

## CLINICAL SCIENCE

## Limited macular translocation with scleral retraction suture

P Sullivan, L Filsecker, J Sears

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**Background/aims:** Macular translocation with scleral imbrication is a new technique for treating subfoveal choroidal neovascular membranes (CNV). This procedure shortens the sclera but may result in a minimal decrease in the internal circumference of the globe and limits the amount of foveal displacement. The authors propose a new scleral retraction suture aimed at decreasing the internal circumference of the globe in an effort to increase foveal displacement.

**Methods:** Using a cadaver model, they compared the amount of scleral shortening using a standard scleral imbrication technique and a modified three suture scleral retraction technique. Sections of the globes were digitised and specialised software was used to estimate the amount of scleral shortening. Three patients with subfoveal choroidal neovascularisation underwent limited macular translocation using pars plana vitrectomy and macular detachment with the modified scleral suture technique. The main outcome measures were visual acuity, foveal displacement, and complications.

**Results:** In the cadaver model, the scleral retraction suture resulted in a flatter internal scleral fold compared to the standard suture technique and created approximately 890 µm of effective scleral shortening. In the patients who underwent macular translocation and laser photocoagulation of the CNV, visual acuity improved in two patients and worsened in one patient. The range of foveal displacement was 1400–2400 µm.

**Conclusion:** The foveal displacements achieved in this limited study compared to median displacement previously published using standard suture techniques demonstrates that the scleral retraction suture technique may be a useful adjunct to limited macular translocation. The advantage of this type of suture in conjunction with translocation may depend on the effective scleral shortening offered by this retraction suture.

See end of article for authors' affiliations

Correspondence to: Jonathan Sears, MD, Cole Eye Institute, The Cleveland Clinic Foundation, 9500 Euclid Avenue, Desk 132, Cleveland, OH 44195, USA; [searsj@ccf.org](mailto:searsj@ccf.org)

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Age related macular degeneration (AMD) is a leading cause of severe central visual loss in Western countries. While the majority of patients with AMD have an atrophic form, 10–20% develop exudative macular detachment, often with severe visual loss.<sup>1,2</sup> This results in an acute decrease in vision, with 87% of patients with subfoveal choroidal neovascular membrane (CNV) having 20/200 vision or worse after 2 years.<sup>3</sup> Laser photocoagulation provides stabilisation in vision for those with small subfoveal lesions, but leads to a well known immediate loss of central vision.<sup>3,4</sup> Photodynamic therapy (PDT), the second proved type of treatment, is effective in stabilising vision in some patients with subfoveal CNV. Two year follow up studies require treatment on an average of every 3 months.<sup>5–7</sup> Other non-surgical treatments, such as indocyanine green (ICG) angiography guided treatment of feeder vessels, radiotherapy, and antiangiogenic therapy, were not yet proved to be effective in controlled clinical trials. One of the Submacular Surgery Trial treatment arms is evaluating the efficacy of surgical extraction of eligible subfoveal CNV in AMD.<sup>8</sup>

The concept of retinal relocation was first described in 1983 by Lindsey *et al.*<sup>9</sup> Macular translocation was first performed in humans by Machemer and Steinhorst 10 years later.<sup>10</sup> Initial techniques using 360 degree or 180 degree retinotomies were technically difficult, resulted in torsional diplopia from large translocations, and were associated with a high risk of retinal detachments with proliferative vitreoretinopathy (PVR).<sup>11–19</sup> Newer translocation techniques have been developed to minimise surgical trauma and postoperative complications. These limited macular translocations (LMT) were pioneered by DeJuan, who used imbrication sutures, with or without scleral resection.<sup>20–23</sup> Lewis has used scleral clips<sup>24</sup> to produce a decreased internal circumference of the eye wall. The extent of

translocation with scleral infolding created by imbrication is limited by the height of the invaginated scleral-choroidal fold, as the retina must still cover the internal fold, and by the amount of retinal stretching.

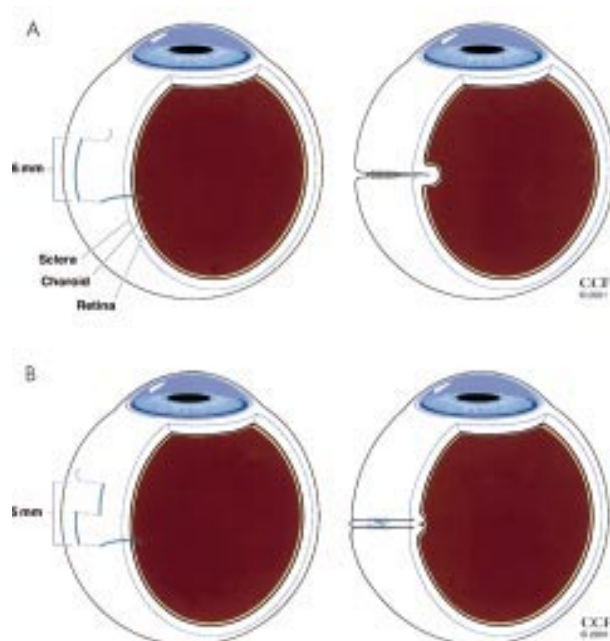
We conducted a prospective study to determine the results and complications of a modification of the limited macular translocation technique initially described by de Juan and colleagues.<sup>20</sup> We evaluated the effectiveness of a modified circumferential retraction suture technique to retract and compress the scleral-choroidal fold in an attempt to shorten the internal circumference of the globe, thereby increasing the extent of retinal translocation.

## MATERIALS AND METHODS

## Cadaver model

We performed scleral imbrication on two human cadaver globes. On one globe, a scleral infolding technique similar to that used by Lewis *et al* was performed.<sup>21</sup> Three 5-0 nylon circumferential mattress sutures were placed in the superotemporal quadrant 9 mm and 15 mm from the surgical limbus (Fig 1A). No crescent-shaped lamellar scleral excision was performed. On the second globe, the modified scleral imbrication suture technique was used (Fig 1B). Three 5-0 nylon circumferential mattress sutures were placed in the superotemporal quadrant at 10 mm, 12.5 mm, and 15.0 mm from the surgical limbus (Fig 1B).

**Abbreviations:** AMD, age related macular degeneration; CNV, choroidal neovascular membrane; ICG, indocyanine green; IVFA, intravenous fluorescein angiography; LMT, limited macular translocations; PBS, phosphate buffered saline; PDT, photodynamic therapy; PVR, proliferative vitreoretinopathy



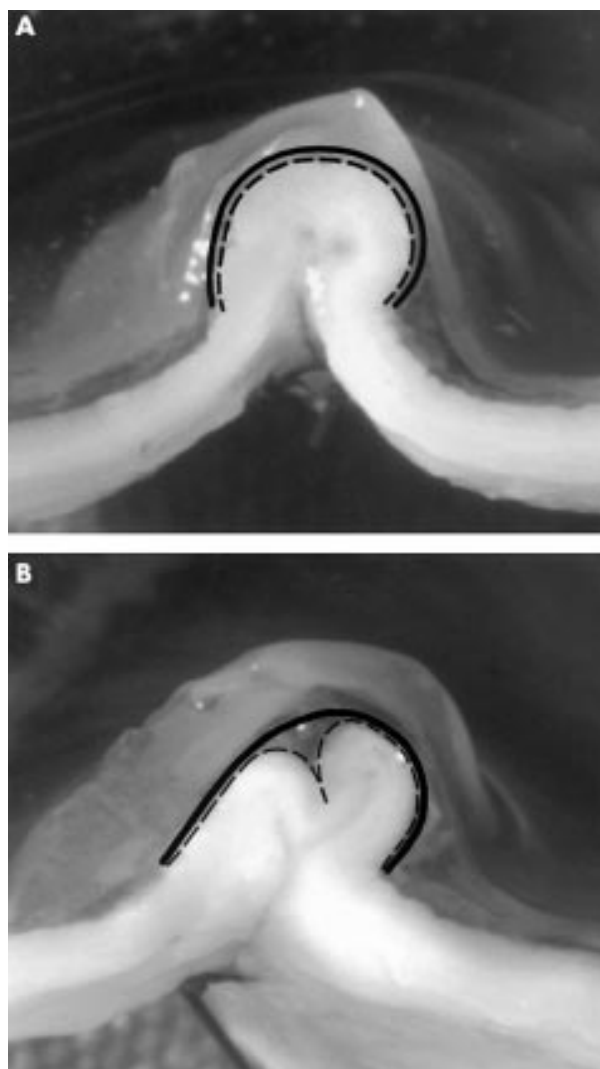
**Figure 1** (A) Standard imbrication: three 5-0 nylon circumferential mattress sutures in the superotemporal quadrant 9 mm and 15 mm from the surgical limbus. (B) Modified imbrication: three 5-0 nylon circumferential mattress sutures were placed in the superotemporal quadrant at 10 mm, 12.5 mm, and 15.0 mm from the surgical limbus. Medical illustration created by David Schumick, BS, copyright Cleveland Clinic Foundation Art Department.

The globes were immediately fixed in 4% paraformaldehyde in phosphate buffered saline (PBS), pH 7.4, for 45 minutes then removed to 20% sucrose overnight at 4°C. Next, the globes were sectioned in an anterior-posterior plane through the imbrication, and the cut surface photographed (Fig 2A and B). The images were then digitised and the amount of effective scleral shortening was measured three times. Scion Image software was used to measure the internal length of imbricated sclera, and approximates the length of sclera and choroid the overlying retina would traverse if attached. The difference between the mean of the two distances is an estimation of the effective scleral shortening.

### Patients

Three consecutive patients underwent limited macular translocation for subfoveal CNV due to AMD using a modified scleral imbrication suture technique. All surgeries were performed by JS at the Cole Eye Institute between February and December 2000. Informed consent was obtained before surgical intervention.

After making a 270 degree peritomy, the superior and lateral rectus muscles were isolated with Jameson muscle hooks and 2-0 silk sutures. Three 5-0 Ethilon sutures were placed in the superotemporal quadrant (Fig 3A and B). Each one of these was placed at 50% scleral thickness in an S-shaped horizontal mattress configuration at 10 mm, 12.5 mm, and 15 mm from the surgical limbus. A standard three port pars plana vitrectomy with elevation of the posterior hyaloid was performed. The temporal half of the retina was detached using a 39 gauge retinal translocation irrigating cannula with balanced salt solution. An air-fluid exchange and Lewis retinal manipulator was used to complete the macular detachment. The three scleral sutures were tightened with the internal eye pressure reduced to 15 mm Hg (Fig 4A and B). A 75% air-fluid exchange was performed. On the operating room table at the end of the surgery, the patients were rolled temporally, then elevated to an upright position



**Figure 2** Cadaver globe cross sections demonstrating (A) single scleral infolding with standard scleral imbrication suture and (B) double scleral infolding with modified scleral imbrication suture for LMT. The solid line represents internal circumference of the fold before suturing, the broken line represents internal circumference of the fold after suturing.

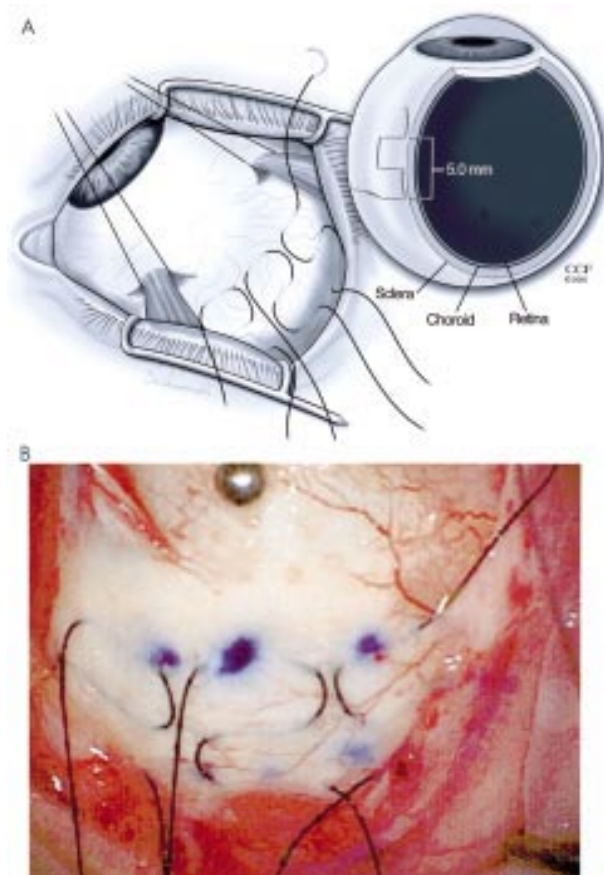
where they remained until the next day. In this way, the air bubble was rolled nasally and then superiorly, from attached retina to detached retina.

Measurements of the distance of macular translocation were made using a micrometer calibrated for intravenous fluorescein angiography (IVFA) negatives using a Zeiss 30 degree fundus camera, similar to the reticule used for assessing CNV diameter before photodynamic therapy. The distance from the centre of the CNV to a vascular landmark was measured in the preoperative and postoperative angiograms. The difference between the two was the effective macular translocation. If possible, the preoperative and postoperative angiogram negatives were superimposed to check the translocation distance.

### RESULTS

#### Cadaver model

The standard imbrication sutures result in a single infolding of choroid and sclera (Fig 1A and 2A). The mean internal length of imbricated sclera and the distance the retina had to traverse the underlying choroid and sclera was both 4.61 mm. The modified imbrication sutures create a double infolding of the



**Figure 3** Drawing (A) and intraoperative photograph (B) of modified scleral imbrication suture for LMT before tightening. The sutures are placed before placement of the infusion cannula. Medical illustration created by David Schumick, BS, copyright Cleveland Clinic Foundation Art Department.

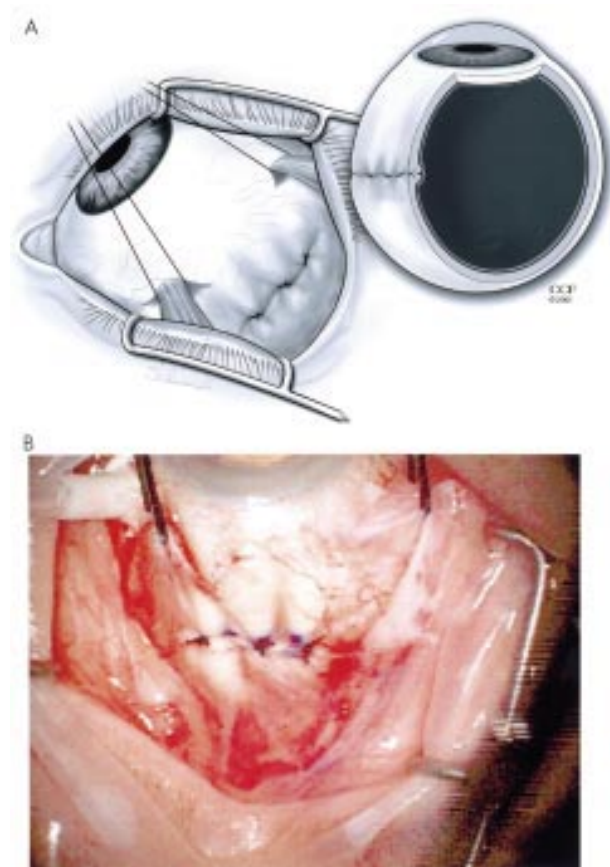
choroid and sclera (Fig 1B and 2B). The mean internal length of imbricated sclera was approximately 5.84 mm, and the distance the overlying retina had to traverse was 4.95 mm (Table 1). The difference between these was 890  $\mu$ m, and represents an estimation of effective scleral shortening (Table 1).

#### Clinical case No 1

An 86 year old woman presented with decreased vision in the right eye for 1 month. Best corrected visual acuity was 20/400 right eye and 20/20 left eye. The anterior segment examination showed well centred posterior chamber intraocular lenses in both eyes.

The right fundus showed a subfoveal CNV with surrounding subretinal blood and overlying neurosensory detachment (Fig 5A). The left fundus showed drusen and RPE mottling. Fluorescein angiography of the right eye showed a classic, subfoveal CNV measuring 3.0 mm in greatest linear dimension centred on the fovea. The greatest linear dimension of the surrounding blood was 6.0 mm (Fig 5A). The inferior edge of the CNV was 5600  $\mu$ m from a vessel above it that was used as a fixed reference point on the retina. The inferior edge of the CNV was 1200  $\mu$ m from the foveal centre.

After informed consent was obtained, the patient underwent an inferior macular translocation with scleral compression sutures 3 days after presentation. On the second postoperative day, the IVFA showed a classic, well defined, extrafoveal CNV (Fig 5B). The inferior edge of the lesion was 4200  $\mu$ m from the vessel used as a fixed point on the retina, demonstrating a foveal displacement of 1400  $\mu$ m. Laser photocoagulation of the CNV was performed the same day.



**Figure 4** Drawing (A) and intraoperative photograph (B) of modified scleral imbrication suture for LMT after tightening. The sutures also create some radial imbrication, which may help in the translocation of the retina, creating shortening of the sclera circumferentially and radially. Medical illustration created by David Schumick, BS, copyright Cleveland Clinic Foundation Art Department.

**Table 1** Measured inner and imbricated scleral distances, in millimetres. The study was performed in cadaver globes using standard and modified LMT suture techniques

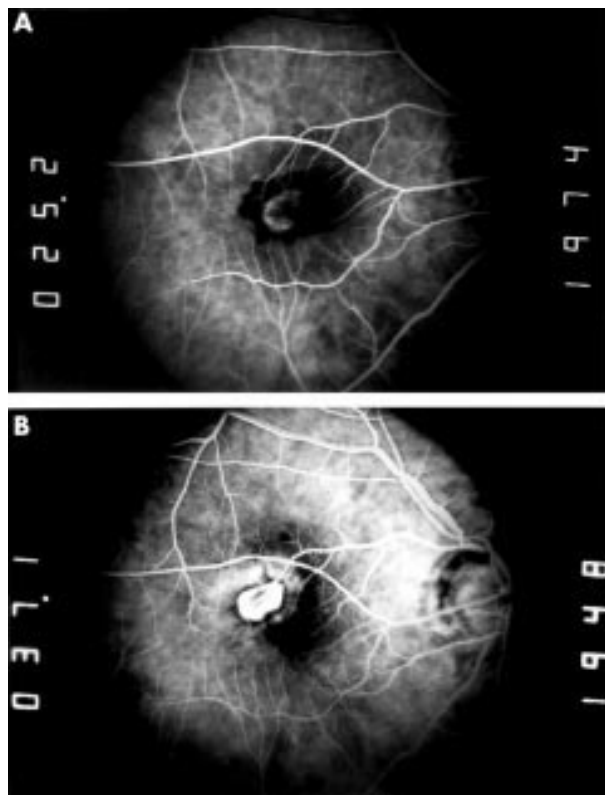
	Standard inner scleral length (mm)	Modified imbricated scleral length (mm)	Modified inner scleral length (mm)	Modified effective scleral shortening (mm)
	4.63	5.83	4.96	0.87
	4.60	5.85	4.93	0.92
	4.59	5.85	4.97	0.88
Mean	4.61	5.84	4.95	0.89
SD	0.02	0.01	0.02	0.03

Visual acuity decreased to 20/80, right eye, because of cataract 2 months after surgery. Her postoperative keratometry readings demonstrated 42.50/47.00 dioptres at 83 degrees.

#### Clinical case No 2

A 77 year old woman presented with a 2 day history of a sudden decrease in vision in her right eye. Best corrected visual acuity was 20/200 right eye and 20/60 left eye. The anterior segment examination showed moderate nuclear sclerosis in both eyes.

Dilated funduscopy of the right eye demonstrated a subfoveal CNV with surrounding subretinal blood. Fluorescein



**Figure 5** Case 1. (A) Preoperative fluorescein angiogram of the right eye demonstrates subfoveal CNV with blood. (B) Postoperative fluorescein angiogram of the right eye shows extrafoveal CNV before laser photocoagulation with translocation of 1400  $\mu\text{m}$ . The superior edge of the CNV was used to measure postoperative translocation

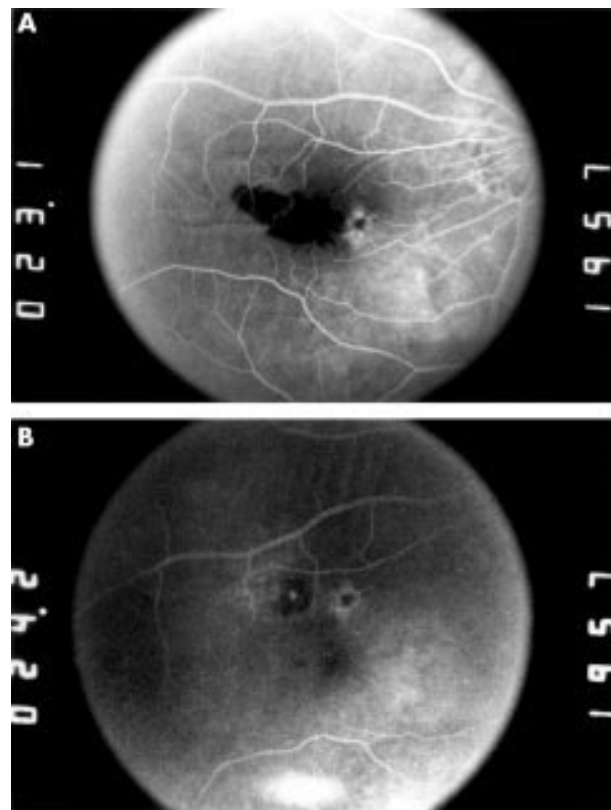
angiography of the right eye revealed subfoveal hyperfluorescence beneath thick blood that was difficult to determine if the complex was classic, occult, or combined classic and occult CNV (Fig 6A). It was impossible to determine exactly where the edge of the CNV was with respect to the foveal centre.

After informed consent was obtained, the patient underwent an inferior LMT 1 day after presentation. On postoperative day 1, the patient had a moderate vitreous haemorrhage and small nasal haemorrhagic choroidal detachment. Both spontaneously resolved. Postoperative fluorescein angiography of the right eye showed a well defined occult CNV (Fig 6B). The inferior edge of a chorioretinal lesion nasal to the fovea (Fig 6A and B) used for measurement of translocation distance was 4300  $\mu\text{m}$  from the retinal vessel preoperatively and postoperatively was 2000  $\mu\text{m}$  from this vessel, demonstrating a total foveal displacement of 2300  $\mu\text{m}$  from its previous location. The patient underwent laser photocoagulation of the CNV the same day. One year after LMT, and 2 weeks after cataract surgery, her visual acuity improved to 20/60 right eye. Postoperative keratometry readings demonstrated 41.75/45.50 dioptres at 105 degrees.

### Clinical case No 3

An 80 year old woman presented with decreased vision in the right eye for 2 months. Best corrected visual acuity was 2 ft/200 right eye, and 20/200 left eye. The anterior segment examination showed well centred posterior chamber intraocular lenses in both eyes.

The right fundus showed a subfoveal disciform scar with scattered drusen. The left fundus showed central macular subretinal blood and lipid. Fluorescein angiography of the left eye showed a classic subfoveal CNV measuring 5300  $\mu\text{m}$  in greatest linear dimension (Fig 7A). The inferior edge of the

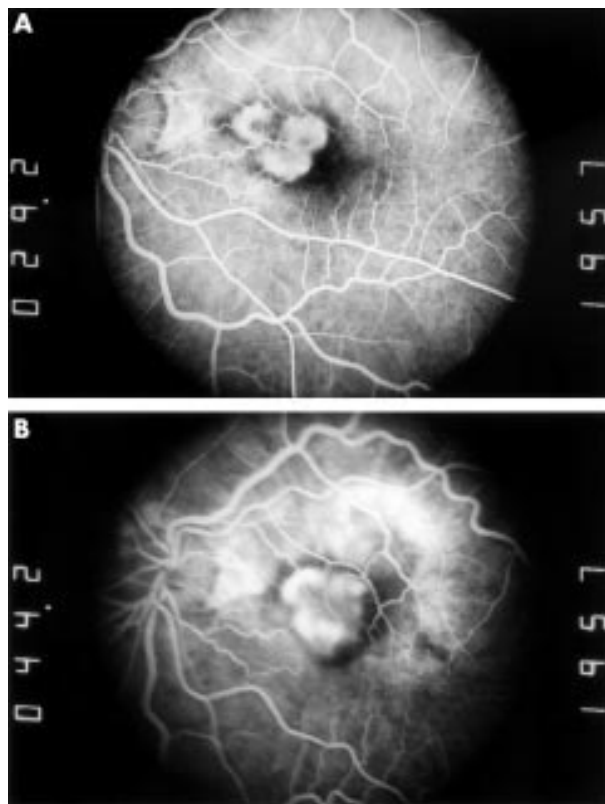


**Figure 6** Case 2. (A) Preoperative fluorescein angiogram right eye demonstrates subfoveal CNV with blood. (B) Postoperative fluorescein angiogram right eye shows extrafoveal CNV before laser photocoagulation with translocation of 2300  $\mu\text{m}$ . The subfoveal CNV was hard to visualise because of the blood. A chorioretinal scar nasal to the fovea was used to measure the translocation, which was found to be 1600  $\mu\text{m}$ .

CNV was 800  $\mu\text{m}$  from the foveal centre. After informed consent was obtained the patient underwent an inferior LMT 2 weeks after presentation. One week later, fluorescein angiography of the left eye demonstrated a macular translocation with a juxtafoveal CNV (Fig 7B). Using a reference vessel and the centre of the CNV, preoperative distance was measured at 2900  $\mu\text{m}$ ; postoperative measurement using the same reference point was 500  $\mu\text{m}$ , demonstrating a translocation of 2400  $\mu\text{m}$ . The centre of the CNV was used because there was a delay in obtaining the postoperative fluorescein angiogram, and the CNV increased in size. Laser treatment was delayed 7 days because the patient was admitted to an outlying hospital with possible bowel obstruction. Laser photocoagulation was attempted, but a fluorescein angiogram revealed persistent subfoveal leakage. Photodynamic therapy was performed. Four months after treatment, the patient's visual acuity was 20/400 left eye. Manifest refraction did not improve visual acuity because of the subfoveal nature of the persistent CNV. Keratometry measurements were not obtained.

### DISCUSSION

Subfoveal choroidal neovascularisation represents 58%–67% of the exudative form of AMD.<sup>25–26</sup> Its proper management is controversial despite the numerous treatment options available. The Macular Photocoagulation Study demonstrated a clear benefit for extrafoveal CNVM.<sup>27–28</sup> However, for new and recurrent subfoveal CNVM, only limited success has been realised. In the MPS, a majority of patients with subfoveal CNVM had an immediate and irreversible loss of central vision from the treatment.<sup>3–4</sup> While for selected patients with small,



**Figure 7** Case 3. (A) Preoperative fluorescein angiogram left eye demonstrates subfoveal CNV. (B) Postoperative fluorescein angiogram left eye shows barely juxtafoveal CNV despite translocation of 2400  $\mu\text{m}$ .

well demarcated lesions this was better than the natural history of subfoveal CNV, many physicians and patients are unwilling to use this method to control visual loss. Since then, 2 year results of the treatment of exudative AMD with photodynamic therapy (TAP) study demonstrated less visual loss in those patients with greater than 50% classic subfoveal lesions by fluorescein angiography.<sup>5,6</sup> After 2 years, 59% of treated patients and 31% of control patients lost three or fewer lines of vision.<sup>6</sup> However, only 3.5% of patients with subfoveal CNV and AMD are eligible.<sup>29</sup> Although the results were less impressive, the verteporfin therapy of subfoveal choroidal neovascularisation in age related macular degeneration (VIP) study demonstrated less visual loss in those with occult and no classic component to the CNV, especially in those with small lesions ( $\leq 4$  disc areas) or with lower levels of visual acuity ( $20/50^{-1}$  or worse).<sup>7</sup> After 2 years, 45% of treated patients and 31% of untreated patients lost three or fewer lines of vision. Early reports of surgical excision of subfoveal CNVM from the submacular surgery trial (SST) have suggested poor visual results.<sup>8</sup>

De Juan *et al* were the first to describe limited macular translocation (LMT) using small posterior retinotomies, partial thickness scleral resection, and circumferential scleral imbrication sutures in an attempt to minimise complications of 360 degree retinotomy and retinal rotation.<sup>20</sup> They reported outcomes for three patients who underwent LMT for subfoveal CNV associated with AMD and angioid streaks. Two patients underwent postoperative laser photocoagulation, and all patients had improved vision after translocations of 350  $\mu\text{m}$  to 1500  $\mu\text{m}$ . Two patients underwent repeat vitrectomy for iatrogenic rhegmatogenous retinal detachments. These were secondary to an open retinotomy and a sclerotomy site tear. Two years later, the same group published a report of inferior limited macular translocation in 102 patients with new or

recurrent subfoveal CNV associated with AMD.<sup>23</sup> Lesions were 1–9 Macular Photocoagulation Study (MPS) disc areas. The range of foveal displacement achieved was 200–2800  $\mu\text{m}$  (median 1200  $\mu\text{m}$ ), and all patients with displacement to an extrafoveal or juxtafoveal location (62%) received photocoagulation. By 6 months, 48% of patients had two or more lines of visual improvement, 16% had six or more lines of visual improvement and 49% had vision better than 20/100. Complications other than those attributable to vitrectomy surgery included CNV at the retinotomy in two eyes and macular fold in three eyes.

In the 2 years since the original report, several authors have reported their experience with variations of the limited macular translocation. Lewis *et al* described their experience in 10 patients with new or recurrent subfoveal CNV associated with AMD.<sup>21</sup> The lesions were six or less MPS disc areas and not associated with subfoveal haemorrhages. The technique was similar to that used by de Juan, but all translocations were inferior, no scleral resection was performed, the scleral imbrication was smaller and two CNV complexes were surgically excised. Postoperative visual acuity decreased in six eyes and increased in four eyes. The range of foveal displacement was 114–1919  $\mu\text{m}$  (mean 1286  $\mu\text{m}$ ). Two patients had iatrogenic retinal breaks, one of which required reoperation for a detachment, and three had folds through the fovea.

Additional variations in imbrication technique have been performed in an attempt to increase the predictability of foveal displacement. The theory of displacement is based on shortening of the internal scleral circumference that allows repositioning of the fovea. However, the real decrease in the internal scleral circumference is minimal owing to the fact that the retina still has to cover the imbricated area. Interestingly, a single report of limited macular translocation without any imbrication resulted in a foveal displacement of 500  $\mu\text{m}$ .<sup>30</sup> The mechanism of action may be retinal elasticity and stretching rather than shortening of the internal circumference of the globe. Using six cadaver globes, Lin *et al* compared scleral infolding with a 6 mm circumferential scleral imbrication and scleral outfolding using a 7 mm interrupted radial mattress suture.<sup>22</sup> They demonstrated a dramatic anteroposterior shortening with outfolding compared to infolding (4.61 mm v 0.36 mm). However, their case report of a limited macular translocation using this suture technique resulted in a foveal displacement of 1800  $\mu\text{m}$ . This displacement is not as dramatic as one would expect, given that the presumed scleral shortening with the outfolding is more than 12 times larger than with infolding. Lewis has reported another technique of outpouching using metallic clips.<sup>24</sup> This technique has the advantage of achieving maximal shortening of the internal scleral circumference, and resulted in at least 1644  $\mu\text{m}$  of foveal displacement in six patients using 4 mm, radially oriented clips. Together, these findings would suggest that scleral shortening contributes to foveal displacement, but is not the sole mechanism. In addition, there may not be a 1:1 relation between peripheral shortening and foveal displacement. Elasticity of viable retina, extent, and location of intraoperative retinal detachment, postoperative positioning, retinal folds, and other undetermined factors may also contribute to foveal displacement in patients undergoing limited macular translocation.

The procedure described here is a simple modification of the original technique. It incorporates a third bite to the standard suture, and traverses 5 mm of sclera. The range of foveal displacements achieved using this technique was 1400–2400  $\mu\text{m}$ . While this is a small series, it suggests that use of the proposed scleral retraction suture may lessen the risk of smaller, inadequate amounts of foveal displacement. This technique does not make the amount of translocation predictable. The cadaver model demonstrated that the scleral retraction produces a double infolding of sclera. This may result in a true decrease in the internal circumference of the globe, and

decrease the length of sclera the retina must cover when reattached. Despite the lack of definitive proof of internal circumference shortening using this modification, at the very least the technique does not increase the risk of the original procedure. The modified suture technique may be a useful adjunct to the standard suture technique, especially in patients who have a thin sclera where clips pose a threat of perforation. The redundant retinal fold was located inferiorly in all patients, adjacent to the border of detached and attached retina in the inferonasal quadrant.

Limited macular translocation is a technique under investigation and currently there is no randomised, controlled clinical trial demonstrating its benefit in improving long term visual acuity or quality of life. Age related macular degeneration is a medical disease that ultimately may be defeated by a medical therapeutics. In the interim, surgical intervention may be appropriate for a select group of patients. Nevertheless, it seems to be an alternative that may offer the best chance of improvement in visual acuity, as long as the possible complications of vitrectomy surgery and other complications of macular translocation such as choroidal haemorrhage are understood in advance by the patient and surgeon. Further improvements in surgical technique may improve the predictability of foveal displacement and increase the utility of limited macular translocation in patients with subfoveal CNV from AMD or other associated conditions.

#### Authors' affiliations

**P Sullivan, J Sears**, Cole Eye Institute, Cleveland Clinic Foundation, Cleveland, OH, USA

**L Filsecker**, Fundacion Oftalmologica Los Andes, Santiago, Chile

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P Sullivan, L Filsecker and J Sears

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