Published in final edited form as:

Am J Ophthalmol. 2015 August ; 160(2): 385–390.e4. doi:10.1016/j.ajo.2015.05.014.

Strabismus Surgery Reoperation Rates with Adjustable and Conventional Sutures

Christopher T. Leffler, MD, MPH¹, Kamyar Vaziri, MD², Kara M. Cavuoto, MD², Craig A. McKeown, M.D.², Stephen G. Schwartz, MD, MBA², Krishna S. Kishor, MD², and Allison Pariyadath, MD¹

¹Department of Ophthalmology, PO Box 980438, Virginia Commonwealth University Medical Center, Richmond, VA 23298-0438

²Bascom Palmer Eye Institute, University of Miami Miller School of Medicine, 900 N.W. 17th St., Miami, FL 33136

Abstract

Purpose—To determine the association of strabismus surgery reoperation rates with adjustable or conventional sutures.

Design—Retrospective cross-sectional study.

Setting—Review of a large national private insurance database.

Study Population—Adults age 18 to 89 having strabismus surgery between 2007 and 2011.

Intervention—Adjustable versus conventional suture strabismus surgery.

Outcome Measure—Reoperation rate in the first postoperative year.

Results—Overall, 526 of 6178 surgical patients had a reoperation (8.5%). Reoperations were performed after 8.1% of adjustable suture surgeries and after 8.6% of conventional suture surgeries ($p=0.57$). Of the 4357 horizontal muscle surgeries, reoperations were performed after 5.8% of adjustable suture surgeries, and after 7.8% of conventional suture surgeries ($p=0.02$). Of the 1072 vertical muscle surgeries, reoperations were performed after 15.2% of adjustable suture surgeries, and after 10.4% of conventional suture surgeries ($p=0.05$). Younger age (18 to 39 years) was associated with a lower reoperation rate ($p=0.02$). The significant multivariable predictors of reoperation for horizontal surgery were adjustable sutures (odds ratio, OR 0.69, 95% confidence interval 0.52 to 0.91), monocular deviation (OR 0.64), complex surgery (OR 1.63), and unilateral surgery on two horizontal muscles (OR 0.70, all $p=0.01$). Adjustable sutures were not

Corresponding author: Christopher T. Leffler, MD, MPH. chrislefflermd@gmail.com. Tel: (804) 828-9315. Fax: (804) 828-1010. Supplemental Material available at AJO.com.

Financial Disclosures: Dr. Leffler, Dr. Vaziri, Dr. Cavuoto, Dr. McKeown, Dr. Kishor and Dr. Pariyadath: None.

Dr. Schwartz has received reimbursement for personal fees from Vindico Pharmaceuticals (Lexington, KY), Alimera Sciences (Alpharetta, GA), Santen Pharmaceutical (Osaka, Japan), and Bausch and Lomb (Rochester, NY).

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

significantly associated with reoperation rates after vertical muscle surgery (multivariable OR 1.45, $p=0.07$).

Conclusions—Adjustable sutures were associated with significantly fewer reoperations for horizontal muscle surgery. Adjustable sutures tended to be associated with more reoperations for vertical muscle surgery, but this observation was not statistically significant in the primary analysis after controlling for age.

Introduction

Adjustable sutures can be used in strabismus surgery to permit refinement of ocular alignment in the immediate postoperative period. Suture adjustment is typically performed within 24 hours of the surgery, before healing of the extraocular muscle to the sclera occurs. The first modern descriptions of adjustable sutures in strabismus surgery were published by Jampolsky in the 1970s.¹ Since that time, several authors have published variations on the original technique.^{2–4}

Adoption of adjustable sutures has been limited due in part to the difficulty of the surgical technique, resulting in a prolonged surgical learning curve.¹ The technique is also thought to have an increased potential for slipped muscles.⁵ Additionally, adjustable sutures may take extra time in the operating room and in the immediate postoperative period. Even patients not needing adjustment may require tying of the primary suture knot, cutting of a noose suture, removal of a traction suture, and conjunctival closure.^{1,6,7} Patients may have discomfort or be uncooperative during adjustment.^{6,8} More recent techniques require less extensive postoperative manipulation on patients not requiring adjustment.^{2,4,8,9}

In addition to the surgical difficulty, the uncertainty of benefit has hampered global adoption of adjustable sutures. To our knowledge, only one small randomized clinical trial (RCT) of adjustable versus conventional sutures has been performed.¹⁰ In this trial, 45 patients were divided into three equal groups: Group 1 received conventional surgery; Group 2 underwent two-stage adjustable suture technique with adjustment performed six hours post-operatively; and Group 3 underwent adjustable suture technique with adjustment performed at the end of the case. Although the investigators reported that the adjustable suture technique was safe and had better outcomes, intraoperative pain and duration of surgery were greater in the adjustable suture groups.¹⁰

In the absence of large RCTs, reviewers have cited retrospective case series, which often suggest better outcomes with adjustable sutures.¹ One study evaluated the results of strabismus surgery as a single surgeon switched from conventional to adjustable surgery.⁶ Zhang et al studied two surgeons who frequently used adjustable sutures and one surgeon who did not.¹¹ Another recent study noted a higher success rate in patients who selected adjustable sutures compared with patients who did not.¹² Demonstrations of adjustable suture efficacy from the retrospective literature have limitations. Reoperation rates may not be reported.¹² Some single-center case series have no control group.^{2,9} Some retrospective series have not demonstrated improved postoperative alignment with adjustable sutures.^{13,14} Moreover, the small number of surgeons involved in all of the case series makes it uncertain if the results can be generalized.

In order to evaluate and compare the reoperation rates of adjustable and conventional suture strabismus surgery, we analyzed a large database of health insurance payments.

Methods

This retrospective population-based cross-sectional study was approved by the Office of Research Subjects Protection of the Virginia Commonwealth University. The study utilized the MarketScan Commercial Claims and Encounters, and the Medicare Supplemental and Coordination of Benefit databases (Truven Health Analytics, Ann Arbor, MI, USA) from the years 2007 through 2011 (the most recent year the database was available). The MarketScan family of databases comprises the largest convenience-based proprietary database in the US, annually encompassing approximately 40–50 million patients with employer-sponsored or supplemental insurance.¹⁵ These databases consist of de-identified, individual-level health records (inpatient and outpatient), obtained from large employers, hospitals, and Medicare programs. Additional details regarding the MarketScan databases, sampling methodologies, and limitations are described elsewhere.¹⁵

Our study searched the database for strabismus surgeries in adults age 18 to 89. The procedure (coded using the Current Procedural Terminology, CPT) and diagnosis (coded using the International Classification of Disease, ICD-9) were noted.

We evaluated reoperations in the first year following horizontal (CPT 67311, 67312) or vertical (CPT 67314, 67316) muscle surgery on one or both eyes. For several reasons, the primary analysis counted any additional incisional horizontal or vertical strabismus surgery in the first year as a reoperation. In the initial analysis which included combined horizontal plus vertical surgeries, it was not clear from the claim whether the adjustable suture was used for a horizontal or a vertical muscle. Moreover, due to half-tendon width and other transpositions, and for other reasons, horizontal muscle surgery might influence vertical alignment, and vice-versa. We also present secondary analyses in which only horizontal surgeries are counted as reoperations following horizontal surgery, and only vertical surgeries are counted as reoperations following vertical surgery.

Because adjustable sutures are not typically used for oblique muscle surgery, we excluded patients having superior oblique surgery (CPT 67318) or diagnosed with fourth nerve palsy (ICD 378.53). Surgeries involving botulinum toxin injection (CPT 67345) were excluded.

Variables associated with strabismus surgery reoperation at one year were determined. Patient groupings for univariate analysis included sex, age (18–39, 40–64, 65–89 years), use of adjustable suture (CPT 67335), number of muscles operated, and several procedure and diagnosis categories (Table 1). The upper age bracket cutoff of 65 years was selected to permit comparisons with studies of Medicare, as age 65 typically defines eligibility for individuals who are not disabled. The patient was included in the adjustable suture group if an adjustable suture was used on any muscle, even if other muscles in the same or the contralateral eye were sutured in the conventional fashion.

Proportions were compared by the Fisher exact test. A multivariable logistic regression model was prepared in a stepwise backwards fashion. Analysis was performed in SPSS (version 22, SPSS Inc., Chicago, IL, USA).

Results

Overall association of suture type with reoperation

In total, 6178 surgical patients were studied. Overall, the reoperation rate was 8.5% (526 of 6178). Reoperations were performed after 134 of 1646 adjustable suture surgeries (8.1%) and after 392 of 4532 conventional suture surgeries (8.6%, $p=0.57$, Supplemental Material at [AJO.com](#)).

In patients having solely horizontal or vertical primary surgery (but not both), the reoperation rate was 8.1% (442 of 5429). Reoperations were performed after 106 of 1409 adjustable suture surgeries (7.5%) and after 336 of 4020 conventional suture surgeries (8.4%, $p=0.34$). As discussed below, the association of adjustable sutures with reoperation rate depended upon whether horizontal or vertical muscle surgery was performed.

Horizontal muscle surgery

For horizontal muscle surgeries, 318 of 4357 had a reoperation by one year (7.3%). The reoperation rate in the first postoperative year was 5.8% with adjustable suture and 7.8% with conventional suture technique ($p=0.02$, Table 2, Figure 1). The reoperation rate was significantly lower in both univariate and multivariable analysis with adjustable sutures (multivariable odds ratio, OR 0.69, 95% confidence interval, CI, 0.52 to 0.91, $p=0.02$), in younger patients (age 18 to 39), with monocular deviations, with unilateral surgery on two horizontal muscles, and with surgery not defined as complex (Tables 2 and 3).

In a secondary analysis which counted only horizontal muscle surgeries as reoperations, 280 patients (6.4%) had a reoperation by one year. Reoperations were performed in 58 patients (5.1%) having adjustable suture technique, and in 222 patients (6.9%) having conventional suture technique ($p=0.03$). The reoperation rate was significantly lower with adjustable sutures (multivariable OR 0.70, 95% CI 0.52 to 0.94, $p=0.02$, Table 3).

In all strata having at least 90 patients, the reoperation rate was always at least 4.5%, regardless of the suture technique used (Figure 2, Supplemental Material at [AJO.com](#)). The CPT code often applied with dysthyroid myopathy or scarring due to prior surgery (67332) was used in 1279 cases (29%, Table 2). A secondary analysis which excluded the 5 patients with planned reoperation (–58 modifier) did not substantially affect the results.

We observed a lower reoperation rate with unilateral surgery on two horizontal muscles (5.9%) compared with bilateral surgery on one horizontal muscle (8.4%, $p=0.01$). This association was strong with surgery for exotropia, for which the reoperation rate was 5.4% for unilateral surgery on two muscles, and 10.3% for bilateral surgery on one muscle ($p=0.001$). This association was not present in cases of esotropia, for which the relevant reoperation rates were 5.9% and 6.1% ($p=1.00$, Supplemental Material at [AJO.com](#)).

Vertical muscle surgery

For vertical muscle surgeries, 124 of 1072 had a reoperation by one year (11.6%). For each patient group defined by age and suture type, the reoperation rate was always about 6% or higher (Figure 3, Supplemental Material at [AJO.com](#)). The reoperation rate was 15.2% with adjustable suture and 10.4% with conventional suture technique ($p=0.045$, Table 4, Figure 1). The reoperation rate was significantly lower in both univariate and multivariable analysis for younger patients (age 18 to 39) (Table 4). In a multivariable model to predict reoperation following vertical strabismus surgery, age 18 to 39 years was a significant predictor (OR 0.52, 95% CI 0.30 to 0.88, $p=0.02$). However, use of adjustable sutures was not a statistically significant predictor in this model (OR 1.45, 95% CI 0.97 to 2.19, $p=0.07$). The tendency for a higher reoperation rate with adjustable sutures, though not statistically significant, was seen for both younger and older patients (Figure 3). The reoperation rate tended to be lower with surgery on a single vertical muscle and higher with mechanical strabismus, but these associations were not significant (Table 4). Exclusion of the 3 patients who had the -58 modifier to denote planned reoperation following vertical muscle surgery did not substantially affect the results.

In a secondary analysis which counted only vertical muscle surgeries as reoperations, 103 patients (9.6%) had a reoperation by one year. Reoperations were performed in 35 patients (13.3%) with adjustable suture technique and in 68 patients (8.4%) with conventional suture technique ($p=0.01$). In a multivariable model to predict vertical muscle reoperations, age 18 to 39 years was associated with fewer reoperations (OR 0.48, 95% CI 0.26 to 0.87, $p=0.02$), while use of adjustable sutures was associated with more reoperations (OR 1.56, 95% CI 1.01 to 2.42, $p=0.045$).

In a secondary multivariable analysis which did not exclude fourth nerve palsy, reoperations following vertical muscle surgery were lower in younger adults aged 18 to 39 years (OR 0.59, 95% CI 0.38 to 0.92, $p=0.02$), and higher with adjustable sutures (OR 1.63, 95% CI 1.13 to 2.33, $p=0.008$).

The CPT code often applied with dysthyroid myopathy or scarring due to prior surgery (67332), was used in 276 cases (28%, Table 2). The tendency for a higher reoperation rate with adjustable sutures was stronger in such cases (CPT 67332, OR 1.79, $p=0.10$) than in cases without this code (OR 1.30, $p=0.32$), though neither association was significant (Supplemental Material at [AJO.com](#)).

DISCUSSION

The present study used reoperation rates as an outcome measure following strabismus surgery, as was suggested by a recent review.¹⁶ We report that adjustable sutures were associated with a significantly lower reoperation rate for horizontal strabismus surgery after controlling for known confounding variables. On the other hand, adjustable sutures tended to be associated with a higher reoperation rate for vertical strabismus surgery, although this association was not significant in the primary analysis after controlling for patient age. This analysis suggests that horizontal and vertical strabismus surgeries should be analyzed separately in studies of adjustable sutures.

The reoperation rate with adjustable sutures in the present study (134 of 1646, 8.1%) was within the range of 5 to 15% which has been reported previously.^{1,7} The strength of the present study was the large number of patients having both adjustable and conventional surgery from a national database. In addition, reoperations could be identified if a patient had the second surgery with a different provider.

The observed clinical predictors of reoperation rate could be confirmed in other large databases. The higher horizontal muscle reoperation rate in the current study with complex strabismus (mechanical, incomitant, paralytic, or transposition) is consistent with the higher reoperation rate previously noted in patients with thyroid disease¹⁷ and in patients with a neurogenic or mechanical cause of strabismus.¹² We observed a lower reoperation rate with unilateral surgery on two horizontal muscles compared with bilateral surgery on one horizontal muscle with surgery for exotropia, but not for esotropia. This finding is consistent with a randomized study of 36 patients with basic type intermittent exotropia which demonstrated a higher success rate with a unilateral recession-resection as compared with bilateral lateral rectus recessions.¹⁸

Inferior rectus recessions for thyroid myopathy are known to sustain late overcorrections when adjustable sutures are used.¹⁹ This observation might be consistent with our finding of a higher odds ratio for reoperation with adjustable sutures in cases of scarring or restrictive myopathy, than in a comparison group. However, the association was not statistically significant in either group, making conclusions uncertain.

This study had multiple limitations. Some reoperations might have been planned or staged, though very few contained a modifier to indicate such deliberate staging. Although a reoperation may indicate that neither the physician nor the patient believed that the first surgery had attained the final treatment goals, reoperation rates may not reflect all dissatisfied patients. Some patients might consider their surgery unsuccessful, but might forgo or delay reoperation. Both physicians and patients might vary in their indications for repeat surgery. Ideally, a goal-directed analysis which considers alignment, diplopia, binocularity, and other factors, can be used to evaluate surgical success.²⁰ Adjustable sutures are not commonly used in children, and it cannot be assumed that these results will apply in children.

Both adjustable and conventional suture surgeries were analyzed in a uniform fashion. Therefore, differences between groups might be related to the surgical technique or to patient characteristics. We used multivariable analysis in an attempt to control for patient characteristics, such as age and known clinical factors. However, unidentified confounders could account for intergroup differences.

The exclusion of patients with fourth nerve palsy from the primary vertical muscle analysis probably excluded some patients having rectus muscle surgery. However, as these rectus muscle surgeries were excluded from both adjustable and conventional suture groups, the comparison of these groups is valid. Moreover, a secondary analysis which included fourth nerve palsy continued to show a tendency toward a higher reoperation rate with adjustable suture use in vertical strabismus surgery.

The analysis of an insurance claim database has additional limitations. The patient's preoperative and postoperative angle of alignment is unknown. Information regarding diagnosis, comorbidities, and visual and neurologic status is unavailable or incomplete. Insurance claims can be inaccurate and incomplete, due to delayed and revised billing, and other factors. Reoperations for which payment is denied are not reflected in the database. Surgeons might have differed in the method of suture placement, and in the timing of postoperative adjustment.

In conclusion, the use of adjustable sutures was associated with a lower reoperation rate for horizontal strabismus surgery. Adjustable sutures tended to be associated with a higher rate of reoperation following vertical strabismus surgery, though this association was not statistically significant in the primary analysis. The major strength of the study is the consistent application of the same metric in a large national database. The study cannot provide a definitive answer to the value of adjustable sutures, but we have illustrated an approach that could be extended to other insurance databases. Moreover, the data could help in performing the power calculations required in designing a large RCT.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding/Support: Partially supported by National Institutes of Health (Bethesda, MD) Center Core Grant P30EY014801 and Research to Prevent Blindness (Washington, DC) Unrestricted Grant to the University of Miami.

Other Acknowledgment: None.

References

1. Nihalani BR, Hunter DG. Adjustable suture strabismus surgery. *Eye (Lond)*. 2011; 25(10):1262–76. [PubMed: 21760626]
2. Parikh RK, Leffler CT. Loop suture technique for optional adjustment in strabismus surgery. *Middle East Afr J Ophthalmol*. 2013; 20(3):225–8. [PubMed: 24014986]
3. Deschler EK, Irsch K, Guyton KL, Guyton DL. A new, removable, sliding noose for adjustable-suture strabismus surgery. *J AAPOS*. 2013; 17(5):524–7. [PubMed: 24160975]
4. Budning AS, Day C, Nguyen A. The short adjustable suture. *Can J Ophthalmol*. 2010; 45(4):359–62. [PubMed: 20648083]
5. Kushner BJ. An evaluation of the semiadjustable suture strabismus surgical procedure. *J AAPOS*. 2004; 8(5):481–7. [PubMed: 15492743]
6. Awadein A, Sharma M, Bazemore MG, Saeed HA, Guyton DL. Adjustable suture strabismus surgery in infants and children. *J AAPOS*. 2008; 12(6):585–90. [PubMed: 18848481]
7. Wisnicki HJ, Repka MX, Guyton DL. Reoperation rate in adjustable strabismus surgery. *J Pediatr Ophthalmol Strabismus*. 1988; 25(3):112–4. [PubMed: 3294373]
8. Coats DK. Ripcord adjustable suture technique for use in strabismus surgery. *Arch Ophthalmol*. 2001; 119(9):1364–7. [PubMed: 11545644]
9. Nihalani BR, Whitman MC, Salgado CM, Loudon SE, Hunter DG. Short tag noose technique for optional and late suture adjustment in strabismus surgery. *Arch Ophthalmol*. 2009; 127(12):1584–90. [PubMed: 20008711]

10. Sharma P, Julka A, Gadia R, Chhabra A, Dehnan M. Evaluation of single-stage adjustable strabismus surgery under conscious sedation. *Indian J Ophthalmol*. 2009; 57(2):121–5. [PubMed: 19237785]
11. Zhang MS, Hutchinson AK, Drack AV, Cleveland J, Lambert SR. Improved ocular alignment with adjustable sutures in adults undergoing strabismus surgery. *Ophthalmology*. 2012; 119(2):396–402. [PubMed: 22036633]
12. Mireskandari K, Cotesta M, Schofield J, Kraft SP. Utility of adjustable sutures in primary strabismus surgery and reoperations. *Ophthalmology*. 2012; 119(3):629–33. [PubMed: 22115713]
13. Bishop F, Doran RM. Adjustable and nonadjustable strabismus surgery: a retrospective case-matched study. *Strabismus*. 2004; 12(1):3–11. [PubMed: 15255363]
14. Park YC, Chun BY, Kwon JY. Comparison of the stability of postoperative alignment in sensory exotropia: adjustable versus non-adjustable surgery. *Korean J Ophthalmol*. 2009; 23(4):277–280. [PubMed: 20046688]
15. Danielson, E. [Accessed 11/11/2014] White Paper: Health Research Data for the Real World: The MarketScan® Databases. Truven Health Analytics. Jan. 2014 Available at http://truvenhealth.com/Portals/0/Users/031/31/31/PH_13434%200314_MarketScan_WP_web.pdf
16. Haridas A, Sundaram V. Adjustable versus non-adjustable sutures for strabismus. *Cochrane Database Syst Rev*. 2013 Jul 2.:7.
17. Mills MD, Coats DK, Donahue SP, Wheeler DT. American Academy of Ophthalmology. Strabismus surgery for adults: a report by the American Academy of Ophthalmology. *Ophthalmology*. 2004; 111(6):1255–62. [PubMed: 15177982]
18. Kushner BJ. Selective surgery for intermittent exotropia based on distance/near differences. *Arch Ophthalmol*. 1998; 116(3):324–8. [PubMed: 9514485]
19. Peragallo JH1, Velez FG, Demer JL, Pineles SL. Postoperative drift in patients with thyroid ophthalmopathy undergoing unilateral inferior rectus muscle recession. *Strabismus*. 2013; 21(1): 23–8. [PubMed: 23477773]
20. Ehrenberg M, Nihalani BR, Melvin P, Cain CE, Hunter DG, Dagi LR. Goal-determined metrics to assess outcomes of esotropia surgery. *J AAPOS*. 2014; 18(3):211–6. [PubMed: 24924270]

Biography

Christopher T. Leffler earned his MD at Harvard Medical School and his MPH at the Harvard School of Public Health. He served as a Diving Medical Officer in the U.S. Navy. He performed his ophthalmology residency and fellowship in pediatric ophthalmology at Virginia Commonwealth University, and is currently on faculty. He is the treasurer of the Cogan Ophthalmic History Society. His research interests are pediatric ophthalmology, strabismus, comprehensive ophthalmology, and ophthalmology history.

Figure 1.
Strabismus surgery reoperation rate in the first postoperative year.

Figure 2.

Horizontal strabismus surgery reoperation rate in the first postoperative year. Unless specified otherwise, all patient groups were age 40 to 89 years, and were not unilateral 2-horizontal muscle, complex, or monocular deviation.

Figure 3.
Vertical strabismus surgery reoperation rate in the first postoperative year.

Table 1

Categories of strabismus diagnosis and surgical procedures.

Strabismus category.	Definition.
Esotropia.	ICD 378.00–378.08, 378.21, 378.22, 378.35, 378.41, 378.54, 378.71, 378.82, 378.84.
Exotropia.	ICD 378.10–378.18, 378.23, 378.24, 378.42, 378.51–378.52, 378.81, 378.83, 378.86.
Mechanical.	ICD 240–246, 378.60–378.63; CPT 67332.
Scarring or restrictive.	CPT 67332.
Intermittent.	ICD 358.00, 378.20–378.24, 378.40–378.45.
Alternating.	ICD 378.05–378.08, 378.15–378.18, 378.45.
A or V pattern.	ICD 378.02, 378.03, 378.06, 378.07, 378.12, 378.13, 378.16, 378.17.
Paralytic.	ICD 378.50–378.56, 378.71–378.73, 378.86.
Monocular deviation.	ICD for esotropia (378.01–378.04), exotropia (378.11–378.14), or monofixation syndrome (378.34).
Incomitant.	ICD 240–246, 358.00, 378.02, 378.03, 378.04, 378.06, 378.07, 378.08, 378.12–378.14, 378.16–378.18, 378.50–378.54, 378.60–378.63, 378.71, 378.73, 378.86.
Complex.	Mechanical, incomitant, paralytic strabismus, or transposition (CPT 67320)

ICD = International Classification of Diseases. CPT = Current Procedural Terminology.

Table 2

Univariate associations with reoperation from horizontal strabismus surgery.

Clinical factor.	Factor Present.	Factor Absent.	p value.
Adjustable suture.	5.8% (66/1145)	7.8% (252/3212)	0.02
Age 18 to 39 years.	5.1% (81/1579)	8.5% (237/2778)	<0.001
Age 40 to 64 years.	8.6% (190/2197)	5.9% (128/2160)	0.001
Age 65 to 89 years.	8.1% (47/581)	7.2% (271/3776)	0.44
Monocular deviation.	5.1% (43/837)	7.8% (275/3520)	0.008
2 muscles in 1 eye (CPT 67312).	5.9% (101/1724)	8.2% (217/2633)	0.003
1 muscle in 2 eyes (bilateral CPT 67311).	8.4% (83/990)	7.0% (235/3367)	0.14
1 muscle operated.	8.4% (103/1226)	6.9% (215/3131)	0.08
2 muscles operated.	6.8% (195/2851)	8.2% (123/1506)	0.11
3 muscles operated.	8.0% (11/137)	7.3% (307/4220)	0.74
4 muscles operated.	7.1% (20/280)	7.3% (298/4077)	1.00
Complex.	9.2% (145/1574)	6.2% (173/2783)	<0.001
Esotropia	6.5% (105/1619)	7.8% (213/2738)	0.12
Exotropia	7.3% (165/2267)	7.3% (153/2090)	1.00
Mechanical	8.0% (105/1305)	7% (213/3052)	0.23
Scarring or restrictive	8.1% (103/1279)	7.0% (215/3078)	0.22
Intermittent	6.6% (17/257)	7.3% (301/4100)	0.80
Alternating	7.1% (55/776)	7.3% (263/3581)	0.88
A or V pattern	5.6% (3/54)	7.3% (315/4303)	0.80
Paralytic	14.5% (26/179)	7% (292/4178)	0.001
Incomitant	12.7% (42/332)	6.9% (276/4025)	<0.001
Total.	7.3% (318/4357)	--	--

CPT = Current Procedural Terminology.

Table 3

Horizontal Strabismus Surgery: Multivariable logistic regression to predict risk of reoperation in 1 year.

Risk Factor	Any strabismus reoperation.		Horizontal strabismus reoperation.	
	Odds Ratio (95% CI).	p value.	Odds Ratio (95% CI).	p value.
Adjustable suture (CPT 67335).	0.69 (0.52 to 0.91)	0.01	0.70 (0.52 to 0.94)	0.02
Age 18 to 39 years.	0.56 (0.43 to 0.73)	<0.001	0.59 (0.52 to 0.78)	<0.001
Monocular deviation.	0.64 (0.46 to 0.89)	0.01	0.69 (0.49 to 0.98)	0.04
Two horizontal muscles in 1 eye (CPT 67312).	0.70 (0.55 to 0.90)	0.01	0.71 (0.54 to 0.92)	0.009
Complex (restrictive, paralytic, transposition, incomitance).	1.63 (1.29 to 2.06)	<0.001	1.50 (1.17 to 1.92)	0.001

CI = confidence interval. CPT = Current Procedural Terminology.

Table 4

Univariate predictors of reoperation from vertical strabismus surgery.

Clinical Factor.	Factor Present.	Factor Absent.	p value.
Adjustable suture used.	15.2% (40/264)	10.4% (84/808)	0.045
Age 18 to 39 years.	6.9% (17/247)	13.0% (107/825)	0.009
Age 40 to 64 years.	13.6% (84/617)	8.8% (40/455)	0.016
Age 65 to 89 years.	11.1% (23/208)	11.7% (101/864)	0.90
1 muscle operated.	10.9% (88/809)	13.7% (36/227)	0.22
2 muscles operated.	13.7% (35/256)	10.9% (89/816)	0.26
3 or 4 muscles operated.	16.7% (2/12)	11.5% (122/1060)	0.64
Mechanical strabismus.	12.7% (39/308)	11.1% (85/764)	0.46
Scarring or restrictive	12.5% (37/296)	11.2% (87/776)	0.59
Intermittent	17.6% (3/17)	11.5% (121/1055)	0.43
Alternating	20.0% (4/20)	11.4% (120/1052)	0.28
Incomitant	10.3% (6/58)	11.6% (118/1014)	1.00
Complex	12.0% (42/349)	11.3% (82/723)	0.76
Total.	11.6% (124/1072)	--	--