Postoperative infection following strabismus surgery: case series and increased incidence in a single large referral center

Robert J. House, MD,[a] Jill C. Rotruck, MD,[b] Laura B. Enyedi, MD,[a] David K. Wallace, MD, MPH,[c] Ezzeldin Saleh, MD,[d] and Sharon F. Freedman, MD[a]

Author affiliations: [a]Department of Ophthalmology, Duke University Medical Center, Durham, North Carolina; [b]Department of Ophthalmology and Visual Science, Yale University School of Medicine, New Haven, Connecticut; [c]Department of Ophthalmology, Indiana University School of Medicine, Indianapolis; [d]Department of Pediatrics, Southern Illinois University, Springfield

Funding: Lions Duke Pediatric Eye Research Endowment.

Presented as a poster at the 44th Annual Meeting of the American Association for Pediatric Ophthalmology and Strabismus, Washington, DC, March 18-22, 2018.

Submitted May 10, 2018.
Revision accepted September 16, 2018.

Correspondence: Sharon Freedman, MD, Professor of Ophthalmology and Pediatrics Duke Eye Center, 2351 Erwin Road, Durham, NC 27705 (email: sharon.freedman@duke.edu).

Word count: 2,831
Abstract only: 226

This is the author's manuscript of the article published in final edited form as:

House, R. J., Rotruck, J. C., Enyedi, L. B., Wallace, D. K., Saleh, E., & Freedman, S. F. (2019). Postoperative infection following strabismus surgery: case series and increased incidence in a single large referral center. Journal of American Association for Pediatric Ophthalmology and Strabismus. https://doi.org/10.1016/j.jaapos.2018.09.007

Abstract

Purpose

To identify and analyze cases of postoperative infection following strabismus surgery at a large referral center and to report the incidence, risk factors, and outcomes.

Methods

An electronic database search identified strabismus procedures at Duke Eye Center from July 1996 to October 2017. Diagnosis codes for periocular infections were used to further identify patients with possible infections following strabismus surgery.

Results

Of 9,111 strabismus surgeries, 13 (0.14%) met criteria for probable infection, all occurring since October 2012 (0/6580 before vs 13/2531 [0.51%] after; $P < 0.0001$). Mean age of infection cases was 11.4 years; 11 patients (85%) were under 18 years of age. Associated previous diagnoses were genetic abnormalities with associated developmental delay (n = 5 [38%]), previous skin or ear infection (n = 4 [31%]), and acute or chronic rhinitis (n = 3 [23%]). Infection site cultures revealed methicillin-resistant *Staphylococcus aureus* (n = 3 [23%]), methicillin-sensitive *S. aureus* (n = 3 [23%]), and *Streptococcus pyogenes*/group-A Streptococcus (n = 2 [15%]). Only 1 case had bilateral infection. Infection remained extraocular in all cases, but one eye lost light perception secondary to optic atrophy. No common surgeon/procedure/preparation-related risks were identified.

Conclusions

A unifying explanation for the increase in post–strabismus surgery infections at Duke Eye Center was not identified. Potential risk factors include age <18 years, developmental delay, immune compromise, preceding nonocular infection, and bacterial colonization.

Postoperative infection following strabismus surgery remains uncommon, with reported incidence ranging from 1 in 1100[1] to 1 in 1900[2] cases. Over the last decade, surveys[1,2] and case reports have described postoperative infections manifesting as conjunctivitis, preseptal or orbital cellulitis, subconjunctival or sub-Tenon's abscess, or endophthalmitis.[3-15] Reported signs and symptoms included: conjunctival erythema, mucopurulent discharge, photophobia, periorbital and eyelid edema, tenderness, pain with eye movements, fever, and fatigue.[3-13] Though permanent changes to vision have been reported,[4] the majority of infections resolved with swift diagnosis, systemic antibiotics, and, when indicated, surgical drainage or debridement.[1-13] Proposed risk factors for post-strabismus surgery infection have included excessive eye rubbing, sinusitis, poor hygiene, young age, and Down syndrome.[1,12] There is a lack of consensus on appropriate preventive strategies, such as perioperative antibiotics and postoperative povidone-iodine.[14,16-18] Beginning October 10, 2012, an increase in post–strabismus surgery infections was noted at Duke Eye Center, a large academic referral center. The purpose of this study was to identify and analyze all post–strabismus surgery infections at Duke Eye Center since 1996.

Subjects and Methods

The retrospective and prospective arms of this study were approved by the Duke Health Institutional Review Board. DEDUCE (Duke Enterprise Data Unified Content Explorer), a secure database, was queried to identify patients of any surgeon at Duke Eye Center whose medical record contained CPT code(s) for eye muscle surgery (67316, 67318, 67334, 67311, 67314, 67312, 67313, 67340). These results were then cross-referenced for ICD-9 and ICD-10 infection codes (H05.012, H05.011, T81.4XXA, T81.4XXS, T81.4XXD, 998.59, 998.5, and 373.13). This analysis includes all cases of suspected postoperative infection following strabismus surgery by a pediatric ophthalmic surgeon at Duke Eye Center that required further treatment (systemic antibiotics, hospitalization, or surgical intervention). Extraocular muscle surgery performed for other reasons (eg, during ruptured globe repair) was excluded.

Data was retrospectively collected for cases from July 6, 1996, to May 23, 2017. Written informed consent was obtained and data prospectively collected for cases from May 24, 2017, to October 30, 2017. Data collected for each study patient included the following: age at surgery, sex, past medical history, pre- and postoperative examinations, date of procedure, procedure details, surgeon, date of infection onset, results of imaging studies, laboratory results, microbiology results, medical and/or surgical management, treatment of infection, most recent visual acuity, and ocular alignment results.

During the study period, strabismus cases were prepared by the surgeon in a similar fashion. Preoperatively, a drop of 5% povidone-iodine was placed in the operative eye(s). Periocular skin was cleansed 3 times using povidone-iodine 10% on sterile gauze, starting at the lashes and progressing out to the forehead and down to the tip of the nose. Each patient was covered with sterile disposable drapes: drape over the forehead, head-to-toe split drape exposing only the eye(s), and an adherent fenestrated plastic drape to seal off the area around the eye(s). The fenestrated drape was variably used to cover the lashes. Use of a bladed speculum also varied among surgeons. For binocular surgery, a fresh fenestrated drape was placed when switching to the second eye. The same surgical instruments were used for both eyes.

A fresh bottle of sterile topical phenylephrine or oxymetazoline was frequently instilled just before surgical preparation. Choice of limbal versus fornix conjunctival incisions and use of adjustable sutures depended on patient characteristics and surgeon preference. The vast majority of cases, and all infection cases in this study, used a double-armed 6-0 polyglactin 910 braided suture to secure the muscle. For both limbal and fornix conjunctival incisions, the conjunctiva was reapproximated using interrupted 8-0 polyglactin 910 sutures. Use of post-procedure subconjunctival bupivacaine was common. Povidone-iodine 2.5%-5% was variably instilled in the eye just after removal of the lid speculum. All operated patients received antibiotic-steroid ointment (tobramycin-dexamethasone or neomycin-polymixin-dexamethasone) at the conclusion of surgery. Surgical preparation, intraoperative use of dilating drops and subconjunctival bupivacaine, surgical instrumentation and sterilization methods, surgical equipment, and postsurgical infection prophylaxis were consistent throughout the study period. Routine postoperative regimens varied over the study period and among surgeons and included tobramycin-dexamethasone, neomycin-polymixin-dexamethasone or polymyxin-trimethoprim with or without a prednisolone taper. First postoperative visits occurred 1-7 days after surgery. Infection site cultures were obtained from abscess drainage, when indicated, or by conjunctival culture.

Study cases (post-strabismus infections) were placed into categories based on the severity of their clinical course and corresponding treatment (Table 1). Statistical analyses were performed using Microsoft Excel (Microsoft Corp., Redmond, WA). The Fisher exact test was used to compare the proportion of patients with postoperative infection prior to October 10, 2012, and from that date forward.

Results

A total of 7,268 patients who underwent 9,111 strabismus procedures during the study period were identified. The total number of procedures constituted the “denominator” for our study group, with mean age at surgery 25.1 ± 25.9 years (median age, 11.2; range, 0.33-95.4). Of total procedures, 5,423 (59.5%) occurred in children; 3,688 (40.5%), in adults.

Thirteen surgical encounters (0.14%), met criteria for probable infection (Table 2**)**, with all study cases occurring since October 2012 (0/6580 before vs 13/2531 [0.51%] after; $P < 0.0001$]. Twelve patients identified by the DEDUCE search met inclusion criteria. One case was included in the prospective arm.

With the exception of 1 study case, all patients were scheduled for follow-up on postoperative day 1. Clinical evidence of infection developed 1-20 days (median, 3; mean, 7.2) following surgery. Presenting characteristics (Table 3) varied between study cases: conjunctival injection (n = 10 [77%]), eyelid erythema and swelling (n = 10 [77%]), bump/bulge over the muscle insertion (n = 8 [62%]), discharge (n = 7 [54%]), eye pain and/or increased tenderness over the surgical site (n = 5 [38%]), systemic signs (n = 4 [31%]), fever (n = 2 [15%]), and photophobia (n = 2 [15%]). No cases were associated with documented bacteremia.

Mean age of the study group was 11.4 years (range, 1-55; median, 6), with 11 (85%) under 18. No study cases were associated with intraoperative complications, such as scleral perforation or lost muscle, nor did any study cases involve adjustable sutures. Infection involved the 2nd, 3rd, or 4th operated muscle in 11 cases (first eye, 6 cases; 2nd eye, 5 cases; binocular, 2 cases; first muscle infected, 1 case). Although 7 study patients (54%) underwent bilateral surgery, only 1 had bilateral infection. Subconjunctival bupivacaine was used at the time of conjunctival closure in 85% of cases. As for all strabismus cases at the Duke Eye Center, all study patients received either end of case topical 5% povidone-iodine (69%) and/or antibiotic-steroid ointment (69%) (Table 2**)**. Postoperative topical antibiotics and steroids were prescribed for all study cases, but regimen varied by surgeon.

Relevant previous diagnoses included the following: genetic abnormalities with associated developmental delay (n = 5 [38%]), previous skin or ear infection (n = 4 [31%]), and acute or chronic rhinitis (n = 3 [23%]). Of cases with genetic abnormalities and developmental delay, 3 had Down syndrome, 1 had a genomic gain mutation of chromosome 15 (15q11.2), and 1 had a novel *FOXP1* mutation.

Infection site cultures were obtained for 10 study patients (77%), 3 from abscess drainage. Cultures grew the following strains: methicillin-resistant *Staphylococcus aureus* (MRSA) in three, methicillin-sensitive *S. aureus* (MSSA) in two, *Streptococcus pyogenes*/group A Streptococcus (GAS) and coagulase-negative staphylococcus (CoNS; n = 1), MSSA and GAS (n = 1), no growth (n = 2), and improper processing of sample (n = 1). All patients received treatment with topical antibiotic eye drops and systemic antibiotics. Treatment included hospitalization for intravenous antibiotics in 7 cases (54%) and surgical incision and drainage in 4 (31%). Resolution of the infection following treatment with a return to preoperative visual acuity occurred in all cases but one, where orbital cellulitis secondary to MRSA resolved, but the patient lost light perception from either ocular hypertension or infectious nerve invasion with resulting optic atrophy.

Probable infection cases were categorized into groups based on the severity of their clinical course (Table 1) with 5 in category A (mild), 4 in category B (moderate), and 4 in category C (severe). Of the 4 category C cases (Table 2), 3 had a previously diagnosed developmental delay [cases 6, 7, 12 (Figure 1)] and 2 (cases 5, 6) grew MRSA on eye culture. The only bilateral infection occurred in a child with Down syndrome and a history of acute myeloid leukemia in remission.

Discussion

To our knowledge, this is the largest single referral center analysis of postoperative infection following strabismus surgery. Although uncommon, it is paramount for strabismus surgeons to understand signs of possible infection and to identify patients at risk. We report an overall incidence of postoperative infection of 0.14% with an incidence of 0.51% since October 2012. Surgical technique, preparation, instrumentation and sterilization, and peri- and postoperative medication were consistent over the study period. Therefore, a careful analysis of each case was undertaken to evaluate for a unifying cause as well as individual risk factors.

Signs and symptoms of infection described in our series (Table 3) were similar to previous reports.[1-14] Patients presenting with systemic features tended toward more severe infection. Many less severe infections presented with a red "bump" or localized swelling over the muscle insertion, without visible underlying purulent material or computed tomography (CT) evidence of an abscess, in contrast to previously described cases.[7,8,10,12,13] Apparent post–strabismus surgery abscess can be due to an infected epithelial inclusion cyst.[19] Onset of clinical features of infection averaged 7.2 days (range, 1-20; median, 3). This is later than the mean of 2.8 days to presentation averaged from 10 post-strabismus infection case reports published since 2005.[3-10,12,13] Cases 5 and 9 (Figure 2, Table 2) developed symptoms at the postoperative day 1 appointment and immediately after the appointment, respectively. There was no relationship between severity of infection and time to presentation.

Although a reduction in bacterial load of the eye and lashes is theoretically achieved by a meticulous surgical preparation technique using povidone-iodine, cultures following preparation of conjunctiva, sutures, and needles are reportedly contaminated at rates of 25%-31%.[17,18] Scrubbing of the lashes or use of a bladed speculum does not yield lower contamination rates,[18] but repeat use of povidone-iodine in the fornix before initial incision decreased the rate of contamination to 10%.[17] Although Rogers and colleauges[18] did not find an increase in bacterial contamination rates for materials found on the first and second muscle, our series, though small, found that infection was more common in muscles that were not the first to be operated (at least

11/13).

Culture-positive cases in our series identified MRSA, MSSA, GAS, and CoNS. Of note, only 3 cultures were obtained from abscess drainage. Conjunctival swab results may grow skin flora; however, colonization of the conjunctiva by a virulent organism increases the likelihood it is the causative organism. As with prior reports,[1,5] *S. aureus* (MSSA and MRSA) was the most commonly cultured organism (46%), followed by GAS (15%). Although sensitivities to methicillin are not always reported, the only previously published case of post–strabismus infection due to MRSA we encountered is one included in our series.[11] Our severe cases included 2 cases of MRSA, 1 case of MSSA, and 1 bilateral case with MSSA in one eye and MSSA and GAS in the other. While other bacteria have been reported in postoperative infections (*Haemophilus influenza*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis,* and *Streptococcus pneumoniae*),[15,18] the more severe cases of extraocular infection in the literature have also been due to MSSA[7,8,13] and GAS.[6,9,10] In our series, subconjunctival abscesses occurred in the setting of MRSA, MSSA, and MSSA/GAS; however, the only 2 patients with abscesses who grew MRSA were children ages 4 and 5 years who had a history of prior skin abscess (cases 5, 6; Table 2). Whereas the general colonization rate with MRSA in children is 1.5%,[20] colonization in children with a history of a MRSA skin or soft tissue infection is around 76%.[21]

All cases in this series received prophylactic measures against infection, including end of case povidone-iodine 5% to the fornix (69%) and/or antibiotic-steroid ointment (69% documented), with at least 1 week of topical antibiotic and steroid prophylaxis (100%). Koederitz and colleagues[14] demonstrated prophylactic single-dose povidone-iodine following strabismus surgery is noninferior to antibiotic-steroid drops for preventing infection. Prophylactic antibiotics used postoperatively have variable coverage of the causative organisms in our series.[22,23] Past reports have acknowledged the lack of scientific evidence when using these prophylactic treatments, and have discussed the financial burden as well as the difficulty applying topical therapies in children.[1,2,14,22]

Risk factors inherent to patients may play a role in increased susceptibility to infections. Kivlin and Wilson[1] noted that the most reported predisposing factors included excessive eye rubbing, sinusitis, and poor hygiene. A review of case series also found reports of patients with developmental delay,[6] Down syndrome,[12] sinusitis,[6,10] and a patient with a history of recurrent acute otitis media and mastoiditis.[13] Children were over-represented among our study cases (85%), but comprised only 60% of all strabismus cases performed. These findings support prior literature describing a higher incidence of post–strabismus surgery infections in children compared to adults,[1,5,23] likely with multifactorial causes. Two cases (8, 10; Table 2) had CT evidence of sinusitis found while managing their post–strabismus surgery infections and 1 had a history of chronic ear infections. Subclinical sinusitis found on CT postoperatively has been previously reported,[1,6,10] and is a likely risk factor for postoperative infection as well as for periocular infections, regardless of surgery. Of the 4 severe cases (category C), all had other medical diagnoses that increased infection risk. Two had a history of soft tissue abscesses and grew MRSA on eye culture. Three cases had Down syndrome (cases 1, 7, 12; Figure 1, eTable 1), including 2 with severe infection. Down syndrome is associated with immunologic alterations (decreased antibody response, defects in neutrophil chemotaxis, low naïve T-cell and B-cell counts, reduced ranges of lymphocyte subsets, and hematologic malignancies) and a subsequent increased susceptibility to bacterial and viral infections.[24] Case 8 (Table 2) carried a diagnosis of *FOXP1* mutation, which is also associated with developmental delay and immunological defects.[25]

As demonstrated in our present series, severe cases of infection can improve significantly with intravenous antibiotics and abscess drainage, as indicated. While most cases of severe post–strabismus surgery infection have an excellent visual prognosis, severe orbital cellulitis with a virulent organism can cause blindness from secondary optic neuropathy (case 5; Table 2).

Our study should be considered in light of several limitations. Risk factor analysis was limited by relatively small sample size, lack of risk factor analysis for noninfected cases, and the inability to control for preparatory technique, exact surgical technique, incision type, use of postoperative povidone-iodine, or postoperative antibiotic/steroid choice and regimen. Diagnosis and coding variations over time may have led to missed cases in the DEDUCE search, with a possible predisposition to missing older codes. Cases of suspected minor infection that were not reported to the physician or did not require treatment with oral or intravenous antibiotics could have been missed. Some of the milder cases of this series may have been caused by an inflammatory process rather than an underlying infectious cause. Our threshold for intervening with oral antibiotics has likely been lowered since our first sentinel case in 2012, possibly inflating our incidence.

Post–strabismus surgery infection ranges from mild cases, where infection cannot be easily differentiated from normal postoperative or suture-related inflammation, to cases severe enough to require parenteral antibiotics, hospitalization, and even abscess drainage. Potential risk factors for infection include age <18 years, developmental delay, immune function irregularity, history of MRSA infection, and chronic or acute sinus infection. The increased incidence of postoperative infection at one large referral center was not clearly related to any one risk and appears multifactorial.

Literature Search

PubMed was searched in July 2017 and February 2018 with unrestricted dates using the term *strabismus* and variations of the following terms: *infection*, *complications*, *strabismus surgery*, *postoperative infection*, *cellulitis*, and *abscess*.

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Legends

FIG 1. A 16-year-old girl (case 12) with a past medical history of Down syndrome and acute myelogenous leukemia underwent bilateral medial rectus re-recessions and bilateral superior oblique tenotomies. Three days later she presented with bilateral orbital cellulitis and medial rectus abscesses, visible on clinical examination (A-B) and confirmed by computed tomography (C). Incision and drainage were performed, and intravenous vancomycin and cefazolin were continued for 5 days. Abscess material grew methicillin-sensitive *Staphylococcus aureus* in both eyes and group A Streptococcus in the right eye. She was discharged home on oral cephalexin after 5 days. Her infection fully resolved and vision returned to baseline. Consecutive exotropia occurred subsequently.

FIG 2. A 12-month-old girl (case 9) with mild anemia presented for nonaccommodative alternating esotropia. She underwent left medial rectus recession and left lateral rectus resection with inferior fornix incisions. Fever, lid swelling, redness, and irritability developed by afternoon postoperative day 1, with clinical picture of preseptal cellulitis. Computed tomography showed preseptal involvement only. She was hospitalized for 1 week and improved slowly on intravenous piperacillin-tazobactam and vancomycin (to cover presumed MRSA). Cultures were negative. She was discharged on oral cefdinir. All symptoms resolved after several weeks of antibiotics. She remains orthotropic in primary gaze.

Table 1. Categories of infection

Category	Description	Characteristics
A	Mild	Difficult to distinguish infection from granuloma or reaction to suture; oral antibiotics prescribed
B	Moderate	Definite infection but localized and not requiring incision or drainage
C	Severe	Requires intravenous antibiotics and incision/drainage

Table 2. Synopsis of patients: clinical course and treatment

Case	Age, years	Sex	Other medical diagnoses	History prior infxn	Procedure	Infection location	End surgery PVP-I	End Sx meds	Symptom onset, days	Clinical impression	Category	Culture results	Comments
1	2	M	DS; nasal congestion; thyroid disease; tetrology of Fallot	N	B-MRc	OD (MR)	Y	N	3	Preseptal vs orbital cellulitis	B	MRSA	—
2	8	M	ADHD; allergic rhinitis	N	L-MRc and L-LRs	OS (MR)	Y	Y	14	Perimuscular infxn vs inflammation	A	NG	S/P B-IO anteriorization
3	20	F	ADHD; chronic rhinitis; Hashimoto thyroid disease	N	L-MRc and L-LRs	OS (LR)	Y	Y	5	Perimuscular infxn vs inflammation	A	NG	S/P B-MRc
4	10	M	N	N	B-MRc	OD (MR)	Y	N	15	Perimuscular abcess vs Tenon cyst	A	No Cx	—
5	5	M	Prematurity; tympanostomy tubes	MRSA skin abscess	B-LRc and B-IO myectomies	OD (LR)	N	Y	1	Orbital cellulitis	C	MRSA	Developed NLP VA from optic atrophy
6[a]	4	M	Chromosome 15 mutation; hydrocephalus; cleft palate		B-LRc and B-SO tenotomies	OS (LR)	N	Y	19	Subconjunctival abscess	C	MRSA	Skin abscesses post-op
7	14	M	DS; autism; celiac disease	N	R-MRc and R-LRs	OD (MR/LR)[b]	Y	N	3	Orbital cellulitis with muscle abscesses	C	MSSA	Eye rubbing with stuffed toy
8	1	M	*FOXP1* mutation; prematurity; developmental delay; seizures; anemia	Multiple ear infxns	B-MRc	OD (MR)	N	Y	2	Preseptal cellulitis	B	GAS/ CoNS	Known GAS exposure; fever 4 days before surgery
9	1	F	Iron deficiency anemia	MRSA contacts at home	L-MRc and L-LRs	OS (LR)	Y	Y	1	Preseptal cellulitis	B	NG[c]	—
10	3	F	Congenital hip dysplasia	N	B-MRc	OS	Y	N	9	Preseptal cellulitis; possible myositis	B	No Cx	Sinus muscosal thickening on CT
11	55	F	Rosacea	Rosacea	L-LRc with 3/4 TW transp and L-MRs with 1/2 TW transp	OS (MR)	N	Y	16	Suture abscess vs inflammation vs perimuscular infxn	A	MSSA	—
12	16	F	DS; AML (in remission)	N	B-MRc and B-SO tenotomies	OU (MR)	Y	Y	3	Bilateral orbital cellulitis with abscesses	C	MSSA/ GAS	S/P B-MR
13	2	M	N	N	R-MRc and R-LRp	OD (LR)	Y	Y	3	Preseptal cellultis vs inflammation	A	No Cx	—

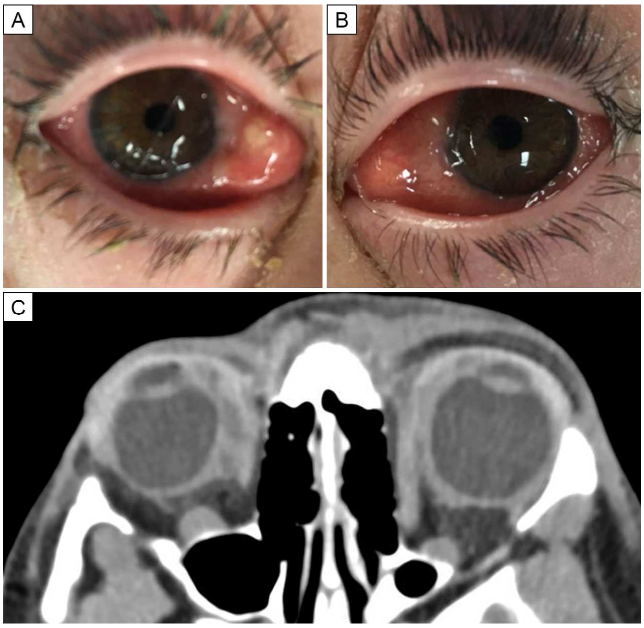
ADHD, attention deficit/hyperactivity disorder; *AML*, acute myeloid leukemia; *B, bilateral*; *CoNS*, coagulase-negative Staphylococcus; *CT*, computed tomography; *Cx*, culture; *DS*, Down syndrome; *GAS*, group A Streptococcus; *Infxn*, infection; *IO*, inferior oblique; *L*, left; *LR*, lateral rectus muscle; *LRc*, lateral rectus recession; *LRp*, lateral rectus plication; *LRs*, lateral rectus resection; *MR*, medial rectus muscle; *MRc*, medial rectus recession; *MRs*, medial rectus resection; *MRSA*, methicillin-resistant *Staphylococcus aureus*; *MSSA*, methicillin-sensitive *Staphylococcus aureus*; *NG*, no growth; *NLP*, no light perception *OD*, right eye; *OS*, left eye; *OU*, both eyes; *PVP-I*, povidone iodine; *R*, right; *SO*, superior oblique muscle; *Sx*, surgery; *TW transp,* tendon width transposition; *S/P*, status post; *VA*, visual acuity.

[a]Case presented previously as a video presentation Labowsky et al.[11]
[b]Case presented with simultaneous abscesses located near the medial and lateral rectus insertions.
[c]Cultured after antibiotics given as original samples were lost.

Table 3. Presenting clinical features of post–strabismus surgery infection cases

Case	Eyelid swelling and erythema	Increasing conjunctival injection	Bump/bulge over muscle insertion	Discharge	Eye pain and increasing localized tenderness	Systemic features[a]	Fever	Photophobia
1	+	+		+		+		
2			+					
3	+		+		+			
4		+	+					
5	+	+	+	+	+	+	+	
6	+	+	+			+		+
7	+	+		+		+		
8	+	+		+				
9	+						+	
10		+			+			+
11	+	+	+	+	+			
12	+	+	+	+	+			
13	+	+	+	+				
Total (%)	10 (76.9)	10 (76.9)	8 (61.5)	7 (53.9)	5 (38.5)	4 (30.8)	2 (15.4)	2 (15.4)

[a]For example, fussiness, crying, somnolence.


A
B
C

Postoperative infection following strabismus surgery: case series and increased incidence in a single large referral center

Robert J. House, MD,[a] Jill C. Rotruck, MD,[b] Laura B. Enyedi, MD,[a] David K. Wallace, MD, MPH,[c] Ezzeldin Saleh, MD,[d] and Sharon F. Freedman, MD[a]

Author affiliations: [a]Department of Ophthalmology, Duke University Medical Center, Durham, North Carolina; [b]Department of Ophthalmology and Visual Science, Yale University School of Medicine, New Haven, Connecticut; [c]Department of Ophthalmology, Indiana University School of Medicine, Indianapolis; [d]Department of Pediatrics, Southern Illinois University, Springfield

Abstract

Purpose

To identify and analyze cases of postoperative infection following strabismus surgery at a large referral center and to report the incidence, risk factors, and outcomes.

Methods

An electronic database search identified strabismus procedures at Duke Eye Center from July 1996 to October 2017. Diagnosis codes for periocular infections were used to further identify patients with possible infections following strabismus surgery.

Results

Of 9,111 strabismus surgeries, 13 (0.14%) met criteria for probable infection, all occurring since October 2012 (0/6580 before vs 13/2531 [0.51%] after; $P < 0.0001$). Mean age of infection cases was 11.4 years; 11 patients (85%) were under 18 years of age. Associated previous diagnoses were genetic abnormalities with associated developmental delay (n = 5 [38%]), previous skin or ear infection (n = 4 [31%]), and acute or chronic rhinitis (n = 3 [23%]). Infection site cultures revealed methicillin-resistant *Staphylococcus aureus* (n = 3 [23%]), methicillin-sensitive *S. aureus* (n = 3 [23%]), and *Streptococcus pyogenes*/group-A Streptococcus (n = 2 [15%]). Only 1 case had bilateral infection. Infection remained extraocular in all cases, but one eye lost light perception secondary to optic atrophy. No common surgeon/procedure/preparation-related risks were identified.

Conclusions

A unifying explanation for the increase in post–strabismus surgery infections at Duke Eye Center was not identified. Potential risk factors include age <18 years, developmental delay, immune compromise, preceding nonocular infection, and bacterial colonization.

Postoperative infection following strabismus surgery remains uncommon, with reported incidence ranging from 1 in 1,100[1] to 1 in 1,900[2] cases. Proposed risk factors for post–strabismus surgery infection have included excessive eye rubbing, sinusitis, poor hygiene, young age, and Down syndrome.[1,3] Beginning in October 10, 2012, an increase in post–strabismus surgery infections was noted at Duke Eye Center. This analysis of all post–strabismus surgery infections at Duke Eye Center since 1996 was undertaken to identify possible causes of this increase.

Subjects and Methods

Following approval by the Duke Health Institutional Review Board, data was collected retrospectively for cases from 07/06/1996-05/23/2017 and prospectively for cases from 5/24/2017-10/30/2017. DEDUCE, a secure searchable database, identified patients of any surgeon at Duke Eye Center whose medical record contained CPT code(s) for eye muscle surgery. These results were then cross-referenced for ICD-9 and ICD-10 infection codes. This analysis includes all cases of suspected postoperative infection following strabismus surgery by a pediatric ophthalmic surgeon at Duke Eye Center requiring treatment.

During the study period, strabismus cases were prepared for surgery in a similar fashion. In all cases, povidone-iodine 10% was used to clean the periocular area and povidone-iodine 5% was instilled in the operative eye(s). Lashes were variably covered using a bladed speculum or a fenestrated drape. The vast majority of cases, and all infection cases, used a double-armed 6-0 polyglactin 910 braided suture to secure the muscle. For both limbal and fornix conjunctival incisions, the conjunctiva was reapproximated using interrupted 8-0 polyglactin 910 sutures. Povidone-iodine 2.5%-5% was variably instilled in the eye just after lid speculum removal. All operated patients received antibiotic-steroid ointment at the conclusion of surgery. Postoperative combinations of topical antibiotics and steroids varied over the study period.

Results

The DEDUCE search identified thirteen strabismus surgery cases (0.14%) that met criteria for probable infection, all occurring since October 2012 (0/6580 before vs 13/2,531 [0.51%] after, $P < 0.0001$). Mean age at surgery was 25.1 ± 25.9 years, whereas the mean age of infection cases was 11.4 years, with 11 cases (85%) under 18 years of age. No study cases were associated with intraoperative complications. Infection involved the 2nd, 3rd, or 4th operated muscle in 11 cases. Although 7 patients (54%) underwent bilateral surgery, only 1 had bilateral infection.

Subconjunctival bupivacaine was used at the time of conjunctival closure in 85% of cases. All study patients received either end of case topical 5% povidone-iodine (69%) and/or antibiotic-steroid ointment (69%). Postoperative topical antibiotics and steroids were prescribed for all study cases.

Associated previous diagnoses included genetic abnormalities with associated developmental delay (n = 5 [38%]), previous skin or ear infection (n = 4 [31%]), and acute or chronic rhinitis (n = 3 [23%]). Of cases with genetic abnormalities and developmental delay, three had Down syndrome, one had a genomic gain mutation of chromosome 15 (15q11.2), and one had a novel variant *FOXP1* mutation.

Infection site cultures were obtained for 10 patients (77%). Infection site cultures grew methicillin-resistant *Staphylococcus aureus* (n = 3 [23%]), methicillin-sensitive *S. aureus* (n = 3 [23%]), and *Streptococcus pyogenes*/group-A Streptococcus (n = 2 [15%]). One case had bilateral infection (see Figure). Infection remained extraocular in all cases, but one eye lost light perception secondary to optic atrophy.

No common surgeon, procedure, or preparation-related risks were identified.

Discussion

To our knowledge, this is the largest single referral center analysis of postoperative infection following strabismus surgery. We report an overall incidence of postoperative infection of 0.14% with an incidence of 0.51% since 10/2012. Surgical technique, preparation, instrumentation and sterilization, and peri- and postoperative medication were consistent over the study period.

As has been previously reported,[1,3,4] children were over-represented among our study cases (85%), while comprising only 60% of all strabismus cases performed.

In 2 cases, sinusitis was incidentally found on CT imaging obtained to evaluate the orbit. One patient had a history of chronic ear infections. Subclinical sinusitis found on CT postoperatively has been previously reported[1,5,6] and is a likely risk factor for post-operative infection as well as for periocular infections, regardless of surgery.

The 4 most severe cases in this series all had other medical diagnoses that increased infection risk. Two had a history of soft tissue abscesses and grew MRSA on eye culture. While the general colonization rate with MRSA in children is 1.5%,[7] colonization in children with a history of a MRSA skin or soft tissue infection is around 76%.[8] Two severe cases and one moderately severe case had Down syndrome. Down syndrome is associated with immunologic alterations with increased susceptibility to bacterial and viral infections.[9] One severe case carried a diagnosis of *FOXP1* mutation, which is also associated with developmental delay and immunological defects.[10]

A unifying explanation for the increase in post–strabismus surgery infections at Duke Eye Center was not identified. Potential risk factors include age below 18 years, developmental delay, immune compromise, preceding nonocular infection, and bacterial colonization.

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Legends

FIG. A 16-year-old girl (case 12) with a past medical history of Down syndrome and acute myelogenous leukemia underwent bilateral medial rectus re-recessions and bilateral superior oblique tenotomies. Three days later she presented with bilateral orbital cellulitis and medial rectus abscesses, visible on clinical examination (A-B) and confirmed by computed tomography (C). Incision and drainage were performed, and intravenous vancomycin and cefazolin were continued for 5 days. Abscess material grew methicillin-sensitive *Staphylococcus aureus* in both eyes and group A Streptococcus in the right eye. She was discharged home on oral cephalexin after 5 days. Her infection fully resolved and vision returned to baseline. Consecutive exotropia occurred subsequently.