



## The incidence and clinical outcome of complications in 4,000 consecutive strabismus operations

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<b>PURPOSE</b>	To test the validity of the British Ophthalmic Surveillance Unit (BOSU) study's incidence figure of severe complications following strabismus surgery and to determine the incidence, type, risk factors, and outcome of all strabismus surgery complications at a single institution.
<b>METHODS</b>	A prospective audit of consecutive strabismus operations performed by consultants or trainees was carried out between 2011 and 2016 at Moorfields Eye Hospital NHS Foundation Trust. Patient diagnosis, age, sex, surgical details, complications, and outcome were recorded from hospital records. We classified complications as minor, moderate, or severe. The outcome was graded using the Bradbury and Taylor grading system (I to IV), with a poor or very poor outcome meaning loss of corrected visual acuity or unexpected primary position diplopia.
<b>RESULTS</b>	A total of 4,076 consecutive strabismus operations were performed during the study period. There were 46 (1.13%) complications, of which 28 (0.69%) were minor, 7 (0.17%) were moderate, and 9 (0.22%) were severe. Only 1 patient (0.02%) had a poor visual outcome. Two patients had nonocular postoperative complications (0.05%).
<b>CONCLUSIONS</b>	In this large, prospective series, we found the rate of severe complications of strabismus surgery to be 1 in 455 cases. Our results validate the findings of the BOSU study. (J AAPOS 2019;23:140.e1-6)

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In 2013 Bradbury and Taylor<sup>1</sup> reported the results of a 2-year national surveillance study on the complications of strabismus surgery in the United Kingdom. Coordinated by the British Ophthalmic Surveillance Unit (BOSU), their study estimated the incidence of severe complications in strabismus surgery at 1 in 400 operations, with a poor or very poor outcome (defined by Bradbury and Taylor as “loss of corrected visual acuity or unexpected primary position diplopia”) in 1 in 2,400 cases. This landmark study provided a benchmark for audit and an evidence base for discussing the risks of strabismus surgery with patients. The study, however, relied on anonymous surgeons volunteering to take part and remembering to return questionnaires; thus, complications may have been underreported. Furthermore, the total number of operations performed

was not recorded but estimated. In addition, the study only sought to identify a limited, predefined list of severe complications. Some well-known severe complications, such as wrong muscle surgery, anterior segment ischemia, and many minor complications were excluded. The current study aimed to investigate the incidence and outcomes of strabismus surgery complications, using a methodology less affected by these limitations. We conducted a single-institution, multiple-surgeon, long-term, prospective study with a comprehensive capture of complications of all severities and accurate counting of operations performed to test the validity of Bradbury and Taylor's results and to provide more information on the risks of strabismus surgery for consenting patients.

### Subjects and Methods

A prospective audit of consecutive strabismus operations was carried out between 2011 and 2016 following Institutional Audit Committee Approval. All operations were performed at Moorfields Eye Hospital NHS Foundation Trust, a large ophthalmology teaching hospital, and were performed by both consultant and trainee surgeons. Consultant strabismus surgeons within the pediatric and strabismus service at our hospital were contacted by email every 2 months and asked to report any suspected strabismus surgery complications. Reporting of trivial and possible complications was actively encouraged. The patient

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diagnosis, age, sex, operation details, complication, and outcome were recorded from hospital records. We defined strabismus surgery as an incisional surgical procedure performed on the extraocular muscles to treat strabismus. Botulinum toxin injection was excluded. We also excluded over- and undercorrection, provided there was no evidence of muscle slip or loss: however, if there was a poor visual outcome—for example, persistent, unexpected, primary-position diplopia—over- or undercorrection was included.

Strabismus surgery complications were classified as minor, moderate, or severe. Minor complications were self-limiting and very unlikely to alter the outcome of surgery. Moderate complications required additional treatment unrelated to the strabismus but did not compromise the outcome of strabismus surgery. Severe complications had the potential to result in a poor visual outcome, as defined by Bradbury and Taylor.<sup>1</sup> The grading system used by Bradbury and Taylor was used to assess the outcome of complications at or before 6 months.<sup>1</sup>

The number of strabismus operations carried out during the audit period was initially obtained from a data clerk running a search on hospital coding data. This yielded a significantly smaller number than expected, given the number of procedures usually carried out per session and per consultant; however, AR and NA additionally searched the records of every theater list of strabismus consultants for the audit period on our electronic patient record system and found the same final figure. We were careful to exclude patients who cancelled on the day of surgery. Hospital coding data was used to estimate the percentage of pediatric and adult strabismus surgeries during the study time period.

The key figure of the incidence of severe complications was expressed as a percentage and its 95% confidence interval was calculated using the Agresti-Coull (adjusted Wald) interval method, based on a normal approximation.<sup>2</sup> The  $\chi^2$  test was used to assess statistical significance.

## Results

In total, 4,076 consecutive strabismus operations were performed between April 1, 2011, and December 31, 2016. Of these, complications (of any grade) occurred in 44 cases after strabismus surgery; 2 patients had 2 complications each, yielding a total of 46 complications, 9 of which were severe. The overall complication rate was 1.13%, or 1 in 89; for severe complications, 0.22% (95% CI, 0.11%-0.43%), or 1 in 455. The complication details, including outcome, severity grading, and Bradbury and Taylor outcome score, are provided in [Table 1](#). Complication rates and comparison with BOSU figures are provided in [Table 2](#).

Of the patients who underwent surgery during the study period, 84% were adults (>16 years of age); 16% were children. The rate of severe complications was 0.23% for adults and 0.16% for children, a difference that was not statistically significant ( $P = 0.610$ ).

For 7 of 44 patients, only clinical data were reported and, some demographic data were missing. In these cases, the operating surgeon communicated the nature of the compli-

cation with no patient identification details. For 5 patients, the final clinical outcome was not recorded because the patient was lost to follow-up.

Nine patients (0.22%) had severe complications. Of these, 8 had a good visual outcome, with no double vision in the primary position or reduction in vision. Only 1 patient (0.02%) of 4,076 had a complication that led to a poor visual outcome, that is, loss of visual acuity from 20/20 to 20/30 and a persistent central scotoma.

Three patients had intraoperative globe perforation, for an overall incidence rate of 0.07%. Anterior chamber shallowing during traction suture placement at the start of the operation led to the diagnosis in 2 patients. One of the 3 perforations involved the retina. No retinal laser treatment or cryotherapy was administered, and the patient healed without any retinal sequelae.

Two patients had a suspected slipped muscle (0.05%), confirmed at secondary surgery in both cases. One slipped muscle occurred on a resected medial rectus muscle that was secured with an adjustable suture, and the muscle slipped within 24 hours of the operation. The other slipped muscle was a medial rectus muscle of a thyroid patient, which was recessed with an adjustable suture and the muscle was tightened at adjustment. In both patients the slipped muscle was found and reattached at secondary surgery.

Two patients had pulled-in-two syndrome (PITS) intraoperatively (0.05%): a 67-year-old woman who had inactive thyroid eye disease and previous surgery on the medial rectus muscle, which disinserted from the globe on muscle hooking, and a 75-year-old woman in whom a posterior fixation suture was used on the right inferior rectus muscle, which pulled in two after hooking. The second patient had no previous surgery and no cause of their hypotropia was identified. Both patients were repaired at the time of primary surgery, and both had a good outcome. No patients had lost muscles.

One patient had wrong muscle surgery: a right medial rectus recession and lateral rectus resection was planned for a 3-year-old with a right esotropia. The superior rectus was resected inadvertently, which was recognized intraoperatively. The superior rectus was recessed by the same amount and the lateral rectus was resected as planned.

With regard to moderate severity complications, 4 patients had mild anterior scleritis (incidence rate of 0.10%), which resolved after a short course of oral, nonsteroidal, anti-inflammatory drugs or oral steroids. One patient had a history of nonsurgically induced anterior scleritis in the other eye. In this patient, preoperative investigations for an underlying condition were negative and so, in the absence of a systemic cause, prophylactic immunosuppression was not administered prior to their strabismus surgery.

Three patients in our study (incidence rate of 0.07%) were treated for preseptal cellulitis postoperatively. There were no cases of postseptal orbital cellulitis. One patient, a 6-year-old, was treated with oral antibiotics for possible cellulitis and with oral steroids for suspected scleritis/

Table 1. Strabismus surgery complications severity, outcome and Bradbury and Taylor<sup>1</sup> outcome grade

Description	No.	Adult/child	Grade of complication	Outcome	Bradbury Taylor outcome grade
Corneal abrasion	2	Adult (1); unknown (1)	Minor	Resolved with topical antibiotics (2)	II (2)
Corneal dellen	1	Child (1)	Minor	Resolved with topical lubricants	II
Exposed conjunctival suture	2	Adult (1); unknown (1)	Minor	Resolved with topical lubricants (1) Removed (1)	II (2)
Suture granuloma	2	Adult (1); unknown (1)	Minor	Excision under local anesthetic (1); unknown (1)	II (1) Unknown (1)
Conjunctival wound dehiscence	1	Adult (1)	Minor	Conjunctival resuturing under local anesthetic	II
Exposed Tenon's	1	Adult (1)	Minor	Trimmed at slit-lamp under topical anesthetic	II
Vasovagal episode during adjustment	1	Adult (1)	Minor	Spontaneous recovery	I
Bruising to ear from clip; facial bruising following IO disinsertion	2	Adult (2)	Minor	Spontaneous recovery	I (2)
Drug intolerance to topical neomycin and dexamethasone	2	Adult (2)	Minor	Cessation of drug (1); change of drug (1)	I (2)
Refractive error	3	Adult (1); child (1); unknown (1)	Minor	Small myopic shift	I (2) Unknown (1)
Steroid responder	11	Adult (9); unknown (2)	Minor	Resolved after cessation of topical steroids (2); short course topical glaucoma medication (4); course topical and oral glaucoma medication (3); unknown (2)	I (2) II (7) Unknown (2)
Anterior segment ischemia (mild)	1	Unknown (1)	Moderate	Unknown	Unknown
Anterior scleritis	3	Adult (3)	Moderate	Oral nonsteroidal anti-inflammatory drugs (1); oral steroids (2)	II (3)
Allergic reaction to polyglactin 910 sutures/ anterior scleritis/periorbital cellulitis	1	Child (1)	Moderate	Oral antibiotics, oral prednisolone, topical steroids	II
Preseptal cellulitis	2	Child (1); adult (1)	Moderate	Intravenous and oral antibiotics (1); oral antibiotics (1)	II (2)
PITS	2	Adult (2)	Severe	Muscle found at time of surgery and resutured (2)	I (2)
Wrong muscle surgery	1	Child (1)	Severe	SR resected in error and recessed by same amount	I
Slipped muscle	2	Adult (2)	Severe	Returned to theater post-op; muscle found and reattached	II (2)
Globe perforation with vitreous loss	1	Child (1)	Severe	Prophylactic oral antibiotics administered; no cryotherapy or retinal laser	II
Globe perforation without vitreous loss	2	Adult (2)	Severe	Surgery was abandoned; patient given oral or topical prophylactic antibiotics (2)	II (2)
Loss of vision (central scotoma due to PAMM)	1	Adult (1)	Severe	Poor outcome due to 1 line loss Snellen VA	IV
Post-op retroperitoneal hematoma	1	Adult (1)	Nonocular	Readmitted to hospital for inpatient care	N/A
Post-op subdural hygroma	1	Adult (1)	Nonocular	Resolved without treatment	N/A

IO, inferior oblique muscle; N/A, not applicable; PAMM, paracentral acute middle maculopathy; PITS, pull-in-two syndrome; SR, superior rectus muscle; VA, visual acuity.

Table 2. Incidence rates from this study compared to British Ophthalmic Surveillance Unit (BOSU) findings

Complication	BOSU incidence (%)	Current study incidence (%)
Overall complication rate	N/A	1.13 (1 in 89)
Severe complication rate	0.25 (1 in 400)	0.22 (1 in 455)
Poor or very poor visual outcome	0.04 (1 in 2400)	0.02 (1 in 4076)
Globe perforation	0.08	0.07
Snapped/lost muscle	0.02	0.05
Suspected slipped muscle	0.07	0.05
Periorbital infection	0.06	0.07
Scleritis	0.02	0.10

severe allergic reaction. A 3-year-old was admitted for intravenous antibiotics for a preseptal cellulitis. A 40-year-old was treated with oral antibiotics for suspected preseptal cellulitis. All patients responded well to antibiotics.

The most commonly reported minor complication of surgery was raised intraocular pressure (IOP), which occurred in 11 patients (0.27%). Patients were routinely placed on a postoperative regime that included dexamethasone 0.1% eye drops for 2-4 weeks. All cases of raised IOP returned to normal after cessation of topical steroids and a course of topical and/or oral glaucoma medication. Nine patients had minor conjunctival or corneal problems, as detailed in Table 1. Finally, a postoperative refractive error was noted in 3 patients, 2 of whom had undergone recession and resection of two horizontal rectus muscles; 1 had undergone bilateral medial rectus recession. One of our patients had had previous laser-assisted in-situ keratomileusis (LASIK) and redo LASIK. He sustained a 1 D myopic shift with no induced astigmatism at 2 weeks postoperatively, which resolved spontaneously, and his visual acuity was 6/6 unaided at 3 months postoperatively. An 8-year-old had a myopic shift postoperatively that reduced after 3 months, and the outcome of the other patient is unknown.

Two patients had nonocular complications. One of the patients, who had an elevated IOP postoperatively that required topical glaucoma medication and oral acetazolamide, developed persistent headaches. She had no history of head trauma. Computer tomography of the head showed bilateral subdural hygromas consistent with low cerebral spinal fluid pressure. The headaches abated and imaging findings returned to normal after oral acetazolamide was stopped. Subdural hygromas may be caused by dehydration, which can occur in the perioperative period due to fasting for a general anesthesia. Acetazolamide lowers intracranial pressure and therefore could theoretically cause a subdural hygroma, but this has not been reported in the literature.

The other patient had a postoperative retroperitoneal hematoma. He was taking warfarin with an international normalized ratio of 2.3 at the time of surgery. He had uncomplicated strabismus surgery under general anesthesia

and was discharged without complaint, but was admitted to another hospital on the same day for a retroperitoneal hematoma. He required a prolonged hospital admission and intensive care. The cause of his hematoma was a ruptured lumbar artery.

## Discussion

To our knowledge, this is the largest prospective series of consecutive cases reporting on the full range of complications of strabismus surgery. Previous studies have included literature reviews,<sup>3,4</sup> retrospective series,<sup>5</sup> or a series focused on a single complication.<sup>6,7</sup>

Our principal finding was an overall rate of severe strabismus surgery complications of 0.22%, or 1 in 455 cases. The similarity of this figure to the estimate from the BOSU study of 1 in 400 cases serves to validate the BOSU study findings. The single patient in our cohort with a severe complication and poor visual outcome underwent routine lateral rectus resection and medial rectus recession under a general anesthesia. Topical adrenaline 0.1% was used at the start of the procedure and sub-Tenon's injection of bupivacaine 0.5% was administered at the end of the procedure. He described a central white patch in the vision of the operated eye immediately postoperatively, which improved but persisted over the subsequent 15 months. Optical coherence tomography (OCT) imaging was in keeping with paracentral acute middle maculopathy. It is most likely that cilioretinal artery territory infarction occurred during the perioperative period. We have found only one previous report of a similar occurrence after strabismus surgery.<sup>8</sup> OCT may help in the diagnosis of such cases, which would previously have been labeled unexplained.

The incidence rate of 0.07% for globe perforations in our study is comparable with the BOSU study rate of 0.08%.<sup>1</sup> Prospective studies examining eyes for signs of scleral perforation after strabismus surgery have estimated the incidence of retinal perforation to be 0.4%-2.8% and choroidal injury without globe perforation to be 1.4%-5.1%.<sup>9,10</sup> Of the 3 globe perforations in our cohort, 1 had had multiple previous operations; this may have resulted in scarring and thinning at the limbus. At our institution, a 5-0 braided Poly (ethylene terephthalate) suture on a 3/8 circle spatulated needle was routinely used to place traction sutures at the limbus, rather than a reverse cutting suture, which has been associated with an increased risk of perforation.<sup>6</sup> However, a safer option may be to use locking toothed forceps and no traction sutures at all.

The BOSU study incidence of suspected slipped muscles was 0.07% and snapped and/or lost muscles was 0.02%. From a survey of American Association for Pediatric Ophthalmology and Strabismus (AAPOS) members, Greenwald estimated the incidence of PITS to be approximately 1 in every 5,000 strabismus surgeries overall and 1 in 700 for adult strabismus surgery (Erzurum S, Greenwald M. Pulled in two II: a survey of AAPOS. 17th Annual

Meeting of the AAPOS. 1991). Ellis and colleagues<sup>11</sup> conducted an online survey of strabismus surgeons requesting information on patients with the PITS complication and reported that 70% of patients were over 50 years old, 65% of patients were female, 28% had previous ocular surgery, 8% had thyroid eye disease, and the most commonly involved muscles were the medial and inferior rectus. Our patients shared these predisposing factors.

The incidence of scleritis in our cohort was 0.10%, compared with the BOSU study's finding of 0.02%.<sup>1</sup> The BOSU study incidence rate of severe infection was 0.06%,<sup>1</sup> which is similar to our incidence of 0.07%, although we also included mild or suspected infections in this category. Ing<sup>12</sup> reported the incidence rate of infections after strabismus surgery to be 1 in 1,900 for cellulitis (0.05%). Kivlin and colleagues<sup>13</sup> found a predominance of preschool children in reported cases from a survey of AAPOS members, which is in keeping with our findings; 2 of 3 of our patients with this complication were young children.

In our study cohort, 0.27% of patients experienced raised IOP. It has been estimated that up to one-third of adults are steroid responders and that a higher percentage of patients with primary open-angle glaucoma have a clinically significant rise in IOP on topical steroids.<sup>14</sup> Kwok and colleagues<sup>15</sup> reported a steroid response in 56% of children <10 years of age treated with topical 0.1% dexamethasone 6 times daily for 4 weeks. In the majority of patients, there is likely to be a clinically insignificant transient IOP rise within the first 2 weeks,<sup>16</sup> which is unlikely to cause any long-term harm. High-risk patients, such as children and those with glaucoma risk factors, may benefit from a shorter course of postoperative steroid drops. Diclofenac drops are an alternative, but there are increasing reports of corneal melt with use of diclofenac drops.<sup>17-20</sup>

With respect to minor postoperative complications, induced astigmatism and induced refractive error are well-recognized, although the exact mechanism is not fully understood. It has been hypothesized that muscle surgery alters the forces on the cornea and sclera, which may result in changed corneal topography.<sup>21</sup> It has also been postulated that a shift in the lens iris diaphragm may also contribute to induced refractive error.<sup>21,22</sup> Most induced refractive errors improve or resolve spontaneously within 4-6 months, but some persist.<sup>23</sup>

Although it is possible that some underreporting occurred, the extent of which would be difficult to quantify, we encouraged and received reports of even minor complications and promoted a culture of open and full reporting. Other strengths of our study are that it adopted a different methodology than did BOSU, with a more accurate estimation of complication numbers and operations. We also included all severity grades of complications so that we might obtain as complete a picture as possible of the full range of adverse events. The setting was a large teaching hospital, with surgery performed by all grades of surgeons; thus, the findings ought to be applicable to similar settings.

Our study findings complement and support the BOSU study's incidence figures for severe complications in strabismus surgery and also provide additional data on the incidence of less severe complications. Based on our findings and the BOSU study, when consenting patients for strabismus surgery, the incidence figures we now use are: a 1 in 100 risk of any complications, the majority of which are minor and resolve with nonsurgical treatment; a 1 in 400 risk of severe complications (including globe perforation, cellulitis, lost/snapped/slipped muscle); and a <1 in 2,000 risk of a poor visual outcome (meaning loss of visual acuity or unexpected double vision in the primary position).

## Literature Search

PubMed was searched without date restriction on June 1, 2018, for English-language results using *strabismus complication(s)* and associated terms: *infection, slipped muscle, lost muscle, pulled-in-two syndrome, globe perforation, wrong muscle surgery, scleritis, retinal detachment, visual loss, paracentral acute middle maculopathy, anterior segment ischemia, refractive error, steroid response, steroid responder, conjunctiva, corneal, granuloma, allergic, and postoperative*.

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## References

1. Bradbury JA, Taylor RH. Severe complications of strabismus surgery. *J AAPOS* 2013;17:59-63.
2. Brown LD, Cat TT, DasGupta A. Interval estimation for a proportion. *Stat Sci* 2001;16:101-33.
3. Wan MJ, Hunter DG. Complications of strabismus surgery: incidence and risk factors. *Semin Ophthalmol* 2014;29:421-8.
4. Olitsky SE, Coats DK. Complications of strabismus surgery. *Middle East Afr J Ophthalmol* 2015;22:271-8.
5. Yurdakul NS, Koç F. Ocular complications of strabismus surgery. *Surg Sci* 2014;5:397-402.
6. Morris RJ, Rosen PH, Fells P. Incidence of inadvertent globe perforation during strabismus surgery. *Br J Ophthalmol* 1990;74:490-93.
7. Cibis GW. Incidence of inadvertent perforation in strabismus surgery. *Ophthalmic Surg* 1992;23:360-61.
8. Feibel RM, Guyton DL. Case reports transient central retinal artery occlusion after posterior sub-Tenon's anesthesia. *J Cataract Refract Surg* 2003;29:1821-4.
9. Noel LP, Bloom JN, Clarke WN, Bawazeer A. Retinal perforation in strabismus surgery. *J Pediatr Ophthalmol Strabismus* 1997;34:115-17.
10. Dang Y, Racu C, Isenberg SJ. Scleral penetrations and perforations in strabismus surgery and associated risk factors. *J AAPOS* 2004;8:325-31.
11. Ellis EM, Kinori M, Robbins SL, Granet DB. Pulled-in-two syndrome: a multicenter survey of risk factors, management and outcomes. *J AAPOS* 2016;20:387-91.
12. Ing MR. Infection following strabismus surgery. *Ophthalmic Surg* 1991;22:41-3.

13. Kivlin JD, Wilson ME Jr. Periocular Infection Study Group. Periocular infection after strabismus surgery. *J Pediatr Ophthalmol Strabismus* 1995;32:42-9.
14. American Academy of Ophthalmology. Drugs and glaucoma. In: American Academy of Ophthalmology Basic and Clinical Science Course. Section 10: Glaucoma. San Francisco, CA: American Academy of Ophthalmology; 2015-2016:103.
15. Kwok AK, Lam DS, Ng JS, Fan DS, Chew SJ, Tso MO. Ocular-hypertensive response to topical steroids in children. *Ophthalmology* 1997;104:2112-16.
16. Phulke S, Kaushik S, Kaur S, Pandav SS. Steroid-induced glaucoma: an avoidable irreversible blindness. *J Curr Glaucoma Pract* 2017;11:67-72.
17. Dadeya S, Kamlesh. Comparative evaluation of diclofenac and dexamethasone following strabismus surgery. *J Pediatr Ophthalmol Strabismus* 2002;39:166-8.
18. Khan HA, Amitava AK. Topical diclofenac versus dexamethasone after strabismus surgery: a double-blind randomized clinical trial of anti-inflammatory effect and ocular hypertensive response. *Indian J Ophthalmol* 2007;55:271-5.
19. Snir M, Axer-Siegel R, Friling R, Weinberger D. Efficacy of diclofenac versus dexamethasone for treatment after strabismus surgery. *Ophthalmology* 2000;107:1884-8.
20. Lin JC, Rapuano CJ, Laibson PR, Eagle RC Jr, Cohen EJ. Corneal melting associated with use of topical nonsteroidal anti-inflammatory drugs after ocular surgery. *Arch Ophthalmol* 2000;118:1129-34.
21. Hutcheson KA. Large, visually significant, and transient change in refractive error after uncomplicated strabismus surgery. *J AAPOS* 2003;7:295-7.
22. Preslan MW, Cioffi G, Min YI. Refractive error changes following strabismus surgery. *J Pediatr Ophthalmol Strabismus* 1992;29:300-304.
23. Al-Tamimi E, Al-Nosair G, Yassin S. Effect of horizontal strabismus surgery on the refractive status. *Strabismus* 2015;23:111-16.