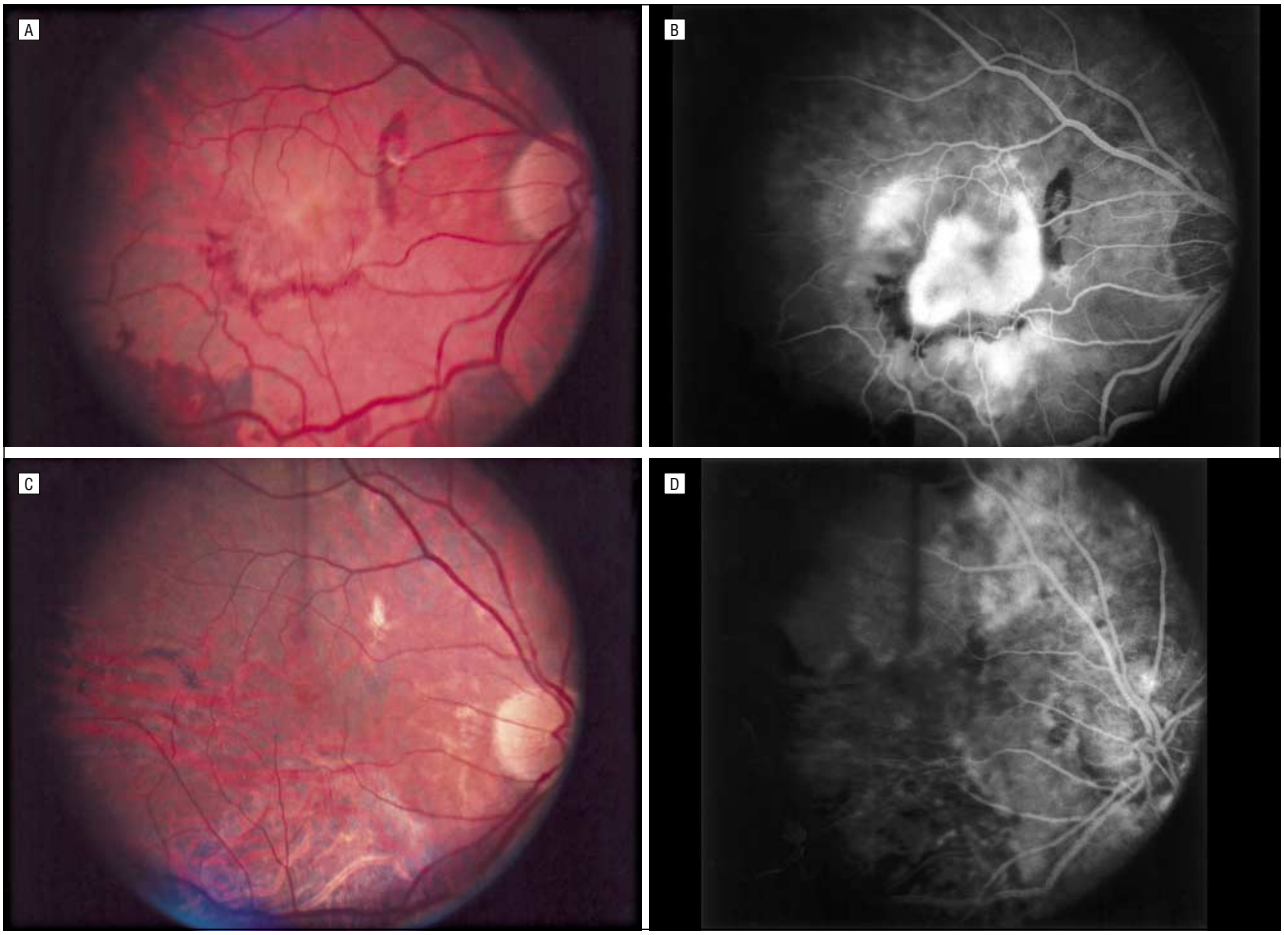

Figure 3. Patient 7, an 81-year-old woman, had preoperative near and distance visual acuities of 20/64 and 20/70, respectively. Reading speed was 11 words/min. A, Preoperative examination revealed a subfoveal neovascular membrane with surrounding subretinal hemorrhage. B, A midphase fluorescein angiogram revealed a subfoveal classic membrane with areas of hypofluorescence corresponding with subretinal hemorrhage. C, One year after macular translocation with 360° peripheral retinectomy and subsequent muscle rotation, near and distance visual acuities had both improved to 20/40. Reading speed had improved to 120 words/min. There is no evidence of subretinal fluid or hemorrhage. Retinal pigment epithelium atrophy from the original site of choroidal neovascularization (CNV) removal is present along the inferotemporal arcade. D, A fluorescein angiogram reveals translocation of the fovea away from the site of the original CNV. There is no evidence of CNV.

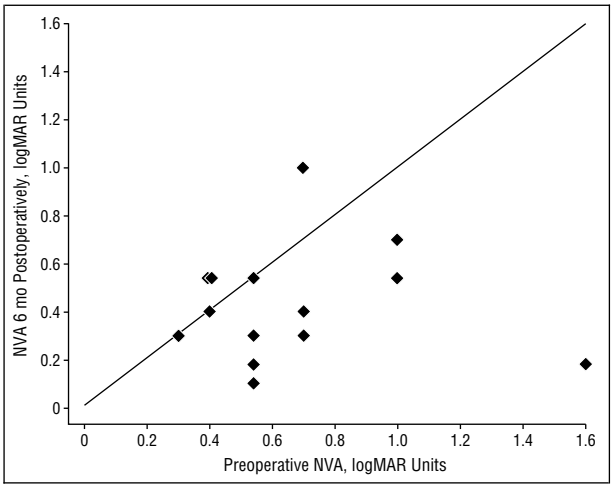

Figure 4. Preoperative and 6-month postoperative near visual acuity (NVA), measured in logMAR (logarithm of the minimum angle of resolution) units.

Median preoperative best-corrected near visual acuity was 0.54 logMAR units (range, 0.30 logMAR units to 1.6 logMAR units). One patient did not return for the 6-month follow-up. This patient's visual acuity was recorded by an outside ophthalmologist and was not used in the data analysis. Six months postoperatively, the median best-corrected logMAR score improved to 0.40 (P=.02) (**Figure 4**). Of 14 patients, 5 (36%) remained within 0.2 logMAR units of their preoperative near visual acuity, and 8 (57%) improved more than 0.2 logMAR units. Of 14 patients, 13 (93%) achieved near visual acuity of 20/100 or better at 6 months, and 3 (21%) achieved near visual acuity of 20/40 or better (**Table 2**).

One-year follow-up data were available on 13 patients. Two patients died before their 1-year follow-up date. The median 12-month near visual acuity was 0.54 logMAR units. No statistical difference existed between the median preoperative and 12-month near visual acuity nor between the median 6-month and 12-month near visual acuities. At 12 months, 5 (38%) of 13 patients remained within 0.2 logMAR units of their preoperative score, 5 (38%) improved more than 0.2 logMAR units, and 3 (23%) worsened more than 0.2 logMAR units compared with their preoperative score (**Figure 5**). One year postoperatively, 11 (85%) of 13 patients achieved near visual acuity of at least 20/100, and 4 patients (31%) achieved near acuity of at least 20/40.

Table 2. Preoperative and Postoperative Near Visual Acuity*

Patient No.	Near Visual Acuity		
	Preoperatively	6 mo Postoperatively	12 mo Postoperatively
1	20/100	20/200	Deceased
2	20/70	20/70	20/50
3	20/70	20/25	20/20
4	20/200	20/70	20/70
5	20/50	20/50	Deceased
6	20/200	20/100	20/200
7	20/70	20/40	20/40
8	20/70	20/30	20/40
9	20/100	20/40	20/100
10	20/50	20/70	20/70
11	20/50	20/70	20/200
12	20/800	20/30	20/25
13	20/40	20/40	20/70
14	20/40	NA	20/70
15	20/100	20/50	20/80
Mean	20/90	20/55	20/64
Median	20/70	20/50	20/70

*NA indicates not available.

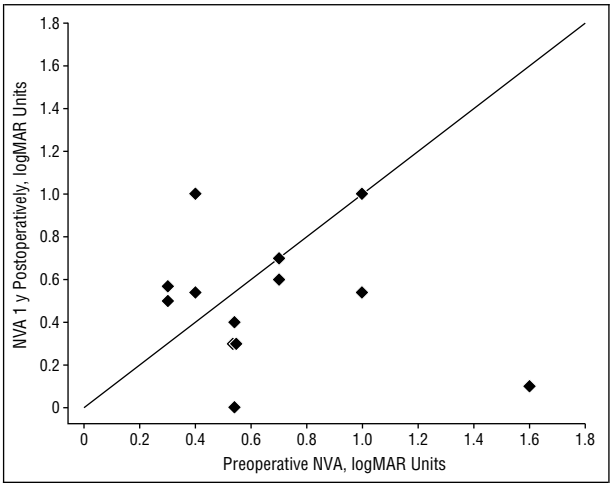

Figure 5. Preoperative and 1-year postoperative near visual acuity (NVA), measured in logMAR (logarithm of the minimum angle of resolution) units.

Table 3. Preoperative and Postoperative Reading Speed*

Patient No.	Reading Speed, Words/min		
	Preoperatively	6 mo Postoperatively	12 mo Postoperatively
1	81	38	Deceased
2	96	96	96
3	40	26†	Alzheimer disease†
4	105	140	133
5	63	22	Deceased
6	57	23	53
7	11	62	120
8	71	120	120
9	66	52	65
10	60	75	65
11	109	51	48
12	13	101	96
13	71	74	62
14	70	NA	93
15	120	114	96
Mean	69	74	87
Median	70	74	95

*NA indicates not available.
†Patient developed progressive Alzheimer disease and was unable to participate in the reading test.

Median preoperative reading speed was 70 words/min. Patient 3 had a postoperative reading speed that could not be accurately measured because she developed Alzheimer disease, and her data were excluded from further reading speed analyses (her 12-month distance and near visual acuities were 20/32 and 20/25 Snellen equivalents, respectively). Six months postoperatively, the median reading speed improved to 74 words/min ($P=.85$). Five (38%) of 13 patients remained within 25 words/min of their original starting reading speed (**Table 3**), and 4 patients (31%) gained more than 25 words/min in their reading speed; 7 (54%) of 13 patients had a 6-month reading speed of 70 words/min or greater.

The median reading speed at the 1-year follow-up increased from the preoperative median speed of 70 words/min to 95 words/min ($P=.37$). Seven (58%) of 12 patients had a 12-month reading speed of 70 words/min or greater.

In terms of functional reading ability, 8 (67%) of 12 patients reported the ability to read standard-sized newsprint at the 1-year follow-up. Although not all patients were tested with low vision aids prior to surgery, none of these patients were able to read preoperatively with their reading glasses; 5 patients were able to read with the use of low-add ($<+4.00$ D) reading correction, and 3 patients required the use of high-add ($\geq +4.00$ D) reading correction.

The preoperative median best-corrected distance visual acuity was 65 letters on ETDRS testing (range, 45 to 86 letters). Converted to Snellen visual acuity, this corresponded to a median best-corrected distance acuity of 20/100 (range, 20/32 to 20/320) (**Table 4**). The 6-month postoperative median best-corrected visual acuity was also 65 letters on ETDRS testing (range, 48 to 86 letters; Snellen equivalent, 20/100). Distance visual acuity remained within 10 letters on ETDRS testing in 10 (71%) of 14 patients and improved by 11 or more letters in 3 patients (21%). It decreased by 11 or more letters in 1 (7%) of 14 patients. At 6 months postoperatively, 10 (71%) of 14 patients achieved a best-corrected distance visual acuity of 20/100 or better, and 3 (21%) achieved a distance visual acuity of at least 20/40.

The distance visual acuity remained stable through 1 year of follow-up. The median 1-year postoperative distance visual acuity was 64 letters by ETDRS testing (range, 48-87 letters). There was no statistical difference between median preoperative and 1-year postoperative distance visual acuity (65 letters vs 64 letters). One year postoperatively, 10 (77%) of 13 patients achieved best-corrected ETDRS testing distance visual acuity of at least 20/100, and 4 (31%) achieved a distance acuity of at least 20/40 (Table 4).

Age, sex, preoperative visual acuity, size of lesion, and duration of loss of vision were not predictive of

Table 4. Distance Visual Acuity 6 and 12 Months Postoperatively*

Patient No.	ETDRS Chart Score					Snellen Equivalent		
	Preoperatively	6 mo Postoperatively	Change in Letters	12 mo Postoperatively	Change in Letters	Preoperatively	6 mo Postoperatively	12 mo Postoperatively
1	63	61	–2	Deceased	Deceased	20/100	20/100	Deceased
2	73	63	–10	64	–9	20/64	20/100	20/100
3	81	86	5	87	6	20/40	20/32	20/32
4	50	65	15	53	3	20/200	20/100	20/160
5	74	65	–9	Deceased	Deceased	20/64	20/100	Deceased
6	52	50	–2	63	11	20/160	20/200	20/100
7	74	74	0	83	9	20/64	20/64	20/40
8	63	79	16	83	20	20/100	20/50	20/40
9	54	57	3	67	13	20/160	20/125	20/80
10	65	65	0	63	–2	20/100	20/100	20/100
11	86	50	–36	48	–38	20/32	20/200	20/200
12	45	83	38	89	44	20/250	20/40	20/32
13	80	81	1	76	–4	20/50	20/40	20/50
14†	71	. . .	. . .	64	–7	20/64	20/40†	20/100
15	50	58	8	54	4	20/200	20/125	20/160
Mean	65	67	2	69	4	20/100	20/80	20/80
Median	65	65	0	64	4	20/100	20/100	20/100

*ETDRS indicates Early Treatment Diabetic Retinopathy Study; ellipses, not applicable.
†Patient did not return for the 6-month visit. Visual acuity was obtained by an outside ophthalmologist and was not used in the data analysis.

6-month or 12-month postoperative distance visual acuity, near visual acuity, or reading speed.

Four patients (27%) developed recurrent extrafoveal CNV, with a range of onset from 1 to 9 months postoperatively. These recurrences were treated with standard focal laser photocoagulation. Patients with recurrent CNV were more likely to develop worsened distance visual acuity at the 6-month ($P=.04$) and 12-month ($P=.05$) postoperative visits. Recurrent CNV was not correlated with worsened near vision or reading speed.

A subgroup analysis of patients without CNV recurrence (n=11) revealed a median lesion size of 6 MPS disc areas. For this group, the median 6-month near visual acuity was significantly better than the preoperative acuity (0.35 logMAR units vs 0.70 logMAR units respectively; $P=.02$). The difference between preoperative and 12-month near visual acuity was not statistically significant. Although the median reading speed improved from 66 words/min preoperatively to 75 words/min at 6 months and 96 words/min at 12 months postoperatively, the differences were not statistically significant. The median distance acuity improved significantly after surgery. For patients who had measurements of distance visual acuity at 6 and 12 months postoperatively, median preoperative distance acuity was 54 ETDRS letters. Distance acuity improved to 65 letters at 6 months postoperatively ($P=.03$) and to 67 letters at 12 months postoperatively ($P=.03$).

No retinal detachments, proliferative vitreoretinopathy, or macular folds developed in this series of patients. The most common postoperative complications were the development of cystoid macular edema in 3 patients (20%) and epiretinal membrane in 3 patients (20%).

COMMENT

Macular translocation with 360° peripheral retinectomy is a promising new surgical technique for the treatment of large subfoveal CNV. Earlier studies have demonstrated that certain patients with subfoveal CNV can recover good central vision following macular translocation.[15-22] Macular translocation with 360° peripheral retinectomy offers the potential benefit of relocating the fovea away from the CNV site and of removing the CNV, which in turn may halt membrane growth. Furthermore, macular translocation with 360° peripheral retinectomy is not limited by potential obscuration of the lesion by blood nor by the nature of CNV within the lesion.

Our preliminary study indicates that macular translocation with 360° peripheral retinectomy can stabilize, and sometimes improve, central visual function in patients with subfoveal CNV. At the 6-month postoperative follow-up, a statistically significant number of patients experienced an improvement in their near visual acuity. Of 14 patients, 13 (93%) achieved a near visual acuity of 20/100 or better and 7 (54%) achieved a reading speed of at least 70 words/min. At 6 months postoperatively, 10 patients (71%) achieved a best-corrected distance visual acuity of at least 20/100, and 3 (21%) achieved a distance acuity of at least 20/40. One-year follow-up data revealed stable near and distance visual acuity and reading speed compared with the preoperative and 6-month measurements. At 1 year, the majority of patients (11 [85%] of 13) achieved near acuity of at least 20/100, and 4 (31%) achieved near acuity of at least 20/40. A majority of patients (10 [77%] of 13) also achieved best-corrected distance visual acuity of at least 20/100, and 4 (31%) achieved a distance acuity of at least 20/40. Seven (58%) of 12 patients had a 12-month reading speed of 70 words/min or greater. When asked about reading function, 8 (67%) of 12 patients reported being able to read the newspaper postoperatively with standard reading glasses. None of these patients could read newsprint preoperatively.

Although the functional results are promising, a cautionary note should be raised for those patients with good baseline visual acuity. Seven of the 8 patients with a preoperative visual acuity of at least 20/100 and with follow-up at 1 year maintained 20/100 or better visual acuity 1 year postoperatively. One patient improved by 20 letters on ETDRS testing, 6 patients remained within 10 letters, and 1 patient worsened by 38 letters. This last patient's visual acuity worsening from 20/32 preoperatively to 20/200 postoperatively illustrates the point that visual acuity can worsen after macular translocation with 360° peripheral retinectomy.

Our visual outcomes compared favorably with published series of macular translocation with 360° peripheral retinectomy for the treatment of subfoveal CNV secondary to AMD. Eckardt et al[16] report that 22 of 30 patients had the same or better distance visual acuity postoperatively, with an average follow-up of 10.5 months. Four eyes had an improvement of 3 or more lines, and 2 eyes lost 3 or more lines. In their study, 18 of 30 eyes had near visual acuity of at least 20/50 at the last reported follow-up. With the same technique, Wolf et al[24] report a significant gain in visual acuity in only 1 of 7 operated eyes. More recently, Ohji et al[21] report their results of 36 patients who had undergone macular translocation with 360° peripheral retinectomy. Three patients (8%) achieved a final visual acuity greater than 20/40, and 23 patients (64%) achieved a visual acuity of at least 20/200 at the last follow-up. Aisenbrey et al[22] report stabilization of baseline vision at the 1-year follow-up in their series of 90 consecutive patients with a heterogeneous composition of CNV. Visual acuity improved in 24 patients (27%), remained stable in 37 patients (41%), and worsened in 29 patients (32%) 12 months postoperatively. Near visual acuity and reading speed were not reported in these 2 later papers.[21,22]

Similar visual results are reported in studies of limited macular translocation treating smaller subfoveal lesions. Pieramici et al[18] report their experience with limited translocations (median lesion size, 3 MPS disc areas) in a consecutive series of 102 eyes. Data on 31 eyes were available at the 6-month follow-up. A distance visual acuity of 20/40 to 20/80 was achieved in 12 of 31 eyes, and visual acuity better than 20/40 was achieved in 3 of 31 eyes. Lewis et al[17] report their experience using a similar technique for macular translocation. In their series of 10 patients (median lesion size, 2 MPS disc areas), preoperative median visual acuity was 20/111. No patients had a postoperative visual acuity better than 20/80. However, comparing results between limited and full macular translocations should be done cautiously. Because of their larger sizes, many of the lesions treated by full macular translocation could not have been treated successfully with the shorter foveal displacement of limited translocations. As a result, the difference in macular lesion characteristics of patients undergoing full vs those undergoing limited macular translocation must be recognized in any comparison of visual outcomes.

Another difference between the full and limited macular translocation techniques is the pars plana lensectomy and insertion of an intraocular lens at the time of the macular translocation for all phakic patients. In our series, 5 patients were pseudophakic prior to undergoing full macular translocation with 360° peripheral retinectomy. Comparisons between the pseudophakic and phakic groups revealed no statistical differences in preoperative visual acuity and final visual outcomes. Although the sample sizes were small, the lack of a difference in visual outcomes between the 2 groups suggests that the cataract extraction was not the major reason for the observed improvement in visual function.

One limitation of this study is the absence of a control group with which to compare visual outcomes. The Macular Photocoagulation Study subfoveal laser study[4] and the TAP Study[8,9] have demonstrated that most patients with untreated subfoveal CNV develop severe visual loss and that only a few patients experience an improvement in vision. For example, in the control group of the MPS subfoveal trial, at 6 months, only 12 (7%) of 171 patients attained distance visual acuity better than 20/100, and only 1 (0.05%) attained a visual acuity better than 20/40. Those patients, however, did not necessarily have CNV and poor vision in the fellow eye as did our patients. Poor vision in the fellow eye can impact the visual acuity in the treated eye, making it difficult to compare the results of our study with others. Thus, a randomized trial of macular translocation with 360° peripheral retinectomy vs observation is warranted to evaluate these outcomes.

Proven treatment options available to the patients in our series were limited. No patients would have qualified for standard MPS laser treatment given the large sizes of their lesions (median, 9 MPS disc areas; range, 4-16 MPS disc areas). Although 3 of the patients in our series (No. 2, 7, and 8) would have been eligible for photodynamic therapy, this treatment option was not available at the time of their enrollment in our trial. The remaining 12 eyes would not have qualified for photodynamic therapy secondary to their lesion characteristics. Comparisons between our visual outcomes and those of the TAP studies are not possible. In our series, 13 (93%) of 14 patients at 6 months and 12 (92%) of 13 at 1 year had lost fewer than 15 letters of visual acuity. One year postoperatively, 10 (77%) of 13 patients achieved visual acuity of at least 20/100, and 4 (31%) achieved visual acuity of 20/40. Our data suggest that macular translocation with 360° peripheral retinectomy can provide a reasonable opportunity for preservation of vision. Furthermore, macular translocation with 360° peripheral retinectomy may also offer a chance of visual improvement in a mixed group of large subfoveal lesions that may not be eligible for any other treatment.

To date, the impact of various treatments on reading ability and near visual acuity in patients with AMD has not been well studied. Distance visual acuity and contrast thresholds were tested in the MPS[5] and the TAP study.[8,9] Although the MPS tested reading speeds, near visual acuities were not specifically measured in the MPS or the TAP study. From a quality of life standpoint, near visual function is important to patients.[25] Eckardt et al[16] reported encouraging outcomes for near visual acuity following macular translocation. In this study, we measured in a standardized manner not only the near acuity but also the reading speed following macular transloca-

tion with 360° peripheral retinectomy. Studies have indicated that patients with an absolute scotoma covering part or all of the central 5° of the visual field have a median reading speed of 25 words/min with a maximum speed never exceeding 70 words/min.[25] Following macular translocation, more than half our patients (7 [58%] of 12) achieved a reading speed of 70 words/min or greater. A majority of patients (8 [67%] of 12) were able to read standard newsprint using reading glasses. These results suggest that successful translocation can preserve central foveal photoreceptor function.

Outcomes after full macular translocation have been limited by complications, including retinal detachment with proliferative vitreoretinopathy, cystoid macular edema, and CNV recurrence.[16,24] However, with new instrumentation and techniques, the rate of complications has dramatically decreased. In our small series, there were no retinal detachments or cases of proliferative vitreoretinopathy. The most common postoperative complications were recurrence of CNV, development of cystoid macular edema, and development of epiretinal membrane. Although the recurrences of CNV were treated with standard laser photocoagulation, it is not surprising that the presence of CNV recurrence was associated with a worsened visual outcome.

Modifications to the original inclusion criteria were made during this trial. Many of our patients were enrolled in the study despite having a history of more than 6 months of loss of vision. One patient had visual loss for 64 weeks before surgery. Yet, surprisingly, duration of vision loss was not correlated with a worsened visual outcome. It is possible that visual outcomes may be even better if surgery is performed before irreversible foveal damage has occurred. It would be useful to have an objective measure of the extent of irreversible vision loss preoperatively.

In conclusion, our preliminary study indicates that full macular translocation with 360° peripheral retinectomy can stabilize and sometimes improve the visual prognosis in patients with subfoveal CNV secondary to AMD. Macular translocation with 360° peripheral retinectomy has the potential to restore the ability to read. The results of this study with heterogeneous composition of the neovascular AMD, including 3 cases in which hemorrhage was a predominant component, should be interpreted carefully. Longer follow-up is necessary to confirm these findings and to monitor for any long-term complications. The impact of macular translocation with 360° peripheral retinectomy on quality of life measures is currently being studied. The early data support the establishment of a prospective, randomized clinical trial to examine the benefit of this treatment and to define the best criteria for treatment eligibility.

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