

ACHIEVING SUCCESS WITH THE SILICONE EXPANDER FOR OVERACTING SUPERIOR OBLIQUES*

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ABSTRACT

Purpose: To report the results of and complications with silicone expander surgery for the overacting superior oblique.

Methods: A total of 26 patients with bilateral overaction of the superior oblique and A-pattern strabismus and 5 patients with unilateral overacting superior oblique secondary to inferior oblique palsy were treated with a 7 mm silicone expander. Care was taken not to enter the sub-Tenon's space.

Results: The group that underwent bilateral superior oblique surgery had an average preoperative pattern of 37.42 diopters (D) and an average correction of 35.37 D. Three patients had a severe unilateral postoperative inflammatory incident that was successfully treated with oral and topical corticosteroids. One of these patient developed Brown's syndrome. Another patient, who had no postoperative inflammatory incident, also developed Brown's syndrome. In these 4 patients, the sub-Tenon's space was inadvertently entered during surgery.

Conclusion: The silicone expander surgery has a very high success rate in treating the A-pattern associated with the bilateral overacting superior oblique. This procedure also works well for the unilateral superior oblique that overacts owing to an inferior oblique palsy. No cyclotorsion symptoms occurred after this surgery. However, 4 patients had complications because the sub-Tenon's space was exposed during surgery. With this procedure, there is a learning curve to obtain the skill not to enter the sub-Tenon's space.

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INTRODUCTION

Complete bilateral tenotomy for superior oblique overaction in A-pattern strabismus has been successful in alleviating the A-pattern. However, many patients have been left with cyclovertical torsional problems and superior oblique palsy postoperatively.

For the past 4 years, the silicone expander has been used in an attempt to have fewer cases of postoperative excyclotropia and/or superior oblique palsy following tenotomy of the superior oblique. The superior oblique tendon expander operation was first performed by Kenneth Wright in the treatment of Brown's syndrome.^{1,2} He introduced the graded lengthening method to weaken a superior oblique by using a different length of silicone, depending on how much he desired to weaken the tendon. He later extended his procedure for overacting superior obliques, such as that which occurs in A-pattern strabismus.^{3,4} His goal with this new surgical procedure was to treat an overacting superior oblique without producing a superior oblique palsy. He reported only a rare case of superior oblique underaction after surgery.

In 1998, Seawright and Gole⁵ reported on 18 patients treated with silicone expanders for superior oblique overaction. None of their patients showed superior oblique palsy postoperatively. No mention was made of torsional problems.

We report our results with use of the silicone expander for the overacting superior oblique as seen not only with A-pattern strabismus but also as with inferior oblique palsy. We also discuss the potential complications, how to avoid them, and how to treat them when they do occur.

PATIENTS AND METHODS

A total of 31 patients are included in this study. Twenty-six presented with bilateral superior oblique overaction associated with an A-pattern strabismus. Twenty had exotropia and 6 had esotropia. Five patients who were treated were given a diagnosis of unilateral superior oblique overaction associated with unilateral inferior oblique palsy. The 26 patients with bilateral superior oblique dysfunction also underwent horizontal muscle surgery for either exotropia or esotropia. The amount of surgery performed was based on the deviation in the primary position at distance without consideration of any abduction from the superior oblique occurring in the primary position. Abduction from the superior oblique occurs mainly in the down position.⁶

The bilateral group consisted of 14 adults (defined in this study as age 10 and older) and 12 children. The adults ranged in age from 10 to 59 years (average, 28.4 years) and the children from 1.5 to 7 years (average, 4.3 years). Average age of all patients was 16.79 years.

In each patient, the same procedure was performed on the superior oblique: tenotomy followed by placement of a 7 mm length of No. 40 silicone band. In the bilateral group, follow-up was a minimum of 1 year and a maximum of 4 years (average, 2.4 years).

All the patients in this series had at least 3+ overaction of the superior oblique, and 50% had 4+ overaction. Overaction of 3+ was considered to be present when the eye looking down and in had the superotemporal limbus almost hidden by the lower eyelid. Overaction of 4+ was considered to be present when the eye attempting to look down and in, continued its arc course and began to abduct.

The approach to the superior oblique used in this series was first described by Parks⁷ and later elucidated in a videotape by Marshall Parks and David Stager (personal communication, June 1995). A superotemporal conjunctival incision parallel to the limbus is made for 7 to 8 mm temporal to the lateral border of the superior rectus beginning 2 to 3 mm posterior to the temporal insertion. The incision is taken down to the sclera, and a large muscle hook is placed under the superior rectus for tractional purposes. Under direct visualization, a small Stevens hook is used to isolate the temporal insertion of the superior oblique, which is pulled forward toward the limbus. Two Stevens muscle hooks expose the nasal side of the superior rectus muscle. The superior oblique tendon can be seen through the intermuscular membrane on the nasal side of the superior rectus muscle. The anterior aspect of the intermuscular membrane is opened, and another Stevens hook grabs the superior oblique under direct visualization (Fig 1). The surgeon must be careful not to disturb the posterior aspect of the intermuscular membrane, which would lead to the sclera and the sub-Tenon's space (Fig 2).

Two double-armed 7-0 Prolene sutures are placed into the superior oblique tendon and locked at the anterior and posterior sides. The 2 sutures are 2 mm apart, and the first is located 5 mm nasal to the nasal border of the superior oblique. The second suture is placed 2 mm nasal to the first suture. The tenotomy is performed, and a 7 mm piece of No. 40 retinal silicone band is sutured into the superior oblique tendon with the 2 double-armed 7-0 Prolene sutures (Fig 3). Before the silicone band is sutured into place, forced ductions of Guyton are performed to be certain all the superior oblique tendon has been cut. The conjunctival opening is closed with several 8-0 Vicryl sutures.

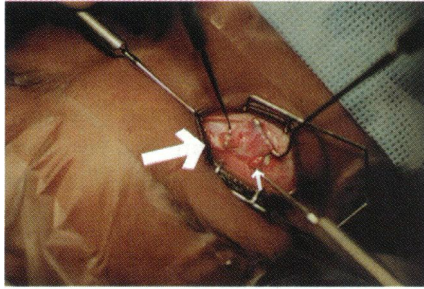


FIGURE 1

Large Jamesen muscle hook holds right superior rectus. Small Stevens muscle hook pulls on superior oblique temporally (small arrow) so that surgeon can see superior oblique move nasally and easily pick it up with a second Stevens hook (large arrow) under direct visualization.

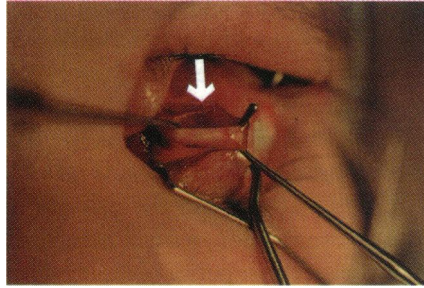


FIGURE 2

Superior oblique tendon has been isolated nasal to right superior rectus muscle with intermuscular membrane posterior to tendon left intact (arrow) so that sclera is protected from expander surgery.

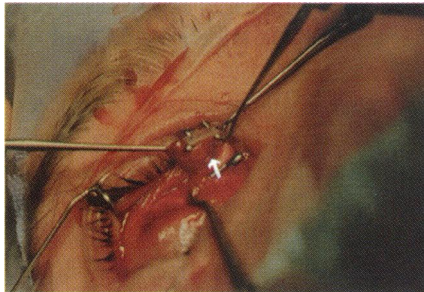


FIGURE 3

Superior oblique silicone expander has been sutured in place with posterior intermuscular membrane (sub-Tenon's space) still intact (arrow) and no exposure to sclera. This is patient's right eye.

RESULTS

The adults had an average of 36.7 diopters (D) in the A-pattern preoperatively, with an average correction of 35.7 D. The children had an average preoperative pattern of 38.24 D, with an average of 35.00 D correction. The combined group of 26 patients had an average preoperative pattern of 37.42 D, with an average correction of 35.37 D (Table I).

TABLE I: BILATERAL SUPERIOR OBLIQUE SURGERY FOR
A-PATTERN MEASUREMENT IN PRISM DIOPTERS

DIAGNOSIS	AVERAGE	RANGE
Adults		
Preop	36.7	25-50
Correction	35.7	19-50
Children		
Preop	38.24	25-55
Correction	35.00	25-55
Adults and children		
Preop	37.42	25-55
Correction	35.37	19-55

ECCE, Extracapsular cataract extraction; PE, phacoemulsification

Two patients had a consecutive esotropia after exotropia surgery, but the A-pattern was corrected. Three patients had a residual significant exotropia requiring a second procedure, but the A-pattern was alleviated. None of the patients over age 10 complained of torsional symptoms postoperatively. Only 3 measured any excyclotorsion with the Maddox rod, and this was always less than 5°. Twenty years ago, when all of my strabismus patients underwent operation as inpatients, I saw many patients with torsional complaints following tenotomy of the superior oblique when I made rounds on the evening of surgery. Often, these patients had torsional symptoms for several weeks after surgery before they adapted to their new postoperative position. This was not seen in any of our patients with the silicone expander.

Three patients had a similar postoperative complication, consisting of an inflammatory incident. The patients presented within 4 days and had the appearance of an orbital cellulitis. Each patient had a tremendous amount of chemosis in the area of the operated superior oblique of one eye, with swelling of the lids, often both upper and lower eyelids (Fig 4 and 5). None of the patients was febrile. One patient had undergone a unilateral superior oblique expander for treatment of inferior oblique

**FIGURE 4**

Close-up view of area of silicone expander surgery of left eye on postoperative day 3 showing tremendous amount of chemosis and erythema. Sub-Tenon's space had inadvertently been entered during surgery.

**FIGURE 5**

Same patient as in Figure 4, showing swelling of lids in addition to chemosis of conjunctiva. Patient's appearance resembled that of an orbital cellulitis.

**FIGURE 6**

Same patient as in Figures 4 and 5 after receiving systemic corticosteroids for 2 weeks. All chemosis has resolved, and much of lid edema has disappeared.

palsy. All had discomfort in the involved eye, but none was incapacitated with pain.

Primarily because of concern about the acute swelling, patients immediately sought medical evaluation. All had only a minimal, clear, watery discharge, which was not unusual for a postoperative strabismus patient. Each patient was treated with topical corticosteroid drops as well as oral prednisone, 2 mg/kg/day for 10 days and then tapered to zero. All responded to this treatment with resolution of the inflammatory incident (Fig 6). Two patients had no residual scarring, with ductions remaining full. One did develop a Brown's syndrome with an inability to elevate in adduction past the midline. However, because the patient was orthophoric in the primary position, no further surgery was performed. All 3 patients had similar surgical events in which the sub-Tenon's space had inadvertently been entered during the silicone expander procedure. Possibly, the cause of this inflammation is the rubbing of the silicone onto bare sclera, producing a scleritis that spreads to give the appearance of an orbital cellulitis.

One additional patient presented with a postoperative Brown's syndrome but without any postoperative inflammatory incident. Again, however, the sub-Tenon's space had been entered.

Four of the 5 patients with unilateral inferior oblique palsy had excellent results from the silicone expander surgery for the antagonist superior oblique. Each had a small residual hypertropia on head tilt to the uninvolved side (for a right inferior oblique palsy, a small left hypertropia on left head tilt; for a left inferior oblique palsy, a small right hypertropia on right head tilt). The fifth patient had a left hypertropia in the primary position at distance and near after placement of a silicone expander to the left superior oblique. The overacting superior oblique was neutralized, but a subsequent recession of the ipsilateral superior rectus was needed to obtain a good surgical result.

Prior to this study, 22 patients with an A-pattern exotropia had been treated with a posterior four fifths tenotomy of the superior oblique bilaterally in addition to routine horizontal muscle surgery. In 5 patients, the superior oblique continued to overact bilaterally, and in 3 the superior oblique continued to overact unilaterally. These 8 patients subsequently underwent complete tenotomy of the superior oblique with resolution of the overacting superior oblique. Prieto-Diaz⁸ described the tenectomy of the posterior four fifths of the superior oblique in which a triangle of tissue was removed. The most difficult part of this procedure is to perform the same amount of surgery on both sides. If more is done on one side, then that side will have a relative superior oblique palsy when compared to the other side. Also, in some cases, I obviously did not tenotomize

enough tissue, because the superior oblique continued to overact.

DISCUSSION

Berke,⁹ in 1946, was one of the first to describe a tenectomy and tenotomy of the superior oblique for an overacting superior oblique. Twenty tenotomies in 13 patients did not produce any superior oblique palsies in Berke's series. Caldeird^{10,11} described a graduated recession of the superior oblique as a method to treat an overacting superior oblique. No cases of Brown's syndrome were reported, and only one case of underaction of the superior oblique was seen postoperatively.

Ciancia and Prieto-Diaz¹² also discussed recession of the superior oblique without inducing any hyperdeviations. Buckley and Flynn¹³ compared recession to tenotomy and found the results comparable but noted that the recession of the superior oblique unilaterally resulted in slight undercorrections. Shin and associates¹⁴ reported good results with a posterior superior oblique tenectomy at the scleral insertion for overacting superior oblique. Five patients did have a hyperdeviation induced in the primary position, but there were no postoperative cyclotorsional complaints or Brown's syndrome.

Wilson and associates¹⁵ reported 2 cases in which downgaze was restricted after placement of a superior oblique tendon expander. Surgical exploration revealed adhesions, and the restriction resolved on removal of the expander. These investigators also reported the postoperative complication of superior oblique paresis at the same time of reoperation.

Parks and Eustis¹⁶ recommended a simultaneous superior oblique tenotomy and inferior oblique recession in Brown's syndrome in order to reduce the incidence of superior oblique palsy after tenotomy of the superior oblique. They felt that superior oblique palsy after tenotomy alone was quite common. Olivier and Von Noorden¹⁷ reported 8 cases in which a superior oblique palsy occurred following tenectomy of the superior oblique in Brown's syndrome. They also reported the development of a superior oblique palsy in 3 of 6 patients with unilateral inferior oblique palsy treated with a unilateral superior oblique tenectomy.¹⁸

Scott and Nankin¹⁹ reported 6 cases of an isolated inferior oblique palsy treated with unilateral superior oblique tenotomy. In all cases, the vertical deviation was improved. In this series, there were no cases in which fusion, being present preoperatively, was lost. In several cases, diplopia that had been present before surgery was no longer present after surgery. The investigators did not mention torsional problems with this series.

Venkata and associates²⁰ reported good results in performing a posteri-

or 90% tenotomy of the superior oblique at its insertion for an overacting superior oblique. They felt that it was an effective procedure for weakening the vertical action without inducing torsional problems. Harley and Manley²¹ reported improvement in 19 of 20 patients who had A-pattern exotropia with overaction of the superior obliques in whom a bilateral superior oblique tenectomy was performed. Subsequent operation was needed in one patient for a head tilt and hypertropia. The investigators did not mention torsional problems with this series.

CONCLUSIONS

While many approaches have been proposed for the surgical treatment of the overacting superior oblique, it is evident that the silicone expander is a reliable and safe method. However, there is a learning curve in obtaining the skill to avoid the sub-Tenon's space in the nasal approach to the superior oblique. By keeping the posterior intermuscular membrane intact, the silicone expander surgery will be successful without inflammatory symptoms, iatrogenic Brown's syndrome, or adhesions leading to restrictive strabismus. If the sub-Tenon's space is entered, systemic and local corticosteroids should be given immediately for several days postoperatively in an attempt to prevent the complications that can arise from this incident. The complication rate in this series was 4 in 31 (12.9%), which is considered to be high. However, in the past 21 cases, only once has the sub-Tenon's space been entered. This patient received topical and systemic corticosteroid therapy for 2 weeks postoperatively without complications.

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DISCUSSION

C. GAIL SUMMERS, MD. Superior oblique surgery is not for the casual strabismus surgeon. Our mentors have carefully instructed us in the delicate nature of superior oblique weakening with its various permutations, including full-tendon tenectomy, tenotomy, recession, posterior tendon tenectomy or tenotomy, and now superior oblique tendon expander surgery. These various procedures have been successively developed in an attempt to avoid undercorrection and overcorrection, reduce the torsional effects of superior oblique surgery, and provide the potential for reversibility. Dr Pollard has kindly shared his experience with the use of the silicone expander in two groups of patients: those with A-pattern strabismus and overacting superior obliques, and those with unilateral inferior oblique palsy. We are grateful that he has not only demonstrated his surgical expertise, but has also focused on one of the serious complications that can occur. Beyond that, he has provided a recommendation for management of this important postoperative complication.

Let us first examine the methodology of this study. It is a retrospective review of nonconsecutive patients who fit the diagnostic criterion of either A-pattern strabismus with bilateral overaction of the superior obliques, or inferior oblique palsy with unilateral superior oblique overaction. There is no comparison group to assess the benefit of expander surgery compared with other methods of superior oblique weakening, and the motility examinations are unmasked. On the other hand, Dr Pollard has provided us with data on patients who were followed up for a minimum of 1 year. Each patient received the same surgery with a standard 7 mm silicone band, with the A-pattern strabismus group receiving bilateral surgery and the inferior oblique palsy group receiving unilateral surgery.

With regard to results, Dr Pollard achieved resolution of the A-pattern in all 26 patients, with a wide range of correction, between 19 and 55 prism diopters, being achieved despite using only one length of spacer. Four of the 5 patients in the inferior oblique palsy group achieved a successful result with the expander surgery. No surgery is without complications, and Dr Pollard has carefully reported his experience. Ten percent of his patients developed a postoperative inflammatory syndrome, and 6% had a postoperative "Brown's" syndrome. Only one patient required additional surgery. Of note, no patient had a residual A-pattern, subjective complaint of torsion, down gaze restriction, extrusion of the silicone band, or suture granuloma.

Dr Pollard has made us aware of the postoperative inflammatory syndrome that was associated with inadvertent entering of posterior Tenon's capsule in 3 patients and that was successfully treated with topical and oral corticosteroids in all 3 patients, although 1 went on to develop limitation of elevation of the adducted eye. Dr Pollard's proposed mechanism to explain the inflammatory syndrome is a mechanical irritation of the globe by the silicone band with extraocular movement. While logical, this may not provide a complete explanation. Certainly the grinding of the band against the globe continued after corticosteroids were discontinued, but the inflammatory signs did not recur. A study performed by Park and associates, reported in the 1993 Korean Journal of Ophthalmology, examined rabbits that had undergone either simple superior oblique tenotomy or tenotomy with the placement of a 4 mm segment of silicone band. Inflammation and foreign body reaction were similar in the groups. In addition, the foreign body reaction was described to be around the suture and not the silicone implant.

There are 3 questions that I would like to direct to Dr Pollard: First, were there any patients with violation of posterior Tenon's who did not have postoperative complications? Second, does he think that there would be value in primary closure of an inadvertent rent in posterior Tenon's, or

is there a role for sub-Tenon's injection of corticosteroids at the time of surgery when a rent occurs? Last, when there is a clinical picture of cellulitis, would he consider adding antibiotic therapy?

In concluding, I want to thank Dr Pollard for presenting his results and reminding us of the technical expertise that is required when this procedure is performed.

DR MALCOLM R. INC. I enjoyed the paper very much, and I have a couple of questions. Was there any evaluation of the fusional status of these patients with an A-pattern strabismus either before or after surgery? You might not expect patients to complain of symptoms related to cyclotorsion if they did not have fusion before surgery. Differentiating between a marked inflammatory response and a cellulitis can be a problem. Those of us who have had cases of cellulitis following strabismus surgery realize the importance of starting antibiotic treatment very early to prevent endophthalmitis. In your patient who had one inflamed eye and one normal eye, I would have started antibiotics. Can you use pain as a distinguishing feature? All of my patients whom I suspected of having endophthalmitis had pain.

DR EDWARD L. RAAB. I enjoyed the paper very much and have two questions. If rubbing of the expander on the globe is producing the inflammatory response, could you not put the expander more nasally, but still avoid the trochlea? My second question is, did you explore any of the patients with Brown's syndrome? This seems to me more like a pseudo-Brown's syndrome. There are congenital as well as acquired postoperative examples of this. I reported such a case in which there were abnormal attachments between the superior oblique tendon and the superior rectus capsule, giving a functional shortening of the superior oblique.

DR EUGENE M. HELVESTON. Thank you very much for bringing this interesting topic to our attention. To paraphrase an old saying, the complexity of superior oblique surgery is limited only by the perverse ingenuity of the surgeon. A lot goes on in the region of the trochlea. I have a few questions. Were the patients divided between primary and secondary cases? By secondary cases, I mean those who have already had medial rectus recessions. My second question is, does a muscle really ever overact? Is it not stopped properly, or is it allowed to function out of its primary field of action? I noticed that in most of the photographs showing overaction of the superior oblique, we saw an exodeviation. I wonder if this is a manifestation of the secondary and tertiary actions of the superior oblique in abduction and intorsion of the eye. Was there a traction test done before

surgery? I noticed that the superior oblique tendons appeared to be fairly long in the normal to even loose category, and yet overactions were described; I would suggest that the overactions were in reality overexpressions. Finally, is a 13% complication rate acceptable? Would you select an expander over other methods of weakening the superior oblique, such as a partial disinsertion of the superior oblique?

DR STEWART M. WOLF. I would like to compliment the authors on their careful studies and their careful surgery. The superior oblique has a unique anatomy and has been the subject of great interest over the years. Historically, Edward Jackson was very interested in the superior oblique, transposing the insertion of the superior oblique to other locations on the globe to see what effect this would have. Then there was a long period in which virtually no superior oblique surgery was done. A statement "Nolo me tangere," meaning "Don't touch me" summarized the feeling for a long time. I congratulate the authors for revisiting this area.

DR W. RICHARD GREEN. Silastic is a well-tolerated material, but it often becomes encapsulated in a fibrous tissue. Furthermore, the retinal surgeons have found that they cannot suture it but must clamp it. Therefore, I wonder how it tolerates sutures; will sutures pull out with the force of the normal muscle action? Over a period of time, are the therapeutic effects of the surgery lost? I suspect they might be because of the scarring that occurs in the presence of a foreign body.

DR DAVID R. STAGER. I would like to add to the concept that adhesions occur to both the sclera and the superior rectus. Dr Pollard has kept the expander about 5 mm away from the superior rectus so he doesn't get adhesions and limitation in down gaze. The superior oblique will stick to anything on the sclera; staying outside the inner layer of the intermuscular septum, or Tenon's capsule, is an extremely important aspect of this procedure. The expander can be too long; we have had trouble with some that were over 8 mm, so I think 4 to 7 mm is probably the correct length. The procedure does work in cases of Brown's syndrome; we have done a series of about 20 cases that will be published. We have about an 88% success rate in the cases where the expander was less than 8 mm long.

DR ZANE F. POLLARD. Thank you, Dr Wolff, for your comments. Dr Green, I did not report my series for a long time, as I personally wanted at least a 1-year follow-up, with some of the patients having over a 4-year follow-up. There have been no extrusions, because I learned from Dr Stager to keep the silicone below 8 mm. Whether the procedure will become

undone with time, we do not know, but each suture of the Prolene was tied with 5 throws to make it as secure as possible.

Dr Helveston, all of these surgical cases were primary without any prior strabismus procedures. You asked about the forced ductions, and they were all performed at the time of surgery using David Guyton's technique. They were all positive, or what I would call positive using Guyton's method. After the tenotomy, and before the placement of the silicone, forced ductions were totally normal, which told me that the entire tendon had been cut.

Dr Raab, you asked if we could go more nasally. I believe that we could. We did go 5 mm nasal to the nasal border of the superior rectus in each case. If we go a few more millimeters, we would ensure that the spacer would stay out of the sub-Tenon's space. The 2 patients with the postoperative Brown's syndrome had only a Brown's syndrome and not a Brown's plus. The Brown's plus, as described by Dr Jampolsky, had either a vertical deviation in the primary position, a face turn with chin-up position, or both. I do not operate for Brown's syndrome, but I do operate for a Brown's plus. Since both these patients had only a Brown's syndrome, they were not re-explored.

Dr Ing, the purpose of my paper was really to present the complications of this procedure rather than to report on the stereopsis obtained from the surgery. However, I can tell you that many of the adult patients did obtain fusion and stereopsis. Some people ask if adult strabismus surgery is only cosmetic, and the answer is obviously that it is not. Many of our adult patients do obtain fusion and stereopsis, but the percentage is not as great as we obtain on our pediatric population. You also asked if I should have put the patient on antibiotics when she first appeared with the postoperative inflammatory incident. I did not want to "shotgun" the patient with steroids and antibiotics, because then I would never have known which of the 2 cured the patient. This was also a question asked by Dr Summers. I elected to give her only steroids for 3 reasons: She was afebrile, she did not have a purulent discharge, and she was eating normally. She was a very reliable patient, and therefore I felt safe treating her only with steroids, knowing that she would call me at once if anything changed. I have learned from treating many children with orbital cellulitis that these patients lose their appetites as a result of their illness. The same holds true for adults. When the second patient in this series presented with the postoperative inflammatory incident, I felt more secure using steroids having already treated one patient.

Dr Summers, I want to thank you for your comments and for so thoroughly discussing and studying my paper. I am a little embarrassed that I did not think of closing the posterior Tenon's, but that is an excellent addi-

tion, and I can assure you that the next time this happens, I will try to repair posterior Tenon's. There was one patient that had the sub-Tenon's space exposure recognized at the time of surgery who was placed on topical and systemic steroid therapy postoperatively without any inflammatory or restrictive incidents. The question was, should a sub-Tenon's injection of steroids be done at the time of surgery when we know there has been an exposure of the sub-Tenon's space? I certainly agree that it makes good sense to do this.

I thank all the discussants, especially Dr Summers, for their thoughts. I would like to thank the program committee for allowing me to present this topic and to participate in this meeting.