

Scleral Penetrations and Perforations in Strabismus Surgery: Incidence, Risk Factors and Sequelae[†]

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Objective: To evaluate the incidence and identify associated risk factors and sequelae of scleral penetrations and perforations during strabismus surgery.

Material and Method: Medical records of patients who underwent strabismus surgery at Siriraj Hospital between June 2001 and May 2006 were reviewed. Strabismus operations were performed by residents in ophthalmology training, pediatric ophthalmology fellows, or attending physicians. The authors documented demographic data, surgical techniques, and management of the scleral penetrations and perforations. All patients with scleral penetrations or perforations were examined intraoperation by indirect ophthalmoscopy and followed up for at least 6 months to determine late sequelae of this complication.

Results: Of the 1025 patients and 2195 procedures, scleral penetrations (full thickness scleral pass without retinal break) were recognized in 15 procedures (0.68%). No scleral perforation (full thickness scleral pass with retinal break) was found. The mean age of these complications during strabismus operations was 14.26 years. Scleral penetrations were more likely to occur with rectus muscle recession than rectus muscle resection. All sclera penetrations occurred while rectus muscles were recessed and reattached to the new insertions. All 15 scleral penetrations were performed by residents in training or pediatric ophthalmology fellows. Re-operation in the same extraocular muscle was not a risk factor for this complication. All patients with scleral penetrations were managed by dilated pupils and fundus examinations and the authors applied cryotherapy or indirect ophthalmoscopic laser to the retinal lesions. Retinal detachment, vitreous hemorrhage, and endophthalmitis were not found in the present study.

Conclusion: The incidence of scleral penetrations in the present study was 0.68%. Risk factors of scleral penetrations in strabismus surgery are rectus muscle recession and surgeon factors. No serious complications such as retinal detachment or endophthalmitis were found in this study.

Keywords: Scleral perforation, Scleral penetration, Strabismus surgery, Muscle recession, Muscle resection, Complication

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Accidental globe perforation or penetration is a well-recognized complication of strabismus surgery. Earlier reports found that the incidence of globe perforation occurred in 9% to 12% of all strabismus

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surgeries with higher incidence in those who had posterior fixation sutures added⁽¹⁻³⁾. Both prospective and retrospective studies reported the incidence range between 0.3% and 2.8%⁽⁴⁻⁷⁾. The true incidence of this complication is not well established because of a number of reasons, including the fact that affect individuals may remain asymptomatic, the lack of routine postoperative retinal examinations, and the

difficulty in identifying occult chorioretinal lesions. However, the incidence of scleral perforation or penetration has been dramatically reduced overtime due to improvement of instrumentation and surgical techniques^(4,5,8).

The event of globe perforation or penetration can occur at any step of the strabismus operation procedure, most commonly during muscle reattachment to the sclera. Others occur during dissection of extraocular muscles from the globes, suture the muscles before disinsertion, and placement of traction suture at the limbus⁽⁹⁾. Although complication of a globe perforation or penetration can lead to serious complications such as vitreous hemorrhage, endophthalmitis, retinal detachment, lens dislocation, cataract, glaucoma, hyphema, or severe visual loss, these complications are usually rare⁽⁹⁻¹¹⁾.

The present study was designed to assess three main purposes; 1) to evaluate the incidence of recognized globe penetrations or perforations; 2) to identify associated risk factors; 3) to search for serious sequelae from globe penetrations or perforations.

Material and Method

The medical records of patients who underwent strabismus surgery at Siriraj Hospital were reviewed between June 2001 and May 2006. Strabismus surgery was performed by residents in ophthalmology training, pediatric ophthalmology fellows, or attending physicians. Demographic data including age at surgery, gender, surgical techniques, surgeons (residents, fellows, attending physicians), step of the procedure during occurrence of recognized scleral penetrations or perforations, and management of these complications were documented.

Various diagnostic patients in the present study included esotropia, exotropia, vertical strabismus, cranial nerve palsy (3rd, 4th, or 6th nerve), thyroid eye disease, and strabismus syndrome were enrolled. A number of strabismus surgery techniques were recessions, resections, advancement, tucking, myotomy, myectomy, botulinum toxin injection, and muscle transposition with posterior fixation sutures. Hang-back procedures were categorized as the resection because scleral bites were placed at the insertion site as in resection of the muscles. All surgical procedures used either a fornix or a limbal approach.

During the operation, if a deep scleral pass or a uveal pigment along scleral tract was noticed, 1% tropicamide eye drop was administered to the operated eyes. All patients who were suspected for scleral

penetrations or perforations were examined intra-operation by indirect ophthalmoscopy. According to Dang Y, et al study, a scleral penetration was defined as full thickness scleral pass with the presence of retinal hemorrhage or retinal edema in the area of muscle surgery without the presence of a retinal break. A scleral perforation was defined as full thickness scleral pass with retinal break with or without hemorrhages or retinal edema⁽¹²⁾. All fundus abnormalities observed through indirect ophthalmoscopy were recorded in each patient's chart and subsequently collected for the purposes of the present study.

All patients with recognized scleral penetrations or perforations were managed by cryotherapy or indirect ophthalmoscopic laser promptly. Patients with these complications were followed-up post-operatively at first week, first month, and sixth month. Symptoms of flashing or floater as well as the ophthalmic examinations, which included visual acuity, ocular motility, anterior segment, and fundus examination, were recorded. The consequences of the globe penetrations or perforations (for example, cataract, hyphema, lens subluxation, glaucoma, endophthalmitis, retinal detachment, and posterior segment hemorrhage) were observed in every visit.

The data were entered into a spreadsheet and analyzed by SPSS program version 11.0. Nominal variables including gender, surgical procedures, and surgeons were analyzed by using Fisher's exact test. Hypothesis testing was performed with a level of significance at 0.05 and a 95% confidence interval.

Results

Of the 1025 patients and 2195 procedures, scleral penetrations were recognized in fifteen procedures (in 15 patients). No scleral perforation was detected. The incidence of the complication related to patient was 15 in 1025 patients (1.46%). Re-operation in the same extraocular muscle was not demonstrated in all patients with this complication. Most patients had surgery for more than one procedure so the incidence per procedure is 15 in 2195 (0.68%). Fifteen patients with scleral penetrations occurred in three males and 12 females. Mean age was 14.26 years (range from 1 year to 45 years). For the patients without these complications, mean age was 15.87 years (range from 10 months to 75 years). There was no statistical difference in mean age between these two groups.

Of 2195 procedures, there were 1428 horizontal and vertical rectus muscle recessions, 442 horizontal and vertical rectus muscle resections and

325 other procedures including inferior oblique myectomy, inferior oblique recession, inferior oblique anteriorization, muscle transposition, and adjustable suture technique as shown in Table 1.

Table 1 shows the characteristics of the population divided into two groups: patients without complications and patients with scleral penetrations. Table 1 summarizes the associations between various risk factors and the occurrences of scleral penetrations.

The fundus of suspected scleral penetrations was immediately examined by indirect ophthalmoscopy. When retinal edema or hemorrhage was demonstrated in the area of needle passed, the diagnosis of this complication was confirmed. The 15 penetrations showed retinal hemorrhage or edema at the penetration site on fundus examination. The location of scleral penetrations was seen outside by the needle tract that corresponding to the retinal lesions. All 15 cases with these complications, the surgeons feel too deep. The needle passed and saw the uveal pigment coming along with the needle. Management was applied immediately when surgeons saw the uveal pigment. Thirteen in

fifteen cases were managed by cryotherapy and only two cases were managed by indirect ophthalmoscopic laser photocoagulation. Antibiotic eye drop were administered to all patients undergoing strabismus surgery routinely.

One of 15 patients was found to have localized vitreous hemorrhage along retinal hemorrhage but retinal break could not obviously be detected. Four of fifteen patients were sutured with 6/0 silk at the sclera where the needle passed through. At the last visit (mean 15 months; range from 8 to 28 months), none of the four patients had lost any of their best-corrected visual acuity and sight-threatening complications such as retinal detachment or endophthalmitis.

Only recession procedure was found in all 15 scleral penetration cases. Most penetrations (12 of 15 patients) occurred during medial rectus recession on either eye; 10 patients in left eye and two patients in right eye. In two of 15 patients, the penetrations occurred during lateral rectus recession; one in the right and another in the left eye. In only one case, the scleral penetration resulted from recession of left

Table 1. Demographic data of patients

	Patients without complication (n = 1,010) cases	Patients with complication (scleral penetration) (n = 15) cases
Age at surgery (years)	15.87 ± 14.81* (10 m-75 yr)**	14.26 ± 13.05* (1-45 yr)**
Gender		
Female	547	12 (2.15%)
Male	463	3 (0.64%)
Surgeon		
Resident	368	11 (2.90%)
Fellow	113	4 (3.42%)
Staff	544	0
Surgical procedures (total 2,195)		
Horizontal and vertical rectus recessions	1,413 (64.37%)	15 (0.68%)
Horizontal and vertical rectus resections	442 (20.14%)	0
IO recessions	62 (2.82%)	0
IO myectomy	114 (5.19%)	0
IO anteriorization	74 (3.37%)	0
Adjustable sutures	12 (0.55%)	0
Advancement	7 (0.32%)	0
SO tucking	7 (0.32%)	0
Transposition	32 (1.46%)	0
Others	17 (0.77%)	0

* mean ± standard deviation; ** (range)

IO: inferior oblique muscle, SO: superior oblique muscle

Others: Botulinum toxin injection®, IO extirpation, SO Tenotomy, disinsertion, plication, Harada-ito, Faden, marginal myotomy

superior rectus muscle. All scleral penetrations occurred during the step of muscle reattachment to the sclera in recession procedure. All recession procedures were the only procedure associated with scleral penetrations ($p=0.002$), (95% CI 0.0052, 0.0157).

In present study, mean follow-up period of these complicated cases was 18.27 months (range from 6 to 45 months). Decreased vision was not detected in all 15 patients with these complications. All of the patients with retinal edema or hemorrhage resolved with chorioretinal pigmentations. The chorioretinal pigmentations resulting from cryotherapy or indirect ophthalmoscopic laser application were revealed at about one month follow-up time. The patients who experienced these complications were followed-up for at least six months and did not have serious sequelae such as retinal detachment, vitreous hemorrhage, or endophthalmitis.

Of all 1025 patients underwent strabismus surgery, 368 cases were performed by residents, 113 cases were performed by fellows, and 544 cases were performed by attending physicians. Among the eyes with scleral penetrations, most cases (11 of 15 patients) were performed by residents whereas another four of 15 penetration patients were performed by fellows. None in this complication was performed by attending physicians. This shows statistical difference for surgeon factor between trainees and staff ($p = 0.00$, X^2), (95% CI 0.0156, 0.0467).

Discussion

The extraocular muscle surgery is one of the most common surgical procedures in ophthalmology practices and every surgeon has to keep in mind and precaution to take care to diminish the risk of scleral perforation⁽⁴⁾.

In prior studies reported various incidence of recognized scleral penetrations or perforations in extraocular muscle surgery; Awad et al⁽⁷⁾ reported perforations in 15 of 4,886 patients (0.3%), Morris et al⁽⁴⁾ reported perforations in 1 of 67 patients (1.5%), a survey questionnaire study of Simon et al⁽⁵⁾ reported only 728 perforations of 554000 extraocular muscle procedures (0.13%). A prospective study by Dang et al⁽¹²⁾, fundus examination before and after the operation to detect any occult complications, reported higher incidence of 5.1% for scleral penetration and 2.8% for scleral perforation in relation to the operated eyes. The incidence in the present study showed 15 of 1,025 patients (1.46%), closely matches that of those reported by Morris et al. Because scleral penetrations

or perforations in extraocular muscle surgery rarely occurs, the authors concluded that the incidence of scleral penetrations or perforations was usually various that depend on the number of cases, procedures, methods of detection and so on.

The uncertain incidence of scleral perforations resulting from extraocular muscle surgery was established because of challenges in consistent detection. In reviewing the previous literature on many scleral perforation studies, the most important drawbacks are lack of prospective studies, small number of subjects, lack of statistical analysis, and insufficient information from medical recordings. Among retrospective nature of the present study, the authors lack some of the relevant data and occult penetrations may potentially go unnoticed. Hence, the authors only reported the incidence of recognized scleral penetrations confirmed by fundus examination.

According to the anatomy of the human eye, the scleral area posterior to rectus muscle insertion where the sclera was passed by needle for muscle reattachment during recession procedure is certainly thinner than any other areas of sclera. In previous reports, they found that recession procedure was most likely association with this complication. Dang et al⁽¹²⁾ reported 17 cases with scleral penetrations and perforations that occurred during recession procedure and just two cases with this complication occurred in resection and transposition procedures. Awad et al⁽⁷⁾ reported five from 15 complicated cases that scleral perforation occurred during muscle reattachment to the sclera after recession. Many surgeons concluded that recession procedure was one of the risk factors causing scleral penetrations or perforations. In the present study, all of scleral penetrations occurred when recessions were performed during scleral pass in muscle reattachment step. Comparison between the recession procedure and other procedures found that recession procedure was statistically significant ($p=0.002$) related to these complications.

Although recession procedure is still believed to be a risk factor in scleral perforations or penetrations during extraocular muscle surgery, other points to be focused are type of horizontal rectus muscle and side of operated eye. To begin with, most perforations or penetrations took place in horizontal rectus muscle. Dang et al⁽¹²⁾ reported that horizontal rectus muscles were most frequently associated with penetrations and perforations when compared to vertical rectus and oblique muscles. In the present study, 14 of 15 penetration cases were found in

horizontal rectus muscle surgery; 12 in medial rectus and two in lateral rectus, but only one penetration case was found in vertical rectus muscle (superior rectus) surgery. Another interesting point in the present study is that most of all penetration cases (10 of 15 patients) occurred during medial rectus recession in the left eye. The authors hypothesize that performing scleral suture during medial rectus recession in the left eye is obstructed by the ridge of the patient's nose. It really affects step in performing scleral suture that is difficult and inconvenient. Consequently, inconvenience and difficulty during medial rectus recession in the left eye can result in scleral penetration or perforation. Because of more operations in horizontal muscles than that in vertical muscles, so the authors found these complications common in horizontal muscle procedures.

There are some controversies in surgeon factor to develop these complications. Some literatures showed that surgeon factor played a role as another risk factor related to these complications. In a retrospective study, Simon et al⁽⁵⁾ indicated that perforations were two times more common with residents or fellows operating than with attending surgeons. In a prospective study; however, Cibis⁽¹³⁾ found that occurrence of the observed perforations between residents and attending surgeons is equal. Another prospective study, Dang et al⁽¹²⁾ reported occurrence of scleral perforations and penetrations only performed by residents and fellows, not including attending surgeon. They concluded that the surgeon's experience was not related to the frequency of these complications. In the present retrospective study, which are based on residents, fellows and attending surgeons, all 15 complicated cases underwent extra-ocular muscle surgery performed by residents and fellows. Thus surgeon factor was statistically significantly different in the present study ($p = 0.00$). Because the control of needle passage through superficial scleral fibers is the only way to prevent inadvertent globe perforation, this complication may inevitably be influenced by surgical experience. The presented data support the conclusion that surgeon's experience is another risk factor in these complications.

The management of these complications is still controversial. Basmadjian et al⁽¹⁴⁾ advocated treatment with cryotherapy to reduce the incidence of retinal detachment. In an animal model study; on the other hand, revealed higher incidence of retinal detachment resulting from cryotherapy in treating retinal holes after globe perforation⁽¹⁵⁾. Cryotherapy

brought about proliferation of the released retinal pigment epithelial cells leading to vitreoretinal traction. Many surgeons tend toward observation due to relatively low numbers of retinal detachment compare to relatively high number of scleral penetrations or perforations. In the present study, all patients with scleral penetrations were applied by either laser retinopexy or cryotherapy, and none reported disturbance of vision and developed retinal detachment. No effect in visual acuity change was subsequently detected in the study period but the authors have to observe that in the long term.

Although the incidence of scleral perforations and penetrations in the present study is low (0.68%), surgeons should keep in mind in surgical procedure and their risk factors. In the authors' review, risk factors for these complications are rectus muscle recession and surgeon factors so the authors recommend that in order to minimize this complication, surgeons should perform strabismus surgery with caution in every operation especially rectus muscle recession procedure. Other than these risk factors, surgical technique and scleral thickness that increases from neonate to adult may take a role in these complications. Therefore, surgeons should be alert in step of muscle reattachment posterior to insertion and keep in mind all these risk factors during doing strabismus surgery. No serious complications such as retinal detachment or endophthalmitis were found in the present study.

There are some limitations in the present study. First, because of the nature of retrospective study, some interesting data may be biased. Second, the follow-up times in some cases are too short. Some sequelae; for example retinal detachment, might occur many years after surgery. Last, the authors did not do fundus examinations in every patient before and after surgery. This results in missing some occult perforations leading to underestimate the true incidence of these complications.

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การเย็บเปลือกลูกตาทะลุเข้าไปข้างใน และแทงเป็นรูจากการผ่าตัดแก้ไขตาเหล่: อุบัติการณ์, ปัจจัยเสี่ยง และผลที่ตามมา

ธรรมบุญ สุรชาติกำธรกุล, พิทยา ภมรเวชวรรณ, สุชาติดา กัมปนาทแสนยากร, นพมาศ วงศ์ไพฑูรย์ปิยะ, อัครินทร์ นิมมานนิตย์

วัตถุประสงค์: เพื่อประเมินหาอุบัติการณ์ และบ่งบอกปัจจัยเสี่ยง และผลที่ตามมาของการเย็บแทงทะลุเปลือกตาเข้าไปข้างใน และแทงเป็นรูของเปลือกลูกตาในการผ่าตัดแก้ไขตาเหล่

วัสดุและวิธีการ: เป็นการศึกษาเวชระเบียนย้อนหลังในผู้ป่วยที่ได้รับการผ่าตัดแก้ไขตาเหล่ ที่โรงพยาบาลศิริราช ช่วงเดือนมิถุนายน พ.ศ. 2544 ถึงพฤษภาคม พ.ศ. 2549 การผ่าตัดแก้ไขตาเหล่ ดำเนินการโดยแพทย์ประจำบ้าน จักษุวิทยา, แพทย์ประจำบ้านต่อยอดสาขาวิชาจักษุวิทยาเด็กและกล้ามเนื้อตา และจักษุแพทย์สาขาวิชา จักษุวิทยาเด็กและกล้ามเนื้อตา โดยเก็บข้อมูลทั่วไปของผู้ป่วย วิธีการผ่าตัดและขั้นตอนการแก้ไขหลังการเย็บทะลุเข้าไปข้างในและแทงเป็นรูของเปลือกลูกตา ผู้ป่วยที่มีภาวะแทรกซ้อนนี้จะได้รับการตรวจจอประสาทตาทันทีในห้องผ่าตัด และติดตามตรวจจอประสาทตาอย่างน้อย 6 เดือนเพื่อดูผลระยะยาวที่จะตามมาของภาวะแทรกซ้อนนี้

ผลการศึกษา: ผู้ป่วย 1,025 ราย และ 2,195 หัตถการ พบเปลือกลูกตาทะลุจากการเย็บ 15 หัตถการ (0.68%) เป็นการทะลุผ่านเปลือกลูกตาทุกชั้น แต่ไม่มีจอประสาทตาดีกขาด โดยไม่พบภาวะเปลือกลูกตาแทงทะลุเป็นรู ที่มีจอประสาทตาดีกขาด อายุเฉลี่ยในการเกิดผลข้างเคียงนี้คือ 14.26 ปี วิธีทำผ่าตัดกล้ามเนื้อตาแบบถอยร่น มีโอกาสเกิดเปลือกลูกตาทะลุได้มากกว่าวิธีอื่นอย่างมีนัยสำคัญทางสถิติ ผู้ป่วยทุกรายที่เกิดเปลือกลูกตาทะลุ จะเกิดในขั้นตอนเย็บกล้ามเนื้อตาคลับไปติดที่เปลือกลูกตา การเกิดเปลือกลูกตาทะลุทั้ง 15 หัตถการขณะทำผ่าตัดแก้ไขตาเหล่เกิดจากการผ่าตัดของแพทย์ประจำบ้านและแพทย์ประจำบ้านต่อยอด การผ่าตัดซ้ำในกล้ามเนื้อตาคลับเดียวกัน ไม่เป็นปัจจัยเสี่ยงในการเกิดภาวะแทรกซ้อนนี้ ผู้ป่วยทุกรายที่มีภาวะแทรกซ้อนนี้ได้รับการรักษาโดยการขยายม่านตาและตรวจจอประสาทตา เราใช้การจี้ความเย็นหรือยิงเลเซอร์ไปที่จอประสาทตาในบริเวณที่เปลือกลูกตาถูกเย็บทะลุเข้าไปข้างใน ภาวะจอประสาทตาลอก, เลือดออกในวุ้นตา และภาวะติดเชื้อในตาไม่พบในการศึกษาครั้งนี้

สรุป: อุบัติการณ์ของการเกิดเปลือกลูกตาเย็บทะลุ คือ 0.68% ปัจจัยเสี่ยงที่ทำให้เกิดผลแทรกซ้อนนี้คือ การผ่าตัดที่เป็นการถอยร่นของกล้ามเนื้อตา และปัจจัยจากแพทย์ผู้ผ่าตัดในการศึกษานี้ไม่พบผลข้างเคียงร้ายแรง เช่น จอประสาทตาลอก และการติดเชื้อในลูกตาตามมา