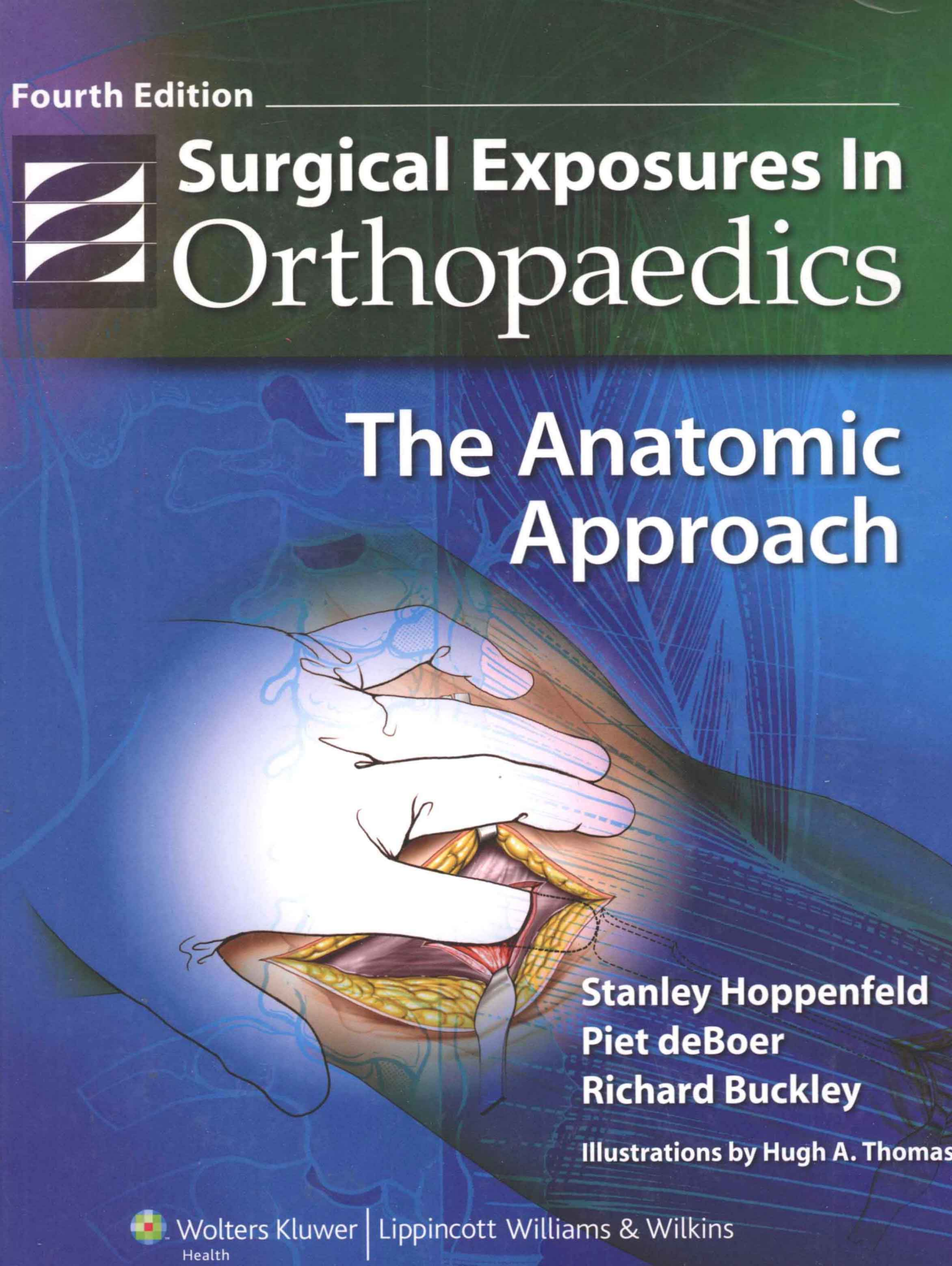
Fourth Edition

Surgical Exposures In Orthopaedics

The Anatomic Approach



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Illustrations by Hugh A. Thomas

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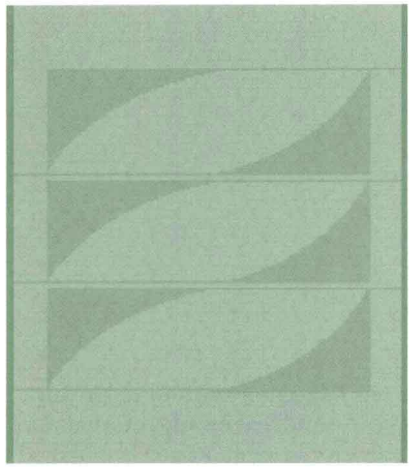

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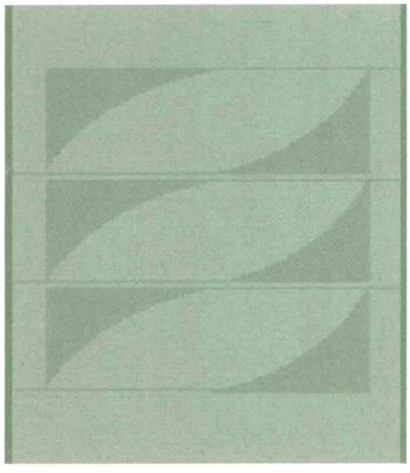

SURGICAL EXPOSURES IN ORTHOPAEDICS

The Anatomic Approach

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Dedication

To my wife Norma,
my sons Jon-David,
Robert, and Stephen,
and my parents Agatha and David,
all in their own special way have made my life full
and made this book possible.
S.H.

To Suzanne, Katy, James, Jan,
and all the other members of my family.
P.deB.

To my wife Lois,
who organizes my "whole"
life and makes it manageable,
who I respect greatly,
and my two children,
Shannon and Andrew.
R.B.

Preface

Surgical Exposures in Orthopaedics—The Anatomic Approach was first published in 1984, 25 years ago. The standard surgical approach textbooks at the time were out of date and the principle of linking surgical anatomy to surgical approaches using incisive text and wonderfully clear diagrams (then in black and white) was greeted favorably by orthopaedists and trauma surgeons around the world. Throughout its history, this text has remained the number one best seller in its field. It has been translated into five languages and is extensively used around the world on all five continents. On many occasions, while travelling around the world to teach, the authors have been thanked by residents who have reported how the book has helped them, often in difficult and emergency situations when working either alone or poorly supervised. It is also clear that residents particularly value those classical surgical approaches first described by A.K. Henry in his book on extensile approaches.

Why, then, produce a fourth edition? Standard textbooks need to change to reflect those changes that occur within their sphere of interest. The difficulty with this is to differentiate between genuine and permanent changes in the practice of orthopaedics. The young surgeon must be presented with the subject in what can only be described as "the fashion of the time" that occurs in all branches of medicine, especially orthopaedics. In the first edition of the book, great emphasis was given to the concept of subperiosteal dissection. Subperiosteal dissection ensured that the surgical approach did not damage vital structures close to the bone, but the sacrifice was significant devitalization of the bone and its surrounding soft tissues. The preservation of the blood supply to the area to be exposed has been a consistent theme in the past 24 years. The second edition of the book saw abandonment of the concept of subperiosteal dissection and the establishment of epi-periosteal planes for surgical use.

Minimal access surgery has been present in orthopaedic surgery for many years. Intramedullary nailing, through a closed technique, did not expose the fracture site and preserved the fracture hematoma. Similarly, external fixation can be seen as an attempt to provide stability to a fracture site, while preserving the fracture hematoma and the natural healing processes that occur around the fracture. Arthroscopy is probably the best example of effective use of minimal access surgery, a fact recognized by the inclusion of standard arthroscopic techniques for the knee and shoulder in the third edition.

The fourth edition includes many new approaches involving minimal access surgery. These approaches are used mainly in the field of traumatology and reflect the major surgical interest of two of the authors and the majority of their resident readers. New minimal access approaches are included for the humerus, distal femur, and proximal and distal tibia. New external fixation approaches are included, especially bridging fixation. New approaches for the spine and calcaneus were conspicuously absent in previous editions, now part of this revision.

Minimal access surgery is a classic double edge sword. The purpose of the surgery is to preserve the biology around the site of traumatic injury and to minimize the associated soft-tissue damage in elective orthopaedic surgery. The cost of this technique is decreased visualization, and many of the techniques described require the use of imaging to be safe.

C-arm technologies are now readily available throughout the world. Computer-assisted surgery is also growing rapidly, particularly in the field of joint replacement surgery.

A big danger of minimal access surgery is inadvertent damage to vital structures. It follows, therefore, that sound knowledge of underlying anatomy is even more critical for minimal access surgery than it is for conventional open approaches. Readers are earnestly advised to study the anatomical sections of the new approaches along with the classic approaches to ensure patient safety.

We feel that the fourth edition of the book now incorporates a comprehensive range of surgical approaches required for the treatment of patients with orthopaedic and traumatological complaints. Classic extensile surgical approaches, minimal access surgery, arthroscopy, and external fixation are all tools that a competent surgeon must be able to use to fully help patients.

Stanley Hoppenfeld, M.D.
Piet deBoer, M.A., F.R.C.S.
Richard Buckley, M.D., F.R.C.S.C.

Preface to the Third Edition

Since its publication in 1984, *Surgical Exposures in Orthopaedics—The Anatomic Approach* has been the standard textbook for surgical approaches in orthopaedics and traumatology, regularly consulted by trainees as well as by experienced surgeons throughout the world. Its enduring success is evidence that it continues to meet a need in the practice of orthopaedics and traumatology. Why, then, a third edition?

The field of orthopaedics continues to evolve at a rapid rate. The previous edition introduced the concept of preserving blood supply and minimizing soft-tissue damage in fracture surgery in order to preserve the biological envelope of the injured bone as much as possible. In this edition we introduce three minimal access approaches to allow the surgeon to perform intramedullary nailing of the femur, tibia, and humerus. Again, we emphasize that "you should make every effort to preserve the soft-tissue attachments of the bone wherever possible. Only expose what you actually need to see to ensure an adequate surgical procedure."

A significant development in the field has been the enormous increase in arthroscopic procedures, which have largely replaced open operations within the knee joint. Arthroscopy of the shoulder joint similarly is a rapidly developing approach. Therefore, this new edition introduces arthroscopic approaches to these joints—specifically the anteromedial and anterolateral approaches to the knee joint, and the anterior and posterior approaches to the shoulder joint, which allow the surgeons to examine the joint and have proved acceptable to large numbers of surgeons for some time.

Although arthroscopic procedures have largely superseded open procedures and surgery in the developed world, surgeons still need to incorporate the classic surgical approaches to the knee. These approaches and knowledge of their underlying anatomy are useful when a surgeon has to deal with an open wound with associated ligament damage or when operating in countries where arthroscopy is not readily available.

The third edition also contains changes in the section on acetabular approaches, particularly in the posterior approach to the acetabulum, which has become the standard approach for these complex and challenging injuries.

In addition, full color has been added to all the illustrations, enhancing their attractiveness as well as their verisimilitude.

Piet deBoer, M.A., F.R.C.S.
Stanley Hoppenfeld, M.D.

Preface to the Second Edition

How do you make a good book better in a radically changing orthopaedic environment? By keeping to basics and heeding the requests of our fellow surgeons who have written to us over these past nine years, since the publication of the first edition.

The emphasis on the concept of internervous planes remains a hallmark of the book. The basic principle of "do not cut round structures" is further reinforced by adding color to the nerves, arteries, and veins, which enhances the clinical dimensions of the illustrations.

New surgical approaches have been added, such as the anterolateral approach to the shoulder, the anterolateral approach to the tibia, and an improved lateral approach to the hip.

A whole new section on approaches to the acetabulum and pelvis is presented. The chapter is enriched with numerous original detailed surgical and anatomic drawings.

A new chapter on safe routes for percutaneous insertion of external fixators into the long bones is offered. The illustrations with their insets provide three-dimensional clarity and location of the important neurovascular structures.

Although anatomy has clearly not changed in the past nine years, more emphasis has been given to the preservation of the blood supply to the bone during orthopaedic surgery. This concept is of particular importance in fracture surgery where the blood supply to the bone has often been disrupted by the original injury. Preservation of blood supply is achieved by maintaining the soft tissue envelope of the bone. The approaches described in this book necessarily describe exposure of the whole anatomical site; the illustrations demonstrate this. In clinical practice you will often only need part of the approach described. You should make every effort to preserve the soft tissue attachments of the bone wherever possible. Do not fall into the trap of stripping bone extensively to allow complete exposure of all sides of a fracture; dead bone does not unite in the fracture situation.

Only expose what you actually need to see to ensure an adequate surgical procedure. The concept of "biological fixation" of fractures relies on these principles.

Stanley Hoppenfeld, M.D.
Piet deBoer, M.A., F.R.C.S.

Preface to the First Edition

It has often been said that successful orthopaedic procedures are based on a simple principle: Get to bone and stay there. *Surgical Exposures in Orthopaedics: The Anatomic Approach*, the product of an anatomy course for orthopaedic surgeons that has been run at the Albert Einstein College of Medicine for the past 15 years, expands on the principle. The book explains the techniques of commonly used orthopaedic approaches and relates the regional anatomy of the area relevant to the approach.

Safety in surgery depends on knowledge of anatomy and technical skill. The two go hand in hand; one is useless without the other. Surgical skill can be learned only by practical experience under expert supervision. But the knowledge that underlies it must come from both book and dissection. Structurally, this book is divided into 11 chapters, each dealing with a particular area of the body. The most commonly performed approaches are described; we have omitted approaches designed only for one specific procedure—they are best understood in the original papers of those who first described them. Nevertheless, the vast majority of orthopaedic procedures can be safely and successfully accomplished through the approaches we have included.

Orthopaedics is a rapidly evolving field. New procedures are appearing at a prodigious rate; some are discarded in a comparatively short time. Thus, any book that concerns itself with the specifics of operative surgery inevitably becomes dated, sometimes even before publication. To avoid this problem, we have concentrated on getting to the bone or joint concerned, and not on what to do after. When applicable, we have included references to individual surgical procedures but without incorporating their details into our textbook.

The key to *Surgical Exposures in Orthopaedics* is a consistent organization throughout (*see* Table 1). Each approach is explained; then the relevant surgical anatomy of the area is discussed. When one or more approaches share anatomy, they are grouped together, with the relevant anatomical section at the end. The idea is for the surgeon to read the approach and anatomy sections together before attempting a given procedure, because once the anatomical principles of a procedure are fully understood, the logic of an approach becomes clear.

SURGICAL APPROACHES

The crucial element in successful surgical approaches is exploiting *internervous planes*. These planes lie between muscles—muscles supplied by different nerves. Internervous planes are helpful mainly because they can be used along their entire length without either of the muscles involved being denervated. These approaches can generally be extended to expose adjacent structures. Virtually all the classic extensile approaches to bone use internervous planes—a concept first described by A. K. Henry, who believed that if the key to operative surgery is surgical anatomy, then the key to surgical anatomy is the internervous plane.

The approach sections are structured as follows.

The introduction to each approach describes indications and points out the major advantages or disadvantages of the proposed surgery. Significant dangers are also outlined in this section.

Table 1. Chapter Outline

I. Surgical Approach

(Introduction)
Position of Patient on Operating Table
Landmarks and Incision
Internervous Plane
Superficial Surgical Dissection
Deep Surgical Dissection
Dangers
How to Enlarge the Approach
  Local Measures
  Extensile Measures

II. Applied Surgical Anatomy

Overview
Landmarks and Incision
Superficial Surgical Dissection and Its Dangers
Deep Surgical Dissection and Its Dangers
Special Anatomical Points

The *position of the patient* is critical to clear, full exposures, as well as to the comfort of the operating surgeon.

Surgical *landmarks* form the basis for any incision; they are described with instructions on how to find them. The *incision* follows these key landmarks. Although the incisions described are generally straight, many surgeons prefer to use curved or zigzag incisions because they heal with less tension than do equivalent straight incisions.

The approaches often allow exposure of the whole length of a bone; usually, only part of an exposure is required for any given operation. The surgical dissection has been divided into *superficial* and *deep surgical dissections* for teaching purposes to reinforce the concept that each layer must be developed fully before the next layer is dissected. Adequate exposure depends on a systematic and deliberate technique that exploits each plane completely before deeper dissection begins.

The *dangers* of each approach are listed under four headings: nerves, vessels, muscles and tendons, and special points. The dangers are described, along with how to avoid them.

The approach section concludes with a description of *how to enlarge the approach*. All too often, the surgeon discovers that the incised exposure is inadequate. There are two ways in which the exposure can be enlarged: *Local measures* include extending skin incisions, repositioning retractors, detaching muscles, or even adjusting the light source; and *extensile* measures are ways in which an approach can be extended to include adjacent bony structures. In approaches through internervous planes, extensile measures may permit the exposure of the entire length of the bone.

ANATOMICAL SECTIONS

The anatomy of each approach begins with a brief overview of the muscular anatomy, along with the arrangement of the neurovascular structures.

The anatomy of the *landmarks* relates these structures to their surroundings. The anatomy of the *skin incision* describes the angle between the incision and the natural lines of skin cleavage first described by Langer—a relationship that may influence the size and prominence of the resultant scar. Nevertheless, the site of a skin incision must be determined largely by safety and effectiveness and not by cosmetic considerations. Skin incisions generally avoid cutting major cutaneous nerves; where they might, the danger is clearly stated.

The anatomy of the *superficial and deep surgical dissection* discusses the regional anatomy encountered during the approaches—not only the anatomy of the plane to be used but also that of adjacent structures that may appear if the surgeon strays out of plane. Perhaps the greatest value of knowing topographical anatomy is in cases of trauma, where the surgeon may explore wounds with confidence, aware of the potential dangers created by any given wound. Relevant clinical information on the anatomical structures is offered, but a comprehensive clinical picture is beyond the scope of this book. The origins, insertions, actions, and nerve supplies of relevant muscles are listed in legends under the muscles' illustrations.

The anatomical and surgical illustrations are drawn from the surgeon's point of view whenever possible, with the patient on the operating table, so that the surgeon can see exactly how the approach must look when he operates.

The anatomical terms used in *Surgical Exposures in Orthopaedics* are generally those used in modern anatomical textbooks. Terms now in orthopaedic usage sometimes differ from them; when that occurs (for instance, with the flexor retinaculum/transverse carpal ligament), both terms are given. Variation also occurs in usage on either side of the Atlantic; we have used those terms on which the authors (one American and one English) have reached consensus. It has been said that all of orthopaedic surgical approaches can be reduced to one line: "Avoid cutting round structures." This book has been written to tell you how.

Stanley Hoppenfeld, M.D.
Piet deBoer, M.A., F.R.C.S.

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Introduction: Orthopaedic Surgical Technique

Surgical technique in orthopaedics varies from surgeon to surgeon; the more experienced the surgeon, the fewer instruments he uses and the simpler his technique becomes. Certain principles, however, remain constant. They are listed below as they apply to each surgical section.

The *position of the patient* is fundamental to any approach; it is always worth taking time to ensure that the patient is in the best position and that he is secured so that he cannot move during the procedure. Operating tables are well padded, but certain bony prominences—such as the head of the fibula and greater trochanter—are not. These prominences must always be padded adequately to prevent skin breakdown and nerve entrapment during surgery. Patients who are prone must have suitable padding placed under their pelvis, chest, head, and nose to allow respiration during surgery. Many different systems ensure adequate ventilation of the patient; bolsters placed longitudinally under the side of the patient are probably the best. Ventilation of the prone patient must be adequate before surgery, since repositioning of the patient during surgery is difficult and almost inevitably contaminates the sterile field.

The surgeon should be comfortable during surgery, with the patient placed at the correct height for the surgeon's size or the table low enough to allow him to operate sitting down.

In surgery on the limbs, a tourniquet is often used to create a bloodless field, making identification of vital structures easier and expediting surgery.

To apply the tourniquet, empty the limb of blood, either by elevating it for 3 to 5 minutes or by applying a soft rubber compression bandage. The tourniquet should be padded with a soft dressing to prevent the wrinkles (and blisters) that inevitably occur when the skin is pinched. The tourniquet may be applied to the upper arm or thigh. Both of these areas are well muscled; the major nerves are protected from compression of the tourniquet. The inflated pressure of the tourniquet should be about 275 mm Hg in the upper limb and 450 mm Hg in the lower limb, depending on the circumference of the limb. Test the tourniquet by inflating it before applying it to the patient. In children, inflate the tourniquet to 50% above their systolic pressure. In hypertensive patients, inflate it 50% more than their systolic pressure. Finally, do not leave the tourniquet inflated for longer than 1 hour in the upper limb and 1½ hours in the lower limb to minimize risk; do not use tourniquets when the peripheral circulation of the patient is suspect or in the presence of sickle cell disease.

Partial exsanguination of the limb, which can be achieved after 2 minutes of elevation, leaves blood in the venous structures. It makes for a bloodier field during surgery but does make it easier to identify neurovascular bundles—something of immense value in, for example, lateral meniscectomy, where it is safer to identify and to coagulate the lateral inferior geniculate artery than to cut it accidentally, learning about it only after the tourniquet has been deflated. Deflate the tourniquet before closure to identify and to coagulate major bleeding points.

The *landmarks* are critical to the planning of any incision. It is often convenient to mark them on the skin with methylene blue to ensure that the skin incision lines up with them.

All skin incisions heal with the formation of scar tissue, which contracts with time. For this reason, skin incisions should not cross flexion creases at 90°; cutting perpendicular to flexion creases can cause contractures to develop over the involved joints. That is why incisions that cross major flexion creases are usually curved to traverse the crease at about 60°. The techniques of the *superficial and deep surgical dissections* are the province of practical experience, not book knowledge. However, two techniques are frequently referred to in the book.

Subperiosteal dissection protects vital structures that lie near the bone, helping to prevent their damage by instruments. The rule holds true, but vital structures often lie on the periosteum itself: the posterior interosseous nerve, for instance, lies on the periosteum of the neck of the radius. The radial nerve lies on the periosteum on the back of the humerus. In these cases subperiosteal dissection must be strictly subperiosteal, something that may not be possible if the periosteum is damaged in case of fracture. The periosteum normally detaches easily from the bone except at sites of muscle or ligament attachments where it may adhere strongly. Blunt dissection may be difficult or impossible at the sites of insertion. Note that the periosteum of children is thicker than that of adults, more easily defined, and less adherent to bone. In fracture surgery subperiosteal dissection is rarely indicated except in the region of the proximal radius and the center of the humeral shaft. Subperiosteal stripping will destroy the periosteal supply of blood to the bone and if extensive will devitalize the fracture site. In such cases periosteal stripping is only permissible to allow accurate reduction of the fracture. The more experienced the surgeon becomes the less soft tissue damage he will need to create to allow accurate visualization and reduction of the fracture.

The second technique is that of detaching muscle from bone. Remember to strip *into* the *acute angle* that fibers make with the bone to which they attach. This is perhaps clearest in the fibula: To detach the peroneal muscles, pass an elevator from distal to proximal; to detach the interosseous membrane, where fibers run in a different direction, strip from proximal to distal.

Exposures can be improved in two ways. *Local measures* enhance the immediate exposure. *Extensile measures* allow the surgeon to expose adjacent bony structures. It is vital to appreciate that not all approaches are extensile: Specialized approaches should be used only in cases where the pathology is accurately pinpointed and where the surgeon does not have to expose any adjacent structures. Inadequate exposure is one of the most common causes of surgical failure. If the surgeon is in difficulty, one of the first things he should try is to improve the exposure either by local or by extensile means.