VOLUME ONE

McGLAMRY'S

Comprehensive Textbook of Foot and Ankle Surgery

Fourth Edition

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Foreword

The fourth edition of *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery* has been written to meet the current need for a comprehensive work on foot and ankle surgery, not only for podiatric surgeons but also for orthopaedic foot and ankle surgeons, who are making valuable contributions to this field.

Foot and ankle surgery has evolved at a rapid pace over the past 30 years. Not until an understanding of foot and ankle biomechanics and the principles of AO-ASIF were materially refined was this surgery practiced with precision. Prior to that time, functional arthroplasty and fusion dominated the field. Orthopaedic companies assisted in that revolution with the development of unique designs of internal and external fixation that brought the surgical results into a functional cure rather than a palliative "fix."

In concert with this revolution, E. Dalton McGlamry, DPM, founded the Podiatry Institute in Atlanta and soon thereafter edited the text *Fundamentals of Foot Surgery* and the first edition of *The Comprehensive Textbook of Foot Surgery*. Dr. McGlamry was a great inspiration to all podiatric surgeons, and his legacy has been carried on by many of his residents and colleagues.

This two-volume edition of *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery*, edited by Joe T. Southerland, DPM, and assisted by 151 authors, consists of 117 chapters and more than 1,900 pages and is worthy of comparison with *Campbell's Operative Orthopedics*. Virtually every aspect of foot and ankle surgery has been covered, from ingrown nails to total ankle arthroplasty and hybrid external fixation.

To overcome the widespread conception of foot and ankle surgery as a purely mechanical equation, an effort is made in the first section of this text to correlate the technical principles used in this subspecialty. This is followed by a section on perioperative management, which includes the various aspects that one encounters in foot and ankle surgery. The next 50 chapters follow guidelines of anatomical sites where foot and ankle surgery is performed, beginning with nail surgery and concluding with midfoot and hindfoot arthrodesis. The section on first ray, hallux abducto valgus, and related deformities is especially noteworthy, with 14 chapters on the subject covering virtually every aspect of contemporary correction of bunion deformities and their complications. This is true as well for the section on trauma, with 18 comprehensive chapters on the subject.

This book is designed to be a user-friendly and clinically relevant text on common foot and ankle surgery procedures. As the discipline becomes more and more sophisticated, it is obvious that the technical component of operative intervention is critical to clinical success or failure. Therefore, there continues to be an important need to understand the technical aspects of foot and ankle surgery. Many pearls of wisdom are detailed by the authors in order to deal with the multiple potential pitfalls seen in patients with complex foot and ankle deformities.

I have often said that "surgery is both a science and an art, but foot and ankle surgery may be more art than science." This text should prove to be the resource of choice for modern foot and ankle surgery care over the next several years. It will serve those who are novices in the field who wish to concentrate on principles, those experienced surgeons who wish to fine-tune their approach, and everyone in between.

Lowell Scott Weil, Sr, DPM
Weil Foot and Ankle Institute
Des Plaines, Illinois

Preface

It is with great pleasure that we present the fourth edition of *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery*. The goal of this text, as always, is to help students build a good foundation, to help residents develop their skills, and to help surgeons hone their technique.

Like the three previous editions, this book encompasses all facets of foot and ankle surgery. This edition, however, places greater emphasis on an instructional approach so as to better help the surgeon, resident, or student *see* how the procedures are done. It has been completely reorganized to present content in a more logical fashion. Divided into 12 parts across 2 volumes, it begins with basics such as biomaterials and pain management and moves through anatomic locations, physiologic conditions, special surgery, tumors, and trauma. This fourth edition has dozens more chapters and contributors than earlier volumes, making it the most truly comprehensive *Comprehensive Textbook* so far. In addition, for the first time, the textbook has been printed in full color throughout, greatly clarifying the appearance of disorders, diagnostic signs, and surgical landmarks and bringing the operative steps to life.

As the lead editor, I extend my gratitude to the section editors for their work in helping make this a reality. However, most appreciated are the authors, without whom a book of this sort cannot exist. Amid the responsibilities of practice, teaching, and family lives, they were able to find the time needed to write these chapters. Unfortunately, this edition is missing one esteemed author, Gerard V. Yu, who passed away unexpectedly in 2005.

It has been a several-year journey since we started work on this book, and I am very proud to be a part of it. It is my hope that it delivers what we set out to do.

Joe T. Southerland, DPM, FACFAS

Introduction

As the director of Medical Education of the Podiatry Institute, I am proud to provide the Introduction for the fourth edition of *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery*.

This textbook is the ongoing testament to the life passion of E. Dalton McGlamry, DPM. This ambitious project was conceived 30 years ago under the direction of Dr. McGlamry. The supporting staff included graduates of the original Doctor's Hospital Podiatric Residency and many other highly talented and dedicated educators in the podiatric profession.

The first edition, called simply *Comprehensive Textbook of Foot Surgery*, took several years to compile and edit and was published in 1987. It could not have been completed without the tireless support of Dalton's wife, Becky, who served the unenviable roll as authors' editor. The second edition was produced in 1992 under the guidance of editors Dalton McGlamry, Alan Banks, and Michael Downey. The third edition was released in 2001 with Alan Banks, Michael Downey, Dennis Martin, and Steve Miller serving as editors. You now hold the fourth edition. Our many thanks are owed to editors Joe Southerland, Jeffrey Boberg, Michael Downey, Aprajita Nakra, and Linnie Rabjohn for their countless hours of work.

Anyone who has attempted to produce a scientific paper knows the many hours of commitment and effort that are necessary to complete even a single article. That the dedicated faculty of the Podiatry Institute have stuck together for over 40 years and overseen the publication of a major textbook on foot and ankle surgery through four editions is a remarkable feat. One of our dearest members, the late Gerard Vincent Yu, deserves special mention. His many contributions to podiatric education, his drive and energy, his integrity, his love of the profession, and his commitment to colleagues and friends have inspired and always will inspire us.

The contributing authors for this textbook throughout its lifespan so far are too many to mention individually, but without each and every one of them those editions could not have been completed. I would like to recognize and salute each of the individuals who once again have sacrificed their personal time and energy to perpetuate this information.

The completion of this edition of *McGlamry's Comprehensive Textbook of Foot and Ankle Surgery* could not have been possible without the tireless efforts of Mr. Dan Vickers, the executive director of the Podiatry Institute. It has been Dan's commitment and support to the project, to the institute, and to each of us that has kept us on track to reach our goal once again.

John A. Ruch, DPM

CHAPTER

58

John A. Ruch
Lopa Dalmia
Patrick B. Hall

Triple Arthrodesis

The triple arthrodesis performed today is a variation of the procedure described by Ryerson in 1923 (1). Modifications have evolved out of the need to meet new challenges as the triple arthrodesis has been applied to a greater variety of disorders (2–12). The basic aim of a triple arthrodesis is to improve foot function by providing stability, correction of deformity, and elimination of pain. Providing the patient with a stable, pain free platform for ambulation through triple arthrodesis offers gratifying and predictable results for a variety of foot deformities (13–23).

INDICATIONS

In the broadest sense, the triple arthrodesis is used to achieve four major goals: correction of deformity, relief of pain, stabilization, and improved function. The dominant deformity in the early twentieth century was flaccid paralysis secondary to poliomyelitis. Today, various conditions are amenable to repair with triple arthrodesis. Table 58.1 reflects the wide range of diagnoses in which this surgery is performed. Many of these disease processes reflect similar deformities; each of the major deformities can be categorized into valgus, varus, or miscellaneous conditions (Table 58.2).

PREOPERATIVE CONSIDERATIONS

Certain considerations should be made before triple arthrodesis is performed. These include patient expectations, the desired goal of the fusion and its functional effect, timing of the surgical intervention, biomechanical and positional considerations of the subtalar joint (STJ) and midtarsal joint, the position and alignment of the ankle and leg, bone quality, soft tissue quality, the patient's age, and the anticipated recovery time.

Candidates for triple arthrodesis usually possess conditions that have proven resistant to conservative therapy, or they have a condition that cannot be expected to respond to conservative measures and one in which the surgeon can expect an adequate result with fusion. The elimination of STJ and midtarsal joint motion may restrict the ability of the patient to adapt to uneven surfaces and terrain; however, in candidates for triple arthrodesis, this motion is often either painful or absent preoperatively. Additionally, the existing deformity often prevents the motion from serving any benefit for the patient, due to either painful arthritis or uncontrollable instability.

Evaluation of ankle joint range of motion is a critical part of the preoperative assessment. This may reveal either an arthritic limitation or a soft tissue equinus contracture, altering the surgical plan. Careful examination needs to be performed in a patient with a severely collapsed pes valgus deformity because significant amounts of dorsiflexion may occur at the midtarsal joint level. In patients with rigid pes valgus conditions, it is difficult to position the foot adequately to assess the true amount of ankle dorsiflexion until the joints have been resected at the time of surgery. In contrast, ankle joint dorsiflexion in patients with a pes cavus deformity may first appear inadequate because of the increase in the osseous height from the maximally supinated position of the midtarsal joint and STJ. Upon restoring a more plantigrade osseous alignment after fusion, one may note a suitable increase in the dorsiflexory motion at the ankle.

Perhaps the most critical aspect of triple arthrodesis is the ultimate position of the foot after fusion. Poor or inappropriate positioning of the foot may be one of the primary reasons for residual pain and the creation of adjacent arthritis postoperatively. The heel should be aligned to rest in a neutral to slightly everted position. The greatest success in triple arthrodesis has been achieved with the midtarsal joint positioned in slight valgus when fused, that is, with the medial column slightly plantarflexed relative to the lateral column. This position increases the stability of the medial column and first ray, permitting enhanced first metatarsophalangeal joint motion. The valgus positioning may also be more easily accommodated with an orthotic device postoperatively. If the medial column is dorsiflexed relative to the lateral column, the patient is left with a fixed forefoot varus deformity for which no suitable compensation exists.

It is important to plan the alignment of the forefoot to the rearfoot and the rearfoot to the leg (Fig. 58.1). This is especially critical in determining the final position of fusion. The foot normally exhibits 10 to 15 degrees of abduction from the line of progression in gait. In arthrodesis of the rearfoot, the surgeon must know the position of the knee during gait as well as during the surgical procedure. If the knee functions when medially rotated at 15 degrees, then it would be desirable to abduct the foot on the leg 30 degrees, thus resulting in a 15-degree abduction from the line of progression. It is not advisable to abduct a foot if the patient already possesses 15 to 30 degrees of lateral position of the knee in gait. In the latter instance, the foot may be aligned directly with the knee.

These preoperative assessments are aided by a series of weight-bearing radiographs (Fig. 58.2) including dorsoplantar, medial oblique, lateral, and calcaneal axial views. Weight-bearing films allow a more representative view of osseous alignment. The degree of deformity should be evaluated in each of the cardinal planes prior to proceeding with surgical reconstruction.

TECHNIQUE

MEDIAL INCISION/DISSECTION

Landmarks for the medial approach to triple arthrodesis include the medial gutter of the ankle joint proximally and

TABLE 58.1 Conditions That May Benefit from Triple Arthrodesis

Idiopathic collapsing pes planovalgus deformity
Peroneal spastic flatfoot
Tarsal coalition
Congenital vertical talus
Chronic pain
Rheumatoid arthritis
Degenerative arthritis
Posttraumatic arthritis
Charcot arthropathy
Tibial posterior tendon dysfunction
Idiopathic cavus and cavovarus deformities
Residual or uncorrected clubfoot
Poliomyelitis
Spina bifida
Friedreich ataxia
Charcot-Marie-Tooth disease
Muscular dystrophy
Cerebral palsy
Myelodysplasia
Arthrogryposis
Joint instability

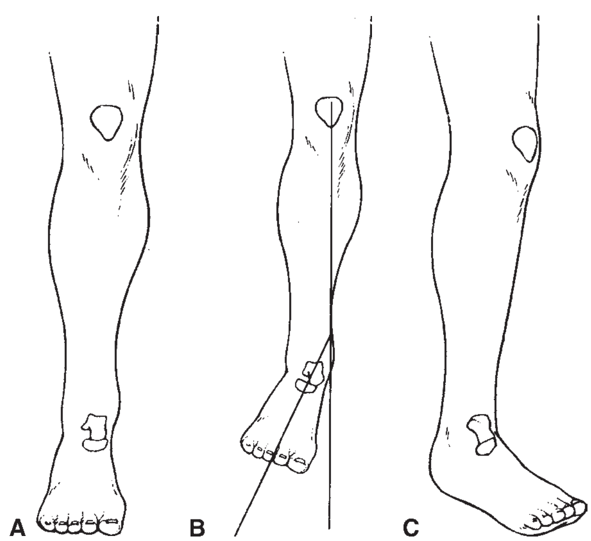


Figure 58.1 Relationship of the knee position to the foot. **A:** Rectus knee and foot. **B:** Rectus knee with the foot abducted 30 degrees. **C:** Internal knee position with the foot adducted 25 degrees.

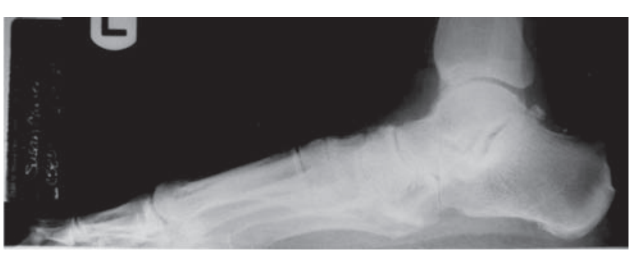


Figure 58.2 Preoperative radiograph.

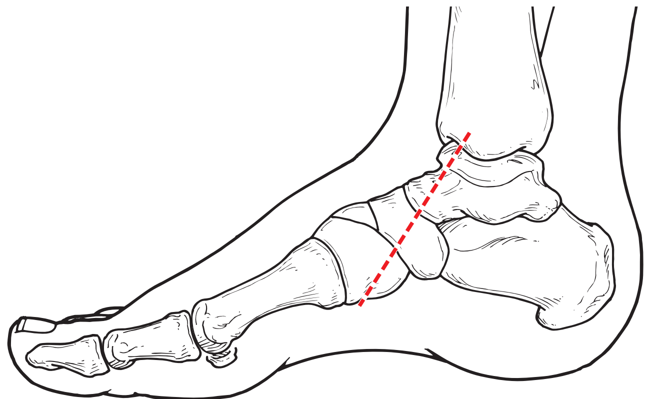
TABLE 58.2 Indications for Triple Arthrodesis

Valgus foot deformities
Collapsing pes planovalgus deformity
Tibial posterior tendon dysfunction
Tarsal coalition
Arthritic conditions
Rheumatoid arthritis
Degenerative arthritis
Posttraumatic arthritis
Chronic pain
Varus foot deformities
Cavus and cavovarus
Talipes equinovarus
Miscellaneous conditions
Joint instability
Neuromuscular disease
Hereditary familial sensorimotor neuropathies
Paralytic deformities
Cerebral palsy
Charcot arthropathy
Other diseases affecting the spinal cord and brain

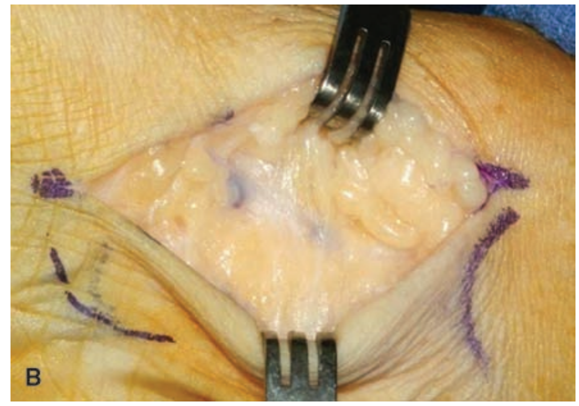
the inferior aspect of the navicular cuneiform joint (Fig. 58.3). This oblique orientation provides full exposure of the talonavicular joint and allows for screw fixation of the STJ and the talonavicular joint. A dorsal to plantar fixation of the STJ utilizes insertion of the large cancellous screw at the dorsal medial aspect of the talar neck. Fixation of the talonavicular joint with a large cancellous screw is directed from the distal inferior aspect of the navicular up into the head and neck of the talus.

Medial skin incision for exposure of the talonavicular joint and insertion of the TN screw and the talocalcaneal screw extends from the medial gutter of the ankle to inferior aspect of the navicular cuneiform joint (Fig. 58.4A). The greater saphenous vein will usually be encountered during dissection through the subcutaneous layers. Inferior tributaries may be transected and ligated and the main portion of the vein reflected superiorly (Fig. 58.4B). The primary incision for exposure of the talonavicular joint is made through the deep fascia and capsule along

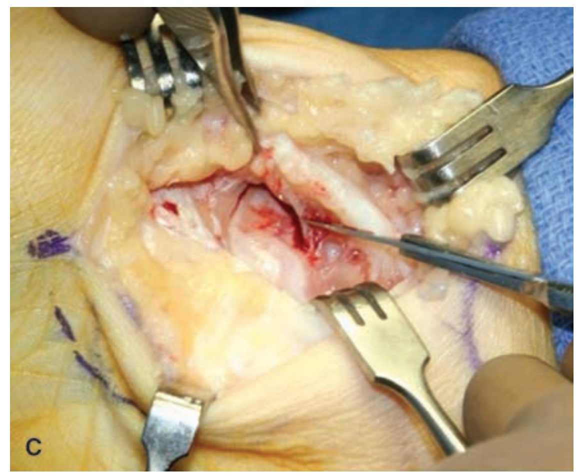
Figure 58.3 Landmarks for the medial approach to triple arthrodesis include the medial gutter of the ankle joint proximally and the inferior aspect of the navicular cuneiform joint.



A



B

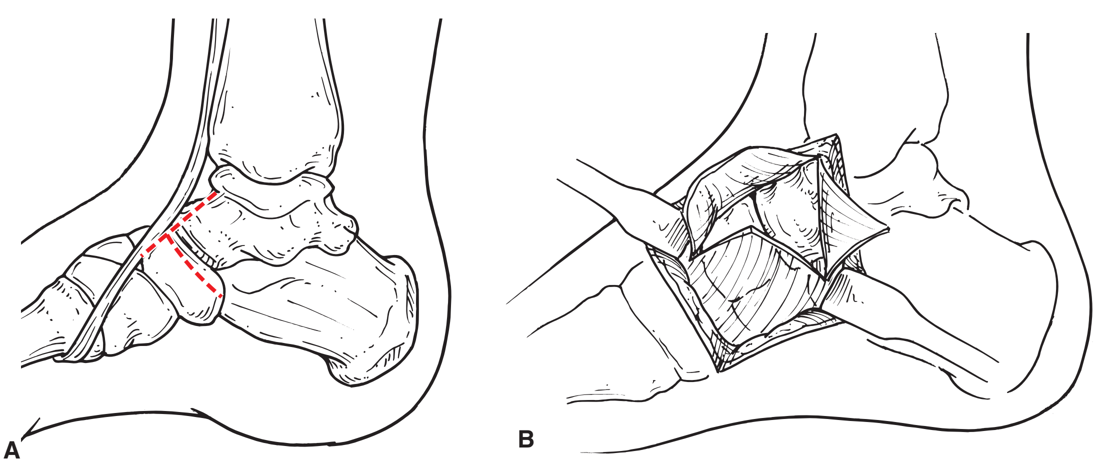


C

Figure 58.4 **A:** Medial skin incision. **B:** Dissection through the subcutaneous layers. **C:** Primary incision for exposure of the talonavicular joint.

the dorsal medial aspect of the joint. The incision extends from the medial gutter of the ankle joint to the navicular cuneiform joint (Fig. 58.4C).

The capsular incision for the talonavicular joint is a T incision (Fig. 58.5A and B). The dorsal medial longitudinal incision allows for reflection of capsular tissues for the dorsal aspect of the talonavicular joint. The vertical medical incision allows for deliverance of the head of the talus without reflecting capsular tissues of the medial aspect of navicular. A secondary incision is made vertically along the proximal medial edge of the navicular but does not usually transect the tibialis posterior tendon (Fig. 58.5C and D). This modification in the talonavicular incision leaves capsule and periosteal tissues intact over the medial aspect of the navicular. The capsule



A

B

Figure 58.5 **A,B:** Capsular incision for the talonavicular joint. *(Continues on next page)*

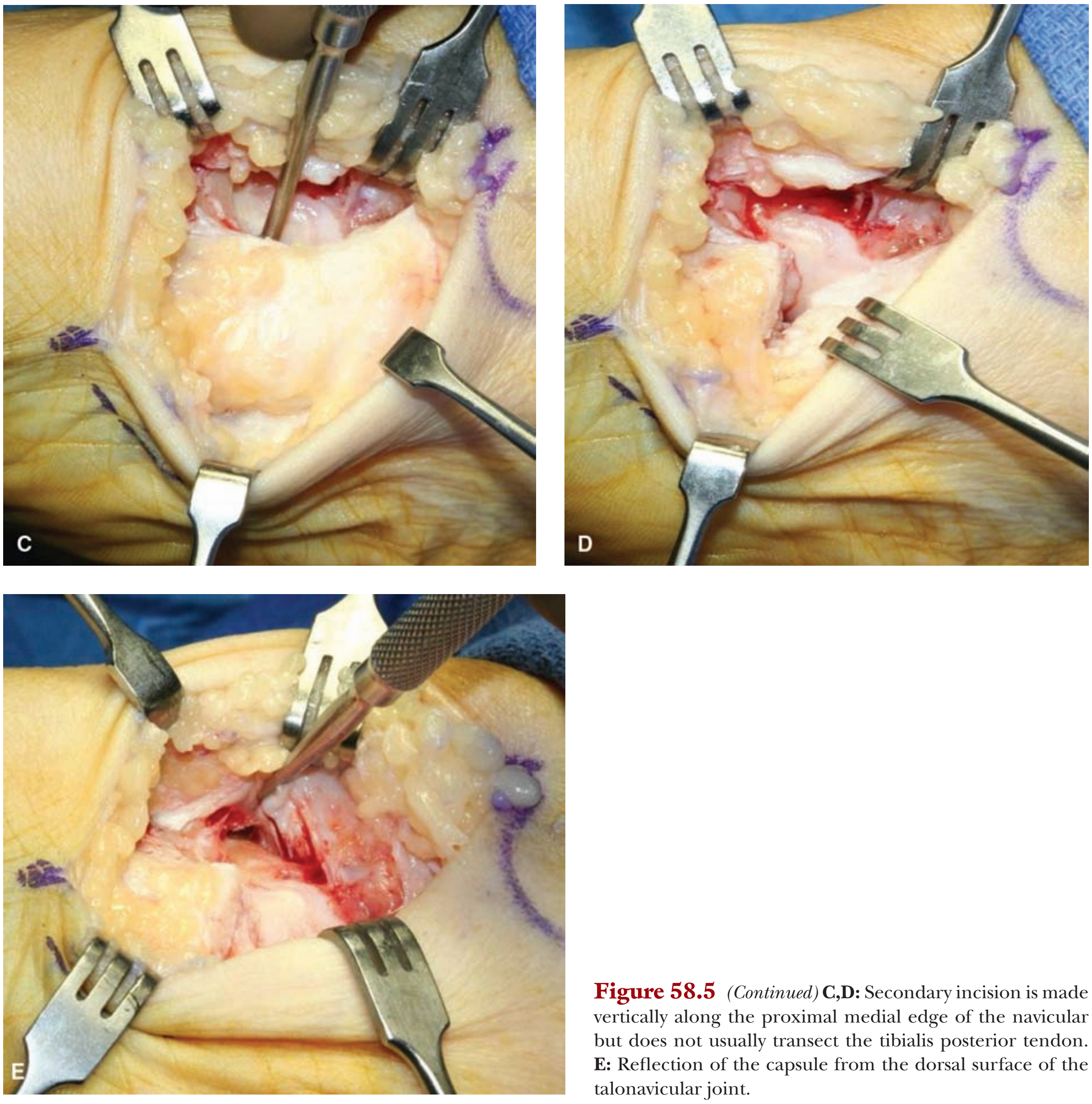


Figure 58.5 *(Continued)* **C,D:** Secondary incision is made vertically along the proximal medial edge of the navicular but does not usually transect the tibialis posterior tendon. **E:** Reflection of the capsule from the dorsal surface of the talonavicular joint.

is reflected from the dorsal surface of the talonavicular joint and will routinely release the dorsal talonavicular ligament (Fig. 58.5E). This modification in the arthrotomy of the talonavicular joint provides full exposure and minimizes soft tissue or periosteal reflection.

TALONAVICULAR JOINT RESECTION

Joint resection starts with contour resection of the talar head (Fig. 58.6A). The contour joint resection technique of the talar head preserves the shape of the joint and minimizes bone resection. Preservation of the joint contour also allows for manual repositioning of the midtarsal joints by a normal rotation of the medial column. Contour resection of the articular cartilage and subchondral plate of the talar head is performed with the use of a small osteotome (no. 10) and mallet (Fig. 58.6B). The osteotome is advanced only several millimeters to avoid excessive depth and penetration into talar head (Fig. 58.6C). This technique is extremely helpful because of the convex contour of the talar head. The depth of the osteotome is directed beneath the subchondral plate in a mosaic pattern designed to resect the articular surface and preserve the contour of the head of the talus (Fig. 58.6D).

The small lamina spreader is repositioned for resection of the articular surface of the navicular (Fig. 58.7A). Curettage technique is used to remove the articular cartilage on the navicular (Fig. 58.6B).

Care is taken to maintain the dorsal rim of the bone to assure bone-to-bone contact of the convex talar head and the concave navicular surface (Fig. 58.7C). A rotary oval burr is used to penetrate the subchondral plate (Fig. 58.7D and E). Distraction of the talonavicular joint with a lamina spreader demonstrates the resection of the articular surfaces of the head of the talus and the concave surface of the navicular exposing raw cancellous bone (Fig. 58.7F).

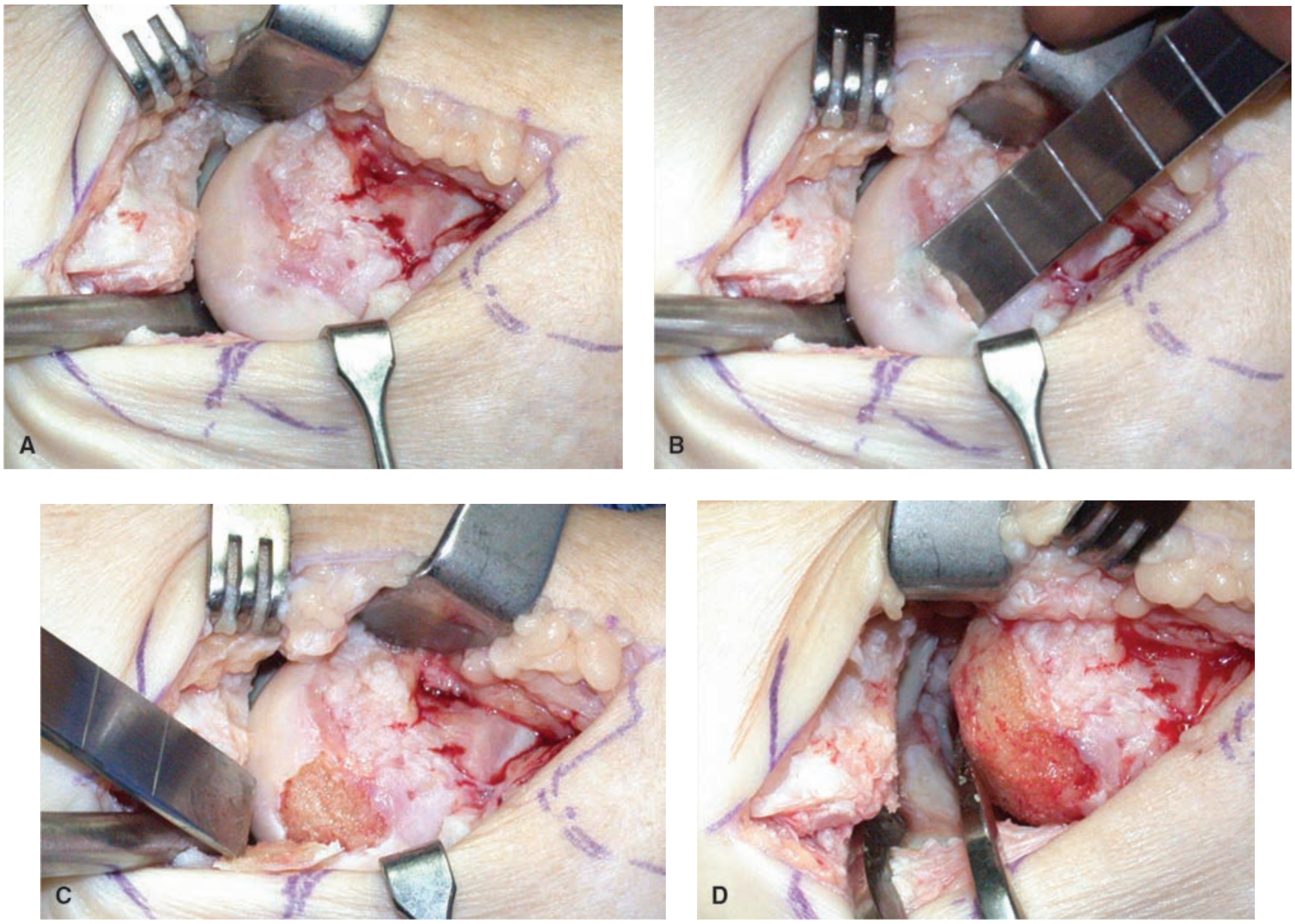


Figure 58.6 **A:** Contour resection of the talar head. **B:** Contour resection of the articular cartilage and subchondral plate of the talar head. **C,D:** Osteotome advancement.

LATERAL INCISION/DISSECTION

Landmarks for the lateral approach for triple arthrodesis include the distal tip of the fibular malleolus and the junction of the fourth and fifth metatarsal bases (Fig. 58.8A). A relatively straight line incision between these two points crosses the inferior edge of the sinus tarsi and the dorsal lateral aspect of the calcaneal cuboid joint (CCJ). The incision is usually between the course of the sural nerve and the intermediate dorsal cutaneous nerve. Controlled depth incision technique is used to separate the skin and to avoid laceration of the underlying veins (Fig. 58.8B). Dissection through the subcutaneous tissues exposes the deep fascia over the extensor digitorum brevis

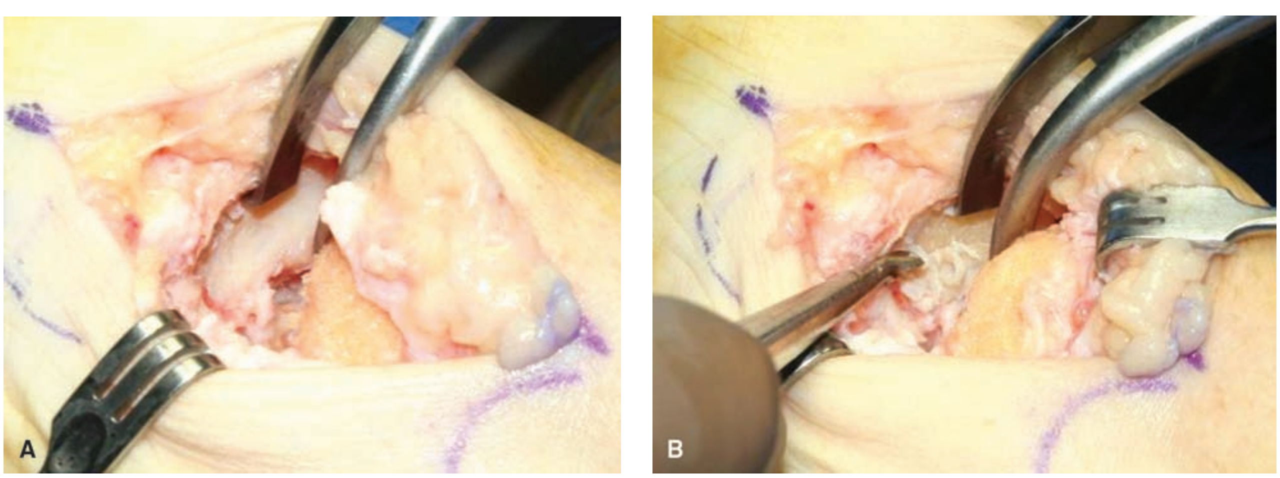


Figure 58.7 **A:** Repositioning of the small lamina spreader. **B:** Removal of the articular cartilage on the navicular. *(Continues on next page)*

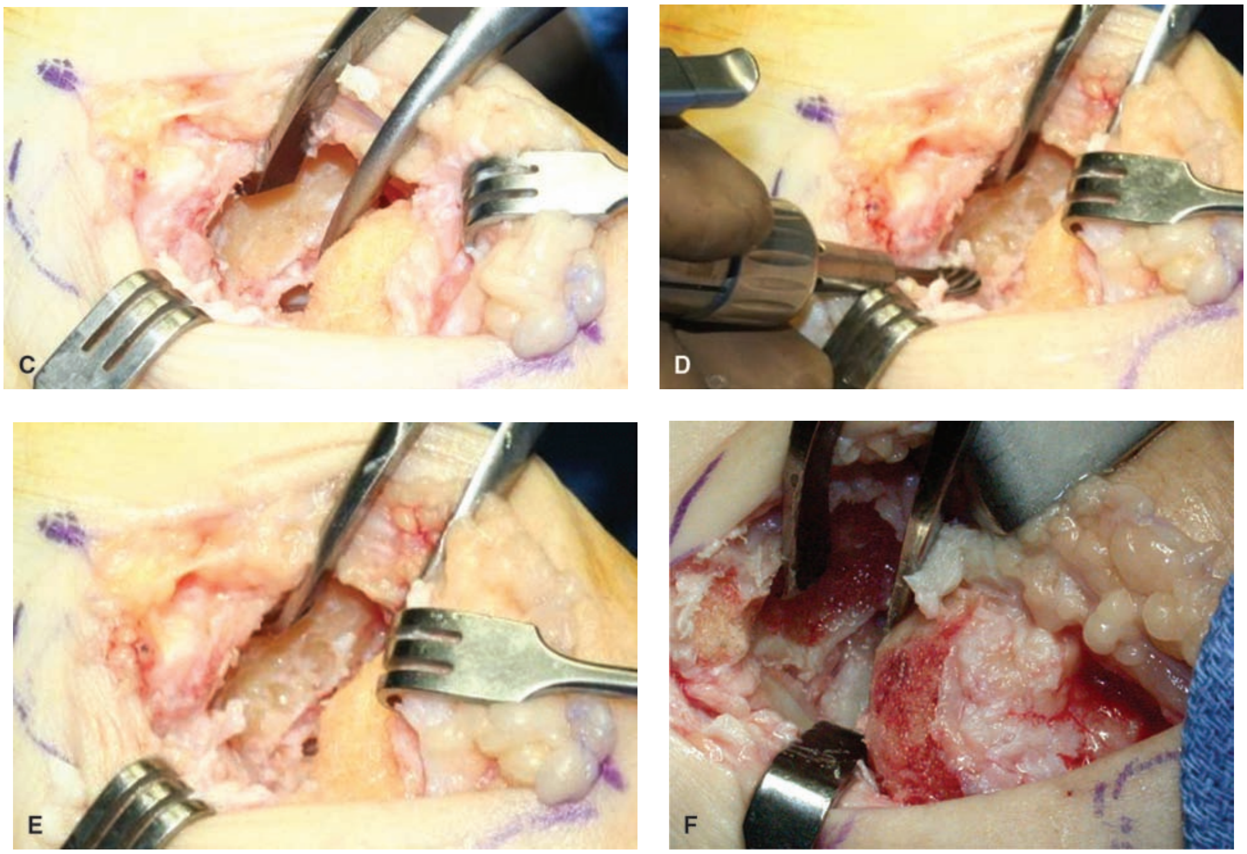


Figure 58.7 *(Continued)* **C:** The dorsal rim of bone is maintained. **D,E:** A rotary oval burr is used to penetrate the subchondral plate. **F:** Head of the talus and concave surface of the navicular, exposing raw cancellous bone.

(EDB) muscle belly (Fig. 58.8C). Superficial veins that crossed the incision may be ligated or cauterized. A communicating branch of the sural nerve to the intermediate dorsal cutaneous nerve may be encountered. If the nerve can be safely retracted, it is preserved, but more often it is sacrificed (Fig. 58.8D). The superficial fascia or the subcutaneous layer is easily separated from the deep fascia, especially over the extensor digitorum muscle belly, using blunt sponge technique (Fig. 58.8E). The primary purpose of this separation between the layers is to facilitate wound closure. The tendon of the peroneus tertius is encountered overlying the EDB muscle belly.

The anatomic pathway to the STJ and CCJ lies between the inferior edge of the EDB muscle belly and the superior aspect of the peroneal tendons (Fig. 58.9A). Reflection of

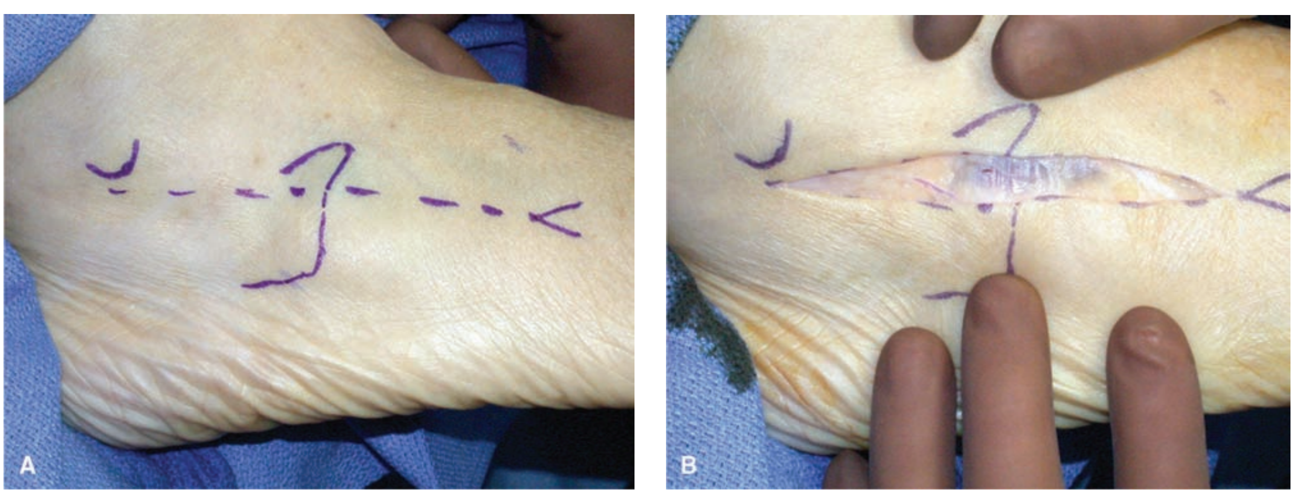
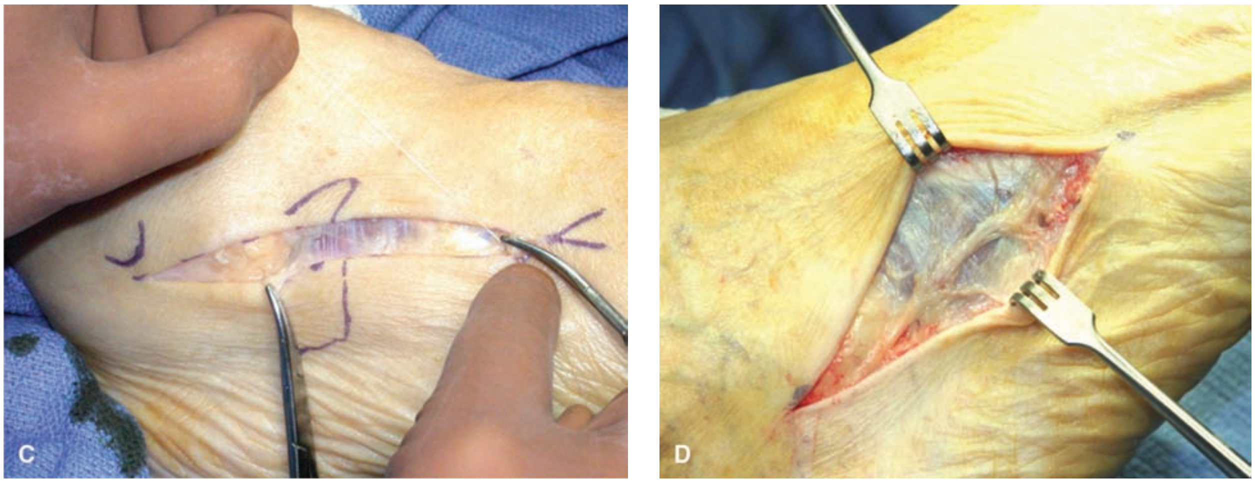


Figure 58.8 **A:** Landmarks for the lateral approach for triple arthrodesis include the distal tip of the fibular malleolus and the junction of the fourth and fifth metatarsal bases. **B:** Controlled depth incision technique to separate the skin and to avoid laceration of the underlying veins.



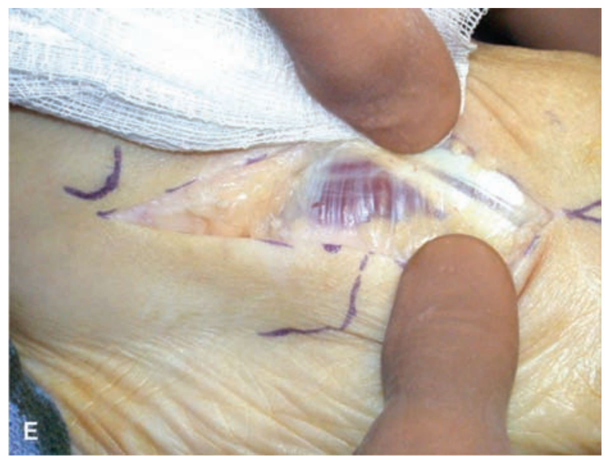


Figure 58.8 *(Continued)* **C:** Exposure of the deep fascia over the EDB muscle belly. **D:** Communicating branch of the sural nerve to the intermediate dorsal cutaneous nerve. **E:** Separation of the superficial fascia or the subcutaneous layer from the deep fascia, especially over the extensor digitorum muscle belly, using blunt sponge technique.

the subcutaneous tissues reveals the key dissection landmarks for deep fascial incision: the junction of the inferior edge of the EDB muscle belly and the course of the peroneal tendons (Fig. 58.9B and C). The deep fascia incision is placed at the inferior edge of EDB muscle just superior to the peroneal retinaculum and the sheath extending into the sinus tarsi (Fig. 58.9D). The edge of the EDB muscle belly is easily reflected from the capsular tissue over the dorsal lateral aspect of the CCJ (Fig. 58.9E). A venous plexus is consistently identified beneath the muscle belly overlying the cuboid. This venous plexus should be isolated and ligated (Fig. 58.9F and G).

The EDB muscle origin from the anterolateral aspect of the sinus tarsi is visualized (Fig. 58.10A). The muscle belly is retracted for visualization of the dorsal lateral aspect of the CCJ. The peroneal tendons should be totally ensheathed. The lateral process of the talus is the key structure for

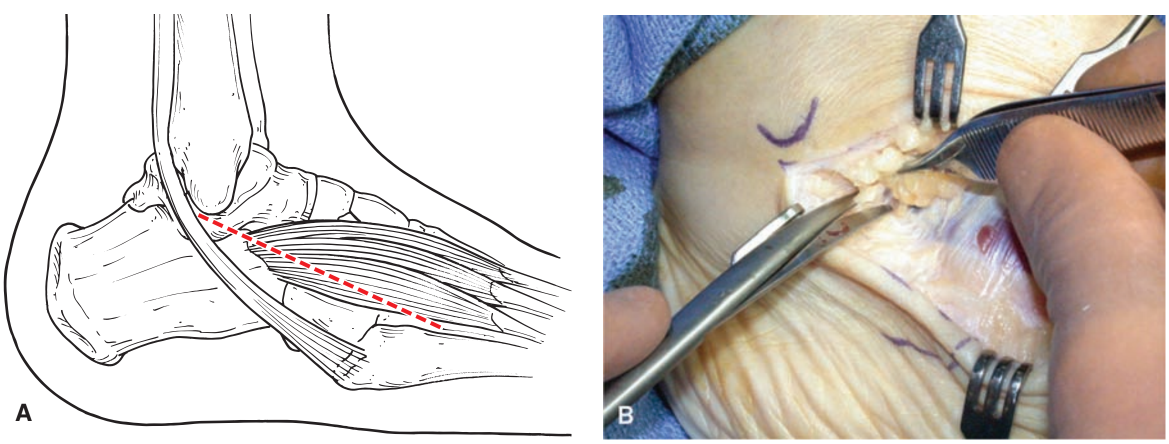


Figure 58.9 **A:** Anatomic pathway to the STJ and CCJ. **B,C:** The key dissection landmarks for deep fascial incision. *(Continues on next page)*

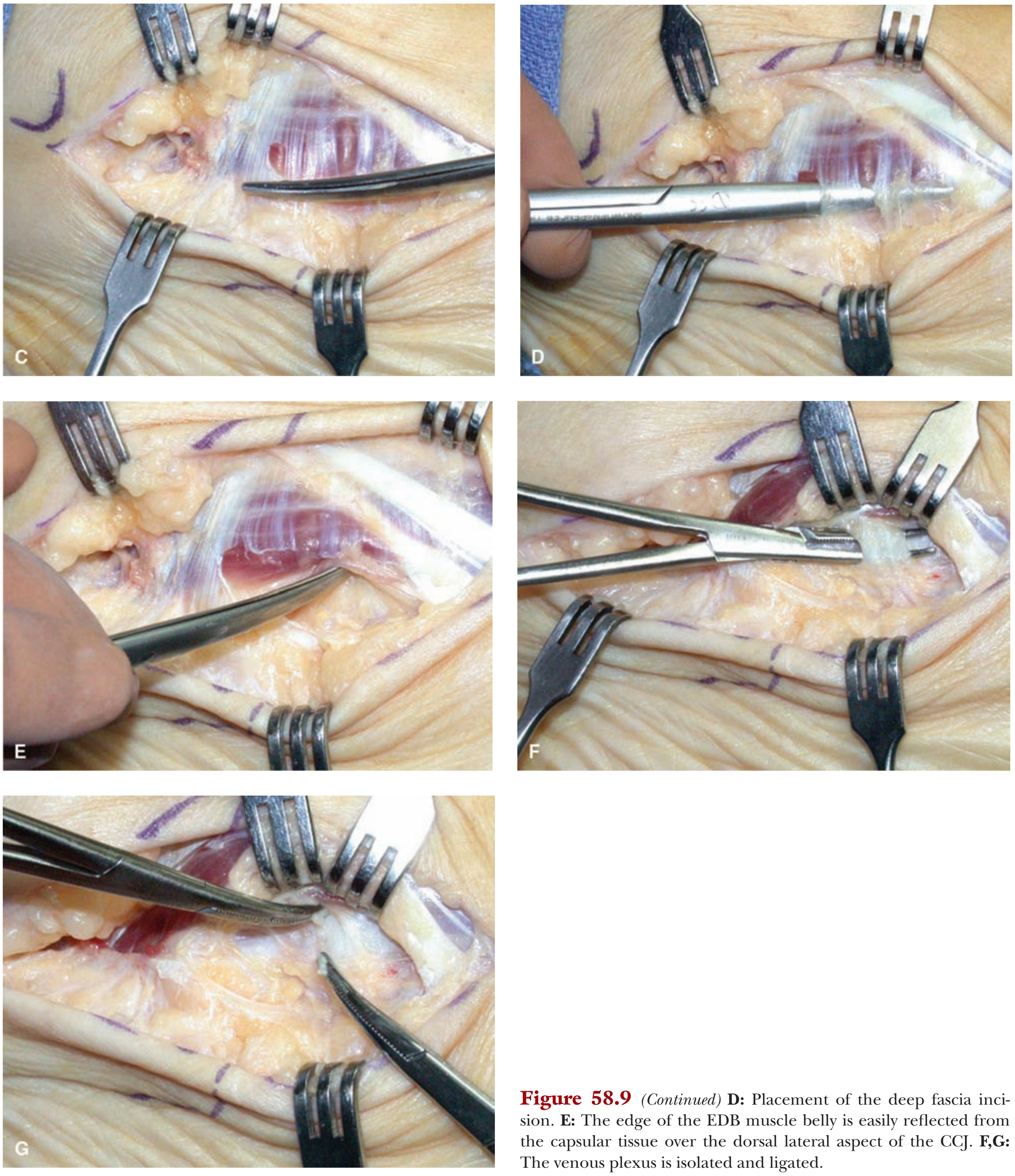
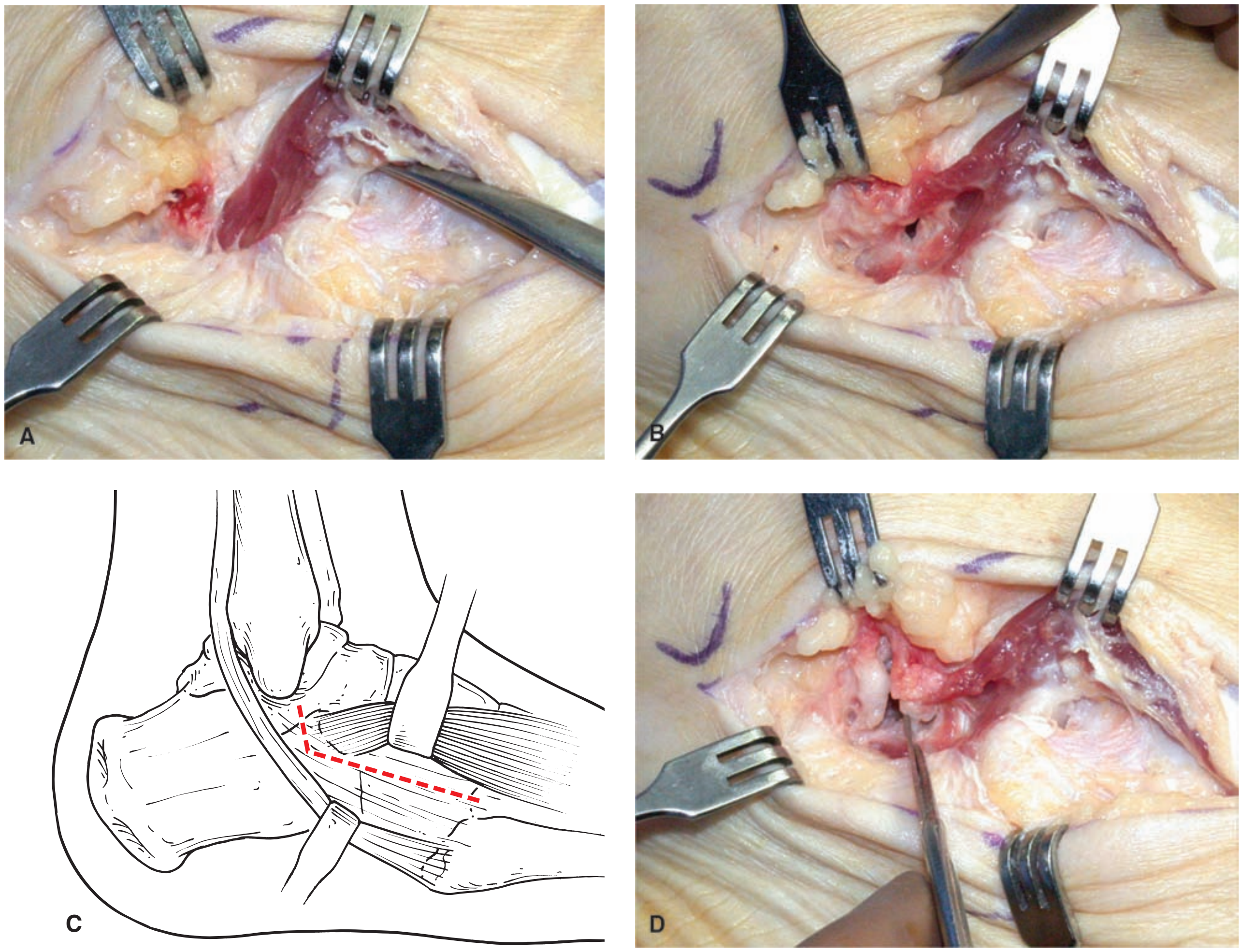


Figure 58.9 *(Continued)* **D:** Placement of the deep fascia incision. **E:** The edge of the EDB muscle belly is easily reflected from the capsular tissue over the dorsal lateral aspect of the CCJ. **F,G:** The venous plexus is isolated and ligated.

orientation of the periosteal incision and identification of the STJ (Fig. 58.10B). An inverted-L lateral incision is planned for exposure of STJ and CC joints. The capsular incision for exposure of the STJ and CCJ reflects the EDB muscle belly subperiosteally from the dorsal aspect of the calcaneus and the cuboid (Fig. 58.10C). A vertical incision is made at the anterior edge of the lateral process of the talus (Fig. 58.10D). This incision encounters the dorsal lateral edge of the calcaneus and the entrance to the sinus tarsi (Fig. 58.10E). The incision is then extended distally along the dorsal lateral edge of the calcaneus, across the CCJ, and out to the metatarsal cuneiform articulation.

The EDB muscle belly is then reflected from the dorsal surface of the cuboid and the dorsal aspect of the calcaneus (Fig. 58.11A). This dissection of the sinus tarsi communicates with the elevation of the dorsal tissue over the calcaneocuboid



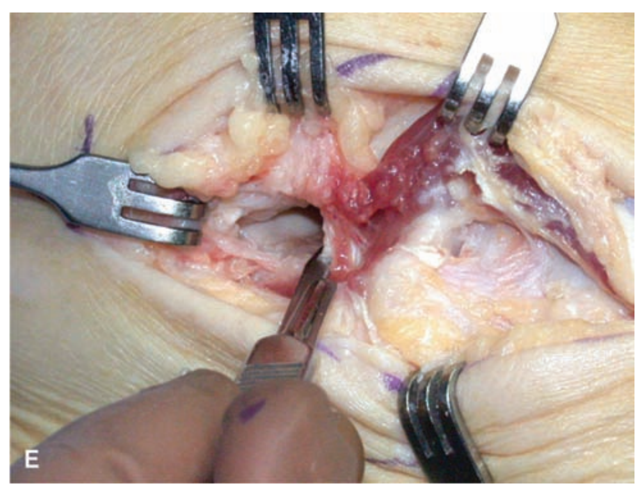
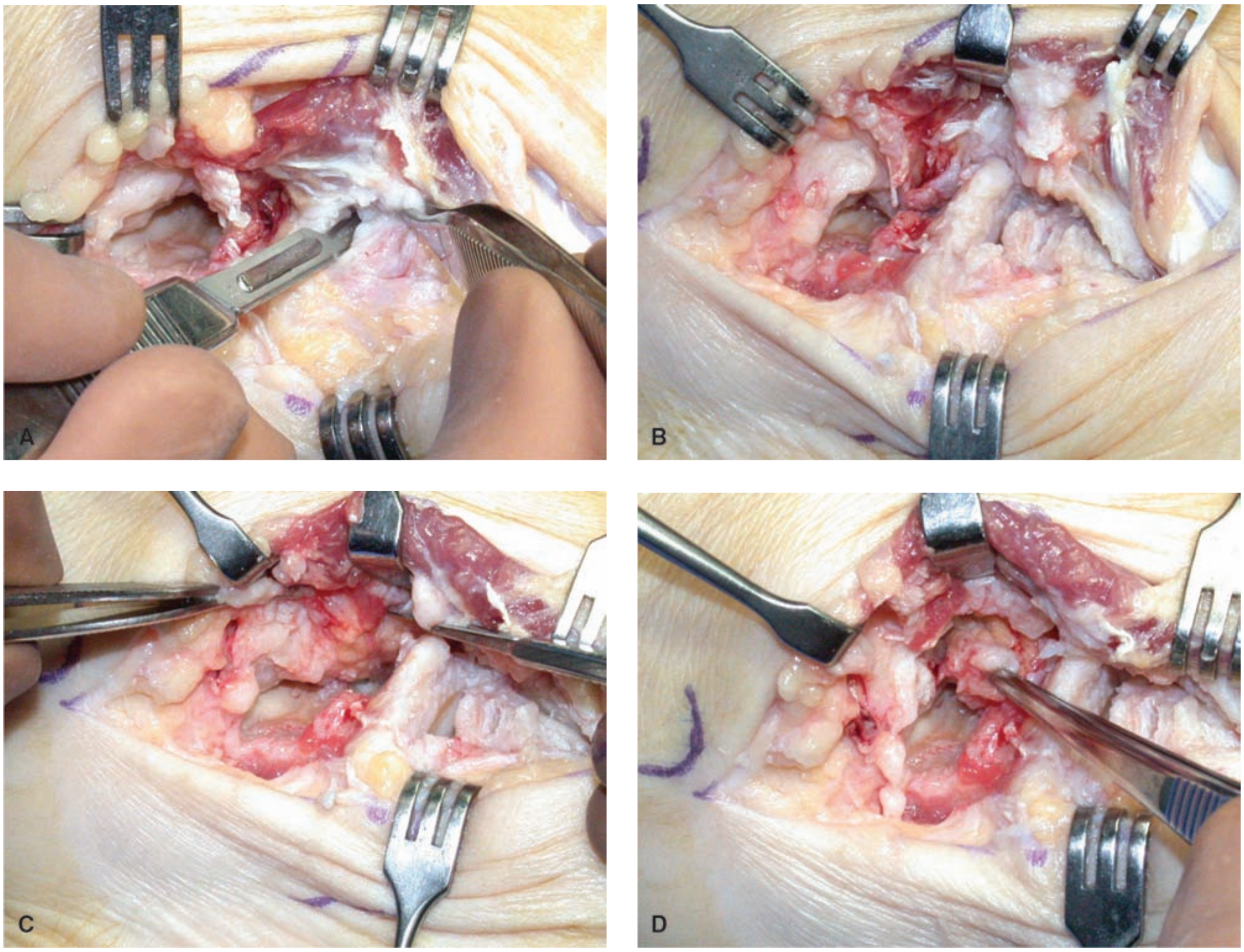


Figure 58.10 **A:** The EDB muscle origin from the anterolateral aspect of the sinus tarsi. **B:** The lateral process of the talus is the key structure for orientation of the periosteal incision and identification of the STJ. **C:** Capsular incision for exposure of the STJ and CCJ. **D,E:**Vertical incision made at the anterior edge of the lateral process of the talus and extended distally along the dorsal lateral edge of the calcaneus, across the CCJ and out to the metatarsal cuneiform articulation.

joint as an intact tissue flap. The subperiosteal or submuscular dissection is carried across the dorsal surface of the calcaneal cuboid region to the lateral aspect of the talonavicular joint complex (Fig. 58.11B and C). A fibrofatty plug that fills the sinus tarsi is circumscribed and then dissected away from the lateral aspect of the head and neck of the talus (Fig. 58.11D and E).

CALCANEAL CUBOID JOINT RESECTION

Correction of the transverse plane deformity, abduction, or adduction of the forefoot is exclusively at the midtarsal joints. In the adducted forefoot, a laterally based wedge is performed in the CCJ to abduct the forefoot. Saw resection is the preferred technique of resection for the CCJ (Fig. 58.12).



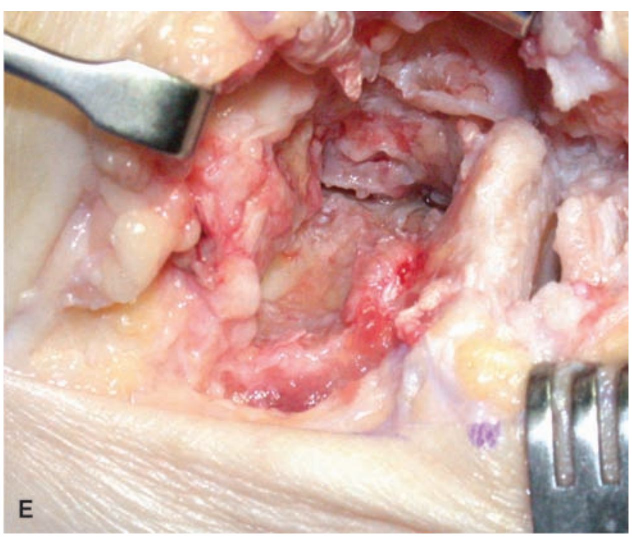


Figure 58.11 **A:** EDB muscle belly reflected from the dorsal surface of the cuboid and the dorsal aspect of the calcaneus. **B,C:** The EDB muscle belly has been elevated from the dorsal aspect of the calcaneus and cuboid, exposing the CCJ and the anterior margin of the posterior facet of the STJ. **D:** A fibrofatty plug that fills the sinus tarsi is circumscribed and then dissected away from the lateral aspect of the head and neck of the talus. **E:** A close-up view following resection of the fibrofatty plug of the sinus tarsi demonstrates the middle facet of the STJ.

Joint resection begins with the articular surface of the calcaneus. A 1- to 2-mm wedge of the articular surface and the subchondral plate is resected (Fig. 58.13A). Correction for transverse plane deformity can be achieved with resecting more for this surface (Fig. 58.13B). A fish scale pattern is created in the subchondral bone surface of the calcaneus for good bone-to-bone contact (Fig. 58.13C). The articular cartilage and the subchondral plate of the cuboid are resected with clear visualization of the resected calcaneal surface (Fig. 58.13D and E).

SUBTALAR JOINT RESECTION

Contour resection of the articular surfaces of the STJ is performed with the use of a small osteotome and mallet

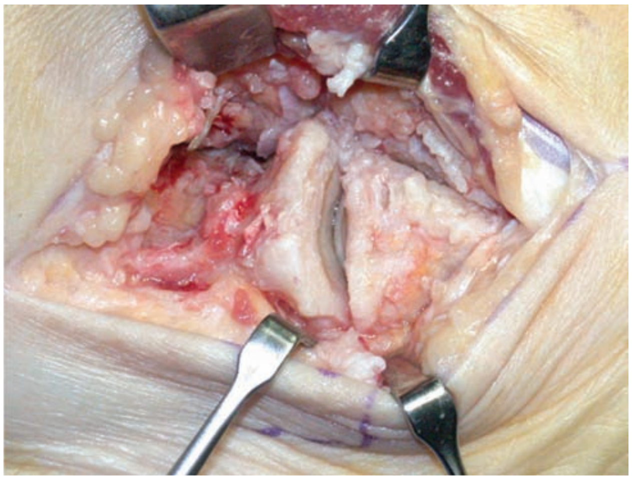
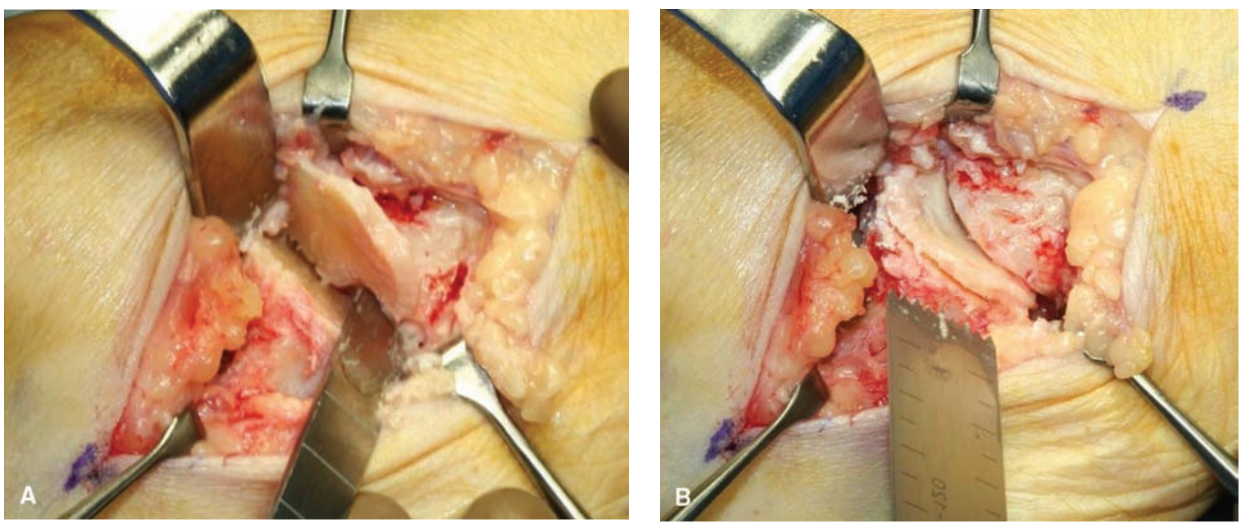


Figure 58.12 Laterally based wedge in the CCJ to abduct the adducted forefoot.

(Fig. 58.14A and B). The osteotome is directed just beneath the subchondral bone plate and penetrates approximately 5 to 8 mm into the substance of the calcaneus. This controlled penetration is used to maintain the contour of the posterior facet and avoid excessive bone resection (Fig. 58.14C). Sequential resection of the remaining portions of the facet is performed again in incremental segments (Fig. 58.14D), allowing the surgeon to sculpt or maintain the contour of the original joint facet with a mosaic pattern of joint resection. A similar technique is used for resection of the articular cartilage and subchondral bone plate of the talar component of the posterior facet (Fig. 58.14E and F).

Resection of the articular cartilage and the subchondral bone plate from the concave talar portion of the posterior facet is performed by sequential small sections to follow the contour of the facet and avoid fragmentation of the large medial shelf of the talus (Fig. 58.15A). Again, the osteotome is advanced only several millimeters to avoid excessive depth and penetration into the posterior aspect of the talus



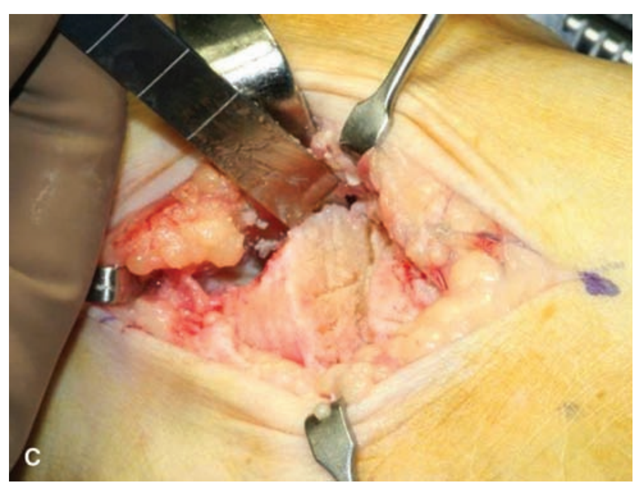


Figure 58.13 **A:** A 1- to 2-mm wedge of the articular surface and the subchondral plate is resected. **B:** Transverse plane deformity is corrected by resecting more of this surface. **C:** Fish scale pattern created in the subchondral bone surface of the calcaneus. *(Continues on next page)*

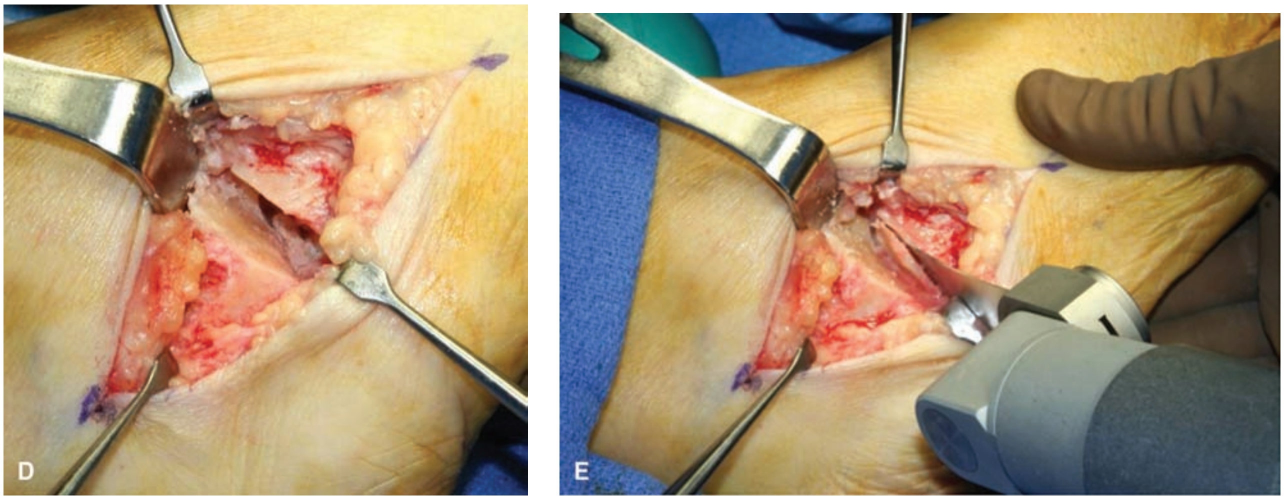


Figure 58.13 *(Continued)* **D,E:** Resection of the articular cartilage and the subchondral plate of the cuboid.

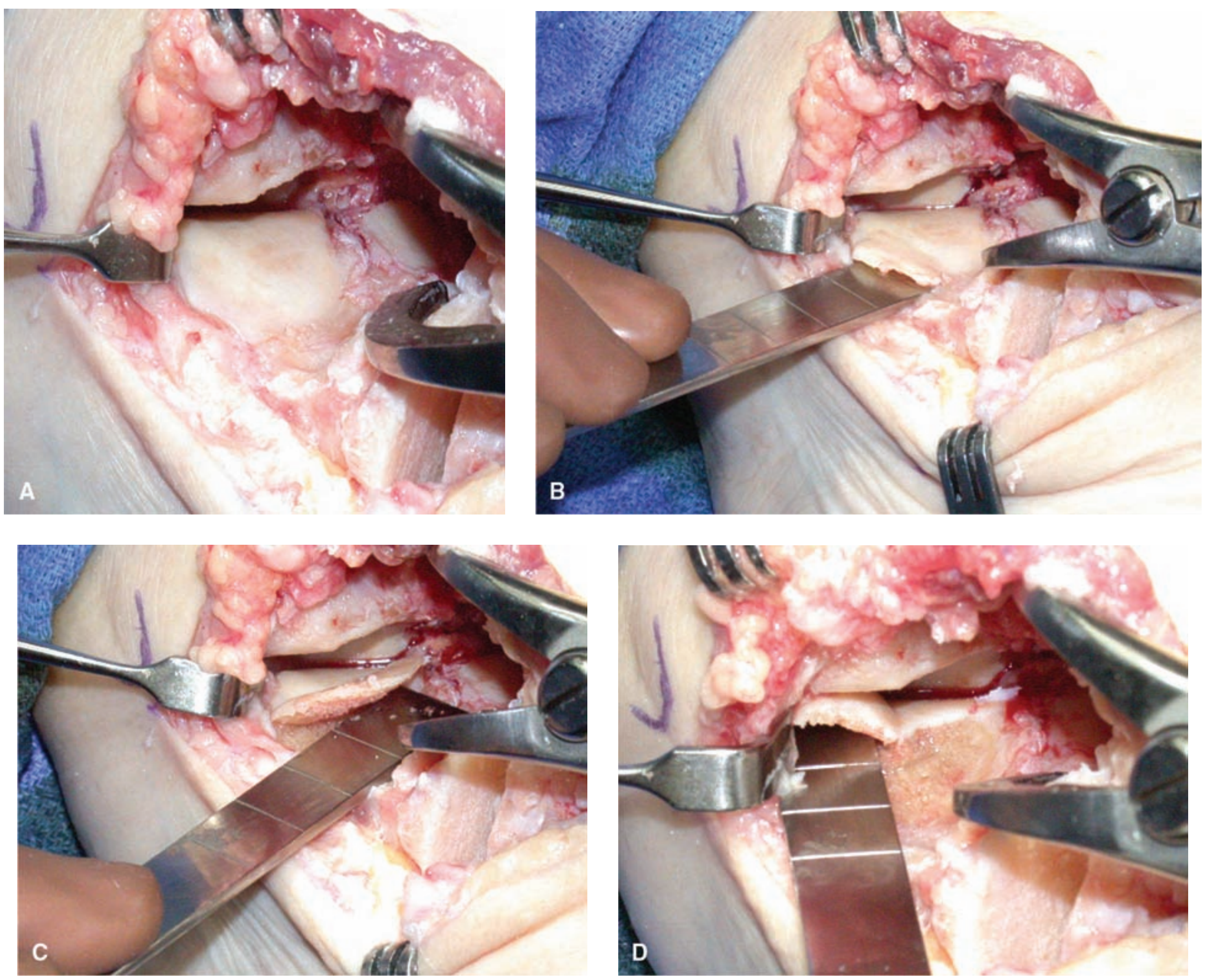


Figure 58.14 **A:** An anterior lateral view of the STJ demonstrates the articular surface of the calcaneal portion of the posterior facet and middle facet overlying the sustentaculum tali. The joint is distracted with the use of a small lamina spreader. **B:** Contour resection of the articular surfaces of the STJ. **C:** The osteotome is directed just beneath the subchondral bone plate and penetrates approximately 5 to 8 mm into the substance of the calcaneus.

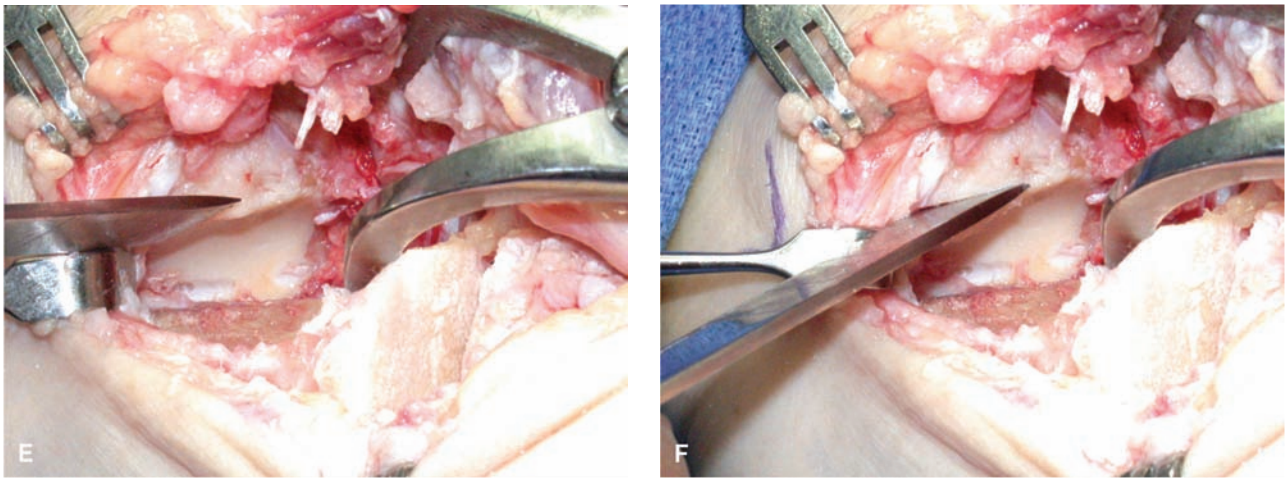


Figure 58.14 *(Continued)* **D,E:** Sequential resection of the remaining portions of the facet and of the articular cartilage and subchondral bone plate of the talar component of the posterior facet. **F:** The osteotome is placed at the anterior lateral aspect of the joint and directed just beneath the subchondral plate following the slope of the anterior portion of the facet.

(Fig. 58.15B). This technique is extremely helpful because of the concave contour of the talar portion of the posterior facet. The contour joint resection technique of the posterior facet of the STJ preserves the shape of the joint and minimizes bone resection and loss of height of the rearfoot complex (Fig. 58.15C). Preservation of the joint contour also allows for manual repositioning of the STJ and midtarsal joint by a normal rotation of the STJ complex. The calcaneal portion of the middle facet is identified and is resected in a similar subchondral plate resection technique (Fig. 58.15D). The talar surface of the middle facet is also resected with an osteotome (Fig. 58.15E and F).

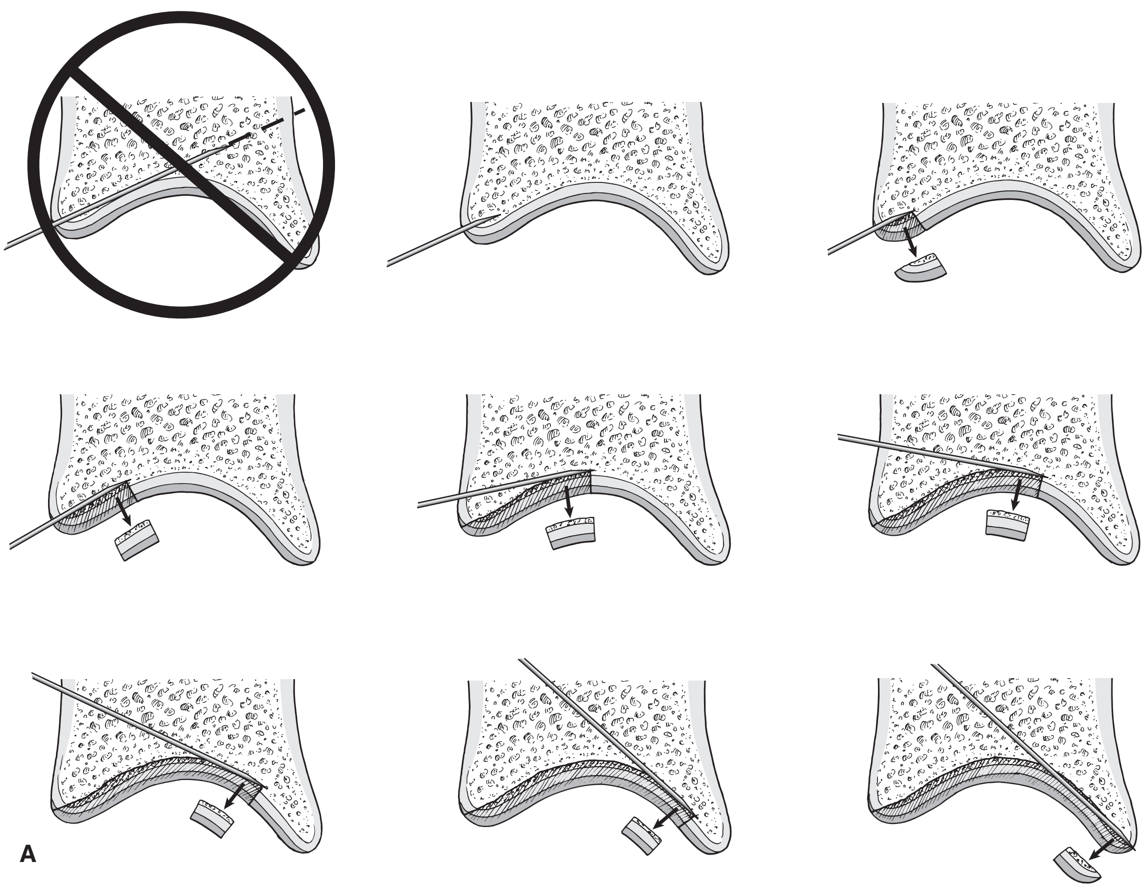


Figure 58.15 **A:** Resection of the articular cartilage and the subchondral bone plate from the concave talar portion of the posterior facet. *(Continues on next page)*

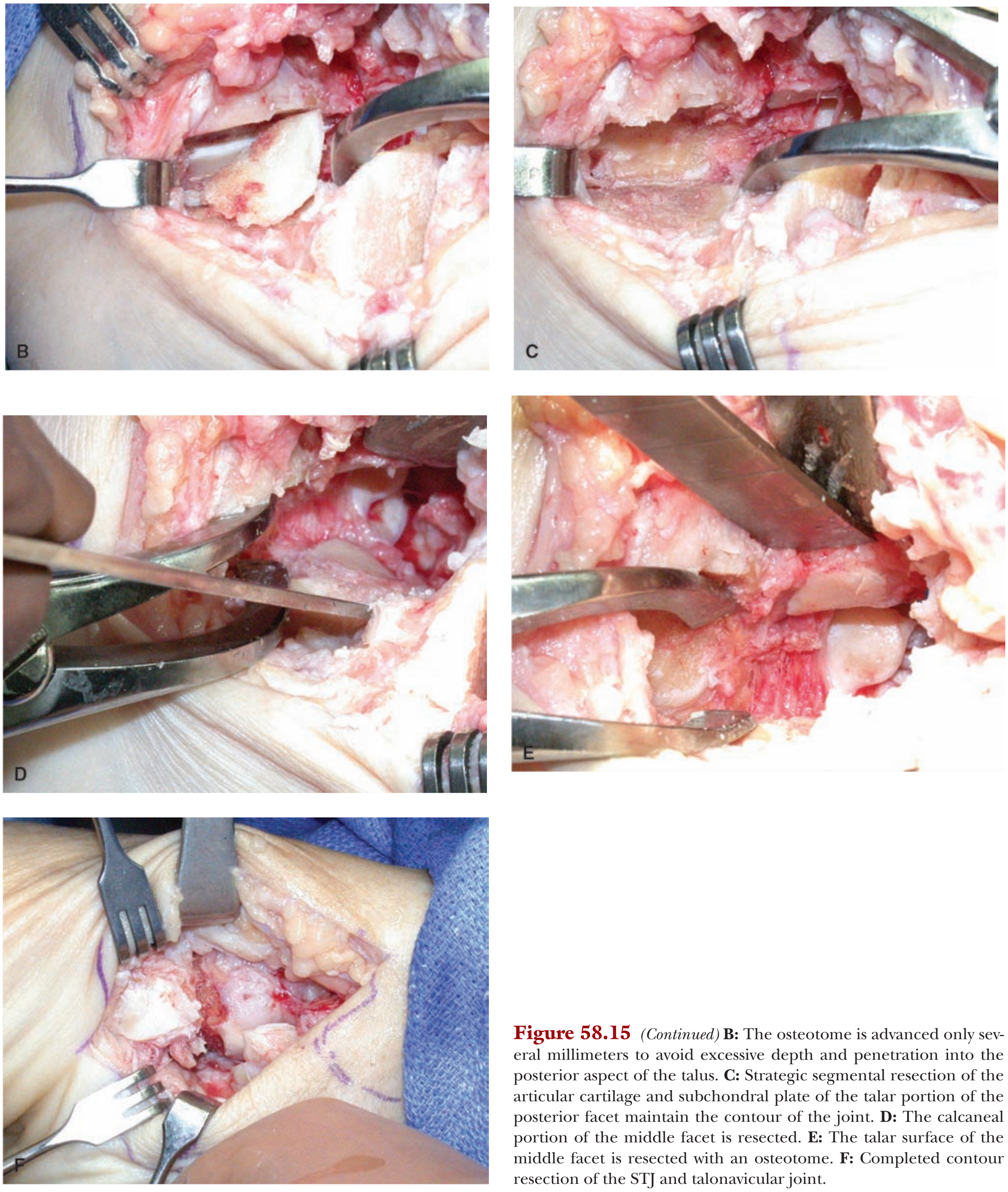


Figure 58.15 *(Continued)* **B:** The osteotome is advanced only several millimeters to avoid excessive depth and penetration into the posterior aspect of the talus. **C:** Strategic segmental resection of the articular cartilage and subchondral plate of the talar portion of the posterior facet maintain the contour of the joint. **D:** The calcaneal portion of the middle facet is resected. **E:** The talar surface of the middle facet is resected with an osteotome. **F:** Completed contour resection of the STJ and talonavicular joint.

ALIGNMENT/TEMPORARY FIXATION

Contour resection of the STJ and talonavicular joint allows for manual repositioning or realignment of the rearfoot complex. This joint resection technique allows the surgeon to position the foot into a stable plantar grade alignment by manipulating the rearfoot joints through a relatively normal joint range of motion and alignment of the foot to the leg. The optimal position for the rearfoot complex is identified and temporarily fixated with the insertion of Steinmann pins (Fig. 58.16A). Alignment of the talonavicular joint is performed initially and temporarily fixated with a Steinmann pin (Fig. 58.16B). With contour resection of the STJ and midtarsal joint, optimal positioning of the talonavicular joint will usually create the desired alignment

Figure 58.16 Steinmann pins are used for temporary fixation of the rearfoot complex **(A),** the talonavicular joint **(B)**, and the STJ and midtarsal joint **(C)**.

and apposition of the STJ and CCJ. Temporary fixation of the STJ and midtarsal joint has been performed with insertion of Steinmann pins (Fig. 58.16C). The pins may be used for relative guidance for insertion of the permanent fixation devices. If traditional noncannulated cancellous screws are utilized, positioning of the temporary fixation pins should be offset from the optimal point of penetration intended for the permanent fixation devices. If cannulated screw fixation is intended, the guidewires are placed in the optimum position for the fixation device.

PERMANENT FIXATION

Permanent fixation of the STJ is usually performed initially. A 3.2-mm drill is inserted in the dorsal medial aspect of the neck of the talus and directed toward the posterior, inferior lateral corner of the calcaneus (Fig. 58.17A and B). A large 6.5-mm cancellous screw with a 32-mm thread pattern is inserted for compression fixation of the STJ (Fig. 58.17C). Intraoperative x-rays should be used to confirm the position and alignment of the fixation devices.

Fixation of the talonavicular joint is performed by the insertion of a large cancellous screw (16-mm thread pattern), which is inserted from the distal inferior aspect of the navicular and directed proximally up into the neck of the talus (Fig. 58.17D and E). The CCJ is fixated with a large cancellous screw (16-mm thread pattern). The screw is inserted from the dorsal lateral aspect of the distal cuboid and directed proximally across the CCJ and into the midportion of the body of the calcaneus (Fig. 58.17F–H).

If screw purchase is not completely secure and adequate, apposition and alignment of the joint may be forced with the insertion of staple fixation (Fig. 58.18).

CLOSURE

Closed-suction drains are routinely employed to extravasate soft tissue and cancellous bone bleeding after closure of the surgical wounds (Fig. 58.19A). This technique helps avoid formation of significant hematoma. Layered wound closure is employed to restore normal anatomic tissue layers and minimizes dead space that may lead to hematoma and other wound complications (Fig. 58.19B). The skin incisions are usually sutured with an intradermal technique utilizing absorbable sutures (Fig. 58.19C). The incision lines are reinforced with Steri-Strips. The surgical area is usually infiltrated with a long-acting local anesthetic to provide analgesia following the surgical procedure. A well-padded Jones compression dressing and short leg cast are usually employed for the postoperative dressing (Fig. 58.19).

POSTOPERATIVE CONSIDERATIONS

Postoperative management of triple management can be viewed as a sequence of phases from the day of surgery up to 1 year after surgery.

PHASE I: INITIAL MANAGEMENT (DAYS 0 TO 5)

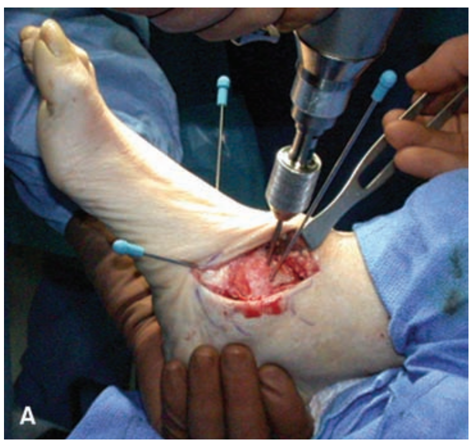
Initial management begins with placement of closed-suction drainage system medially and laterally to evacuate hemorrhagic drainage after closure of the incision. A Jones compression cast is applied following wound closure to control edema. Several days later, the cast is removed and the wound is assessed and the extent of the edema is evaluated. A below-the-knee cast is reapplied for the remainder of the postoperative phase.

PHASE II: WOUND HEALING (DAY 5 TO 4 WEEKS)

This is a period of wound healing and resolution of the inflammatory response. The patient is to remain non-weight-bearing throughout this phase. If significant edema is present, bivalving the cast is an option.

PHASE III: CONSOLIDATION (WEEKS 4 TO 8)

Radiographs are obtained at 3 to 4 weeks postoperatively to assess the progress of osseous healing (Fig. 58.20). The



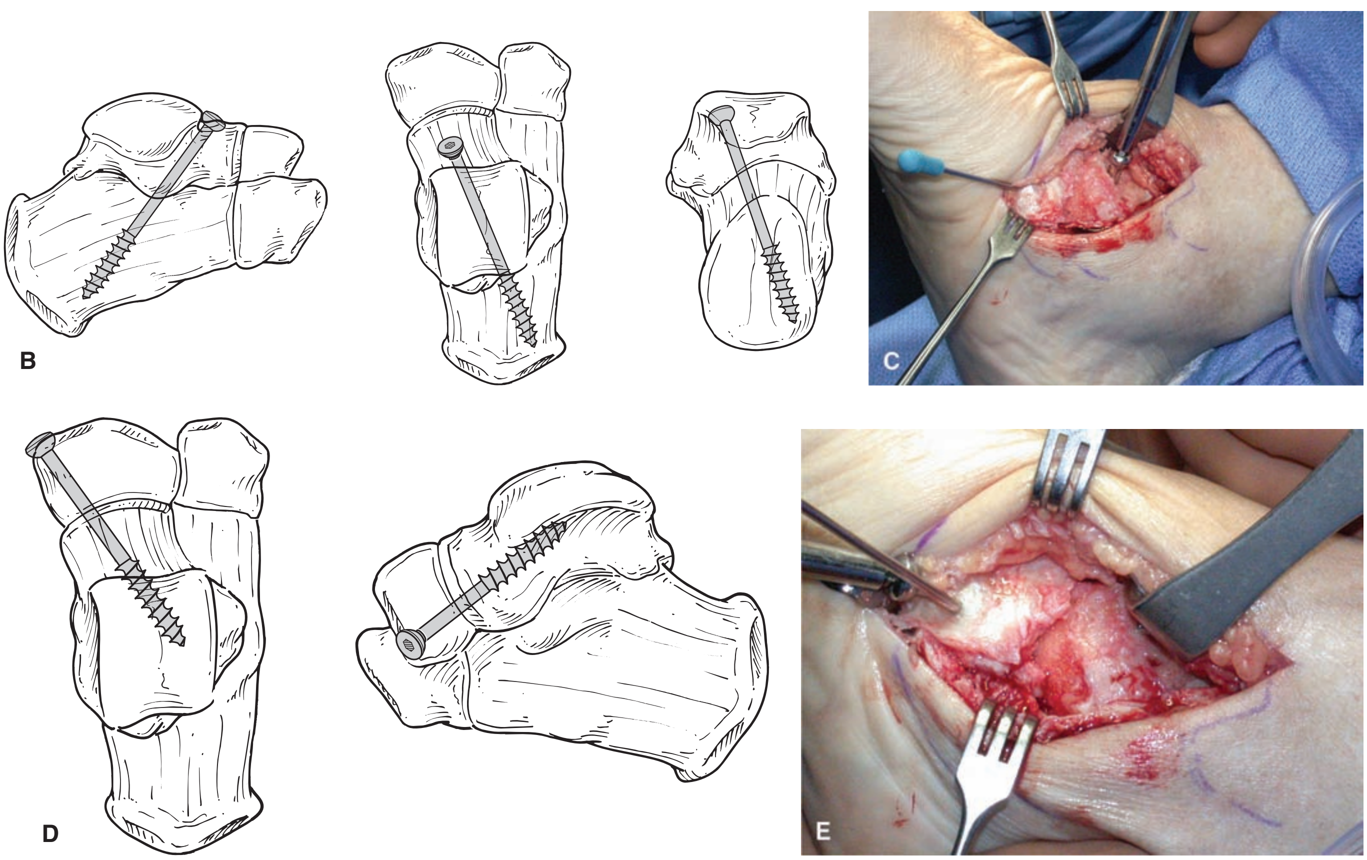
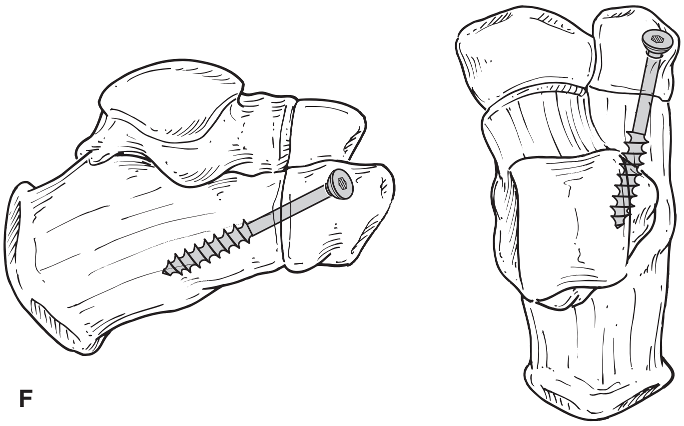
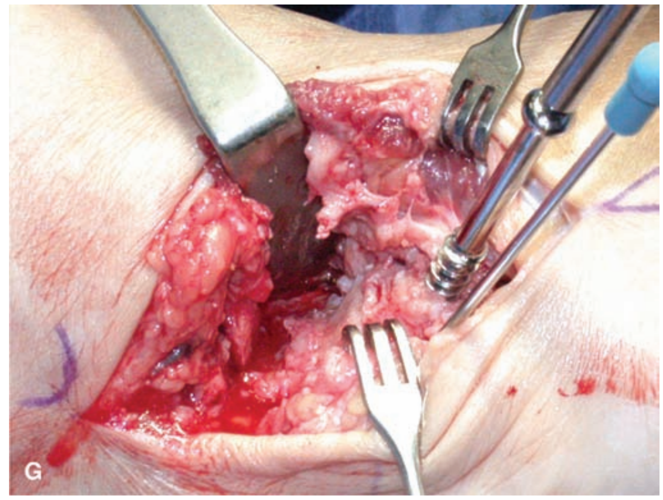


Figure 58.17 **A:** Drill insertion for permanent fixation of the STJ. **B,C:** Orientation of the talocalcaneal screw is from the dorsomedial aspect of the neck of the talus perpendicular across the posterior facet of the STJ to the posterior lateral corner of the calcaneus. **D,E:** Orientation of the talonavicular screw is from the medial, distal inferior aspect of the navicular, up the neck of the talus and into the midsubstance of the dome of the talus.





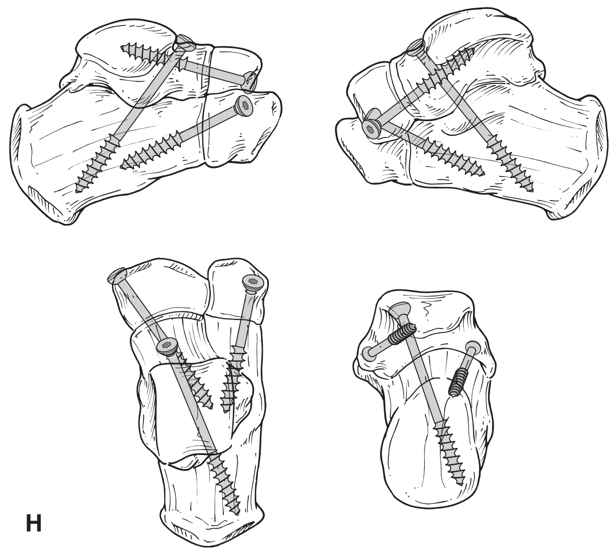
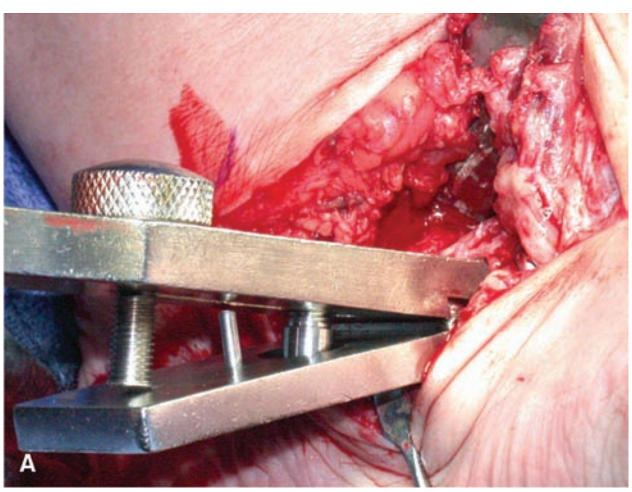


Figure 58.17 *(Continued)* **F,G:** Orientation of the calcaneal–cuboid screw is from the distal dorsal lateral aspect of the cuboid, across the CCJ toward the medial wall of the calcaneus below the sustentaculum tali. **H:** A composite view of fixation of the talonavicular joint, talocalcaneal joint, and CCJ for triple arthrodesis.



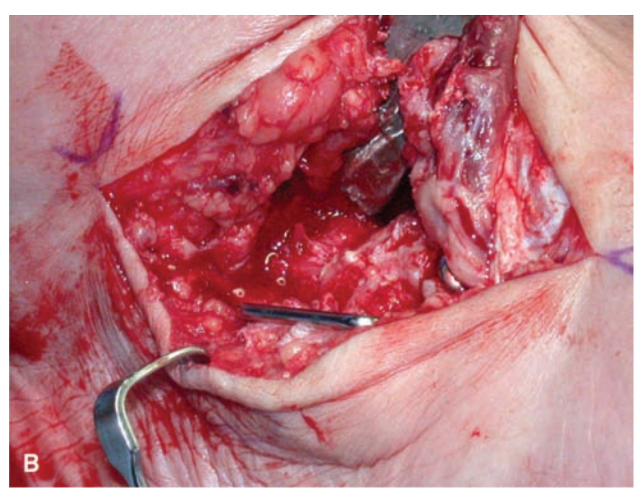


Figure 58.18 **A,B:** If screw purchase is not completely secure and adequate, apposition and alignment of the joint may be forced with the insertion of staple fixation.

Figure 58.19 **A:** Use of closed-suction drains. **B:** Layered wound closure. **C:** Skin incision closure. **D:** Jones compression dressing and short leg cast.

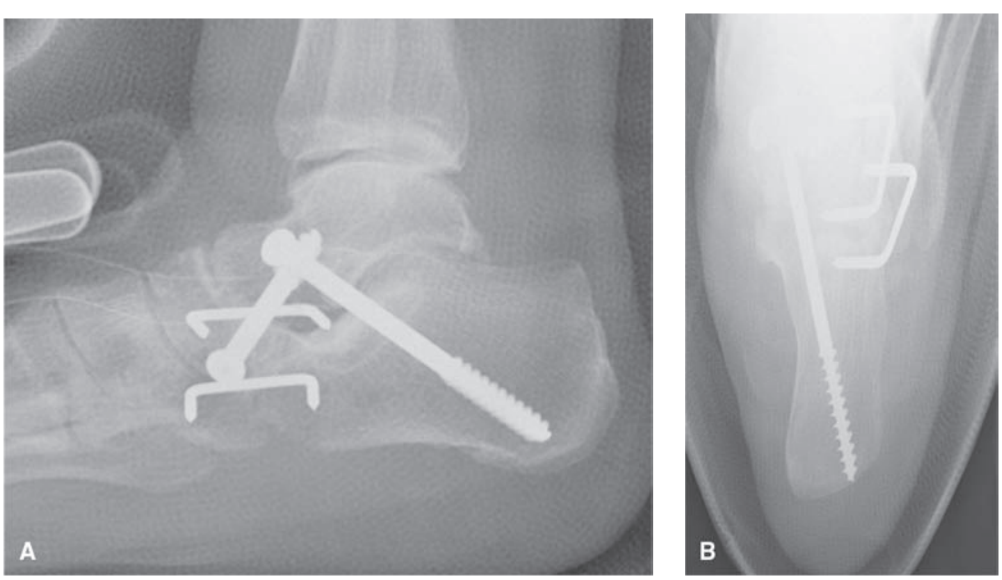


Figure 58.20 Postoperative radiographs.

radiographs are obtained through the cast. Patient is encouraged to perform range-of-motion exercises of the digits and knee and hip while maintaining non-weight-bearing.

PHASE IV (WEEKS 10 TO 12)

Radiographs are repeated at week 10. With evidence of adequate consolidation, patient may begin partial weight-bearing with crutches or walker at week 10 to 12.

PHASE V (3 TO 6 MONTHS)

At 3 months, the patient can begin full weight-bearing with a high-top, padded boot or an elastic foot and ankle support stocking. The patient is able to graduate into a normal activity with aggressive physical therapy by 4 to 6 months to avoid stiffness and disuse atrophy.

RESULTS AND COMPLICATIONS

Triple arthrodesis has proven to be an excellent means of correcting deformity, reducing symptoms, providing stability, and enhancing function for many conditions. Refinements in technique, instrumentation, and fixation and better understanding of biomechanics allow the surgeon to provide a more reliable correction of deformity with a lower rate of complications. Nonetheless, as with any procedure, complications may arise.

Historically, pseudoarthrosis has been a common complication after triple arthrodesis. In modern times, calcaneocuboid joint appears to be the primary site for delayed healing rather than talonavicular joint in the past. The use of two incisions rather than a single lateral incision has likely reduced the rate of talonavicular joint nonunion. Weight-bearing stresses on the lateral column with early weight-bearing are the likely reason for the more frequently encountered nonunion of the CCJ. The role of stable fixation technique cannot be underestimated in reducing the overall incidence of nonunion. Other complications including recurrence of deformity, degenerative arthrosis in adjacent joints, and avascular necrosis have been documented after triple arthrodesis. These complications can be minimized with effective planning, proper technical execution, and sensible postoperative management.

This is a time-tested and effective procedure and is a viable treatment option for various deformities and malformations. Relief of pain, improvement of function, correction of deformity, and stabilization of the rearfoot are clear indications of this procedure.

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