# **CUTTING THE ENCIRCLING BAND**

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> **Purpose:** To report the effect of cutting the encircling band on ocular blood flow. **Methods:** In an interventional case series of 27 eyes with an encircling band, the ocular pulse amplitude (OPA) was measured and pulsatile ocular blood flow (POBF) derived and compared with fellow eyes. The bands were cut in 11 eyes and the POBF measured at 1 month, 3 months, and 1 year. Changes in POBF, buckle height, and visual acuity were determined.

> **Results:** The presence of the encircling band reduced the POBF to a mean of 43% (P < 0.001) of the fellow eye. Cutting the band resulted in a mean recovery to 85.6%. No retina detached after cutting, buckle height was only slightly diminished, and the visual acuity was unaffected.

**Conclusion:** An encircling band diminishes the POBF. Cutting the band restores significant flow.

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The encircling buckle operation for the repair of retinal detachment has been in use for 47 years and is still a frequent procedure. The flat elastic silicone band replaced polyethylene tubes and silicone rods by 1965. Schepens thought the band would stretch in response to the ocular pulse and be less invasive.<sup>1,2</sup>

In 1980, Graham Dobbie<sup>3</sup> observed that the ocular pulse amplitude (OPA), the intraocular pressure, and aqueous flow were diminished in eyes with encircling bands. He thought that this was the effect of diminished pulsatile flow to the ciliary body. Diddie and Ernst<sup>4</sup> studied the effect of encircling bands in a rabbit model and found diminished blood volume in the choroid as well as in the iris and ciliary body. Yoshida et al,<sup>5</sup> Ogasawara et al,<sup>6</sup> and Regillo et al<sup>7</sup> measured the velocity of blood flow in the central retinal artery in eyes with encircling bands and found that it too was diminished.

There is little mention of any deleterious effect of an encircling band on visual function. The first muted alarm was sounded by Winter and Lipka<sup>8</sup> in 1987, who reported a reduction in two-point discrimination in eyes with encircling bands. Yoshida et al<sup>5</sup> described a constricted visual field in an eye with an encircling band and recovery after the band was released. In 1999, Fineman et al<sup>9</sup> reported an orthostatic loss of vision in an encircled eye that recovered after the band was released.

We became interested in the effect of encircling bands after the report of Dobbie. By 1980, we had encircled more than 300 eyes and were beginning to notice unilateral pigment epithelial changes posterior to the band in some of the eyes that had been encircled 10 and 20 years before. It seemed possible that diminished pulsatile blood flow, as observed by Dobbie,

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might be the cause. In July 2000 we embarked on a program to test whether cutting the band would restore the OPA.

#### Design

In a prospective, comparative, interventional case series, the encircling band in 11 eyes was cut after recording a diminished OPA and pulsatile ocular blood flow (POBF). The paired eyes and the eyes of 16 patients with encircling bands served as controls. The patients were consecutive with bands in one eye and initially examined on the private service of the senior author between August 5, 2000, and August 1, 2002. The study and control group were followed for 26 to 49 months. The mean age of patients in the band cut group was 52 years (32-69 years) and of the control group 59.6 years (24-82 years). Hypertension was present in one of the band cut group and in five of the control group. Three patients in the control group had a history of heart disease and one patient was diabetic. Myopia was present in the eyes of all of the patients in the band cut group and in the eyes of half of the patients in the uncut controls.

# Methods

The OPA was measured with the Langham OBF computerized model 201 tonograph (Langham Technologies, Timonium, MD), which derives POBF. POBF was reported by Langham to be a mean of 647  $\pm$  42  $\mu$ L/min.<sup>10</sup> Gekkieva et al in a separate study with the Langham device reported it as  $685 \pm 156$  $\mu$ L/min.<sup>11</sup> We elected to recommend cutting of the band to patients whose POBF in the encircled eye was  $300 \ \mu L/min$ , i.e., less than half of the minimum of the normal range on two consecutive visits whose band had been in place for at least 6 months and whose retina upon examination appeared secure. All encircled eyes that had the band cut and two thirds of the eyes in which the band was not cut had a POBF of 300  $\mu$ L/min or less. Eleven patients agreed to have it done. Symptoms suggestive of ischemia in the group included diminishing vision in two patients, diminished night vision in two patients, reduction in brightness in one patient, mild pain or discomfort in two patients, and intermittent swelling of the eye in one patient. Informed consent for cutting the band was obtained after explaining to the patient the risk of redetachment.

Before cutting the band a retinal drawing was made that documented retinal breaks, areas of coagulation, and the location of the band in relation to the equator. An estimate of the amount of constriction (10%-30%)was made ophthalmoscopically. The estimate was based upon our previous measurements of experimental constriction in an animal model and subsequent observations of measured constrictions in patients.<sup>12</sup> The visual acuity was tested with the ETDRS chart. In an attempt to obtain an objective measurement of function five patients with visual acuity of 20/20 in both eyes had an ERG performed preoperatively and 3 months after cutting of the band. Bands were cut in a quadrant where there was no evidence of coagulation or additional buckling, preferably in an inferior quadrant.

The procedure was performed in the operating room under sterile conditions. Parabulbar anesthesia was obtained with 2 mL of 1% xylocaine injected at the inferior orbital rim through a 1.5-cm 27-gauge needle. Stay sutures were placed in the rectus tendons adjacent to the selected quadrant. When the eye was rotated to expose the quadrant, the band was usually visible beneath the conjunctiva. If not, it was localized with depression under ophthalmoscopic control. The conjunctiva and Tenon's were incised 4 mm anterior to the band and a dissection carried out posteriorly until the band was encountered. The band was lifted from the sclera with blunt forceps and severed with scissors and the cut ends left in place. The area was irrigated with an antibiotic solution and the wound closed with three absorbable sutures. The eye was patched overnight. The next day the retina was examined and the patient instructed upon how to monitor the visual field and to report any developing peripheral defect without delay.

Postoperatively the retina was examined and the POBF measured at 1 month, 3 months, and 1 year. The data obtained with the Langham tonograph before and after cutting the band in the encircled eyes, the paired eyes, and in the control eyes were subject to a statistical analysis by an independent sample t test, a paired sample t test, and Pearson correlation using R statistical software v.1.7.1 (http://www.rproject.org). Differences were considered statistically significant when the *P* value was < 0.05.

## Results

The mean POBF in the encircled eyes (n = 27) was  $274.2 \pm 105.8 \ \mu$ L/min and in the paired unencircled eyes  $485.6 \pm 140 \ \mu$ L/min (Figure 1). The encircling band reduced the POBF to a mean of 43%. This difference was statistically significant (independent sample *t* test, *P* < 0.001). The loss was independent of the amount of estimated constriction (r = 0.28, *P* = 0.39) or the location of the band.



Stastical analysis by independent sample t-test

**Fig. 1.** A box plot comparing pulsatile ocular blood flow in fellow and encircled eyes. The pulsatile ocular blood flow in the encircled eyes is significantly lower (P < 0.001).

## Recovery of POBF

The time that the band had been in place before cutting varied from 7 months to 15.75 years (median 36 months). After the band was cut (n = 11) recovery of POBF was rapid and occurred in all eyes by 1 month and remained unchanged at 3 months and 1 year. The sustained recovery was to a mean of 85.6% of the POBF in the paired eye (paired *t* test, P < 0.01) (Figure 2). The recovery was independent of the number of years the band had been in place (r = 0.56, P = 0.07).

#### Visual Function

The visual acuity improved one line on the ETDRS chart in three eyes, decreased one line in two eyes, and remained unchanged in six eyes.

## Shape of Eye

The height of the buckle beneath the encircling band alone or where augmented by an additional buckling element, after cutting the band, appeared only slightly diminished or unchanged during the ensuing year. The eyes did not recover their former spherical shape, nor did the induced myopia regress.



Stastical analysis by paired sample t-test	
* %POBF = POBF encircled eye 100	
POBE fellow eve	

47.3

140.0

Fig. 2. A box plot showing that cutting the band restores pulsatile ocular blood flow significantly (P < 0.01).

17.1

68.8

# ERG

min

max

The amplitude of the photopic B wave to a single or a flicker stimulus was diminished in the eyes with an encircling band (n = 5), as seen in Figure 3. The difference was also apparent in the scotopic ERG. Cutting the band did not restore significant amplitude when recorded at 3 months. The amplitude of photopic B ERG showed a reduction of 41.5%, photopic flicker ERG showed a reduction of 28.5%, and scotopic B ERG showed a reduction of 27.51%. Taken all together, the overall reduction in ERG amplitude was 30.93%.

#### *Complications*

The cutting of the encircling bands was without complications and no retina detached.

## Discussion

As previous investigators have noted, an encircling band diminishes the OPA and the POBF in the eye. In our series of 27 eyes the amount of reduction was



Fig. 3. The amplitude of the photopic B wave to single stimulus (top left) and to flicker stimulus (top right) is diminished in the encircled eyes. The difference is also apparent in the scotopic ERG to blue and to red (bottom left) and the scotopic bright flash (bottom right). The upper recordings in each Figure are from the encircled eye recorded before cutting the band.

independent of the amount of constriction by the band. The estimated constriction in all but two eyes was within therapeutic limits, i.e., between 10% and 20%: two eyes were estimated to be constricted by 25% and 30%. The diminished mean POBF in the unencircled eyes (485.6  $\mu$ L/min) probably reflects the preponderance of myopia.

Diddie and Ernst<sup>4</sup> suggested that the diminished OPA in the encircled eye was an effect of venous obstruction by the band. Others have suggested that kinking of the long posterior ciliary arteries by the band is a factor.<sup>13</sup> Both may contribute, but the observation that reduction in OPA is independent of the amount of constriction or the location of the band implies that the reduced pulsatile flow is more an effect of restriction of compliance of the globe. Silver et al<sup>14</sup> have pointed out that the eye in diastole is a fluid-filled sphere that must expand to accept the next bolus of blood with systole. We suggest that the elastic silicone band is relatively unresponsive to the 1.5 to 2.5 mmHg surge of the ocular pulse, that it blocks compliance of the globe and thus limits the volume of the systolic pulse that the eye will accept. One might expect that if the band blocks equatorial expansion there might be a compensatory anterior or posterior expansion, but reduced OPA was recorded at the cornea, which refutes the presence of significant anterior compensatory expansion. It is likely that some of the pulsatile flow in the ophthalmic artery is shunted to the lacrimal and orbital vessels (Figure 4).

The unilateral diminished visual sensitivity noted by some patients in the encircled eyes could be ascribed to the previous retinal detachment, developing lens opacity, high myopia, or poor pupillary dilatation. The previous detachment could also contribute to the diminished ERG. However, the predominant reason for the unilateral pigment epithelial dystrophy in some patients was probably an effect of ischemia in the encircled eye. A significant amount of POBF can be restored once the band is cut. Cutting the encircling band is a benign procedure, redetachment is exceedingly unlikely because the buckle effect persists, and the improved pulsatile flow that will result may be advantageous to an aging eye. Choroidal ischemia has been reported to be a precursor of age-related macular degeneration.<sup>15</sup> A prophylactic cutting of the band after a year of retinal stability is practiced by Alice McPherson (personal oral communication, September 6, 2004) and has been reported by Schwartz et al.<sup>16</sup>

The number of patients in this study is small, because of the infrequent use of an encircling band at the New York Hospital since 1980. This study shows,



Fig. 4. A drawing exaggerating normal compliance (dashed line) to systolic pulse (left) versus limited compliance in an eye with an encircling band (right) and demonstrating the probable shunting of ophthalmic artery flow to the lacrimal and orbital vessels (arrows) in the encircled eye.

however, that the encircling procedure causes a relative ischemia, regardless of the amount of constriction, and that there is no recovery over time. We suggest that the possible deleterious effect on visual function might be alleviated by cutting the band early after retinal stability has been achieved.

**Key words:** choroidal ischemia, encircling band, ocular pulse amplitude (OPA), pulsatile ocular blood flow (POBF), retinal detachment, scleral buckle, visual function.

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