

MEDICAL DEVICES

Surgical and Image-Guided Technologies

EDITED BY

MARTIN CULJAT • RAHUL SINGH • HUA LEE



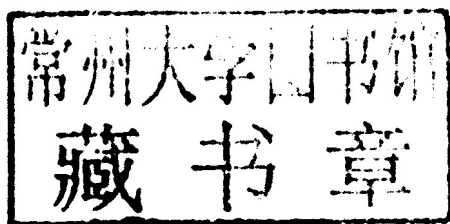
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MEDICAL DEVICES

PREFACE

Recent decades have seen considerable advances in the development of medical devices and technologies. Innovations in instrumentation, implantable devices, and imaging systems have led to new diagnostic and therapeutic techniques and even new medical disciplines. Because of these and other advances in medicine, an increasing number of conditions can now be treated and patient outcomes continue to improve. Researchers, engineers, and clinicians in the biomedical engineering field are now developing the next generation of technologies that will enable procedures never imagined and make modern medicine accessible to more people worldwide. A challenge is to realize these innovations while reducing rather than increasing the cost of health care.

This book is intended primarily for the growing number of undergraduates, graduate students, medical students, and researchers who are interested in medical device design. Currently, there is a lack of concise, modern, device-focused texts that are written for such an audience. As the complexity of medical technologies continues to increase, there will be an acute need for individuals with the knowledge and skills necessary to lead this growing field.

The content of this text was inspired by research activities at the UCLA Center for Advanced Surgical and Interventional Technology (CASIT). To gauge a preliminary assessment of the effectiveness of this book's technical coverage, the editors and several of the authors participated in a one-quarter seminar course at the UC, Santa Barbara during the fall of 2008, receiving superb ratings and reviews. The class attracted students from all engineering majors, as well as the pre-med program, with a breadth of audience and interest level that this book carries through gracefully.

The technical content in this book is presented in a comprehensive manner, consistent with junior/senior undergraduate and first-year graduate students' background level in mathematics, physics, chemistry, and biology. The chapters are written and organized in the form of independent modules, such that lectures can be configured with a high degree of flexibility from year to year. Each chapter was written by one or more clinical or engineering experts, primarily from the fields of biomedical engineering, electrical engineering, mechanical engineering, computer science, surgery, and radiology.

The book is organized into five sections, each with a separate focus. The first section *Introduction to Medical Devices* features two chapters. Chapter 1 provides a brief introduction on the history, future, and terminology related to medical devices, and Chapter 2 provides a thorough overview of factors to consider

during the medical device design process, including topics such as regulatory affairs and manufacturing. The second section focuses on *Minimally Invasive Devices and Techniques* and features four chapters. Chapter 3 discusses principles and tools of laparoscopic surgery, Chapter 4 describes minimally invasive techniques in ophthalmology, Chapter 5 discusses surgical robotics and their application to minimally invasive surgery, and Chapter 6 describes interventional applications of catheters and catheter technologies. *Energy Delivery Devices and Systems* are described in the third section. This section contains chapters on electrosurgical tools used for cautery and coagulation of tissues (Chapter 7), devices used to ablate tissues such as tumors (Chapter 8), and lasers and their application to medicine (Chapter 9). The fourth section, *Implantable Devices and Systems* features chapters on implantable devices for vascular and cardiovascular procedures (Chapter 10), circulatory assist devices for heart failure (Chapter 11), and orthopedic implants, such as hip replacements and spinal fusion devices (Chapter 12). The final section covers *Imaging and Image-Guided Techniques* and includes four chapters. Chapter 13 focuses on endoscopic devices and systems for minimally invasive procedures; Chapter 14 on ultrasound devices used for both imaging and therapy; Chapter 15 on X-ray imaging technologies, including fluoroscopy, mammography, and computed tomography (CT); and Chapter 16 on techniques for image fusion and image-guided navigation of instruments during neurosurgery.

This book does not attempt to cover all of the medical devices and technologies in use today. Instead, the chapters were carefully selected such that a broad spectrum of representative topics in biomedical engineering could be discussed comprehensively. These topics are highly relevant to the state-of-the-art minimally invasive, image-guided, and interventional techniques that are used today.

The editors would like to thank everyone at the CASIT for their input into the development of this project. Additional thanks goes to Ms. Susan Ly for her assistance with copy editing.

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CONTENTS

PREFACE	xvii
CONTRIBUTORS	xix
PART I INTRODUCTION TO MEDICAL DEVICES	1
1. Introduction	3
<i>Martin Culjat</i>	
1.1 History of Medical Devices	3
1.2 Medical Device Terminology	6
1.3 Purpose of the Book	10
2. Design of Medical Devices	11
<i>Gregory Nighswonger</i>	
2.1 Introduction	11
2.2 The Medical Device Design Environment	11
2.2.1 US Regulation	12
2.2.2 Differences in European Regulation	13
2.2.3 Standards	14
2.3 Basic Design Phases	15
2.3.1 Feasibility	15
2.3.2 Planning and Organization—Assembling the Design Team	16
2.3.3 When to Involve Regulatory Affairs	17
2.3.4 Conceptualizing and Review	17
2.3.5 Testing and Refinement	20
2.3.6 Proving the Concept	20
2.3.7 Pilot Testing and Release to Manufacturing	22
2.4 Postmarket Activities	25
2.5 Final Note	25

PART II MINIMALLY INVASIVE DEVICES AND TECHNIQUES	27
3. Instrumentation for Laparoscopic Surgery	29
<i>Camellia Racu-Keefer, Scott Um, Martin Culjat, and Erik Dutson</i>	
3.1 Introduction	29
3.2 Basic Principles	31
3.3 Laparoscopic Instrumentation	34
3.3.1 Trocars	34
3.3.2 Standard Laparoscopic Instruments	37
3.3.3 Additional Laparoscopic Instruments	42
3.3.4 Specimen Retrieval Bags	44
3.3.5 Disposable Instruments	44
3.4 Innovative Applications	45
3.5 Summary and Future Applications	46
4. Surgical Instruments in Ophthalmology	49
<i>Allen Y. Hu, Robert M. Beardsley, and Jean-Pierre Hubschman</i>	
4.1 Introduction	49
4.2 Cataract Surgery	51
4.2.1 Basic Technique	51
4.2.2 Principles of Phacoemulsification	52
4.2.3 Phacoemulsification Instruments	54
4.2.4 Phacoemulsification Systems	55
4.2.5 Future Directions	56
4.3 Vitreoretinal Surgery	56
4.3.1 Basic Techniques	56
4.3.2 Principles of Vitrectomy	57
4.3.3 Vitrectomy Instruments	58
4.3.4 Vitrectomy Systems	60
4.3.5 Future Directions	60
4.4 Other Ophthalmic Surgical Procedures	61
4.5 Conclusion	62
5. Surgical Robotics	63
<i>Jacob Rosen</i>	
5.1 Introduction	63

5.2	Background and Leading Concepts	63
5.2.1	Human–Machine Interfaces: System Approach	65
5.2.2	Tissue Biomechanics	70
5.2.3	Teleoperation	72
5.2.4	Image-Guided Surgery	78
5.2.5	Objective Assessment of Skill	79
5.3	Commercial Systems	80
5.3.1	ROBODOC® (Curexo Technology Corporation)	80
5.3.2	daVinci (Intuitive Surgical)	83
5.3.3	Sensei® X (Hansen Medical)	84
5.3.4	RIO® MAKOpasty (MAKO Surgical Corporation)	86
5.3.5	CyberKnife (Accuray)	89
5.3.6	Renaissance™ (Mazor Robotics)	91
5.3.7	ARTAS® System (Restoration Robotics, Inc.)	92
5.4	Trends and Future Directions	93

6. Catheters in Vascular Therapy **99**

Axel Boese

6.1	Introduction	99
6.2	Historic Overview	100
6.3	Catheter Interventions	102
6.4	Catheter and Guide Wire Shapes and Configurations	105
6.4.1	Catheters	105
6.4.2	Guide Wires	113
6.5	Conclusion	116

PART III ENERGY DELIVERY DEVICES AND SYSTEMS **119**

7. Energy-Based Hemostatic Surgical Devices **121**

Amit P. Mulgaonkar, Warren Grundfest, and Rahul Singh

7.1	Introduction	121
7.2	History of Energy-Based Hemostasis	122

7.3	Energy-Based Surgical Methods and Their Effects on Tissues	125
7.3.1	Disambiguation	126
7.3.2	Thermal Effects on Tissues	127
7.4	Electrosurgery	128
7.4.1	Electrosurgical Theory	128
7.4.2	Cutting and Coagulation Techniques	130
7.4.3	Equipment	131
7.4.4	Considerations and Complications	133
7.5	Future Of Electrosurgery	134
7.6	Conclusion	135
8.	Tissue Ablation Systems	137
	<i>Michael Douek, Justin McWilliams, and David Lu</i>	
8.1	Introduction	137
8.2	Evolving Paradigms in Cancer Therapy	138
8.3	Basic Ablation Categories and Nomenclature	140
8.4	Hyperthermic Ablation	140
8.5	Fundamentals of <i>In Vivo</i> Energy Deposition	141
8.6	Hyperthermic Ablation: Optimizing Tissue Ablation	143
8.7	Radiofrequency Ablation	144
8.8	RFA: Basic Principles	145
8.9	RFA: <i>In Vivo</i> Energy Deposition	145
8.10	Optimizing RFA	147
8.11	Other Hyperthermic Ablation Techniques	149
8.11.1	Microwave Ablation (MWA)	149
8.11.2	MWA: Basic Principles	149
8.11.3	MWA: <i>In Vivo</i> Energy Deposition	151
8.11.4	Optimizing MWA	152
8.12	Laser Ablation	153
8.13	Hypothermic Ablation	154
8.13.1	Cryoablation: Basic Concepts	154
8.13.2	Cryoablation: <i>In Vivo</i> Considerations	154
8.13.3	Optimizing Cryoablation Systems	154

8.14	Chemical Ablation	157
8.15	Novel Techniques	158
8.15.1	High Intensity Focused Ultrasound (HIFU)	158
8.15.2	Irreversible Electroporation (IRE)	159
8.16	Tumor Ablation and Beyond	160

9. Lasers in Medicine **163**

Zachary Taylor, Asael Papour, Oscar Stafsudd, and Warren Grundfest

9.1	Introduction	163
9.1.1	Historical Perspective	164
9.1.2	Basic Operational Concepts	165
9.1.3	First Experimental MASER (Microwave Amplification by Stimulated Emission of Radiation)	166
9.2	Laser Fundamentals	167
9.2.1	Two-Level Systems and Population Inversion	167
9.2.2	Multiple Energy Levels	167
9.2.3	Mode of Operation	169
9.2.4	Beams and Optics	171
9.3	Laser Light Compared to Other Sources of Light	174
9.3.1	Temporal Coherence	174
9.3.2	Spectral Coherence (Line Width)	175
9.3.3	Beam Collimation	177
9.3.4	Short Pulse Duration	177
9.3.5	Summary	178
9.4	Laser–Tissue Interactions	178
9.4.1	Biostimulation	178
9.4.2	Photochemical Interactions	179
9.4.3	Photothermal Interactions	180
9.4.4	Ablation	180
9.4.5	Photodisruption	181
9.5	Lasers in Diagnostics	181
9.5.1	Optical Coherence Tomography	181
9.5.2	Fluorescence Angiography	184
9.5.3	Near Infrared Spectroscopy	185

9.6	Laser Treatments and Therapy	186
9.6.1	Overview of Current Medical Applications of Laser Technology	186
9.6.2	Retinal Photodynamic Therapy (Photochemical)	188
9.6.3	Transpupillary Thermal Therapy (TTT) (Photothermal)	188
9.6.4	Vascular Birth Marks (Photocoagulation)	190
9.6.5	Laser Assisted Corneal Refractive Surgery (Ablation)	191
9.7	Conclusions	196

PART IV IMPLANTABLE DEVICES AND SYSTEMS 197

10. Vascular and Cardiovascular Devices 199

Dan Levi, Allan Tulloch, John Ho, Colin Kealey, and David Rigberg

10.1	Introduction	199
10.2	Biocompatibility Considerations	200
10.3	Materials	202
10.3.1	316L Stainless Steel	203
10.3.2	Nitinol	203
10.3.3	Cobalt–Chromium Alloys	204
10.4	Stents	204
10.5	Closure Devices	206
10.6	Transcatheter Heart Valves	208
10.7	Inferior Vena Cava Filters	212
10.8	Future Directions—Thin Film Nitinol	214
10.9	Conclusion	216

11. Mechanical Circulatory Support Devices 219

Colin Kealey, Paymon Rahgozar, and Murray Kwon

11.1	Introduction	219
11.2	History	220
11.3	Basic Principles	221
11.3.1	Biocompatibility and Mechanical Circulatory Support Devices	221

11.3.2	Hemocompatibility: Microscopic Considerations	222
11.3.3	Hemocompatibility: Macroscopic Considerations	223
11.4	Engineering Considerations in Mechanical Circulatory Support	223
11.4.1	Overview	223
11.4.2	Pump Design	225
11.4.3	Positive Displacement Pumps	225
11.4.4	Rotary Pumps	226
11.4.5	Pulsatile Versus Nonpulsatile Flow	228
11.5	Devices	228
11.5.1	The HeartMate XVE Left Ventricular Assist System	228
11.5.2	The HeartMate II Left Ventricular Assist System	231
11.5.3	Short-Term Mechanical Circulatory Support: The Intraaortic Balloon Pump	234
11.5.4	Pediatric Mechanical Circulatory Support: The Berlin Heart	237
11.6	The Future of MCS Devices	239
11.6.1	CorAide	239
11.6.2	HeartMate III	239
11.6.3	HeartWare	240
11.6.4	VentrAssist	240
11.7	Summary	240

12. Orthopedic Implants **241**

Sophia N. Sangiorgio, Todd S. Johnson, Jon Moseley, G. Bryan Cornwall, and Edward Ebramzadeh

12.1	Introduction	241
12.1.1	Overview	241
12.1.2	History	243
12.2	Basic Principles	244
12.2.1	Optimization for Strength and Stiffness	245
12.2.2	Maximization of Implant Fixation to Host Bone	250
12.2.3	Minimization of Degradation	251

12.2.4	Sterilization of Implants and Instrumentation	253
12.3	Implant Technologies	253
12.3.1	Total Hip Replacement	254
12.3.2	Technology in Total Knee Replacement	263
12.3.3	Technology in Spine Surgery	268
12.4	Summary	272
PART V	IMAGING AND IMAGE-GUIDED TECHNIQUES	275
13.	Endoscopy	277
	<i>Gregory Nighswonger</i>	
13.1	Introduction	277
13.2	Ancient Origins	278
13.3	Modern Endoscopy	280
13.3.1	Creating Cold Light	280
13.3.2	Introduction of Rod-Lens Technology	280
13.4	Principles of Modern Endoscopy	283
13.4.1	Optics	284
13.4.2	Mechanics	284
13.4.3	Electronics	284
13.4.4	Software	285
13.5	The Imaging Chain	285
13.5.1	Light Source (1)	286
13.5.2	Telescope (2)	286
13.5.3	Camera Head (3)	287
13.5.4	Camera CCU (4)	287
13.5.5	Video Cables (5)	287
13.5.6	Monitor (6)	287
13.5.7	Image Management Systems (7)	288
13.6	Endoscopes for Today	288
13.6.1	Rigid Endoscopes—Designs to Enhance Functionality	289
13.6.2	Less Traumatic Ureterorenoscopes	290
13.6.3	Advances in Flexible Endoscope Design	291
13.6.4	Broader Functionality with New Technologies	294