Strabismus Surgery Reoperation Rates With Adjustable and Conventional Sutures

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• PURPOSE: **To determine the association of strabismus surgery reoperation rates with adjustable or conventional sutures.**

• DESIGN: **Retrospective cross-sectional study.**

• METHODS: **SETTING: Review of a large national private insurance database. STUDY POPULATION: Adults aged 18–89 having strabismus surgery between 2007 and 2011. INTERVENTION: Adjustable vs 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 ($P = .57$). Of the 4357 horizontal muscle surgeries, reoperations were performed after 5.8% of adjustable suture surgeries, and after 7.8% of conventional suture surgeries ($P = .02$). Of the 1072 vertical muscle surgeries, reoperations were performed after 15.2% of adjustable suture surgeries and after 10.4% of conventional suture surgeries ($P = .05$). Younger age (18–39 years) was associated with a lower reoperation rate ($P \leq .02$). The significant multivariable predictors of reoperation for horizontal surgery were adjustable sutures (odds ratio [OR] 0.69, 95% confidence interval 0.52–0.91), monocular deviation (OR 0.64), complex surgery (OR 1.63), and unilateral surgery on 2 horizontal muscles (OR 0.70, all $P \leq .01$). Adjustable sutures were not significantly associated with reoperation rates after vertical muscle surgery (multivariable OR 1.45, $P = .07$).**

• 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.**

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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, owing 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 1 small randomized clinical trial (RCT) of adjustable vs conventional sutures has been performed.[10] In this trial, 45 patients were divided into 3 equal groups: Group 1 received conventional surgery; Group 2 underwent 2-stage adjustable suture technique with adjustment performed 6 hours postoperatively; 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 and associates studied 2 surgeons who frequently used adjustable sutures and 1 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

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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 used the MarketScan Commercial Claims and Encounters and the Medicare Supplemental and Coordination of Benefit databases (Truven Health Analytics, Ann Arbor, Michigan, 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 United States, 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 aged 18–89. 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 1 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, owing 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.

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)

CPT = current procedural terminology; ICD = international classification of diseases.

Variables associated with strabismus surgery reoperation at 1 year were determined. Patient groupings for univariate analysis included sex, age (18–39, 40–64, and 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, Illinois, 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