RESULTS OF LEVATOR-ADVANCEMENT BLEPHAROPTOSIS REPAIR USING A STANDARD PROTOCOL: EFFECT OF EPINEPHRINE-INDUCED EYELID POSITION CHANGE*

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ABSTRACT

Purpose: Blepharoptosis repair by levator advancement is successful in most instances, but the postoperative eyelid level is not uniformly predictable. This study was undertaken to evaluate the possible effect of epinephrine (from local anesthetic) on eyelid position.

Methods: Seventeen adults with acquired unilateral ptosis as a result of levator aponeurosis dehiscence underwent levator aponeurosis advancement. The distance between the upper eyelid margin and the central corneal light reflex was measured preoperatively with the patient in both the upright and the supine position, 10 minutes after injection of 1.0 mL of anesthetic solution (2% lidocaine with 1:100,000 epinephrine and 12 U hyaluronidase per mL) in the supine position, intraoperatively after skin closure in the supine position, and 1 week or more postoperatively in the upright position. The ptotic lid was positioned intraoperatively in relation to the contralateral unoperated lid according to the change (presumably) induced by epinephrine stimulation of Müller's muscle.

Results: Eleven (65%) of the 17 patients had final postoperative lid positions within 1 mm between eyes. Two patients (12%) had undercorrection. Four patients (24%) had overcorrection by > 1 mm. The overcorrected lids were satisfactorily positioned, however, and none required further surgery; in 3 of these 4 patients, the unoperated lid had become ptotic, probably as a result of Hering's law. Differences between operated and unoperated lids and between the different times of measurement were analyzed. Significant changes in lid position occurred in the ptotic lids after injection (mean, +1.1 ± 1.5 mm; median, +1.0 mm; $P = .004$) and in the final intraoperative difference between operated and unoperated lids

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(mean, +0.8 ± 0.9 mm; median, +1.0 mm; P = .003). The change in the unoperated lid from preoperative upright to preoperative supine was significantly greater in the 6 failures (mean, -0.8 ± 0.6 mm; median, -1.0 mm) than in the 11 successful outcomes (mean, +0.1 ± 0.8 mm; median, 0.0 mm; P = .03). The change in unoperated lid position after injection of the ptotic lid was significantly greater in the failures (mean, +0.4 ± 0.5 mm; median, + 0.3 mm) than in the successful cases (mean, -0.2 ± 0.4 mm; median, 0.0 mm; P = .02).

Conclusion: Although it seems intuitively reasonable and clinically appropriate to account for the stimulatory effect of epinephrine during ptosis surgery, such intraoperative compensation alone did not yield a universally successful outcome in this study.

INTRODUCTION

Although blepharoptosis repair by levator aponeurosis advancement using local infiltrative anesthesia is successful in most instances, the postoperative eyelid level is not uniformly predictable. Stimulation of Müller's muscle by epinephrine in the local anesthetic solution may contribute to the variability of the intraoperative eyelid position. This study was undertaken to evaluate this effect.

METHODS

Seventeen adult patients with acquired unilateral blepharoptosis as a result of levator aponeurosis dehiscence underwent levator aponeurosis advancement. Patients were excluded if they had ptosis from other causes (such as Horner's syndrome); a history of trauma, prior eyelid surgery, Bell's palsy, Graves' ophthalmopathy, strabismus, or treatment of glaucoma with topical medications; or concomitant blepharoplasty. Eyelid excursion from downgaze to upgaze was > 11 mm in all affected lids. The distance between the upper eyelid margin and the corneal light reflex (Putterman's margin-reflex distance [MRD]) was measured preoperatively in both the upright and supine positions, 10 minutes after subcutaneous injection of 1.0 mL of anesthetic solution (2% lidocaine with 1:100,000 epinephrine and 12 U hyaluronidase per mL) in the supine position, intraoperatively after skin closure in the supine position, and 1 week or later postoperatively in the upright position.

Intravenous or oral sedation was not administered to the patient so as to avoid any possible systemic effect on eyelid height. The ptotic eyelid was positioned intraoperatively in relation to the contralateral "control" lid according to the change (presumably) induced by epinephrine stimulation

of Müller's muscle; for example, if the MRD of the ptotic eyelid changed from 0 to +2 after local anesthetic had been injected, the desired intraoperative level of the operated lid was 2 mm higher than the contralateral unoperated lid. The aponeurosis was secured to the anterior superior tarsal surface with one to three 6-0 silk sutures. Patients remained supine during the entire operation and were not brought to the sitting position to evaluate the eyelid positions. The possible effect of eye dominance was not considered in the determination of intraoperative lid position. The skin incision was approximated with 6-0 fast-absorbing gut sutures. An antibiotic-corticosteroid ointment was prescribed to be applied to the incision twice daily during the first 10 postoperative days.

Because of the non-gaussian nature of the data, factors were compared between operated and control eyes with the Wilcoxon signed-rank test. Comparisons between success and failure groups were compared with the Wilcoxon rank-sum test. The correlation between variables was estimated with the Spearman correlation coefficient.

RESULTS

Eight (47%) of the 17 patients were men and 9 (53%) were women. Patient age ranged from 38 to 91 years; mean age was 71 years and median was 72 years. Ten patients (59%) underwent ptosis repair of the right upper eyelid and 7 patients (41%) of the left upper eyelid.

Eleven (65%) of the 17 patients had final postoperative eyelid positions within 1 mm between eyes. Fig 1 demonstrates the eyelid measurements in a patient with a successful outcome whose ptotic eyelid did not change as a result of the injection of local anesthetic. Fig 2 illustrates another successful repair in which the ptotic eyelid, elevated slightly after the anesthetic injection, was deliberately overcorrected in relation to the contralateral unoperated eyelid, and ultimately was symmetric with the opposite eyelid.

Two patients (12%) had undercorrection; the eyelid measurements of one of the cases are shown in Fig 3. Four patients (24%) had overcorrection by > 1 mm, but no patient required further surgery to lower the operated eyelid. In 3 of these 4 patients, the operated eyelid was satisfactorily positioned and the unoperated eyelid had become ptotic, probably as a result of Hering's law.[1] The overcorrected eyelid in 1 patient had an MRD of approximately +4.5 mm (Fig 4); even though the eyelid was not retracted and the patient was satisfied with its position, the final asymmetry between the 2 eyelids was considered by the surgeon to be unacceptably disparate in light of the hypothesis being tested (ie, that equal compensation for the change in eyelid position after local anesthetic injection will

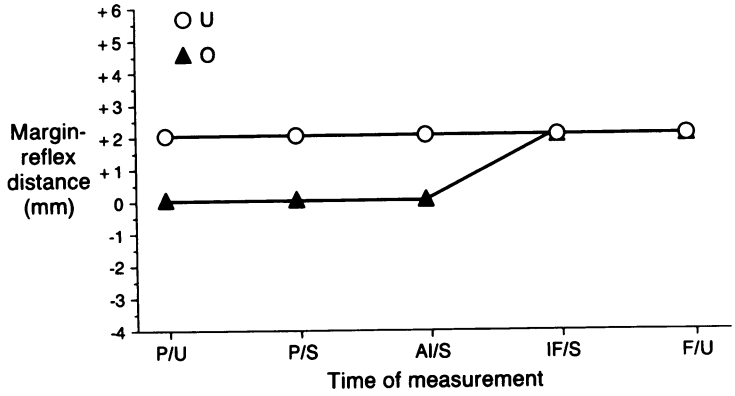

FIGURE 1

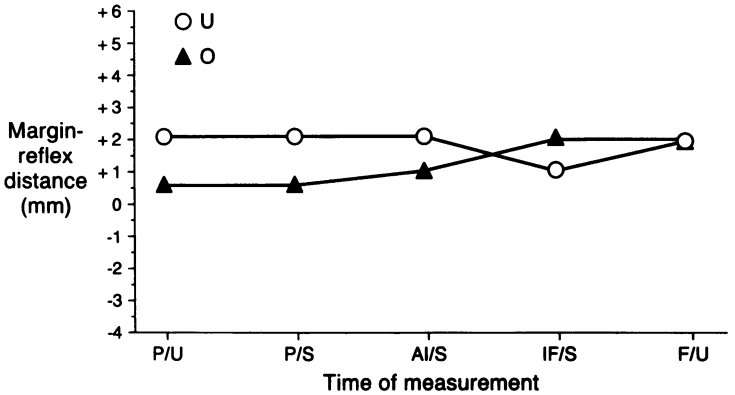

FIGURE 2

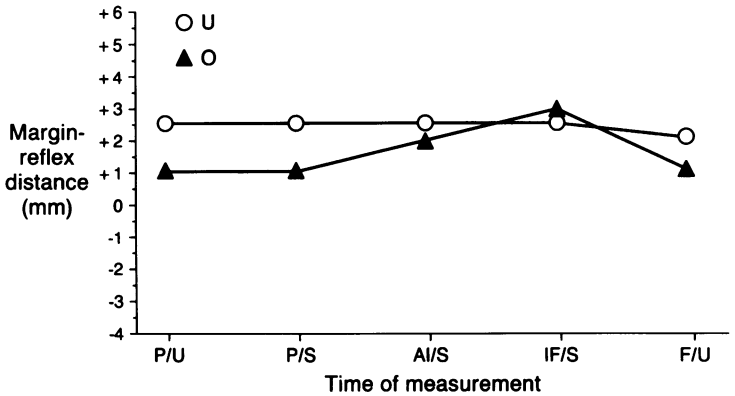

FIGURE 3

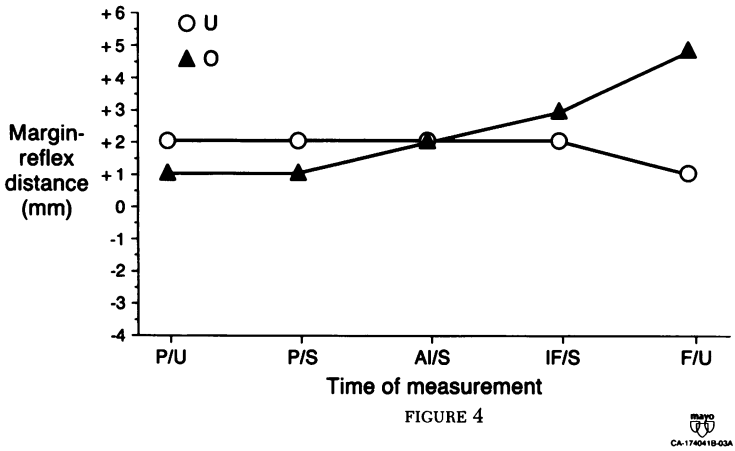

FIGURE 4

FIGURES 1-4

Changes in position of operated, ptotic eyelid (O) and unoperated eyelid (U) in preoperative upright position (P/U), in preoperative supine position (P/S), 10 minutes after injection of local anesthetic in supine position (AI/S), at conclusion of operation in supine position (IF/S), and at follow-up in upright position (F/U). Fig 1 demonstrates symmetric result in patient whose ptotic eyelid did not change in response to local anesthetic, whereas Fig 2 depicts symmetric result in patient whose ptotic eyelid elevated slightly after anesthetic injection and was deliberately overcorrected in relation to contralateral unoperated eyelid. Figs 3 and 4 illustrate changes in eyelid position in patients whose ptotic eyelids were undercorrected and overcorrected, respectively.

yield postoperative eyelid symmetry). Thus, although 15 (88%) of the 17 patients were pleased with their ultimate result, the final position of the operated eyelid was graded clinically by the surgeon as satisfactory in 14 patients (82%), undercorrected in 2 (12%), and overcorrected in 1 (6%). For purposes of data analysis, however, the results were considered successful in 11 patients (65%) and failures in 6 patients (35%).

The MRD measurements are summarized in Table I. The average and median MRDs of the ptotic eyelids in the preoperative upright position were both +0.5 mm, and the positions of both the ptotic and control eyelids changed minimally when the patient was placed in the supine position. After injection of local anesthetic, the average and median MRDs of the ptotic eyelids increased 1.0 mm; the range, however, varied from no change to an increase of 4.0 mm. The average position of the contralateral eyelids was essentially unchanged. The mean final MRD of the operated eyelids (+3.3 mm) was 0.8 mm higher than the unoperated eyelids (+2.5 mm), whereas the median values were equal (+3.0 mm). The final

TABLE I: MARGIN-REFLEX DISTANCE IN 17 PATIENTS WITH UNILATERAL BLEPHAROPTOSIS

	MEAN±STANDARD DEVIATION (MM)	MEDIAN (MM)	RANGE (MM)
Preoperative (upright)			
Operated lid	+0.5 ± 1.0	+0.5	-2.0 to +3.0
Unoperated lid	+2.7 ± 0.9	+3.0	+1.0 to +5.0
Preoperative (supine)			
Operated lid	+0.4 ± 1.4	+0.5	-4.0 to +3.0
Unoperated lid	+2.5 ± 0.6	+2.0	+2.0 to +4.0
Intraoperative after injection of local anesthetic (supine)			
Operated lid	+1.5 ± 1.3	+1.5	0.0 to +4.0
Unoperated lid	+2.5 ± 0.5	+2.5	+2.0 to +3.0
Intraoperative final (supine)			
Operated lid	+3.3 ± 1.0	+3.0	+2.0 to +5.5
Unoperated lid	+2.5 ± 0.5	+3.0	+0.5 to +3.0
Postoperative final (upright)			
Operated lid	+2.8 ± 1.4	+3.0	+0.5 to +4.5
Unoperated lid	+2.4 ± 0.9	+2.0	+1.0 to +4.0

average MRD measurements were +2.8 mm for the originally ptotic eyelids and +2.4 mm for the contralateral unoperated eyelids.

Differences between operated and unoperated eyelids and between the different times of measurement were analyzed. Significant changes in eyelid position occurred in the ptotic eyelids after injection of local anesthetic (mean, +1.1 ± 1.5 mm; median, +1.0 mm; $P = .004$) and in the final intraoperative difference between operated and unoperated eyelids (mean, +0.8 ± 0.9 mm; median, +1.0 mm; $P = .003$). The change in the unoperated eyelid from preoperative upright to preoperative supine was significantly greater in the 6 failures (mean, -0.8 ± 0.6 mm; median, -1.0 mm) than in the 11 successful outcomes (mean, +0.1 ± 0.8 mm; median, 0.0 mm; $P = .03$). The change in unoperated eyelid position after injection

of the ptotic eyelid was significantly greater in the failures (mean, +0.4 ± 0.5 mm; median, + 0.3 mm) than in the successful cases (mean, -0.2 ± 0.4 mm; median, 0.0 mm; P = .02). The only significant linear relationship was the difference between the final intraoperative eyelid positions and the difference between the postoperative eyelid positions (r= 0.51; P = .04). Although the relationship is statistically significant, it is too weak to be considered clinically predictive (Fig 5).

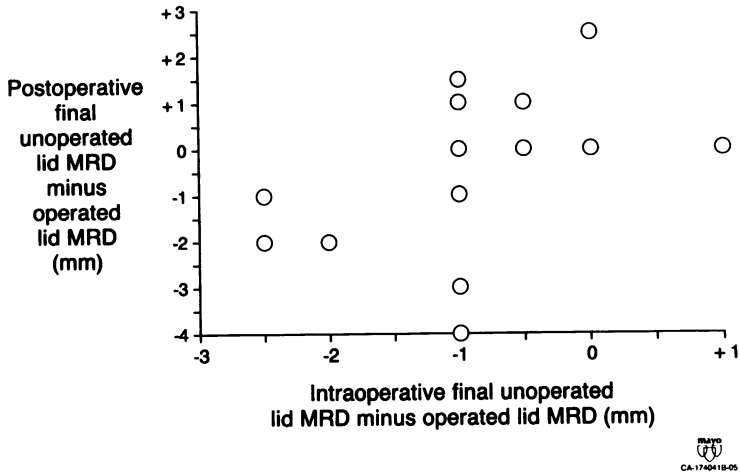

FIGURE 5

Although a linear relationship was identified between the difference in final intraoperative unoperated and operated eyelid positions and the difference between postoperative eyelid positions, it was too weak to be considered clinically predictive (r = 0.51; P = .04).

DISCUSSION

The results of surgical repair for acquired blepharoptosis were greatly improved by the popularization more than 20 years ago of the technique of levator palpebrae superioris aponeurosis repair using local anesthesia by Jones and associates.[2] Many surgeons deliberately overcorrect the ptotic eyelid by approximately 1 mm, expecting a modest decrease in eyelid height postoperatively with the resolution of the local anesthetic–induced paralysis of the orbicularis orbiculi and the stimulation of Müller's muscle.[3] Nevertheless, infallible prediction of the final eyelid position remains an elusive goal.

With hopes of improving the success rate of blepharoptosis repair, Linberg and coworkers[4] analyzed the relationship between intraoperative

and postoperative eyelid heights in 12 patients who underwent aponeurotic advancement. Several factors differed from the current study: 8 patients underwent bilateral surgery; 2 of the operated eyelids were ptotic because of previous trauma; 1 ptotic eyelid was associated with anophthalmos; a blepharoplasty was performed concomitantly in each case; absorbable sutures (5-0 polyglactin 910) were used to secure the levator aponeurosis to the tarsus; and the eyelid positions were determined in the upright position by photographic analysis of the vertical eyelid fissure in relation to the horizontal corneal diameter. A linear relationship was found between the intraoperative eyelid position and the final position 3 months postoperatively. The position of the operated eyelid 1 week postoperatively was an excellent predictor of the 3-month result, supporting the recommendations of Jordan and Anderson[5] and Dortzbach and Kronish[6] that early secondary revision of persistent ptosis or iatrogenic eyelid retraction is appropriate.

The current study may be criticized for the following weaknesses. First, the eyelid positions were measured by the surgeon with a handheld ruler rather than by a masked observer using photographs. Although photographs would be expected to yield more accurate measurements, it was our intent to conduct our observations in a typical clinical setting. Additionally, the MRD may be a more useful measurement than the vertical eyelid fissure, which is affected by the lower eyelid position.

Second, the patient remained in the supine position for the duration of the operation, rather than sitting upright during the assessment of eyelid position. Several years ago, the senior author elected not to change the patient's position during blepharoptosis repair because it was cumbersome for some elderly patients and because it seemed not to affect the final outcome. Although the average changes in eyelid position from the preoperative upright position to the preoperative supine position were minimal for the entire group of patients, the change in the unoperated eyelid from preoperative upright to preoperative supine was significantly greater (mean, -0.8 ± 0.6 mm; median, -1.0 mm) in the 6 surgical failures than in the 11 patients whose final eyelid positions were within 1 mm of each other (mean, +0.1 ± 0.8 mm; median, 0.0 mm). Specifically, it may be prudent to assess the intraoperative eyelid positions in the upright position if the unoperated eyelid height decreases when the patient is supine on the operating table, prior to injection of local anesthetic. Similarly, an elevation of the unoperated eyelid after injection of the ptotic eyelid may augur unpredictable postoperative eyelid positions.

Third, that ocular dominance and its possible effect on eyelid position was not tested may be another potential drawback. Meyer and Wobig[7]

demonstrated that contralateral upper eyelid pseudoretraction or latent blepharoptosis could be unmasked in patients with unilateral or asymmetric blepharoptosis by manually elevating the more ptotic eyelid, which caused the normal or less ptotic eyelid to drop 1 mm or more in 10 (20%) of 50 patients. Ptosis was present or greater in the dominant eye in 7 of the 10 patients, compared with only 7 (18%) of 40 patients in the group whose normal or less ptotic eyelid did not drop when the ptotic eyelid was raised ($P < .001$). Lyon and coworkers[8] confirmed this observation by applying phenylephrine 2.5% to the eye with the more ptotic eyelid; 12 (22%) of 54 patients with unilateral ptosis or asymmetric ptosis demonstrated a contralateral upper eyelid drop. This effect occurred more frequently in patients whose blepharoptosis affected the dominant eye than the nondominant eye (50% versus 12.5%; $P = .01$).

Despite the potential methodologic flaws described, the final anatomic position of the operated eyelid was normal in and acceptable to 15 (88%) of 17 patients, a success rate comparable to that in recent published reports.[9,10] Although it seems intuitively reasonable and clinically appropriate to account for the stimulatory effect of epinephrine during ptosis surgery, such intraoperative compensation alone did not yield a universally successful outcome in this study. Additional investigations to analyze the potential interactions and effects of ocular dominance, patient position, the concentration and volume of epinephrine in the anesthetic solution, and the use of hyaluronidase may help to identify which variable or factors contribute to surgical unpredictability.

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DISCUSSION

DR ROBERT G. SMALL. It is a pleasure to discuss this excellent paper by Dr George Bartley and his associates. He has studied a phenomenon that has often puzzled me at the operating table when I am doing surgery for acquired adult ptosis. This is the elevating effect of epinephrine injected with the local anesthetic on the eyelid being operated on. Lidocaine may paralyze the orbicularis muscle and add to the epinephrine effect. This makes it difficult for the surgeon to know how much to advance the levator aponeurosis. Dr Bartley points out other factors that make ptosis surgery challenging. These include positional effects, ocular dominance, and Hering's law. Please comment on the positional effect. I find that when the patient is moved from the supine to the sitting position on the operating table at the conclusion of the operation, both eyelids frequently assume a higher position.

Dr Bartley found epinephrine-induced lid elevation up to 4 mm with an average of 1 mm. Dr Bartley notes that many surgeons overcorrect the eyelid 1 mm because of the epinephrine effect. In those patients in your series who had an elevation of more than 1 mm, did you overcorrect a greater amount—even up to 4 mm?

Dr Bartley had a very acceptable surgical success rate of 88%—better than the average rate of 85%. Reoperations for ptosis should not be considered complications any more than reoperations for strabismus.

I would like to ask Dr Bartley if he used a light in the operating room to measure the distance of the upper lid from midpupil. I find the use of a light in one hand and a ruler in the other to be cumbersome and unnecessary. It is simpler and just as accurate to hold a ruler close to the patient's eye and measure the distance from the apparent center of the pupil to the upper lid.

The MRD acronym used by Dr Bartley stands for "margin reflex distance" and stems from a valuable contribution by Sarver and Putterman to our concept of upper eyelid position as the distance from midpupil to upper lid (*Arch Ophthalmol* 1985; 103:354-356). MRD measurement is better for evaluating ptosis than vertical lid fissure measurement, since when the lower lid covers the lower limbus, the vertical lid fissure measurement does not correctly reflect the degree of ptosis. However, "MRD" implies the identification of the center of the pupil by a reflex from a light held in the hand of the examiner. Dr Bart Frueh of this organization measured the distance from the apparent center of the pupil to the upper lid in a large number of normal subjects and established the normal mid pupil to upper lid distance (Frueh BR. *Trans Am Ophthalmol Soc*

1984; 82:493-598). Another study defined ptosis as mild, moderate, or severe on the basis of the distance from the apparent center of the pupil to the upper lid using a ruler without a muscle light. These measurements were accurate to 1 mm or less in 75% of patients (Small RG, et al. *Ophthal Plast Reconstr Surg* 1989; 5:171-175). Thus, I would like to make a plea for the simpler method of measuring lid position with a ruler and without a muscle light, and for the generic term "midpupil to upper lid distance," which is clearly understood by all.

Some additional questions: Did you change your technique as a result of this study? Do you have any suggestions for the ptosis surgeon? Did you measure the degree of ptosis (mild, moderate, or severe), and did this relate to the epineprine effect or results of surgery?

Congratulations on a fine contribution!

GERALD HARRIS, MD. I would like to congratulate Dr. Bartley on his impressive effort in pursuit of an elusive goal: symmetry in the repair of the unilateral ptosis patient. I have just two questions.

In his discussion, Dr. Bartley briefly referred to paralysis of orbicularis muscle. I wonder if there is evidence that this represents stimulation of Müeller's muscle by the epinephrine, as opposed to motor denervation of the protractor orbicularis by the lidocaine itself. Secondly, how does he account for other factors that contribute to the intraoperative eyelid level, specifically edema and temporary traumatic paresis of orbicularis from the surgical dissection. I suspect that these play a significant role, in that I have performed bilateral injection of the eyelids in unilateral ptosis surgery to try to balance out the effect that Dr. Bartley is mentioning. I found that my predictability was no greater than if I intentionally overcorrected by one to two millimeters, as has been recommended by others.

Thank you.

NICHOLAS ILIFF, MD. I have an observation and perhaps also a question for the authors in this excellent attempt to try to solve the difficult problems we have with setting eyelids at surgery.

First my observation is that if you set the eyelid at the level equal with the preoperative appearance of the unoperated eye, it can be helpful and I rely a lot on my preoperative photographs and essentially ignore the appearance of the other eyelid at surgery because it almost always changes.

The second thing is, I have always been concerned about assuming that epinephrine is stimulating Müller's muscle and somehow the lidocaine is not affecting Müller's muscle. We tend to assume that the lido-

caine is not affecting Müeller's muscle. So I would like to have the authors comment on how they might separate the actions of the lidocaine on Müeller's muscle.

The third observation is that when you give a local subcutaneously you are going to get a little different effect then from a deeper local and I would like to know if the doctors had looked at exactly how the local is given. My experience has been that usually when you get to the level of Müeller's muscle you have lost the anesthetic effect. If the lidocaine has not gotten to Müeller's muscle it is harder to assume that somehow the epinephrine has gotten to Müeller's muscle. So perhaps some studies could be done, and I would welcome some suggestions as to how they might be done to determine the level of the penetration of the anesthetic.

JAMES AUGSBURGER, MD. Let me preface my remarks by saying that I have no clinical expertise in this field whatsoever, in case anyone had doubts about that. Given the small size of this study group, I question the authors about the probability of a type 2 error in their analysis data. In other words, what is the probability that there may have been a real and possibly clinically important difference in this small series that was simply not detected because of the small study size?

GEORGE B. BARTLEY, MD. I am grateful for the thoughtful comments from various members.

First with regard to Dr. Small's comments and questions. The positional effect that he describes in some patients at the end of the operation seems to be quite variable. When the patient is brought from the supine position to the upright position, as he mentioned, some do seem to "wake up" and the lid elevates. In my experience an equal number of lids seem to drop, even accounting for the paralysis of the orbicularis oculi.

Second, he asked about the presumed stimulation of Müller's muscle and whether those eyelids that elevated considerably had a different outcome. The operated eyelid did elevate more than one millimeter after local anesthetic injection in 5 of 17 patients. Three of these individuals had successful outcomes, but 2 had overcorrection, which perhaps suggests that the risk of overcorrection is indeed increased if the surgeon compensates for the full amount of the epinephrine-induced lid elevation. However, as has been pointed out by Dr. Richard Anderson and others, it is much easier 5 or 6 days postoperatively to lower an eyelid that is a bit on the high side simply by releasing 1 or more sutures, teasing the levator aponeurosis from the tarsus, and allowing the lid to drop, than it is to raise a lid that is droopy at that point in time postoperatively. In that situation,

one basically must do the operation over and advance the levator further. So I would tend to err, if you will, on the side of mild overcorrection than undercorrection, which I believe addresses Dr. Small's third question of whether I have changed my technique at all.

I do not use a hand-held light in the operating room now. I did for the purposes of this study, but as Dr. Small pointed out in his article in 1989 in the journal, *Ophthalmic Plastic and Reconstructive Surgery*, one can estimate the lid position quite accurately just by using the central pupil as the reference point, rather than a corneal light reflex.

Regarding the omission of epinephrine from the anesthetic block, I have not done this. I believe that the vasoconstrictive effects of epinephrine are helpful and, at least for me, outweigh the potential effect that it may or may not have on Müller muscle.

Dr. Harris' question about the paralysis of the orbicularis is very germane. Certainly, we know that one can see upper eyelid retraction in Bell's palsy by the unopposed action of the eyelid retractors when the protractor muscles are paralyzed. This is one reason why such patients were excluded from the study. So, it is true that there may be some effect on the orbicularis from lidocaine, which needs to be considered. However, intraoperatively my judgment has been that it is more likely to see the lids not close completely (lagophthalmos) than to see a true elevation of the eyelid.

Regarding Dr. Harris' comment about compensation for edema that may result from the injection of local anesthetic, I had not thought of his technique of injecting both upper eyelids. It is interesting to learn that it did not seem to make much effect. Some surgeons use hyaluronidase in the anesthetic block, others do not. I personally prefer it, because I think it helps to diffuse the anesthetic and perhaps to reduce the amount of edema.

Dr. Iliff's comments are excellent. I wondered as well about the effect of lidocaine on Müller's muscle. If we assume that epinephrine affects the muscle, we must therefore assume that lidocaine does as well. I inject the eyelids superficially and presume that the drug is diffusing into the posterior aspect of the eyelid, but his is a very good question that perhaps could be addressed by injecting the lids subconjunctivally as Dr. Allen Putterman has suggested for the other eyelid operations.

Regarding the statistical possibility of a type 2 error as Dr. Augsburger mentions, that is why I am grateful to have excellent statistical help by my colleagues in that discipline. I cannot answer his question without conferring with them, but I trust that they gave me appropriate advice in the design of the study.

Thank you.