



**Activate your eBook**

# The Cowboy's Conundrum

Complex and Advanced  
Cases in Shoulder Arthroscopy

---

**Stephen S. ♦ Paul C. ♦ Patrick J. ♦ Christopher R. ♦ Robert U.  
Burkhart Brady Denard Adams Hartzler**

Over 200  
videos of the  
latest shoulder  
arthroscopy  
procedures!



**Wolters Kluwer**



# The Cowboy's Conundrum

## *Complex and Advanced Cases in Shoulder Arthroscopy*

### **Stephen S. Burkhart, MD**

The San Antonio Orthopaedic Group  
Burkhart Research Institute for  
Orthopaedics  
San Antonio, Texas

### **Paul C. Brady, MD**

Tennessee Orthopaedic Clinics  
Knoxville, Tennessee

### **Patrick J. Denard, MD**

Southern Oregon Orthopaedics  
Medford, Oregon

### **Christopher R. Adams, MD**

Naples Community Hospital  
Naples, Florida

### **Robert U. Hartzler, MD**

The San Antonio Orthopaedic Group  
Burkhart Research Institute for  
Orthopaedics  
San Antonio, Texas



**Wolters Kluwer**

Philadelphia • Baltimore • New York • London  
Buenos Aires • Hong Kong • Sydney • Tokyo





Acquisitions Editor: Brian Brown  
Editorial Coordinator: Dave Murphy  
Marketing Manager: Dan Dressler  
Production Project Manager: Bridgett Dougherty  
Design Coordinator: Steve Druding  
Manufacturing Coordinator: Beth Welsh  
Prepress Vendor: SPi Global

Copyright © 2017 Wolters Kluwer

Illustrations and Video copyright © Arthrex

All rights reserved. This book is protected by copyright. No part of this book may be reproduced or transmitted in any form or by any means, including as photocopies or scanned-in or other electronic copies, or utilized by any information storage and retrieval system without written permission from the copyright owner, except for brief quotations embodied in critical articles and reviews. Materials appearing in this book prepared by individuals as part of their official duties as U.S. government employees are not covered by the above-mentioned copyright. To request permission, please contact Wolters Kluwer at Two Commerce Square, 2001 Market Street, Philadelphia, PA 19103, via email at [permissions@lww.com](mailto:permissions@lww.com), or via our website at [lww.com](http://lww.com) (products and services).

9 8 7 6 5 4 3 2 1

Printed in China

---

#### Library of Congress Cataloging-in-Publication Data

Names: Burkhart, Stephen S., 1949- author. | Brady, Paul C., author. | Denard, Patrick J., author. | Adams, Christopher R., author. | Hartzler, Robert U., author.

Title: The cowboy's conundrum : complex and advanced cases in shoulder arthroscopy / Stephen S. Burkhart, Paul C. Brady, Patrick J. Denard, Christopher R. Adams, Robert U. Hartzler.

Description: Philadelphia : Wolters Kluwer, [2017] | Includes bibliographical references and index.

Identifiers: LCCN 2017004479 | ISBN 9781496318855

Subjects: | MESH: Shoulder Joint—surgery | Shoulder—surgery | Arthroscopy—methods

Classification: LCC RD686 | NLM WE 810 | DDC 617.4/720597—dc23 LC record available at <https://lcn.loc.gov/2017004479>

---

This work is provided “as is,” and the publisher disclaims any and all warranties, express or implied, including any warranties as to accuracy, comprehensiveness, or currency of the content of this work.

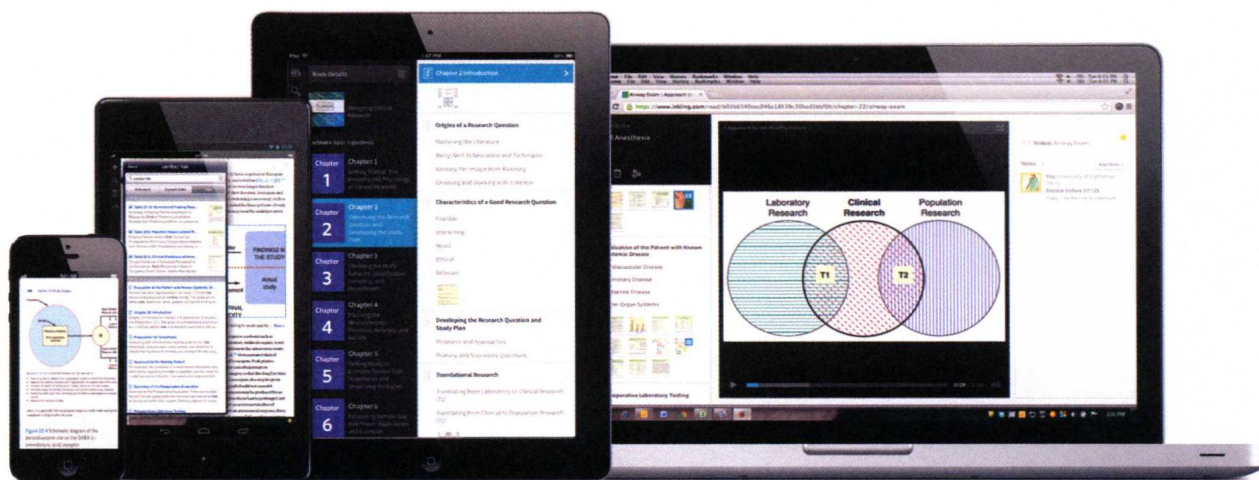
This work is no substitute for individual patient assessment based upon healthcare professionals’ examination of each patient and consideration of, among other things, age, weight, gender, current or prior medical conditions, medication history, laboratory data and other factors unique to the patient. The publisher does not provide medical advice or guidance and this work is merely a reference tool. Healthcare professionals, and not the publisher, are solely responsible for the use of this work including all medical judgments and for any resulting diagnosis and treatments.

Given continuous, rapid advances in medical science and health information, independent professional verification of medical diagnoses, indications, appropriate pharmaceutical selections and dosages, and treatment options should be made and healthcare professionals should consult a variety of sources. When prescribing medication, healthcare professionals are advised to consult the product information sheet (the manufacturer’s package insert) accompanying each drug to verify, among other things, conditions of use, warnings and side effects and identify any changes in dosage schedule or contraindications, particularly if the medication to be administered is new, infrequently used or has a narrow therapeutic range. To the maximum extent permitted under applicable law, no responsibility is assumed by the publisher for any injury and/or damage to persons or property, as a matter of products liability, negligence law or otherwise, or from any reference to or use by any person of this work.



# Get Your Free Enhanced eBook

Your book purchase includes a complimentary download of the enhanced eBook for iOS, Android, PC & Mac.

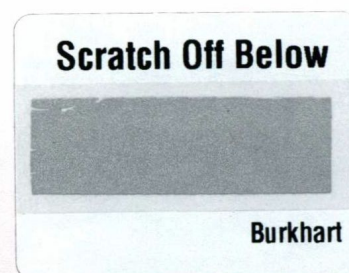


Take advantage of these practical features that will improve your eBook experience:

- The ability to download the eBook on multiple devices at one time — providing a seamless reading experience online or offline
- Powerful search tools and smart navigation cross-links allow you to search within this book, or across your entire library of VitalSource eBooks
- Multiple viewing options offer the ability to scale images and text to any size without losing page clarity as well as responsive design
- The ability to highlight text and add notes with one click

## View or download your eBook now:

- 1 Go to <http://medicine.lww.com/activate>
- 2 Enter your 12-digit code in the box marked "Get Access" and select *Submit Code*



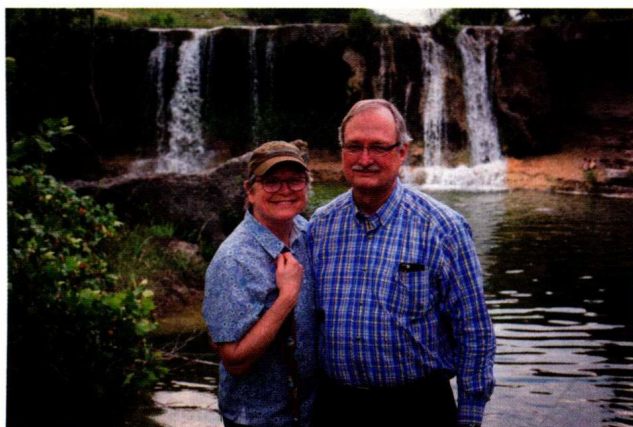
Scratch off the sticker with care.

NOTE: Book cannot be returned once the panel is scratched off.



# Dedication

*"The best way to predict the future is to create it." —ABRAHAM LINCOLN*



To Nora. Thanks for your encouragement, your faith, and your sense of humor through it all.  
And thanks for being my best critic and my only muse.

To my children Zack and Sarah, and to my grandchildren Bekah, Ben, and Joe. It's time to  
have some rambunctious family time again.

To my Fellows and students. There's still so much to be done. I'm looking forward  
to the future that you will create.

Godspeed.

—STEPHEN S. BURKHART, MD

---

What a privilege it is to do what we do! I thank God daily for allowing me the opportunity to  
positively impact people's lives. I also feel fortunate to have had some AMAZING orthopaedic mentors in my life  
including Drs Gary Poehling, David Martin, and Stephen Burkhart. This trio is in my head daily in the operating  
room and the clinic. I thank my father (who recently passed) who was a lifelong teacher and instilled  
in me a passion for teaching. I thank my wife Jennifer and our 4 kiddos (Meredith, Davis, Garrett,  
and Hayden) for encouraging and supporting me during this endeavor. And above all—  
thank you Jesus for allowing me to do what I do each and every day!

—PAUL BRADY, M.D.

---

To Marion: "All you need is love"  
To Annalise and Davis: "Once you're a parent, you're the ghost of your children's future"  
To Stephen Burkhart: "No man ever drowned in his own sweat"

—PATRICK DENARD, MD

---

I would like to first and foremost thank my parents for providing me the foundation in life so I may rejoin them  
again someday. I would also like to acknowledge all of my friends, siblings, and their spouses for all of their love  
and support over the years. I would also like to thank my mentors and friends, Steve Burkhart for teaching me  
the 'Cowboy Way' and Reinhold Schmieding whose passion in life has changed the world. I would like to thank  
my wife Meredith for her enduring love and support, the true unsung hero who has enabled me to help make a  
positive difference in this world. And finally, I wanted to acknowledge and thank my children Joseph, Jacob, and  
Joshua whose love and inspiration have kept me focused on Faith, Hope and Love.

—CHRISTOPHER R. ADAMS, MD

---

For the conundrum of the proper division of my energies between a wonderful family and vocation,  
I am profoundly thankful to God.

*"The happiness of married life depends upon making small sacrifices with readiness and cheerfulness."*

—JOHN SELDEN (1584-1654)

To Sari, thank you for many sacrifices, small and large.

—ROBERT U. HARTZLER, MD



# Introduction to Forewords

For the third time we have two Forewords from my two best friends, Dr. Steve Snyder and Dr. Jim Esch. I cannot overemphasize the impact that these two surgeons have had on the development of shoulder arthroscopy. Yet they continue to deflect credit and praise to others.

From the beginning, the three of us collaborated on so many arthroscopic shoulder programs and educational initiatives that other friends dubbed us *The Three Amigos* of shoulder arthroscopy. That collaboration has continued over the years at venues around the world.

Thanks, Amigos, for your support, encouragement, and friendship over the years.

Vaya con Dios.  
*Stephen S. Burkhart, MD*





# Forewords

Stephen Burkhart, MD, is a trusted, longtime friend, Texas rancher, gifted shoulder surgeon, teacher, inventor, and writer. He has a special love for the land and the people who inhabit this land, especially his patients. He has brought his gifted surgical talents to his patients and has shared these innovative techniques with shoulder surgeons throughout the world. He brings his writing skills, persistence, and dedication to us in his innovative third book. *The Cowboy's Conundrum* is a timely and welcome gift to the surgeon faced with decisions in this era of "evidence-based medicine." A series of case studies brings to light the complex problems, which are faced by shoulder surgeons every day. One example might be a large rotator cuff tear associated with an acute dislocation and a large anterior

labrum detachment. Another decision is when to "hold the cards" and use nonoperative interventions in a patient with a medium-sized rotator cuff tear. Dr. Burkhart shares his experience mixed with the evidence to guide our thinking to arrive at proper treatment for our patients. Twenty-five years ago, many surgeons felt that arthroscopic rotator cuff repair was an illusion. The second half of this book features tips and tricks to smoothly pull off arthroscopic shoulder repairs. Every shoulder surgeon should have a copy of this book at home for preoperative planning and a second copy in his surgical locker to refresh his brain just before scrubbing.

James C. Esch, MD

I have had the pleasure to call Steve Burkhart my friend for more than 30 years. As a passionate teacher, he has few peers. Each decade that I have known him, he has written a shoulder arthroscopy textbook to share his expanded wealth of knowledge and experiences with all of us who share his obsession for this special branch of Orthopaedic surgery. This is the third and final edition, *The Cowboy's Conundrum*.

No doubt it is an arduous undertaking to write, edit, and direct the illustrations of a meaningful modern textbook. Additionally, taking the time to video record, edit, and produce comprehensive case examples that complement each segment of the offering is an unquestionable labor of love. For Dr. Burkhart, adding this undertaking to a busy clinical practice and an exhaustive travel and teaching schedule is commendable if not truly extraordinary.

Dr. Burkhart personifies the unusual individual who is endowed with a combination of a genius intellect and creative imagination coupled with an uncompromising fervor to "get it right" and "make it work." His undergraduate training in engineering facilitated his successful venture into product development. The numerous patents for surgical products and procedures attributable to his efforts attest to his success.

Although his passion is shoulder arthroscopy, Steve Burkhart's fertile mind and talents are tempered by his cowboy ethos. I have been privileged to visit with Nora

and Steve at their Texas ranch and that has afforded me a contrasting view of my vaquero friends. When the cowboy hat goes on the stress and anxiety attendant to his life as a world class surgeon, teacher and inventor morphs into a more relaxed gentleman rancher. As a loving couple for more than 35 years, they are as protective and devoted to each other and their family as any couple I have ever known. There is no doubt that without Nora's support and tender life coaching, it would be impossible for anyone to be as successful as Steve has been no matter how abundant his talents might be.

This book will likely be the last of the Cowboy trilogy. This is a sad but undeniable reminder that unless there is a sunset into which a cowboy can ride, there will be no more tomorrow sunrise when his students can mount up and use the surgical skills they have learned from the master. Thank you for all that you have done for all of us in the field of Shoulder Arthroscopy.



Stephen J. Snyder, MD



Van Nuys, California



# Preface

Does the world really need another cowboy book on shoulder arthroscopy? After all, only 5 years have passed since the last one was written. That was the question that I pondered for about a millisecond before I faced up to the inevitable answer: “Yes!”

Not that any of us really wanted to write another book; we knew that we had to write one. The simple fact is that shoulder arthroscopy is undergoing a rapid transformation. The paradigm shift from open to arthroscopic techniques for most types of shoulder surgery has dramatically accelerated. For all categories of shoulder surgery, except arthroplasty and certain types of fracture fixation, it is not a matter of if the operations can be done arthroscopically, but how to do them arthroscopically. But for many of the more challenging shoulder surgeries, the techniques are not simple, and they may not be intuitive. And therein lies the alpha conundrum.

The 2016 Merriam Webster Dictionary defines conundrum as “a confusing or difficult problem.” Each surgical conundrum involves choices, and the successful surgeon must be able to make wise choices. And that is why we felt compelled to write this book: to logically guide the surgeon through the choices that he or she will face in confronting the countless conundra of a busy shoulder practice. So many conundra; so little time.

In each chapter of this book, there is an overview of principles regarding a specific subject (e.g., instability, rotator cuff tears, etc.). That overview is followed by a series of case studies pertaining to the subject of the chapter. Each case presents a conundrum that must be addressed. The conundrum can present at different levels in the case. For example, the conundrum may involve how to reach the proper diagnosis, whether or not to operate, which procedure to do, how to perform the indicated procedure, how best to rehabilitate the patient, and countless other conundra associated with decision points at various levels in the treatment chain.

So here it is—our third book on shoulder arthroscopy—rounding out our trilogy. You will see that we have kicked up the degree of difficulty several notches. Even so, these complex techniques build on the basic craft and skill-sets that you have already learned. And surgeons are, after all, craftsmen.

Lately I have heard various speakers at shoulder courses tell their audiences to “do what’s best in your hands.” In my view, such directives are ill-advised because the most important thing is to do what is best for the patient. If the surgeon is unable to do what is best for the patient, he needs to either learn how to do it or refer such patients to

someone who is capable of providing the indicated treatment for that patient.

Being a surgeon carries with it a burden of craft and that burden is the most critical part of the contract between surgeon and patient. I was honored to be invited to give the Neer Lecture at the 2014 Closed Meeting of the American Shoulder & Elbow Surgeons. I chose to speak on the burden of craft in shoulder arthroscopy. I am reprinting that lecture for you here, because I believe that the acceptance of that principle is the moral keystone to being a surgeon. I hope that this book, *The Cowboy’s Conundrum*, helps you to achieve the level of craftsmanship necessary to support the burden of craft for your patients.

## ***The Burden of Craft in Arthroscopic Rotator Cuff Repair: Where We Have Been and Where We Are Going\****

The Neer Guest Lecture

2014 Closed Meeting of the American Shoulder and Elbow Surgeons

Stephen S. Burkhart, MD

I am very honored that Dr. Rob Bell, President of the American Shoulder and Elbow Surgeons, has invited me to give this year’s Neer Lecture. Dr. Bell asked me to specifically address my role in the development of arthroscopic rotator cuff repair and to recount the significant resistance that the early arthroscopic shoulder surgeons faced from the Shoulder Establishment as we struggled to achieve mainstream acceptance of this new technology. Having been tasked with such a personal topic, I find myself in an analogous position to that of Winston Churchill at the end of the Second World War. When a journalist asked Mr. Churchill to speculate on how historians would portray his role in the war, he replied without hesitation, “History will be kind to me because I intend to write it.”

So let’s start at the beginning. And for me, it makes the most sense to travel back in time to 1981, the year that I started my practice.

The world in 1981 was a very different place from today’s world. On January 20, 1981, Ronald Reagan was inaugurated President of the United States. That same day, 52 American hostages in Iran were released after having been held captive for 442 days. In March of 1981, Reagan survived an assassination attempt; 3 months earlier John Lennon had not been so lucky. Lennon’s hit song “Starting Over” garnered the highest musical awards posthumously.

\*This article was published in *The American Journal of Orthopaedics*, August 2015, pages 353–358.



The world of shoulder surgery in 1981 was also a very different place. The arthroscope was “the instrument of the devil,” according to Dr. Rockwood. And shoulder surgery was ruled by “The Charlies” (Charles Neer, MD; Charlie Rockwood, MD; and any other Charlie who felt compelled to marginalize shoulder arthroscopy).

My own personal world in the early 1980s was quite daunting as well. I had just completed my residency at the Mayo Clinic and my sports medicine fellowship in Eugene, Oregon. I had a young son, a new daughter, and a new job with the San Antonio Orthopaedic Group. I had a new house with a 21% mortgage loan and a “new” used car with a 23% car loan.

I was simultaneously energized and intimidated by my new job, where I did general orthopaedics with a “special interest” in shoulder surgery and sports medicine. I was initially very proud and humbled by the fact that my senior partners had entrusted me with the care of the most difficult shoulder cases within the practice. But that pride got cut down to its appropriate size one day after I had thanked one of my partners, Dr. Lamar Collie, for his confidence in my potential as a shoulder surgeon. Dr. Collie replied very matter-of-factly, “Sure...but you need to understand that we always make the new guy the shoulder expert because shoulders never do worth a damn.”

The early 1980s were exciting years for shoulders arthroscopy. Most of us who were scoping shoulders had already been doing knee arthroscopy and were trying to adapt arthroscopic knee instruments to the shoulder. This worked for some simple excisional cases; for example, I recall excising the bucket-handle portion of a type III SLAP lesion in a patient in 1983. However, in general, the problems in the shoulder were different from those of the knee, and they usually involved repair rather than excision of damaged tissues. Therefore, the technology that was used in knee arthroscopy was often not directly transferable to the shoulder. Furthermore, treatment of the rotator cuff necessitated the development of arthroscopic techniques in a virtual space, the subacromial space, and this was an entirely new arthroscopic concept.

## DEVELOPMENT OF ARTHROSCOPIC ROTATOR CUFF REPAIR

A major mind-expanding turning point for me occurred in 1984 when I attended one of Dr. Jim Esch’s early San Diego Shoulder Courses. At that course, Dr. Harvard Ellmann of Los Angeles demonstrated to me on a cadaver shoulder how he created a virtual subacromial working space that allowed enough visualization to do an arthroscopic acromioplasty. At that moment, I knew that arthroscopic rotator cuff repair was just around the corner. Until that point, I could not envision complex extra-articular reconstructive surgery, since all previous arthroscopic surgery had been intra-articular. But now, with the realization that a virtual working space could always be created, I knew that it would be a relatively straightforward matter to develop the portals to approach the cuff, and the

implants and the instruments to repair it. But I also knew that the progression to all-arthroscopic repair techniques would have to be stepwise and that the final repair constructs would need to be at least as strong as those of open repair in order to be acceptable. With an undergraduate degree in mechanical engineering, I had a reasonably clear idea of the concepts that I wanted to employ in the instrumentation and techniques; but I could never have envisioned how circuitous the route to the end result would be.

## FIRST STEPS

I sketched out my ideas for some arthroscopic suture passers and knot-tying instruments and presented them to a couple of the major arthroscopy companies in the United States, but they were not interested. They did not believe that arthroscopy would have any meaningful applications in the shoulder. So I enlisted the services of a local San Antonio aircraft machinist to fabricate some instruments for me. By 1987, I was doing arthroscopic side-to-side margin convergence<sup>1</sup> cuff repairs on a regular basis for U-shaped tears. And I was doing these in the most hostile point in the universe for arthroscopic shoulder surgery: San Antonio, Texas.

There were only a few surgeons doing arthroscopic shoulder surgery in the 1980s and early 1990s, and without exception, these surgeons became the leaders in pioneering this new discipline. In general, these were young surgeons in private practice who were outside the hierarchy of academia and professional organizations and thus were relatively sheltered from the blowback of the shoulder rule-makers of the day. They accepted their status as pariahs as they developed their techniques out of view from mainstream orthopaedics. These were men such as Jim Esch, Steve Snyder, Dick Caspari, Lanny Johnson, Gene Wolf, Gary Gartsman, and Rob Bell. We shared our techniques and our ideas with each other, encouraged each other, and generally became good friends.

Thomas Kuhn, in his classic book, *The Structure of Scientific Revolutions*,<sup>2</sup> observed that paradigm shifts within a given field were usually achieved by practitioners who were either very young (and hence naive) or else outside the established hierarchy in that field. The surgeons who contributed most to the shift of shoulder surgery from open to arthroscopic techniques were generally young men in private practice who had little to lose by inciting the disdain of the shoulder establishment. Predictably, the resistance of the mainstream open shoulder surgeons became greater as arthroscopic techniques became more successful and more threatening to the primacy of the open shoulder surgeons. The disdain yielded to disruption and finally to transformation as the paradigm shift occurred. The conflict between the open shoulder surgeons and the arthroscopic shoulder surgeons passed through all the phases that Mahatma Gandhi had described many years before. “First



they ignore you; then they laugh at you; then they fight you; then you win."

## BUILDING A SHIP IN A BOTTLE

As the 1990s began, I recognized that my progress in achieving arthroscopic rotator cuff repair would be extremely slow unless I could find an industry partner who shared my vision for a full-scale conversion to arthroscopic means of repair and who was willing to put forth the effort to make that happen. In 1991, I happened to meet Reinhold Schmieding, who owned a small arthroscopic device company in Naples, Florida, by the name of Arthrex. Reinhold invited me to visit him in Naples to discuss the feasibility of developing arthroscopic repair systems for the shoulder. At that point in time, the world headquarters of Arthrex was a 20-foot by 30-foot storage room in an office service center in Naples, and there were two employees. One of the employees, Don Grafton, was a very talented engineer but had no medical experience. By the end of my first day in Naples, Reinhold and Don and I had agreed that development of arthroscopic repair systems for shoulder instability and for rotator cuff repair would become a top priority for Arthrex.

My initial bias toward arthroscopic cuff repair was that a transosseous bone tunnel technique would be not only possible but would be superior to suture anchor fixation. In fact, my first two patents with Arthrex were for instrumentation for an arthroscopic transosseous repair technique. But I decided to test that hypothesis with two successive biomechanical studies. The first of these studies tested cyclic loading of bone tunnel repairs and the second examined cyclic loading of anchor-based repairs.<sup>3,4</sup> In evaluating the data from of these two studies, I was surprised to find that anchor-based repairs were significantly stronger than bone tunnel repairs. In addition, anchors shifted the weak link from the bone-suture interface to the tendon-suture interface; in essence, anchors optimized bone fixation by shifting the weak link in the construct to the tendon. At that point, I became completely convinced of the superiority of suture anchors over bone tunnels and that conviction has become even stronger over the years. After these two cyclic loading studies, I shifted the focus of my efforts, and those of Arthrex, toward arthroscopic suture anchor repair of the rotator cuff.

## RECONCILING TECHNIQUE AND INSTRUMENTATION WITH ANATOMY AND BIOMECHANICS

Having recognized the importance of the rotator cable attachments both anatomically<sup>5</sup> and biomechanically,<sup>6,7</sup> I believed that it was important to reinforce the rotator cable attachments as a routine part of every rotator cuff repair. In this way, our anatomic and our biomechanical studies had

great translational implications in the development of our techniques and our instrumentation.

As I mentioned earlier, Don Grafton was the chief (and for a long time the only) engineer at Arthrex. Since Don had no medical experience, I invited him to come to San Antonio and observe surgery. Don made many trips to San Antonio, where I would show him the pathology in the OR and point out what I could do with my available instruments and what I could not do. Then, we would go to my house in the evening and brainstorm how to perform the missing surgical manipulations, how to improve those that existed but were suboptimal, and how to optimize the final surgical construct.

Passing the suture through the tendon was an early challenge. One must remember that in the early 1990s, it was not possible for machinists to fabricate complex shapes, so straight tubular retrograde suture passers were the logical first option. We initially developed spring-loaded retrograde hook retrievers (Figure 1) followed by curved suture hooks with shuttling wires (Lasso; Arthrex, Inc., Naples, FL). To me, the most unappealing feature of retrograde suture passage was related to the fact that it generally entailed an oblique angle of approach through the tendon that caused a length-tension mismatch between the upper fibers and the lower fibers of the muscle-tendon unit. We recognized that we could eliminate this tension mismatch if we could pass the suture antegrade such that the suture would pass perpendicular to the tendon fibers. These insights and efforts culminated in the development of the Viper suture passer (Arthrex, Inc.) followed by the FastPass Scorpion suture passer (Arthrex, Inc.), which has a spring-loaded trapdoor on the upper jaw for ergonomic self-retrieving of the suture once it has passed through the tendon.

In order to develop a knot pusher that achieved optimized knots with the highest knot security and the tightest loop security, we used prototype instruments in which we tied and tested literally thousands of knots in the lab. In this manner, we were able to verify that the Surgeon's Sixth Finger Knot Pusher (Arthrex, Inc.) would reproducibly tie optimized knots.<sup>8,9</sup> At that point, we had achieved optimized fixation of knots and optimized bone fixation. However, our suture itself was not yet optimized and was prone to breakage, and our suture-tendon interface was



**FIGURE 1** An early spring-loaded retrograde suture passer (Arthrex, Inc., Naples, FL). Note the straight tubular shape necessitated by the degree of difficulty inherent in trying to fabricate more complex shapes in the early 1990s.



not yet optimized. Clearly we had two more areas that needed improvement.

Don Grafton had the idea for a suture that would be virtually unbreakable, and he developed that idea into a product called FiberWire (Arthrex, Inc.).<sup>10</sup> Shortly thereafter I contributed the idea and design for FiberTape (Arthrex, Inc.), which dramatically enhanced suture pull-out strengths as well as footprint compression.

Anchor designs improved rapidly and dramatically. We decided that the second-generation BioCorkscrew (Arthrex, Inc.) should be fully threaded, and this virtually eliminated anchor failure, even in soft bone.

Optimization of the suture-tendon interface took a giant step forward when the concept of linked double-row rotator cuff repair was introduced by Park, ElAttrache, Tibone, and Lee.<sup>11,12</sup> Much like a Chinese finger trap, the harder you pull the stronger it becomes, with yield load approaching ultimate load.

At this point, it seemed that we had optimized virtually every segment of the rotator cuff repair construct. Every component was just about as good as it could be. Or was it?

## THE ACCIDENTAL QUEST FOR KNOTLESS FIXATION

In November 1998, I made my first trip to China as a guest speaker at the Hong Kong Orthopaedic Association. My first view of the magnificent Hong Kong skyline across Victoria Harbor was truly breathtaking. As I admired the gleaming glass towers and the concrete canyons of the city, I had no idea that the very next day these modern skyscrapers would reveal an ancient secret that would change my approach to arthroscopic rotator cuff repair.

The day after my arrival, Dr. James Lam took me to lunch. As we approached the restaurant, he pointed to a tall building across the street that was being renovated and had scaffolding to support the workers alongside the first nine stories of the exterior wall. Dr. Lam made the comment that he would take me to the construction site after lunch for a closer look at the scaffolding.

After lunch, we walked across the street to the base of the scaffolding. Dr. Lam pointed out that it was constructed entirely of bamboo poles that were held together with lashings but with no knots (Figure 2). Lashings were secured by turning them back on themselves and wrapping them in an entirely knotless manner.<sup>13</sup> I found it incredible that this knotless fixation was so secure that it could support the weight of workers many stories above the ground. I resolved to study this fixation method to determine how it worked and to see if there might be a way that the same mechanism might help us to achieve reliable knotless fixation in surgery.

When I returned home, I broke out my old engineering books from college and reacquainted myself with the concept of cable friction. However, as has happened so



**FIGURE 2** Lashings that secured the bamboo poles of the Hong Kong scaffolding had no knots. They were secured by turning back on themselves and wrapping in a knotless manner.

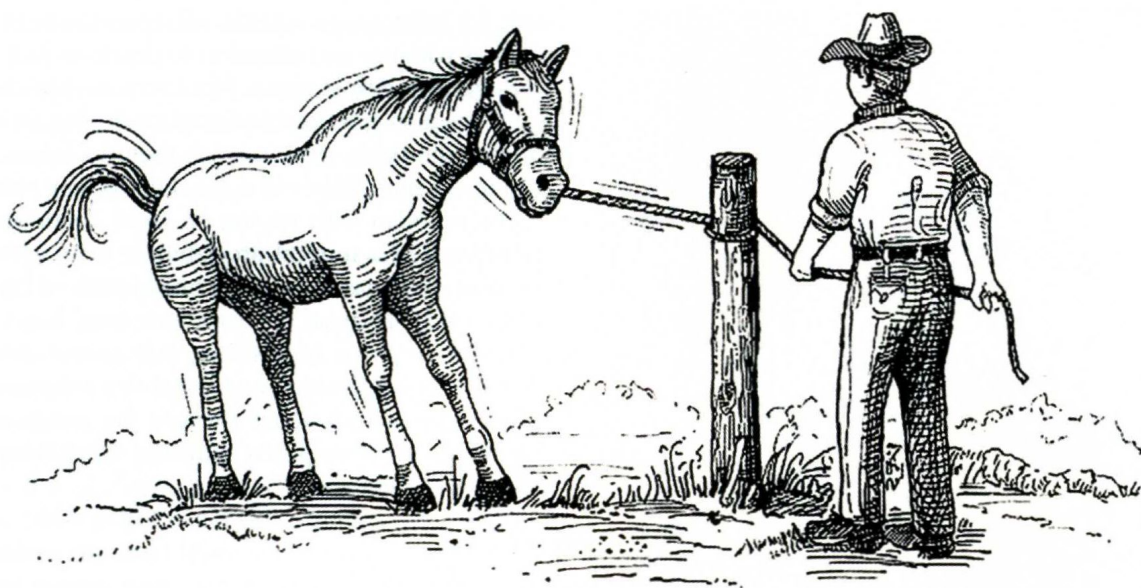
often in the past, it took a practical lesson from the ranch to truly illustrate to me how the concept of cable friction works.

Every cowboy knows that a spirited horse cannot be restrained by a man with a single lead rope. However, the cowboy can wrap the lead rope around a “snubbing post” and gain complete control of the animal, despite the horse’s superior size and strength. The cable friction that is achieved between the rope and the post creates such a large restraining force that the cowboy can easily hold the animal even though no knots have been tied in the rope (Figure 3). In a similar fashion, cable friction is the mechanism for the fixation strength of the lashings in the Hong Kong scaffolding; significant cable friction is achieved as the lashings wrap around each other and also around the bamboo poles.

The concept of cable friction was pivotal in the development of knotless fixation in arthroscopic rotator cuff repair. In the case of lateral row fixation, the eyelet of both the PushLock and SwiveLock suture anchor (Arthrex, Inc.) produces significant cable friction at the eyelet-suture interface, in addition to the frictional force exerted on the suture by virtue of wedging of the suture between the anchor and bone.

Like so many other developments in shoulder arthroscopy, the evolution of the SwiveLock suture anchor occurred in stages. The first stage of development utilized a chain-like suture with consecutive intersecting links (FiberChain; Arthrex, Inc.). I initially developed this idea for an adjustable fixation construct because I thought that a forked eyelet on a SwiveLock would provide a firm fixation point when inserted into the appropriate suture link, yet it was totally adjustable by simply choosing a tighter or looser link (Figure 4). Although this system

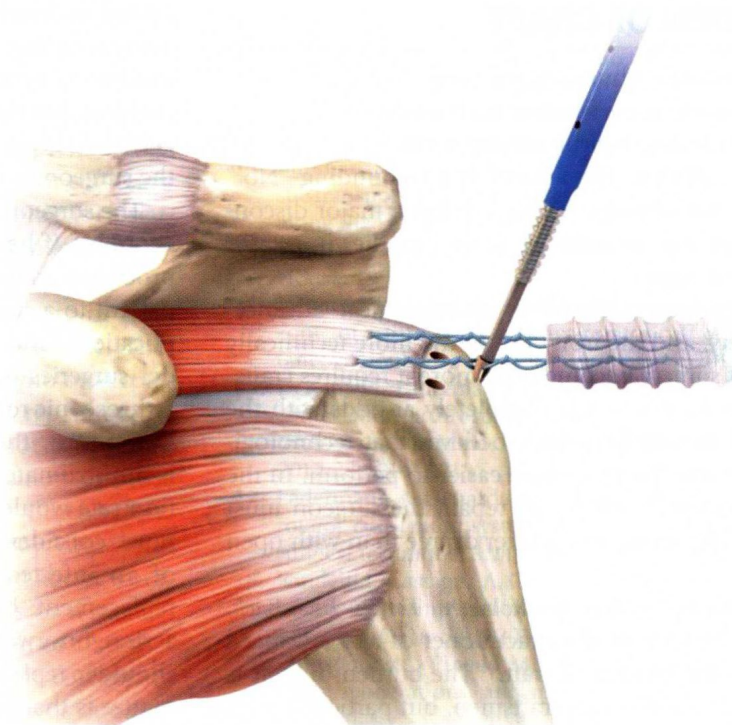




**FIGURE 3** Cable friction is so powerful that a single throw of a lead rope around a “snubbing post” is enough to allow a man to control a much larger and much stronger horse.

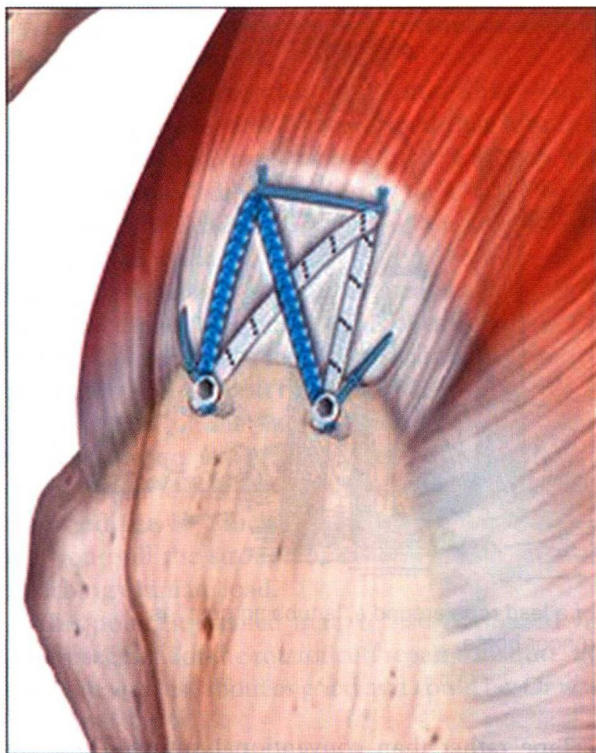
worked very well, it was somewhat technically challenging. The process was greatly simplified after Don Grafton and I developed FiberTape and recognized that the power of cable friction was dramatically increased by the larger contact area between the eyelet and the braided FiberTape. The SpeedBridge construct (Arthrex, Inc.), which provided enhanced cable friction fixation by means of passing FiberTape through the anchor eyelets, also provided a larger compressive interface at the repair site by using

FiberTape rather than conventional suture. These incremental improvements have led to what I would characterize as today’s gold standard for arthroscopic rotator cuff repair: a largely knotless linked double-row construct utilizing FiberTape, with cinch-loop sutures at the anterior and posterior margins of the tear to reinforce the cable attachments and simultaneously reduce the dog-ears that typically occur in those locations, and a double-pulley medial mattress if tendon quality is poor (Figure 5).



**FIGURE 4** The forked eyelet of a BioComposite SwiveLock (Arthrex, Inc., Naples, FL) captures the second link from the lateral edge of the torn rotator cuff. (Reprinted by permission from “The Cowboy’s Companion: A Trail Guide for the Arthroscopic Shoulder Surgeon”; Lippincott Williams & Wilkins, 2012.)





**FIGURE 5** Schematic of a reinforced SpeedBridge rotator cuff repair (Arthrex, Inc., Naples, FL). Cinch-loop sutures reinforce the anterior and posterior rotator cable attachments and simultaneously reduce dog-ears in the tendon. Double-pulley medial mattress sutures (double-mattress sutures linking the two medial anchors) further reinforce the construct in the case of poor-quality tendon. (Reprinted by permission from "The Cowboy's Companion: A Trail Guide for the Arthroscopic Shoulder Surgeon"; Lippincott Williams & Wilkins, 2012).

## THE BURDEN OF CRAFT

With all the recent enthusiasm for Level 1 studies, I think that we need to examine whether such studies will accelerate the rate of technological advancement in rotator cuff repair. In my opinion, the answer is a resounding "No." The basis for that opinion is that I detect a major disconnect in the way that we evaluate Level 1 studies in rotator cuff disease and repair.

There is an irony related to technological advancement in surgery, and the irony is that the more technically advanced that surgery becomes, the more it requires craftsmanship. This simple fact is completely at odds with the perception of the public, which believes that technological advances make the procedure easier to perform. In the case of arthroscopic rotator cuff repair, the surgeon must look, feel, and be aware to a greater degree than with open surgery.

Edward Tenner, in his book *When Things Bite Back*, described the burden of the practitioner of any advanced technology as the burden of craft.<sup>14</sup> The burden of craft is the inherent demand on all craftsmen, but particularly on surgeons to "up our game" if we are to be successful at our

craft. For arthroscopic rotator cuff repair, the burden of craft requires patience and attention to detail, as well as skill at working in a virtual space. Not everyone has these skills. But if one is to practice this discipline, he has an obligation to learn the skills, then to teach them to others, and also to perform surveillance of those skills among practitioners.

The problem with relying on Level 1 studies to assess the efficacy of a surgical procedure is that Level 1 studies are inherently biased by the technical skills of the surgeons in the study. Because of this innate bias, Level 1 studies cannot prove what is possible, they cannot demonstrate the limits of a technique, and they cannot demonstrate the equivalence of techniques because the results are totally dependent on the surgeons' skill, and the skill levels of surgeons are not equal.

Amazingly enough, there are still rotator cuff repair "deniers" who confidently assert from the podium that a large percentage of massive cuff tears cannot be repaired and that even if they can be repaired, they do not have the biologic potential to heal. But in view of the disparity in surgeon skills and results, one must ask whether that surgeon's poor results are the consequence of a biologic deficit in the patient or of a skill deficit in the surgeon.

What I know is that the techniques exist for predictable arthroscopic repair and healing of the vast majority of rotator cuff tears, even massive tears.<sup>15-17</sup> These patients do very well clinically, yet there seems to be a trend among many Orthopaedic surgeons to go straight to reverse total shoulder arthroplasty (rTSA) for massive cuff tears. This trend is occurring despite the fact that results in the literature for rTSA are not as good as arthroscopic cuff repair, and there is a much higher complication rate for rTSA.

So why has this trend toward rTSA for massive cuff tears gained so much momentum? The only reason that I can surmise is that for the average surgeon, rTSA is easier and quicker to perform than arthroscopic repair of a massive cuff tear. But the reason for choosing a specific type of surgery for a given problem should not be that it is easiest for the surgeon; it should be that it is best for the patient.

The surgeon must ask what he would want if it were his shoulder. If he does not have the skill set to provide that procedure to the patient, then he is obligated to send that patient to a surgeon that can provide it. In terms of complications, the most feared complication in most shoulder surgeries is infection. The reported infection rate for arthroscopic rotator cuff repair is 1.6 per 1,000 or 0.0016.<sup>18</sup> In contrast, the average reported infection rate for rTSA is approximately 25 times higher or 0.04.<sup>19</sup> Which infection rate would you choose for yourself? In addition, one must consider the relative severity of the consequences of an infected arthroscopy versus an infected shoulder replacement: by any measure, an infected arthroscopy is a straightforward treatable complication, but an infected shoulder replacement is a human tragedy. The fact of the matter is that patients vastly prefer the minimally invasive arthroscopic approach, and in this day of online searches,



they will discover who can offer an arthroscopic solution to them.

In order to reproducibly achieve successful arthroscopic repair of massive rotator cuff tears, the surgeon must know advanced techniques including subscapularis repair techniques,<sup>20,21</sup> interval slides,<sup>22,23</sup> and self-reinforcing constructs.<sup>24,25</sup>

An 18th century English proverb proclaimed that "It's a poor carpenter who blames his tools." This quote is as true today as it was 300 years ago. The tools for arthroscopic cuff repair exist, and they are excellent.

The burden of craft is the surgeon's burden and obligation. As surgeons, we must accept that challenge and the responsibility of that burden.

As I mentioned earlier, Dr. Rob Bell's charge to me when he invited me to give the Neer Lecture was to sum up my involvement in the development of arthroscopic shoulder surgery. The short version of that summation is that I have been doing shoulder arthroscopy for 31 years; I have 28 US patents related to shoulder instruments and implants and 12 US patents pending; I have published 167 peer-reviewed articles and a couple of dozen book chapters; I have published two textbooks on shoulder arthroscopy; I have trained 25 fellows; and I have hosted several thousand visiting surgeons in my operating room. My greatest professional dream was to see the standard of care for rotator cuff repair and shoulder instability transition from open to arthroscopic techniques, and I have been fortunate enough to have witnessed that paradigm shift during my career.

After 31 years of shoulder arthroscopy, what do I envision over the next 31 years? As we all know, history runs in both directions and some things just haven't happened yet. In terms of rotator cuff treatment, I believe that over the next few years, the guiding principle of treatment will be joint preservation. I believe that all rotator cuff tears, even massive tears, will be repaired arthroscopically. Patients and insurers will demand arthroscopic repair, and surgeons without that skill set will migrate to other subspecialties. As for the role of arthroplasty in treatment of rotator cuff tears, I believe that reverse TSA will be indicated only for pseudoparalysis after failed cuff repair in low-demand elderly patients.

As you can see, I envision a standard of care in rotator cuff treatment that is virtually all arthroscopic. That standard of care will demand that surgeons who treat rotator cuff tears be proficient at arthroscopic repair of the full range of cuff tears. For those who do not yet possess the skills for arthroscopic repair, the acquisition of those skills may not be easy. But as I've said many times before, "There's the easy way, and there's the Cowboy Way." And as my dad used to tell me when I complained about working too hard: "No man ever drowned in his own sweat." We shoulder surgeons must accept the burden of craft that accompanies the new standard of arthroscopic cuff repair, and we must offer our patients the same level of care that we would choose for ourselves.

## HAPPY TRAILS!

## REFERENCES

1. Burkhart SS, Athanasiou KA, Wirth MA. Margin convergence: a method of reducing strain in massive rotator cuff tears. *Arthroscopy*. 1996;12:335–338.
2. Kuhn TS. *The Structure of Scientific Revolutions*. Chicago, IL: University of Chicago Press; 1962.
3. Burkhart SS, Johnson TC, Wirth MA, et al. Cyclic loading of transosseous rotator cuff repairs: tension overload as a possible cause of failure. *Arthroscopy*. 1997;13:172–176.
4. Burkhart SS, Diaz Pagan JL, Wirth MA, et al. Cyclic loading of anchor-based rotator cuff repairs: confirmation of the tension overload phenomenon and comparison of suture anchor fixation with transosseous fixation. *Arthroscopy*. 1997;13:720–724.
5. Burkhart SS, Esch JC, Jolson RS. The rotator crescent and rotator cable: an anatomic description of the shoulder's "suspension bridge." *Arthroscopy*. 1993;9:611–616.
6. Burkhart SS, Nottage WM, Ogilvie-Harris DJ, et al. Partial repair of irreparable rotator cuff tears. *Arthroscopy*. 1994;10:363–370.
7. Halder AM, O'Driscoll SW, Heers G, et al. Biomechanical comparison of effects of supraspinatus tendon detachments, tendon defects, and muscle retractions. *J Bone Joint Surg Am*. 2002;84:780–785.
8. Lo IK, Burkhart SS, Chan KC, et al. Arthroscopic knots: determining the optimal balance of loop security and knot security. *Arthroscopy*. 2004;20:489–502.
9. Lo IK, Ochoa E, Burkhart SS. A comparison of knot security and loop security in arthroscopic knots tied with newer high-strength suture materials. *Arthroscopy*. 2010;26(suppl 1):S120–S126.
10. Lo IK, Burkhart SS, Athanasiou K. Abrasion resistance of two types of nonabsorbable braided suture. *Arthroscopy*. 2004;20:407–413.
11. Park MC, ElAttrache NS, Tibone JE, et al. Part I: Footprint contact characteristics for a "transosseous-equivalent" rotator cuff repair technique compared to a double-row technique. *J Shoulder Elbow Surg*. 2007;16:461–468.
12. Park MC, Tibone JE, ElAttrache NS, et al. Part II: Biomechanical assessment for a footprint-restoring transosseous-equivalent rotator cuff repair technique compared with a double-row repair technique. *J Shoulder Elbow Surg*. 2007;16:469–476.
13. Burkhart SS, Athanasiou KA. The twist-lock concept of tissue transport and suture fixation without knots: observations along the Hong Kong skyline. *Arthroscopy*. 2003;19:613–625.
14. Tenner, E. *Why Things Bite Back*. New York, NY: Random House; 1996.
15. Denard PJ, Jiwani AZ, Lädermann A, et al. Long-term outcome of arthroscopic massive rotator cuff repair: the importance of double-row fixation. *Arthroscopy*. 2012;28:909–915.
16. Denard PJ, Lädermann A, Jiwani AZ, et al. Functional outcome after arthroscopic repair of massive rotator cuff tears in individuals with pseudoparalysis. *Arthroscopy*. 2012;28:1214–1219.
17. Lädermann A, Denard PJ, Burkhart SS. Revision arthroscopic rotator cuff repair: systematic review and authors' preferred surgical technique. *Arthroscopy*. 2012;28:1160–1169.
18. Randelli P, Castagna A, Cabitza F, et al. Infectious and thromboembolic complications of arthroscopic shoulder surgery. *J Shoulder Elbow Surg*. 2010;19:97–101.
19. Zumstein MA, Pinedo M, Old J, et al. Problems, complications, reoperations, and revisions in reverse total shoulder arthroplasty: a systematic review. *J Shoulder Elbow Surg*. 2011;20:146–157.



20. Adams CR, Schoolfield JD, Burkhart SS. The results of arthroscopic subscapularis tendon repairs. *Arthroscopy*. 2008;24:1381–1389.
21. Denard PJ, Jiwani AZ, Ladermann A, et al. Long-term outcome of a consecutive series of subscapularis tendon tears repaired arthroscopically. *Arthroscopy*. 2012;28:1587–1591.
22. Lo IK, Burkhart SS. Arthroscopic repair of massive, contracted, immobile rotator cuff tears using single and double interval slides: technique and preliminary results. *Arthroscopy*. 2004;20:22–33.
23. Lo IK, Burkhart SS. The interval slide in continuity: a method of mobilizing the anterosuperior rotator cuff without disrupting the tear margins. *Arthroscopy*. 2004;20:435–441.
24. Denard PJ, Burkhart SS. Techniques for managing poor quality tissue and bone during arthroscopic rotator cuff repair. *Arthroscopy*. 2011;27:1409–1421.
25. Burkhart SS, Denard PJ, Konicek J, et al. Biomechanical validation of load-sharing rip-stop fixation for the repair of tissue-deficient rotator cuff tears. *Am J Sports Med*. 2014;42:457–462.



# Acknowledgments

The authors wish to thank the many individuals whose efforts made this work possible.

First and foremost, we are indebted to Gina Diaz for her near-sacrificial devotion to this project, for managing every phase of the manuscript, and for making sure that each deadline was met. After managing the content of all three of our “Cowboy” shoulder books, she deserves a rest.

We appreciate the collaboration of Dr. Peter Millett, who contributed some very interesting and challenging cases for discussion in Chapter 6.

The artwork and the animations for this book are spectacular. For the incredibly crisp digital images, we are grateful to Kelly Carvallis for her expertise. The digital animations were skillfully created by Patrick Eckhold.

At Wolters Kluwer, our sincere gratitude goes out to our seasoned team of veterans: Executive Editor Brian Brown, Editorial Coordinator Dave Murphy, Design Coordinator Steve Druding, and Marketing Manager Dan Dressler.

Finally, we wish to thank Reinhold Schmieding, Founder and President of Arthrex, for his vision in recognizing the potential for arthroscopic shoulder surgery and for his support in our development of the techniques that are featured in this book.

*Stephen S. Burkhart, MD*

*Paul C. Brady, MD*

*Patrick J. Denard, MD*

*Christopher R. Adams, MD*

*Robert U. Hartzler, MD*



# Contents

*Introduction to Forewords* v

*Stephen S. Burkhart*

*Forewords* vii

*James C. Esch and Stephen J. Snyder*

*Preface* ix

*Acknowledgments* xvii

<b>CHAPTER 1</b>	<b>Difficult and Unusual Rotator Cuff Tears . . . . .</b>	<b>1</b>
<b>CHAPTER 2</b>	<b>Revision Rotator Cuff Repairs . . . . .</b>	<b>89</b>
<b>CHAPTER 3</b>	<b>Instability . . . . .</b>	<b>130</b>
<b>CHAPTER 4</b>	<b>SLAP Lesions and the Biceps . . . . .</b>	<b>244</b>
<b>CHAPTER 5</b>	<b>The Overhead Athlete . . . . .</b>	<b>275</b>
<b>CHAPTER 6</b>	<b>Shoulder Separations and Other AC Joint Injuries . . . . .</b>	<b>288</b>
<b>CHAPTER 7</b>	<b>The Arthroscopic Treatment of Glenohumeral Osteoarthritis. . .</b>	<b>343</b>
<b>CHAPTER 8</b>	<b>Miscellaneous Shoulder Conditions . . . . .</b>	<b>372</b>
<b>CHAPTER 9</b>	<b>Tips, Tricks, and Pearls . . . . .</b>	<b>416</b>

*Index* 459