

Contents

Preface xii

Acknowledgments xiii

Contributors xiv

Section I: Strabismus Surgery

1. Preparation for Strabismus Surgery 3
Sylvia H. Yoo

1.1 **Goals** 3

1.2 **Advantages** 3

1.3 **Expectations** 3

1.4 **Key Principles** 4

1.5 **Indications** 4

1.6 **Contraindications** 4

1.7 **Preoperative Preparation** 4

1.8 **Surgical Planning** 5

1.9 **Perioperative Tips and Pearls** 5

1.9.1 **Anesthesia** 5

1.9.2 **Positioning** 6

1.9.3 **Prepping and Draping** 6

1.9.4 **Instruments and Supplies** 7

1.10 **What to Avoid** 7

1.11 **Complications** 9

1.12 **Postoperative Care and Expectations** 9

References 10

2. Surgical Anatomy for Strabismus Surgery 11
Sylvia H. Yoo

2.1 **Extraocular Rectus and Oblique Muscles** 11

2.2 **Conjunctiva and Sclera** 12

2.3 **Subconjunctival Fascia** 12

2.4 **Vascular Structures** 12

References 15

3. Conjunctival Incisions for Strabismus Surgery 16
Sylvia H. Yoo

3.1 **Goals** 16

3.2 **Advantages** 16

3.3 **Expectations** 16

3.4 **Key Principles** 16

3.5 **Indications** 17

3.6 **Contraindications** 17

3.7 **Preoperative Preparation** 17

3.8 **Operative Technique** 17

3.8.1 **Fornix Incision** 17

3.8.2 **Limbal Incision** 18

3.9 **Tips and Pearls** 18

3.10 **What to Avoid** 19

3.11 **Complications** 20

 Contents

3.12	Postoperative Care	20	References	20	
4.	Rectus Muscle Surgery			21	
	<i>Sylvia H. Yoo</i>				
4.1	Goals	21	4.9	Tips and Pearls	33
4.2	Advantages	21	4.9.1	Before Starting Surgery	33
4.3	Expectations	21	4.9.2	Use of Muscle Hooks and Forceps	33
4.4	Key Principles	21	4.9.3	Imbricating the Muscle	34
4.5	Indications	22	4.9.4	Disinsertion of the Muscle	34
4.6	Contraindications	22	4.9.5	Reinsertion of the Muscle	34
4.7	Preoperative Preparation	22	4.9.6	Rectus Muscle Recessions	35
4.8	Operative Technique	23	4.9.7	Rectus Muscle Resections and Plications	35
4.8.1	Forced Duction Testing	25	4.9.8	Vertical Rectus Muscle Surgery	35
4.8.2	Isolating the Operative Muscle	25	4.10	What to Avoid	36
4.8.3	Rectus Muscle Recession	27	4.11	Complications	36
4.8.4	Rectus Muscle Resection	30	4.12	Postoperative Care and Expectations	36
4.8.5	Completion of Surgery	33		References	36
5.	Adjustable Suture Technique				37
	<i>Sylvia H. Yoo</i>				
5.1	Goals	37	5.8	Operative Technique	38
5.2	Advantages	37	5.8.1	At the Time of Adjustment	41
5.3	Expectations	37	5.9	Tips and Pearls	42
5.4	Key Principles	37	5.10	What to Avoid	43
5.5	Indications	38	5.11	Complications	43
5.6	Contraindications	38	5.12	Postoperative Care	43
5.7	Preoperative Preparation	38		References	43
6.	Inferior Oblique Muscle Surgery				44
	<i>Sylvia H. Yoo</i>				
6.1	Goals	44	6.6	Contraindications	44
6.2	Advantages	44	6.7	Preoperative Preparation	44
6.3	Expectations	44	6.8	Operative Technique	45
6.4	Key Principles	44	6.8.1	Exaggerated Traction Testing	45
6.5	Indications	44	6.8.2	Isolation and Disinsertion of the Inferior Oblique Muscle	45

6.8.3	Inferior Oblique Recession or Anterior Transposition	48	6.11	Complications	51
6.8.4	Inferior Oblique Myectomy	48	6.12	Postoperative Care and Expectations	51
6.8.5	Inferior Oblique Denervation and Extirpation	50		References	51
6.9	Tips and Pearls	50			
6.10	What to Avoid	51			
7.	Superior Oblique Surgery				52
	<i>Catherine S. Choi and Sylvia H. Yoo</i>				
7.1	Goals	52	7.8.4	Superior Oblique Tuck	55
7.2	Advantages	52	7.8.5	Harada-Ito Procedure	57
7.3	Expectations	52	7.9	Tips and Pearls	58
7.4	Key Principles	52	7.9.1	Superior Oblique Weakening Procedures	58
7.5	Indications	52	7.9.2	Superior Oblique Tightening Procedures	58
7.6	Contraindications	53	7.10	What to Avoid	59
7.7	Preoperative Preparation	53	7.11	Complications	59
7.8	Operative Technique	53	7.12	Postoperative Care	59
7.8.1	Exaggerated Traction Testing	53		References	59
7.8.2	Superior Oblique Tenotomy	53			
7.8.3	Superior Oblique Tenotomy with Suture Spacer	54			
8.	Reoperations				60
	<i>Sylvia H. Yoo</i>				
8.1	Goals	60	8.8	Operative Technique	61
8.2	Advantages	60	8.9	Tips and Pearls	61
8.3	Expectations	60	8.10	What to Avoid	62
8.4	Key Principles	60	8.11	Complications	62
8.5	Indications	60	8.12	Postoperative Care	62
8.6	Contraindications	60		References	62
8.7	Preoperative Preparation	61			
9.	Special Strabismus Procedures				63
	<i>Catherine S. Choi and Sylvia H. Yoo</i>				
9.1	Goals	63	9.1.3	Y-split Procedure of the Lateral Rectus Muscle	63
9.1.1	Transposition Procedures	63	9.1.4	Partial Tendon Recession	63
9.1.2	Posterior Fixation Sutures	63			

Contents

9.2	Advantages	63	9.8.2	Posterior Fixation Sutures	65
9.3	Expectations	63	9.8.3	Y-split Procedure of the Lateral Rectus Muscle	67
9.4	Key Principles	63	9.8.4	Partial Tendon Recession	67
9.5	Indications	64	9.9	Tips and Pearls	68
9.5.1	Transposition Procedures	64	9.9.1	Transposition Procedures	68
9.5.2	Posterior Fixation Sutures	64	9.9.2	Posterior Fixation Sutures	69
9.5.3	Y-split Procedure of the Lateral Rectus Muscle	64	9.9.3	Y-split Procedure of the Lateral Rectus Muscle	69
9.5.4	Partial Tendon Recession	64	9.9.4	Partial Tendon Recession	69
9.6	Contraindications	64	9.10	What to Avoid	70
9.7	Preoperative Preparation	64	9.11	Complications	70
9.8	Operative Technique	64	9.12	Postoperative Care	70
9.8.1	Transposition Procedures	64		References	70
10.	Botulinum Toxin Injection for Strabismus	71			
	<i>Sylvia H. Yoo</i>				
10.1	Goals	71	10.8	Operative Technique	72
10.2	Advantages	71	10.9	Tips and Pearls	73
10.3	Expectations	71	10.10	What to Avoid	73
10.4	Key Principles	71	10.11	Complications	73
10.5	Indications	71	10.12	Postoperative Care	73
10.6	Contraindications	72		References	73
10.7	Preoperative Preparation	72			
Section II: Orbital Procedures					
11.	Nasolacrimal Duct Probing, Intubation, and Balloon Dilatation	77			
	<i>Catherine S. Choi and Maanasa Indaram</i>				
11.1	Goals	77	11.8	Operative Technique	79
11.2	Advantages	77	11.8.1	Nasolacrimal Duct Probing with or without Irrigation	79
11.3	Expectations	77	11.8.2	Nasolacrimal Duct Probing with Intubation	81
11.4	Key Principles	78	11.8.3	Nasolacrimal Duct Probing with Balloon Dilatation	82
11.4.1	Anatomy	78	11.9	Tips and Pearls	83
11.5	Indications	78	11.9.1	Nasolacrimal Duct Probing with Intubation	84
11.6	Contraindications	78			
11.7	Preoperative Preparation	79			

11.9.2	Nasolacrimal Duct Probing with Balloon Dilation.....	84	11.10.2	Nasolacrimal Duct Probing with Balloon Dilation.....	84
11.10	What to Avoid	84	11.11	Complications	84
11.10.1	Nasolacrimal Duct Probing with Intubation.....	84	11.12	Postoperative Care	85
				References.....	85
12.	Dermoid Cyst Excision	86			
	<i>Alison B. Callahan</i>				
12.1	Goals	86	12.8	Operative Technique	87
12.2	Advantages	86	12.9	Tips and Pearls	89
12.3	Expectations	86	12.10	What to Avoid	89
12.4	Key Principles	86	12.11	Complications	89
12.5	Indications	87	12.12	Postoperative Care	89
12.6	Contraindications	87		References.....	89
12.7	Preoperative Preparation	87			
Section III: Anterior Segment Procedures					
13.	Pediatric Cataract Surgery	93			
	<i>Sylvia H. Yoo</i>				
13.1	Goals	93	13.8.2	Cataract Extraction with IOL Implantation.....	99
13.2	Advantages	93	13.8.3	Secondary IOL Implantation.....	100
13.3	Expectations	93	13.9	Tips and Pearls	101
13.4	Key Principles	93	13.10	What to Avoid	101
13.5	Indications	94	13.11	Complications	101
13.6	Contraindications	94	13.12	Postoperative Care	102
13.7	Preoperative Preparation	95		References.....	103
13.8	Operative Technique	96			
13.8.1	Cataract Extraction without IOL Implantation.....	96			
14.	Corneal Collagen Cross-Linking for Keratoconus	105			
	<i>Maanasa Indaram</i>				
14.1	Goals	105	14.4	Key Principles	105
14.2	Advantages	105	14.5	Indications	106
14.3	Expectations	105	14.6	Contraindications	106

Contents

14.7	Preoperative Preparation	106	14.9	Tips and Pearls	108
14.8	Operative Technique	106	14.10	Complications	108
14.8.1	Anesthesia and Preparation	106	14.11	What to Avoid	108
14.8.2	Alcohol-Assisted Corneal Epithelium Removal	106	14.12	Postoperative Care and Precautions	109
14.8.3	Induction with Riboflavin	107		References	109
14.8.4	Treatment with Ultraviolet A (UVA) Light	107			

Section IV: Pediatric Glaucoma Procedures

15.	Goniotomy	113			
	<i>Helen H. Yeung</i>				
15.1	Goals	113	15.8	Operative Technique	114
15.2	Advantages	113	15.8.1	Examination Under Anesthesia	114
15.3	Expectations	113	15.8.2	Goniotomy Procedure	114
15.4	Key Principles	113	15.9	Tips and Pearls	115
15.5	Indications	113	15.10	What to Avoid	116
15.6	Contraindications	113	15.11	Complications	116
15.7	Preoperative Preparation	114	15.12	Postoperative Care	116
			15.13	Acknowledgment	116
				References	116
16.	Trabeculotomy	117			
	<i>Helen H. Yeung</i>				
16.1	Goals	117	16.8	Tips and Pearls	118
16.2	Advantages	117	16.9	What to Avoid	119
16.3	Expectations	117	16.10	Complications	119
16.4	Key Principles	117	16.11	Postoperative Care	119
16.5	Indications	117	16.12	Acknowledgment	120
16.6	Preoperative Preparation	117		References	120
16.7	Operative Technique	117			

Section V: Procedures for Retinopathy of Prematurity

17.	Laser Therapy for Retinopathy of Prematurity	123			
	<i>Shilpa J. Desai and Michelle C. Liang</i>				
17.1	Goals	123	17.2	Advantages	123

17.3	Expectations	123	17.9	Tips and Pearls	126
17.4	Key Principles	123	17.10	What to Avoid	126
17.5	Indications	123	17.11	Complications	126
17.6	Contraindications	123	17.12	Postoperative Care	126
17.7	Preoperative Preparation	124		References	127
17.8	Operative Technique	125			
18.	Anti-Vascular Endothelial Growth Factor Therapy for Retinopathy of Prematurity				128
	<i>Michelle C. Liang and Shilpa J. Desai</i>				
18.1	Goals	128	18.8	Operative Technique	130
18.2	Advantages	128	18.9	Tips and Pearls	132
18.3	Expectations	129	18.10	What to Avoid	132
18.4	Key Principles	129	18.11	Complications	132
18.5	Indications	129	18.12	Postoperative Care	134
18.6	Contraindications	129		References	134
18.7	Preoperative Preparation	129			
Section VI: Examination Under Anesthesia					
19.	Preparations for Examinations under Anesthesia				137
	<i>Sylvia H. Yoo</i>				
19.1	Goals	137	19.7	Operative Technique	137
19.2	Advantages	137	19.8	Tips and Pearls	138
19.3	Expectations	137	19.9	What to Avoid	138
19.4	Key Principles and Preoperative Preparation	137	19.10	Complications	138
19.5	Indications	137	19.11	Postoperative Care	138
19.6	Contraindications	137		Reference	138
	Index				139

Section I

Strabismus Surgery

1	Preparation for Strabismus Surgery	3
2	Surgical Anatomy for Strabismus Surgery	11
3	Conjunctival Incisions for Strabismus Surgery	16
4	Rectus Muscle Surgery	21
5	Adjustable Suture Technique	37
6	Inferior Oblique Muscle Surgery	44
7	Superior Oblique Surgery	52
8	Reoperations	60
9	Special Strabismus Procedures	63
10	Botulinum Toxin Injection for Strabismus	71



1 Preparation for Strabismus Surgery

Sylvia H. Yoo

Summary

The presence of strabismus precludes normal visual development in infancy and early childhood, resulting in poor fusion and, in many cases, amblyopia. Quality of life can also be affected, especially as the child grows older. Refractive correction and amblyopia treatment may improve strabismus in some children, so that strabismus surgery is not needed. In other cases, strabismus may persist, worsen, or develop, despite nonsurgical treatments or due to other underlying etiologies. Children with constant or poorly controlled deviations larger than 10 to 12 prism diopters can benefit from strabismus surgery not only to improve the ocular alignment but also to improve the chances of developing or maintaining fusion. Diplopia rarely occurs in young children due to suppression of the deviating eye, while older children may report diplopia if the strabismus is worsening or is of new-onset.

The preoperative evaluation of a patient with strabismus includes a complete sensorimotor examination to determine a diagnosis with a clear plan for treatment, which may or may not include strabismus surgery. If strabismus surgery is planned, the goals and risks of surgery are discussed with the patient's family and with the patient, if capable of giving assent. In the operating room, patient and surgeon positioning, coordination with the anesthesiologist, and availability of the proper equipment, instruments, and sutures are key factors to ensure as smooth a surgical experience as possible.

The chapters of this section cover the types of strabismus surgery that may be considered in the pediatric population. Overarching information on the goals, advantages, expectations, indications, contraindications, complications, and postoperative care for strabismus surgery is included in this chapter. Information specific to the type of strabismus surgery described is included in each respective chapter.

Keywords: sensorimotor examination, quality of life, anesthesia, positioning, surgical prep, instruments

1.1 Goals

- The ideal outcome of strabismus surgery is orthophoria in all gaze positions while wearing

the appropriate refractive correction to allow development and maintenance of fusion and normal stereoacuity; however, this may not be a realistic surgical outcome in all patients.

- Therefore, the goal of strabismus surgery is an improvement of the ocular alignment, in some cases with a small residual deviation within monofixation range that can allow for development of gross fusion and stable long-term alignment.
- In some cases, improvement of an anomalous head position is the primary goal of strabismus surgery.
- Resolution of diplopia, if present.

1.2 Advantages

- Strabismus surgery is a well-studied treatment for children who have persistent strabismus despite nonsurgical treatments, or for whom nonsurgical treatments are unlikely to improve the eye alignment.
- Observation can be considered an alternative to strabismus surgery but it does not allow for development or maintenance of fusion in early visual development.
- Unlike adults with diplopia due to strabismus, prism glasses are seldom prescribed for strabismus in young children due to suppression and absence of diplopia in most cases.
- In most cases, strabismus surgery can result in stable, long-term improvement of alignment with a favorable risk-to-benefit ratio.
- Compared to botulinum toxin injection, strabismus surgery is less dependent on the presence of or potential for fusion to achieve a good postoperative outcome; if strabismus recurs after botulinum toxin treatment, strabismus surgery is often considered as the next step. Botulinum toxin injection has its own advantages as an alternative to strabismus surgery and is addressed in Chapter 10.

1.3 Expectations

- Safe and effective procedure.
- Improvement of ocular alignment.
- Improvement of stereoacuity in some patients.
- Uncomplicated healing of the operative muscles and conjunctival wounds.

Preparation for Strabismus Surgery

1.4 Key Principles

- The extraocular muscles can be weakened, tightened, and transposed using various methods to improve ocular alignment.
- Proper surgical technique minimizes bleeding and scarring to allow for uncomplicated wound healing and less complex reoperations, should they be needed.

1.5 Indications

The indications for strabismus surgery in the pediatric age range are:

- Abnormal visual development due to strabismus, for which strabismus surgery is performed to increase the chance of normal visual development in early childhood by establishing or re-establishing binocular fusion and treating amblyopia¹ in some patients.
- Strabismus affecting quality of life due to its effects on interpersonal relationships, communication, and self-esteem.²
- An anomalous head position due to ocular torticollis from Duane or other dysinnervation syndrome, nystagmus with a null point that is not in primary gaze,³ or cranial nerve paresis.
- Binocular diplopia.

1.6 Contraindications

- Most patients can safely undergo multiple strabismus surgeries, keeping in mind the following risks:
 - Risk of anterior segment ischemia if two or more rectus muscles in one eye have been previously disinserted. Signs of anterior segment ischemia include conjunctival injection, corneal edema, iritis, iris atrophy, corectopia, posterior synechiae, and cataract formation.
 - Persistent significant misalignment despite multiple strabismus surgeries may indicate that the risks of additional surgery, though low, may actually outweigh the potential benefits, and other treatment options, including observation, may need to be offered. Orbital imaging may be useful in such cases. For example, restriction due to extensive scarring or dysinnervation syndromes with anomalous extraocular muscles may limit the improvement that can be achieved with additional strabismus surgery.
- High general anesthesia risk, in which case the decision for surgery is a collaborative decision

with the patient's pediatrician, the anesthesiology team, and the patient's family. If anesthesia is required for another procedure, an effort should be made to combine procedures to avoid multiple episodes of general anesthesia.

- If the patient family's postoperative expectations do not seem realistic, additional discussion is needed and a second opinion may be offered.

1.7 Preoperative Preparation

A detailed history of the presenting strabismus is obtained, including onset (infantile or acquired), frequency of deviation, fixation preference, and any significant anomalous head position. Older children and teenagers may complain of diplopia. A full past medical history, including the patient's birth and developmental history, as well as family history of amblyopia and strabismus are obtained. The family may recall a relative with a "lazy eye," which should be further elaborated.

A complete ophthalmologic examination is performed in the evaluation of strabismus with attention to the sensorimotor examination. The examination begins with testing of stereoacuity and fusion before any dissociation from occlusion during visual acuity and cover testing. Strabismus measurements and visual acuity testing are then performed. If visual acuity testing determines the presence of amblyopia, treatment with refractive correction and/or occlusion therapy may be indicated. In some cases, strabismus surgery that improves eye alignment may also aid in the treatment of amblyopia.¹

The overall appearance of the patient's eye alignment is observed first. Strabismus measurements are then performed with simultaneous prism cover testing to determine the manifest strabismus, followed by alternate prism cover testing in all gaze positions at distance, and in primary gaze and/or slight downgaze at near.⁴ Patterns such as V- or A-patterns may be noted during the measurements and may be correlated to oblique muscle overaction during evaluation of versions. Measurements in right and left head tilt are also performed if a cyclovertical strabismus is present. Additional latent strabismus may be revealed by prism adaptation testing or prolonged cover testing to maximally dissociate the patient. In poorly cooperative patients and young infants, cover testing in only primary gaze at near or corneal light reflex testing with or without prisms may be used to estimate the deviation. Conversely, older children with