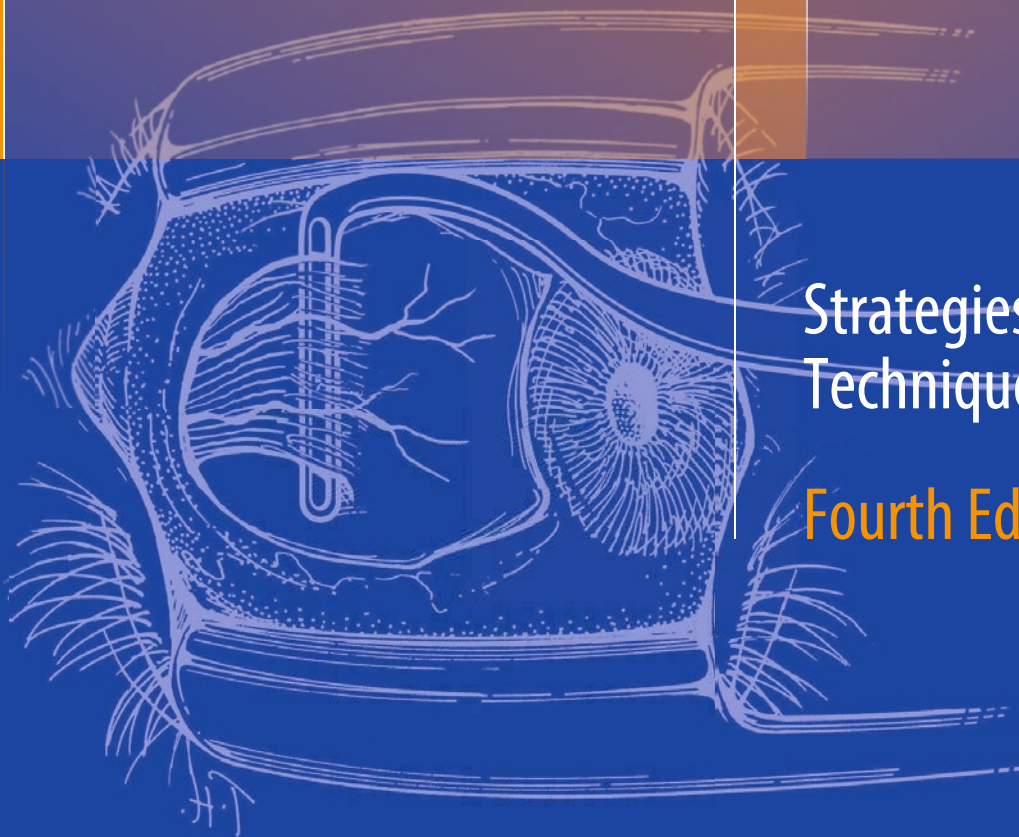


Kenneth W. Wright  
Yi Ning J. Strube

# Color Atlas of Strabismus Surgery



Strategies and  
Techniques

Fourth Edition

EXTRAS ONLINE

 Springer

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Kenneth W. Wright • Yi Ning J. Strube

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Strategies and Techniques

Fourth Edition

 Springer

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## Preface to the Fourth Edition

We are now in our fourth edition of the *Color Atlas of Strabismus Surgery: Strategies and Techniques*. The first edition was published in 1991 by Lippincott. To the author's knowledge, these 23 years represent the longest-running printing of any textbook on ophthalmic surgery. We are sincerely honored to present the latest edition.

Since our last edition, several new strabismus surgery techniques have been developed. We have included detailed descriptions of these techniques including amniotic membrane transplant and minimally invasive procedures. Many of the minimally invasive procedures have been developed by me, Kenneth W. Wright, MD, including central tenotomy and central plication. These new minimally invasive procedures can be done with topical anesthesia.

As the senior author, I must acknowledge the great contribution of Yi Ning J. Strube, MD, FRCSC. Her expertise as a strabismus surgeon and her attention to detail has greatly enhanced this edition. We acknowledge the Wright Foundation, which supports pediatric ophthalmology and strabismus through research, education, and patient care.

Many readers have praised past editions because of the easy-to-read descriptions and simplicity of the line drawings yet applaud the fine details provided by the companion color photographs. They have said, "You can learn and do the procedure right from the book!" This is high praise, and the authors have made every effort to make the fourth edition hold up to that high standard.

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Los Angeles, CA, USA  
Kingston, ON, Canada

Kenneth W. Wright, MD  
Yi Ning J. Strube, MD, MS, FRCSC, DABO

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## Preface to the Third Edition

Strabismus can be devastating to our patients yet often difficult to treat even for the seasoned veteran. The goal of the *Atlas of Strabismus Surgery* is to clearly and succinctly share with the reader strategies and surgical techniques that will improve the care of our patients. The atlas covers the management of a wide range of strabismus disorders from the relatively simple horizontal strabismus to complex cyclovertical deviations. A variety of surgical techniques are presented, starting with the simple basics and progressing to complicated surgical techniques such as the delicate superior oblique tendon expander procedure and the retrieval of a slipped/lost rectus muscle. The atlas is designed to help surgeons of diverse experience, from the resident ophthalmologist to the most experienced strabismologist.

The third edition underwent a true makeover, with virtually every chapter receiving significant changes. Examples include a section on “Planning for success” in Chap. 2 that provides a logical approach to forming a treatment plan. Incomitant strabismus and torticollis associated with nystagmus or strabismus can be challenging to treat, so we have added a chapter specifically dealing with these important disorders. Throughout the book, clinical case examples have been added to illustrate strabismus treatment strategies. Relatively new to most strabismus surgeons is the use of topical anesthesia for strabismus surgery. Topical anesthesia strabismus surgery requires special techniques to avoid patient discomfort, and a chapter has been added on this up-and-coming procedure. The book has been updated to reflect changes in choice of suture materials such as the use of nonabsorbable suture for inferior rectus recession. We are also introducing several new titanium instruments from Titan Surgical Company that improve the efficiency and safety of strabismus surgery.

As in previous editions, color photographs are paired with line drawings to help explain the surgical techniques. The simplicity of the line drawing helps to teach technique, while the photographs add the reality of the surgical field. This format innovated by the author in the first edition won a publishers award in Philadelphia. To even further improve on this winning format, the third edition has a companion DVD with more than 10 videos of strabismus surgery. This combination of line drawings, color photographs, and surgical videos provides the student with the next best thing to live surgery.

I would like to give special thanks to my dear friend Sonal Farzavandi, MD, for her tenacity in editing every line of text, checking each index entry, and helping with the content. Without Sonal’s help, this project would still be lingering today. Lisa Thompson, MD, one of my outstanding fellows, also deserves sincere thanks for her encouragement and for helping with editing the book. It is my sincere hope that the third edition will help the surgeon better manage strabismus, improve patient outcomes, and make the great field of strabismus even more rewarding.

Los Angeles, CA, USA

Kenneth W. Wright, MD

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## Preface to the Second Edition

The second edition of the *Color Atlas of Ophthalmic Surgery—Strabismus* is an updated version of the original award-winning textbook published in 1991. The new atlas retains the same style of simplicity and clarity of the first edition. In addition, we have added a new section, “Management Strategies,” which includes seven chapters on the practical management of strabismus syndromes. The idea is to provide the reader with a concise synopsis of what to do for a specific type of strabismus. Section 2 details strabismus surgical techniques and has been extensively revised and updated from the original edition. Chapter 22, “Reoperation Techniques,” was added and describes the management of slipped/lost muscles and strabismus after retinal detachment surgery. As in the first edition, the section on surgical techniques combines line drawings and color photographs of actual surgery to offer both simplicity and realism required for teaching new techniques. I hope you will find this new edition useful in your strabismus practice.

I would like to add special thanks to Tina Kiss, our pediatric ophthalmology administrator, for her many long hours and weekends without which this project would not have come to fruition. I would also like to extend my sincere gratitude to Laura Bonsall for her encouragement to pursue this project and for her expertise and creativity in the layout and formatting of this book. In addition, I would like to acknowledge all of my fellows who have influenced the material in this book, especially Peter Spiegel, Dean Bonsall, and Gabriela Salvador for their thorough review of the manuscript. Finally, I would like to recognize Allergan, Bausch & Lomb Surgical, Ethicon, Discovery Fund for Eye Research, Cedars-Sinai Medical Center, and University of California, Irvine, for their unselfish support.

Los Angeles, CA, USA

Kenneth W. Wright, MD

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## Preface to the First Edition

The Strabismus volume of *Color Atlas of Ophthalmic Surgery* was written as a practical text to teach strabismus surgical technique. The best surgical training is obviously hands-on experience; however, a surgical reference is critical to prepare the novice student for the surgical experience and also for the veteran surgeon to review or expand his surgical repertoire. No drawing can capture the true appearance of the surgical scene, yet a photograph lacks the simplicity that is necessary for the teaching of a surgical procedure. Our strategy was to provide both line drawings and photographs of actual surgery to provide the most realistic presentation yet with the simplicity necessary for teaching new techniques.

Teaching surgical technique is the major goal of this atlas; however, background information such as muscle physiology and indications for surgery is provided when applicable. The atlas is intended to be a “how-to” book and to describe in detail the most effective specific surgical procedures rather than present a short overview of every surgical procedure. Throughout the atlas, surgical drawings and photographs present the surgeon’s view, with the upper lid at the bottom and lower lid at the top. The drawings and photographs of surgical procedures show the left eye unless otherwise stated.

The author would like to thank the other contributors, Dr. Laurie Christensen, Dr. Michael Repka, Dr. Burton Kushner, Dr. Monte Del Monte, and Dr. Malcolm Mazow for their excellent work. Acknowledgment must also go to Dr. Marshall M. Parks and Dr. David L. Guyton, under whom I was fortunate enough to train. Much of the material in this volume has come either directly or indirectly from their brilliant and innovative work. I would also like to express my sincere gratitude to the fellows who have so greatly influenced and improved my own surgical techniques: Doctors Andrea Lanier, Laurie Christensen, John McVey, and Andrew Terry. I would like to extend special thanks to Dr. Byng-Moo Min and Dr. Chan Park, visiting research fellows from Korea, and Dr. Ann U. Stout for their expert review of the manuscript. Finally, I would like to acknowledge the contributions from Margaret Brown-Multani, Surgical Technician, Children’s Hospital of Los Angeles; Paula Edelman, C.O., Children’s Hospital of Los Angeles, for clinical support; and my sister Lisa Wright for her long hours of editing, revising, and re-revising the manuscript.

Too often, strabismus surgery is referred to as “easy” and is often delegated in training programs to first-year residents. Strabismus surgery is easy when performed properly; however, the untrained surgeon has the potential to do more harm than good. It is the author’s sincere hope that this atlas will improve strabismus surgical techniques and ultimately benefit patients with strabismus.

Los Angeles, CA, USA

Kenneth W. Wright, MD



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## Acknowledgment

Thanks to the supporters of Wright Foundation for Pediatric Ophthalmology and Strabismus who help us with our mission:

*To reduce blindness and suffering from eye disorders in infants and children and to improve the treatment of strabismus through research, education, and clinical care.*

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# Contents

## Part I Management Strategies

<b>1</b>	<b>Amblyopia Treatment</b> . . . . .	3
1.1	Clear Retinal Image . . . . .	3
1.2	Correct Ocular Dominance . . . . .	4
1.2.1	Occlusion therapy . . . . .	4
1.2.2	Penalization therapy . . . . .	4
1.3	End Point for Amblyopia Treatment . . . . .	5
	References . . . . .	5
<b>2</b>	<b>Principles of Strabismus Surgery</b> . . . . .	7
2.1	Planning for Success . . . . .	7
2.2	Paradoxical Diplopia . . . . .	8
2.3	How Does Strabismus Surgery Work? . . . . .	8
2.4	Muscle Weakening Procedures (Recession and Central Tenotomy) . . . . .	9
2.4.1	Recession . . . . .	9
2.4.2	Central Tenotomy . . . . .	10
2.5	Muscle Tightening Procedures (Resection, Tuck, and Plication) . . . . .	10
2.5.1	Resection . . . . .	10
2.5.2	Tuck . . . . .	11
2.5.3	Plication . . . . .	11
2.6	Recession and Resection . . . . .	11
2.7	Faden . . . . .	12
2.8	Muscle Transposition . . . . .	12
	References . . . . .	12
<b>3</b>	<b>Infantile Esotropia</b> . . . . .	13
3.1	Small-Angle Neonatal Esotropia . . . . .	13
3.1.1	Clinical Features . . . . .	13
3.1.2	Etiology . . . . .	13
3.1.3	Clinical Evaluation . . . . .	13
3.1.4	Management . . . . .	13
3.2	Congenital Esotropia . . . . .	14
3.2.1	Clinical Features . . . . .	14
3.2.2	Etiology . . . . .	14
3.2.3	Preoperative Evaluation . . . . .	14
3.2.4	Management . . . . .	14
3.2.5	Prognosis of Congenital ET . . . . .	16
3.3	Ciancia's Syndrome (Cross-Fixation Congenital Esotropia) . . . . .	16
3.3.1	Clinical Features . . . . .	16
3.3.2	Etiology . . . . .	17
3.3.3	Preoperative Evaluation . . . . .	17
3.3.4	Management . . . . .	17

3.4	Infantile Accommodative Esotropia . . . . .	18
3.4.1	Clinical Features . . . . .	18
3.4.2	Etiology . . . . .	18
3.4.3	Clinical Evaluation. . . . .	18
3.4.4	Management. . . . .	18
3.5	Other Issues on Infantile Esotropia. . . . .	21
3.5.1	Möbius Syndrome . . . . .	21
3.5.2	Esotropia, Latent Nystagmus, and Face Turn . . . . .	21
3.5.3	Older Children and Adults with Infantile Esotropia . . . . .	22
3.5.4	Inferior Oblique Overaction. . . . .	22
3.5.5	Dissociated Strabismus: Dissociated Vertical Deviation and Dissociated Horizontal Deviation . . . . .	22
	References . . . . .	22
<b>4</b>	<b>Acquired Esotropia . . . . .</b>	<b>23</b>
4.1	Accommodative Esotropia . . . . .	23
4.1.1	Clinical Features . . . . .	23
4.1.2	Etiology . . . . .	23
4.1.3	Clinical Evaluation. . . . .	23
4.1.4	Management. . . . .	23
4.1.5	Responses to Hypermetropic Correction . . . . .	24
4.1.6	Surgery for Partially Accommodative Esotropia . . . . .	25
4.1.7	Miotics for Accommodative Esotropia . . . . .	26
4.1.8	Postoperative Management of Partially Accommodative Esotropia . . . . .	26
4.2	Non-accommodative Acquired Esotropia . . . . .	27
4.2.1	Clinical Features . . . . .	27
4.2.2	Differential Diagnosis . . . . .	27
4.2.3	Treatment . . . . .	27
4.3	Cyclic Esotropia . . . . .	27
4.3.1	Clinical Features . . . . .	27
4.3.2	Treatment . . . . .	27
4.4	Sensory Esotropia . . . . .	27
4.4.1	Clinical Evaluation. . . . .	27
4.4.2	Treatment . . . . .	28
	References . . . . .	28
<b>5</b>	<b>Exotropia . . . . .</b>	<b>29</b>
5.1	Intermittent Exotropia. . . . .	29
5.1.1	Clinical Features . . . . .	29
5.1.2	Etiology. . . . .	29
5.1.3	Clinical Evaluation . . . . .	29
5.1.4	Nonsurgical Treatment . . . . .	29
5.1.5	High Hypermetropia with Exotropia . . . . .	31
5.1.6	Preoperative Evaluation . . . . .	31
5.1.7	Surgical Treatment . . . . .	31
5.1.8	Classification of Intermittent Exotropia . . . . .	31
5.1.9	Intermittent Exotropia: Oblique Overaction and A and V Patterns . . . . .	33
5.1.10	Postoperative Management. . . . .	33
5.2	Sensory Exotropia. . . . .	34
5.3	Congenital Exotropia . . . . .	34
5.3.1	Clinical Features . . . . .	34
5.3.2	Etiology. . . . .	34
5.3.3	Treatment . . . . .	34
	Reference . . . . .	34

<b>6</b>	<b>Torticollis, Nystagmus, and Incomitant Strabismus</b> . . . . .	35
6.1	Torticollis: Compensatory Head Posturing . . . . .	35
6.1.1	Strabismic Torticollis . . . . .	35
6.2	Torticollis and Nystagmus . . . . .	38
6.2.1	Correcting Strabismus Associated with Nystagmus and Face Turn . . . . .	38
6.3	Manifest Latent Nystagmus with Esotropia and Face Turn . . . . .	39
6.3.1	Treatment . . . . .	39
6.4	Vertical and Torsional Head Posturing for Nystagmus . . . . .	39
6.4.1	Chin Elevation (Eyes are Down) . . . . .	39
6.4.2	Chin Depression (Eyes Are Up) . . . . .	39
6.4.3	Nystagmus with Head Tilt . . . . .	39
6.5	Nystagmus Without a Face Turn . . . . .	39
	References . . . . .	40
<b>7</b>	<b>Complex Strabismus</b> . . . . .	41
7.1	Duane's Syndrome . . . . .	41
7.1.1	Duane's Syndrome Type 1 (Esotropia) . . . . .	41
7.1.2	Duane's Syndrome Type 2 . . . . .	42
7.1.3	Duane's Syndrome Type 3 (Exotropia) . . . . .	42
7.1.4	Duane's Syndrome with Upshoot and Downshoot . . . . .	43
7.1.5	Synergistic Divergence . . . . .	43
7.2	Congenital Fibrosis Syndrome . . . . .	43
7.2.1	Treatment . . . . .	44
7.3	A-Patterns, V-Patterns, and Oblique Overaction . . . . .	44
7.4	Dissociated Strabismus Complex (DVD and DHD) . . . . .	44
7.4.1	Treatment . . . . .	44
7.5	Thyroid Strabismus . . . . .	45
7.5.1	Treatment: Hypotropia (Tight Inferior Rectus Muscle) . . . . .	45
7.6	Brown's Syndrome . . . . .	46
7.6.1	Clinical Features . . . . .	46
7.6.2	Congenital Brown's Syndrome . . . . .	46
7.6.3	Acquired Brown's Syndrome . . . . .	46
7.6.4	Canine Tooth Syndrome . . . . .	46
7.7	Double Elevator Palsy (Monocular Elevation Deficit Syndrome) . . . . .	48
7.7.1	Clinical Features . . . . .	48
7.7.2	Treatment . . . . .	48
7.8	Orbital Floor Fracture . . . . .	48
7.8.1	Tight Inferior Rectus, Restricted Elevation . . . . .	49
7.8.2	Pseudo-inferior Rectus Palsy, Limited Depression . . . . .	49
7.9	Strabismus Associated with Local Anesthetic Injection . . . . .	49
7.10	High Myopia and Esotropia . . . . .	50
7.10.1	Bilateral Myopia and Esotropia . . . . .	50
7.10.2	Heavy Eye Syndrome . . . . .	50
	References . . . . .	52
<b>8</b>	<b>Cranial Nerve Palsies</b> . . . . .	53
8.1	Superior Oblique Palsy . . . . .	53
8.1.1	Clinical Features . . . . .	53
8.1.2	Parks Three-Step Test . . . . .	53
8.1.3	Head Tilt Test Made Easy . . . . .	53
8.1.4	Unilateral Versus Bilateral Superior Oblique Paresis . . . . .	54
8.1.5	Congenital Superior Oblique Palsy . . . . .	55
8.1.6	Traumatic Superior Oblique Paresis . . . . .	56
8.1.7	Other Causes of Superior Oblique Paresis . . . . .	56
8.1.8	General Treatment Guidelines for Superior Oblique Paresis . . . . .	56

8.2	Sixth Nerve Palsy . . . . .	57
8.2.1	Initial Treatment . . . . .	57
8.2.2	Surgical Treatment . . . . .	57
8.2.3	Good Lateral Rectus Function . . . . .	58
8.2.4	Fair Lateral Rectus Function. . . . .	58
8.2.5	Poor Lateral Rectus Function . . . . .	58
8.3	Third Nerve Palsy . . . . .	59
8.3.1	Surgery for Complete Third Nerve Palsy (Exotropia and Hypotropia) . . . . .	59
8.4	Inferior Oblique Paresis . . . . .	59
8.4.1	Clinical Features . . . . .	59
8.4.2	Right Congenital Inferior Oblique Palsy . . . . .	60
	References . . . . .	60

## Part II Surgical Techniques

<b>9</b>	<b>Surgical Anatomy</b> . . . . .	63
9.1	Muscle Measurements . . . . .	63
9.2	Conjunctiva . . . . .	63
9.3	Subconjunctival Fascia . . . . .	64
9.3.1	Muscle Pulley System: Muscle Sleeve . . . . .	64
9.4	Fat Adherence . . . . .	66
9.5	Individual Muscles . . . . .	67
9.5.1	Medial Rectus . . . . .	67
9.5.2	Lateral Rectus . . . . .	67
9.5.3	Inferior Rectus . . . . .	68
9.5.4	Superior Rectus. . . . .	69
9.5.5	Inferior Oblique . . . . .	70
9.5.6	Superior Oblique. . . . .	71
9.6	Vascular Supply and Anterior Segment Ischemia. . . . .	72
	References . . . . .	72
<b>10</b>	<b>Basic Surgical Techniques (Dos and Don'ts)</b> . . . . .	73
10.1	Setup and Exposure . . . . .	73
10.2	Preventing Infection . . . . .	73
10.3	Incision Options . . . . .	74
10.3.1	Limbal Incision . . . . .	74
10.3.2	Fornix or Cul-de-Sac Incision . . . . .	75
10.3.3	Swan Incision . . . . .	75
10.3.4	Combination Fornix-Swan Incision . . . . .	75
10.4	Hooking a Rectus Muscle. . . . .	76
10.5	Muscle Dissection . . . . .	77
10.6	Muscle Suturing Techniques . . . . .	77
10.6.1	Wright Grooved Hook . . . . .	79
10.7	Scleral Needle Pass . . . . .	79
10.7.1	Black Needle for Scleral Pass . . . . .	80
10.8	Pearls for Muscle Recession. . . . .	81
10.8.1	Central Muscle Sag . . . . .	81
10.8.2	Loose Pole Suture. . . . .	81
10.9	Forced Duction Testing . . . . .	82
10.9.1	Rectus Muscles. . . . .	82
10.9.2	Oblique Muscles. . . . .	83
	References . . . . .	85

<b>11</b>	<b>Rectus Muscle Recession</b> . . . . .	87
11.1	Fornix Surgery . . . . .	87
11.1.1	Surgical Technique . . . . .	87
11.2	Limbal Surgery . . . . .	87
11.2.1	Surgical Technique . . . . .	87
11.2.2	Dellen Formation . . . . .	87
11.3	Hang-Back Technique . . . . .	89
11.4	Vertical Rectus Muscle Recession . . . . .	90
11.4.1	Superior Rectus Muscle . . . . .	90
11.4.2	Inferior Rectus Muscle . . . . .	91
11.4.3	Lower Lid Retractor Disinsertion . . . . .	92
<b>12</b>	<b>Topical Anesthesia Strabismus Surgery</b> . . . . .	103
12.1	Principles for Avoiding Pain . . . . .	103
12.2	Topical Anesthesia Technique for Rectus Muscle Recession . . . . .	104
	Reference . . . . .	106
<b>13</b>	<b>Adjustable Suture Technique</b> . . . . .	107
13.1	Patient Selection . . . . .	107
13.2	Initial Anesthesia Considerations . . . . .	107
13.3	Surgical Techniques . . . . .	107
13.3.1	Limbal Versus Fornix Approach . . . . .	108
13.3.2	Limbal Approach: Sliding Noose Technique . . . . .	108
13.3.3	Fornix Approach: Sliding Noose Technique . . . . .	110
13.3.4	Bow-tie Technique . . . . .	110
13.4	Pearls for Postoperative Adjustment . . . . .	110
13.4.1	Adjustment . . . . .	110
13.4.2	Anticipating Postoperative Drift . . . . .	112
13.5	Complications . . . . .	113
13.6	Preventing Late Overcorrection . . . . .	113
	References . . . . .	118
<b>14</b>	<b>Rectus Muscle Tightening Procedures</b> . . . . .	119
14.1	Rectus Muscle Resection . . . . .	119
14.2	Single-Suture Resection: Fornix Approach . . . . .	119
14.3	Double-Suture Resection . . . . .	123
14.4	Wright Plication: Rectus Muscle–Scleral Plication (Vessel Sparing) . . . . .	123
14.5	Left Medial Rectus Plication: Fornix Incision . . . . .	124
	References . . . . .	125
<b>15</b>	<b>Horizontal Rectus Muscle Offsets and the Y-Splitting Procedure</b> . . . . .	127
15.1	Horizontal Rectus Muscle Transpositions for A and V Patterns . . . . .	127
15.2	Horizontal Rectus Muscle Transpositions for Vertical Strabismus . . . . .	127
15.3	Rectus Muscle Transpositions for Torsion . . . . .	128
15.4	Y-Splitting of the Lateral Rectus Muscle for Duane’s Retraction Syndrome . . . . .	128
<b>16</b>	<b>Transposition Surgery for Rectus Muscle Palsy</b> . . . . .	131
16.1	Knapp Procedure . . . . .	131
16.2	Jensen Procedure . . . . .	131
16.3	Hummelsheim Procedure . . . . .	133
16.3.1	Modifications of Transpositions . . . . .	133
16.4	Complications . . . . .	134
	References . . . . .	134

<b>17</b>	<b>Inferior Oblique Muscle Weakening Procedures</b> . . . . .	135
17.1	Quantification of Inferior Oblique Overaction. . . . .	135
17.2	Indications for Surgery. . . . .	135
17.3	Making Procedural Choices . . . . .	135
17.4	Anteriorization Procedure . . . . .	136
17.4.1	Graded Recession: Anteriorization. . . . .	137
17.4.2	“J” Deformity Anteriorization . . . . .	137
17.4.3	Effect of Inferior Oblique Weakening on Horizontal Deviation . . .	138
17.5	Surgical Technique. . . . .	138
17.5.1	Inferior Oblique Anteriorization, Left Eye. . . . .	138
17.5.2	Myectomy. . . . .	138
17.5.3	Extirpation/Denervation of the Inferior Oblique Muscle. . . . .	138
17.6	Complications. . . . .	138
	References . . . . .	146
<b>18</b>	<b>Superior Oblique Tendon Tightening Procedures</b> . . . . .	147
18.1	Physiology of Superior Oblique Tendon Tightening Procedures. . . . .	147
18.1.1	Full Tendon Tuck . . . . .	147
18.1.2	Harada-Ito Procedure . . . . .	147
18.2	Surgical Techniques: Isolation and Exposure of the Superior Oblique Tendon . . . . .	148
18.3	Harada-Ito Procedure . . . . .	148
18.3.1	Disinsertion Harada-Ito Technique. . . . .	148
18.3.2	Classic Harada-Ito Technique. . . . .	153
18.4	Full-Tendon Superior Oblique Tuck. . . . .	154
18.5	Superior Oblique Tendon Plication . . . . .	154
<b>19</b>	<b>Superior Oblique Tendon Weakening Procedures</b> . . . . .	161
19.1	Surgical Exposure for Superior Oblique Tendon Weakening. . . . .	161
19.1.1	Operative Procedure: Temporal Incision–Nasal Tendon Surgery . .	162
19.2	Superior Oblique Tenotomy . . . . .	162
19.3	Silicone Tendon Expander (Wright Procedure) . . . . .	162
19.3.1	The Superior Oblique Silicone Tendon Expander . . . . .	162
19.3.2	Operative Procedure . . . . .	162
19.4	Split Tendon Elongation. . . . .	163
19.5	Posterior Tenectomy. . . . .	164
19.6	Complications. . . . .	164
	References . . . . .	169
<b>20</b>	<b>Faden Operation (Posterior Fixation Suture)</b> . . . . .	171
20.1	How a Faden Works . . . . .	171
20.2	Indications for Faden Operation. . . . .	171
20.2.1	Sixth Nerve Paresis. . . . .	172
20.2.2	High AC/A Ratio . . . . .	172
20.2.3	Other Indications . . . . .	172
20.3	Surgical Techniques . . . . .	172
20.3.1	Faden with Rectus Recession. . . . .	172
20.3.2	Faden Without Recession. . . . .	172
20.4	Complications. . . . .	172

<b>21 Reoperation Techniques</b> .....	177
21.1 Muscle Dehiscence: Lost Muscle, Slipped Muscle, and Stretched Scar ....	177
21.1.1 Slipped Muscle.....	177
21.1.2 Lost Muscle .....	178
21.1.3 Stretched Scar.....	178
21.2 Surgery for a Lost Medial Rectus Muscle .....	179
21.3 Surgery for Stretched Scar .....	180
21.4 Pearls for Reoperation: Rectus Dehiscence .....	180
21.5 Strabismus After Retinal Detachment Surgery .....	181
21.5.1 Causes of Strabismus .....	181
21.5.2 Surgical Approach for Strabismus After Retinal Detachment Surgery .....	181
21.6 Pearls for Strabismus After Retinal Detachment Surgery .....	182
21.7 Amniotic Membrane Transplant for Restrictive Strabismus .....	183
21.7.1 Surgical Technique .....	184
References .....	185
<b>22 Minimally Invasive Strabismus Surgery</b> .....	187
22.1 Central Muscle-Sclera Plication.....	187
22.2 Central Tenotomy.....	187
References .....	189
<b>Erratum</b> .....	E1
<b>Appendix A: Surgical Numbers</b> .....	191
A.1 Binocular Surgery.....	191
A.2 Monocular Surgery.....	191
A.3 Three Muscle Surgery .....	192
A.4 Vertical Numbers .....	192
A.5 Kestenbaum Procedure for Nystagmus .....	192
A.5.1 Face Turn to the Right .....	192
References .....	192
<b>Appendix B: Anesthesia</b> .....	193
<b>Appendix C: Instruments for Muscle Surgery</b> .....	195
C.1 Instruments for Muscle Surgery.....	195
C.2 Sutures .....	195
C.3 Magnification Light Source .....	195
<b>Appendix D: Postoperative Care</b> .....	197
D.1 Immediate Recovery.....	197
D.2 Outpatient Follow-Up.....	197
<b>Index</b> .....	199



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**Part I**

**Management Strategies**

Amblyopia is poor vision caused by abnormal visual stimulation during early visual development. The abnormal visual stimulation disrupts neurodevelopment of visual centers in the brain. Abnormal stimulation can arise from a blurred retinal image, or strabismus with strong fixation preference for one eye and cortical suppression of the nondominant eye. Children under 8 years of age are capable of strong cortical suppression and hence can eliminate double vision. Children who alternate fixation and use either eye will alternate suppression and do not develop amblyopia. The **vertical prism induced tropia test** can be used to determine fixation preference and diagnose unilateral amblyopia in preverbal children with straight eyes or small-angle strabismus [1]. This test is performed by placing a vertically oriented 10 PD prism over one eye, either base down or base up. The vertical prism induces a hypertropia, allowing evaluation of fixation preference. Strong fixation preference for one eye is indicative of amblyopia [2]. Amblyopia can be bilateral in children with bilateral blurred retinal images (e.g., bilateral congenital cataracts, or bilateral high hypermetropia >+5.00 sphere).

Vision is the foremost priority in ophthalmology, so strabismic children with amblyopia should have the amblyopia treated prior to strabismus surgery. After strabismus surgery, the parents often assume that all is well, and will default follow-up appointments. Thus our best chance for treating amblyopia is before strabismus surgery. An exception to this rule is amblyopia associated with large-angle esotropia, with the amblyopic eye fixed in adduction (**strabismus fixus**) so the visual axis is occluded. Part of the amblyopia treatment is to operate on the amblyopic eye to bring it into primary position, to clear the visual axis and allow occlusion therapy.

Amblyopia therapy works best when initiated in children under 3 years of age, but even older children up to 8 or 9 years of age can show visual acuity improvement with diligent

amblyopia therapy. Visual acuity improvement has been documented when children are treated in late childhood, after 8 years of age, especially in those children with no history of prior amblyopia treatment [3]. It is also important to monitor children after strabismus surgery for the development of amblyopia until the ages of 8–9 years. There are two basic strategies to treat amblyopia:

1. Provide a clear retinal image.
2. Correct ocular dominance.

## 1.1 Clear Retinal Image

The first goal of amblyopia therapy is to ensure the presence of a clear retinal image. A careful **cycloplegic refraction** is required for all children with amblyopia and strabismus. Topical cyclopentolate 1 % with tropicamide 1 % given twice can achieve adequate cycloplegia for most patients. Patients with densely pigmented irides may require multiple drops, or even atropine 1 % given twice a day for 3 days if retinoscopy shows variable readings.

Table 1.1 lists refractive errors that are potentially amblyogenic and need correction. Prescribing spectacles for patients with accommodative esotropia is covered in Chap. 4. Patients with straight eyes and anisometropic amblyopia usually have some degree of peripheral fusion. These patients often show significant improvement of visual acuity with optical correction alone, even

**Table 1.1** When is a refractive error amblyogenic?

Type of amblyopia	Refractive error requiring correction <sup>a</sup>
Hypermetropic anisometropia	>+1.50 D of anisometropia
Myopic anisometropia	>−4.00 D of anisometropia
Astigmatic anisometropia	>+1.50 D anisometropia
Bilateral hypermetropia	>+5.00 D OU
Bilateral astigmatism	>+2.50 D OU

<sup>a</sup>These are only suggestions for prescribing spectacles in children, based on the cycloplegic refraction. Decisions on whether or not to treat a specific refractive error should be based on the whole clinical picture, including visual acuity when attainable

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without occlusion therapy. As a rule, give the full hypermetropic correction to the amblyopic eye, because amblyopic eyes do not fully accommodate. If the good eye is mildly hyperopic (+0.75 to +1.50 sphere) it is advisable not to give the full plus to the good eye, as doing so will blur the vision and the child may not wear the spectacles (see Example 1.1). The key is that the spectacles must be worn full time—even in the bathtub or swimming pool!

### Example 1.1

#### Anisometropic Amblyopia

3-year-old

VA:

OD 20/25

OS 20/100

Cycloplegic refraction:

OD +1.00 sphere

OS +3.50 sphere

Stereo acuity without correction: 400 s arc (1/3 animals Titmus test)

Alignment: Orthotropia for distance and near

**Diagnosis:** Anisometropic amblyopia OS with good binocular function

**Treatment:** Prescribe spectacles:

OD +0.50 sphere

OS +3.00 sphere

Note that the plus was slightly reduced to facilitate tolerance for spectacle use. Patient to return every 4 weeks to monitor visual acuity improvement. If improvement plateaus, then start part-time occlusion of the right eye 3–5 h a day.

Patients with bilateral high hypermetropia ( $>+5.00$  sphere) will have bilateral amblyopia. These patients are so hypermetropic that they do not fully accommodate and they do not typically develop accommodative esotropia. They require full hypermetropic correction to provide a clear retinal image and treat the amblyopia (see Example 1.2).

### Example 1.2

#### Bilateral Hypermetropic Amblyopia

5-year-old

VA: 20/200 OU

Cycloplegic refraction: +8.00 sphere OU

Alignment: Orthotropia for distance and near

**Treatment:** Prescribe spectacles with the full plus +8.00 sphere OU.

Note that patients with bilateral high hypermetropic amblyopia will not fully accommodate, so they need their full plus correction to provide a clear retinal image. These patients usually have straight eyes and do not typically have accommodative esotropia as they hypoaccommodate.

## 1.2 Correct Ocular Dominance

Patients with unilateral amblyopia will have strong dominance for the “good eye” and will suppress the amblyopic eye. Part of the strategy to treat amblyopia is to stimulate the amblyopic eye by forcing fixation to the amblyopic eye. There are two ways to switch fixation to the amblyopic eye: (1) occlude the dominant eye, and (2) blur the vision of the dominant eye (penalization).

### 1.2.1 Occlusion therapy

Occlusion therapy consists of patching the sound eye to force fixation to the amblyopic eye. For patients with binocular fusion and amblyopia (e.g., intermittent esotropia and anisometropic amblyopia), part-time occlusion therapy is preferred over full-time in order to maintain binocular fusion. If the child has a constant esotropia and no fusion (e.g., congenital esotropia), then full-time occlusion can be done. Follow-up visits for full-time occlusion therapy should be scheduled at intervals of 1 week per year of the child’s age. For example, a 2-year-old should be checked every 2 weeks to examine the good eye for occlusion-induced amblyopia in addition to monitoring visual improvement of the amblyopic eye. In children less than 1 year of age, part-time occlusion for half of the waking hours is suggested, to avoid the complication of occlusion amblyopia of the good eye.

### 1.2.2 Penalization therapy

Penalization works by blurring the image of the sound eye to force fixation to the amblyopic eye. Blurring of the sound eye can be accomplished by adhesive tape on the spectacle lens, a blurring optical lens, or by atropine drops if the “good eye” is hypermetropic. Atropine penalization consists of instilling one drop of atropine 1 % in the sound eye each day and removing the optical correction of the sound eye while full optical correction is given to the amblyopic eye. If the cycloplegia of the good eye blurs the vision enough to switch fixation to the amblyopic eye, then atropine penalization will usually improve vision [4]. The vertical prism induced tropia test can be used to determine which eye is fixating. The “good eye” must be hypermetropic (at least +2.00 sphere) in order for atropine cycloplegia to blur the vision enough to force fixation to the amblyopic eye, at least for near targets (see Example 1.3). Atropine has been reported to have a beneficial effect for patients between the ages of 3 and 7 years and with acuity of 20/40 to 20/100 [5]. When atropine penalization works, it can provide strong antisuppression therapy, which may result in reverse amblyopia and loss of vision of the sound eye. To avoid reverse amblyopia, patients should be followed closely at intervals of 1 week per year of the patient’s age, not to exceed 3 weeks. Stop penalization if visual acuity in the “good eye” decreases.



**Fig. 1.1** Atropine penalization of left eye. Left eye is treated with atropine 1 % every day and removal of optical correction. Note that the left pupil is dilated and the spectacle lens has been removed

#### Example 1.3

##### Penalization (see Fig. 1.1)

5-year-old, patching failure

VA:

OD 20/200

OS 20/30

Cycloplegic refraction:

OD +5.50 sphere

OS +3.00 sphere

Stereo acuity without correction: 3,000 s arc  
(Positive fly Titmus test)

Alignment: Orthotropia for distance and near

**Diagnosis:** Dense amblyopia, patching failure

**Treatment:** Optical correction right eye; no correction left eye and atropine drops once a day:

OD +5.50 sphere

OS plano + Atropine 1 % every day

Note: The goal is to blur the vision of the “good eye” (left eye) with atropine and no optical correction in order to switch fixation to the amblyopic eye (right eye), which has full optical correction. If atropine penalization induces a switch in fixation to the amblyopic eye, then vision will improve. If the patient continues to fixate with the atropinized good eye, then vision in the amblyopic eye will not improve. In these cases, patching plus atropine penalization may be effective. Note that for atropine penalization to work, the “good eye” must be significantly hypermetropic (>+2.00 sphere).

### 1.3 End Point for Amblyopia Treatment

Amblyopia treatment is usually continued until vision in the amblyopic eye improves to within 1 or 2 Snellen lines of the sound eye. After improvement is achieved, maintenance therapy consisting of part-time occlusion of the sound eye for 1–2 h a day may be necessary until the patient is 7–8 years old. Patients with anisometropic amblyopia and binocular fusion tend to maintain their vision after being treated, even without maintenance occlusion therapy, as long as optical correction is continued.

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## 2.1 Planning for Success

Prior to strabismus surgery, an important and seemingly obvious question should be asked: “Why are we operating?” Is our treatment goal to establish binocular fusion, eliminate diplopia, expand the field of binocular vision, correct a compensatory head posture, or simply to improve cosmetic appearance? Establishing the goals prior to surgery helps us clarify indications for surgery, and formulate a logical treatment plan. The plan that is made should be the one that is best for the patient—not just the plan that is best for correcting the angle of deviation.

The indications for surgery should be based on the patient’s needs: either binocular function or cosmetic appearance (Table 2.1). Urgent surgery is indicated to reestablish binocular fusion in a child with an esophoria that has recently broken down to a tropia. The family should be told that surgery is

indicated to regain binocular fusion and not just to improve the cosmetic appearance. In contrast, surgery for a long-standing sensory esotropia secondary to a blind eye is cosmetic, as there is virtually no potential for binocular fusion. In this case, the indication for surgery should be based on the cosmetic desires of the patient. In some cases, it may be difficult (or even impossible) to determine the binocular potential. For example, an older child with equal vision and a history of esotropia since infancy may or may not have binocular fusion potential. I tend to give these patients the benefit of the doubt and treat them as if they have fusion potential.

Understanding the functional goal also helps direct the surgical plan. Esotropic patients with fusion potential generally require large amounts of surgery, more than the standard surgical numbers (see Chap. 4). A plan based on standard surgery in these patients routinely results in undercorrection. Esotropic patients without binocular fusion potential are ill served by planning for “more” surgery, however, as a consecutive exotropia will inevitably increase over time, and an exotropia is a poor cosmetic outcome. In these patients without fusion potential, it is better to do less surgery, as a small residual esotropia is more stable and has a better appearance than a consecutive exotropia. Consideration of the functional outcome also influences the selection of the type of surgery. Monocular recession-resection surgery produces incomitance, which is not optimal in a fusing patient, as incomitance can cause diplopia in eccentric positions of gaze. Monocular surgery on the blind eye, however, is the procedure of choice for sensory strabismus, to protect the only seeing good eye. These are but a few examples that demonstrate the importance of considering the potential for binocular fusion when planning strabismus surgery. Table 2.2 lists some important signs that indicate the potential for binocular fusion.

Prior to surgery, it is helpful to establish a specific strabismus diagnosis. Most cases of strabismus can be classified into a type, such as partially accommodative esotropia, intermittent exotropia, Duane’s syndrome—esotropia type 1, congenital superior oblique palsy, or Brown’s syndrome. At times, it may be difficult to determine the exact etiology of

**Table 2.1** Indications for strabismus surgery

<i>Binocular function</i>	
Establish binocular fusion	
<ol style="list-style-type: none"> <li>1. Early surgery infantile esotropia</li> <li>2. Partially accommodative esotropia</li> <li>3. Decompensated intermittent exotropia</li> </ol>	
Binocular diplopia	
<ol style="list-style-type: none"> <li>1. Acquired incomitant strabismus (restriction or paresis)</li> <li>2. Acquired comitant strabismus</li> <li>3. Postoperative anomalous retinal correspondence—paradoxical diplopia</li> </ol>	
Binocular field	
<ol style="list-style-type: none"> <li>1. Expand binocular visual field</li> <li>2. Correct face turn or head tilt (associated with nystagmus or incomitant strabismus)</li> </ol>	
<i>Cosmetic appearance</i>	
<ol style="list-style-type: none"> <li>1. Sensory strabismus (associated with unilateral poor vision or dense amblyopia)</li> <li>2. Long-standing infantile strabismus (late surgery for congenital esotropia)</li> <li>3. Lid fissure changes (Duane’s syndrome III co-contraction)</li> </ol>	