Alfred J. Tria
Giles R. Scuderi
Fred D. Cushner
Editors

Complex Cases in Total Knee Arthroplasty

A Compendium of Current Techniques

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Foreword

Total knee arthroplasty is arguably the most successful musculoskeletal surgical intervention of the last century—having now surpassed even Charnley's seminal total hips in numbers, social impact, and longevity. Emboldened by the power of this procedure, we have now extended its indications to younger, older, and more complex patients. Mechanically and materially, there have been many triumphs, especially over the last two decades. Biologically, there remain more challenges, from allergy to particular osteolysis to infection, where we remain embarrassingly ineffective.

The price for this great gift is, however, a far more diverse set of options and decisions for us to address in the beginning of the procedure and more catastrophic consequences when our devices—or their host—fail at the end. As surgeons, we must be prepared to harvest the seeds we have sown.

This superlative text addresses a great number of those issues, not with dogmatic directives, but rather with options and decision points. They are presented by an international group of supremely gifted surgeons who have devoted their careers to vetting and refining the ensuing solutions and techniques to our recurrent challenges in total knee arthroplasty.

The editors are to be commended for their exceptional choice of authors, for their very appealing case model compendium of special problems with bulleted solutions, and for their courage to address many controversial and complex challenges whose successful resolution this volume will hopefully effect. This effort is very much in the spirit of the editors' common mentor, John N. Insall, the true father of modern knee arthroplasty, who would be very proud to witness this text today. It should reside on the desk of every thoughtful knee surgeon who will inevitably be confronted with unique or problematic arthroplasty issues.

Robert E. Booth Jr, MD
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Preface

Total knee arthroplasty has become a routine procedure for the management of the arthritic knee, and the surgical technique has become more reproducible, yet there are complex cases that pose a challenge for surgeons. This book was produced with a clinical case-based approach to provide surgeons with strategies and surgical options for dealing with these challenging cases. Divided into two main sections covering both primary and revision total knee arthroplasty, each chapter opens with a brief introduction, followed by a handful of case studies demonstrating different surgical techniques, providing more than one method to approach the specific knee condition. To assist us in preparing this book, we brought together leading experts in total knee arthroplasty and asked them to share with us their experience for dealing with complex issues in primary and revision surgery. We are honored that each of them has helped us complete this practical real-world case-based approach to total knee arthroplasty, which is intended to be a resource for residents, fellows, and orthopedic surgeons. We are also honored to have Dr. Robert Booth write the foreword for our book and acknowledge the impact that our past mentor, John N. Insall, MD, has had on our careers and teachings.

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Part I

Primary Total Knee Arthroplasty

The Varus Knee

1

Giles R. Scuderi, Trevor P. Scott, Amar S. Ranawat, Chitranjan S. Ranawat, Chad D. Watts, Walter B. Beaver, Trevor J. Shelton, and Stephen M. Howell

Introduction

Giles R. Scuderi

Fixed angular deformity in the coronal plane necessitates special consideration to restore normal alignment during total knee arthroplasty (TKA). Osteoarthritis with a varus deformity is one of the most common deformities presenting for TKA. A recent longitudinal study revealed that 58% of knees with osteoarthritis presented with a varus deformity compared to 18% with valgus deformity [1]. Pathologic and surgical reviews have shown that fixed varus deformity is associated with medial tibial and femoral bone loss and contracture of the medial supporting structures including the deep and superficial medial collateral ligaments and posteromedial capsule.

At the present time, there are various options for correcting a fixed varus deformity, but it is well accepted that accurate soft tissue balance with restoration of the mechanical alignment of the knee joint is critical to a successful outcome. Insall and Ranawat first described the traditional method of soft tissue release [2]; however, it has become evident that over-release of the medial collateral ligaments can potentially lead to instability and elevation of the joint line. Soft tissue release has evolved over the years, to more sequential and controlled releases of the medial supporting structures. While Verdonk described the use of a pie-crusting technique to release the medial collateral ligament when correcting a varus deformity [3], Ranawat adopted a controlled lengthening of the superficial medial collateral ligament by incising it in an inside-out pie-crust manner combined with a capsulotomy of the posteromedial capsule at the level of the tibial resection [4].

The degree of deformity is variable, and severe fixed varus deformity of the knee can pose a challenging problem requiring complete distal release of the superficial medial collateral ligament and insertion of the pes anserinus or osteotomy of the femoral insertion of the medial collateral ligament [5]. In cases with excessive release of the

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medial collateral ligament with the possibility of medial instability, a more constrained implant may be needed to provide adequate stability. Understanding the implications with soft tissue release is paramount to a successful TKA, and the following case reports will describe the various techniques for correcting an osteoarthritic knee with varus deformity.

Option 1: Medial Collateral Ligament Pie Crusting of the Fixed Varus Knee

Trevor P. Scott, Amar S. Ranawat, and Chitranjan S. Ranawat

Case Presentation

History

The patient is a 72-year-old male with 3 years of worsening left knee pain. His pain is primarily medial and is worse with activity and with stairs. It limits his walking to three to five blocks at a time, and he no longer gets adequate pain relief from NSAIDs. His most recent corticosteroid injection was 6 months ago and provided temporary pain relief. He denies any pain in his hip or lumbar spine. There is no history of trauma or prior surgery to the left knee.

Physical Exam

The patient is a fit and athletic male in his 70s. He is in no acute distress and alert and oriented four times. The patient ambulates with an antalgic gait. Left knee skin is intact and there is minimal quadriceps atrophy. The knee is in varus alignment of 10°, which is not correctable. Range of motion is 15°–105°. There is laxity of lateral structures on varus stress. There is tenderness to palpation along the medial and to a lesser extent the lateral joint line. There is positive patellofemoral grind test. The left lower extremity is neurovascularly intact.

Radiographs and Advanced Imaging

Radiographs demonstrate tricompartmental osteoarthritis with varus alignment (Fig. 1.1).

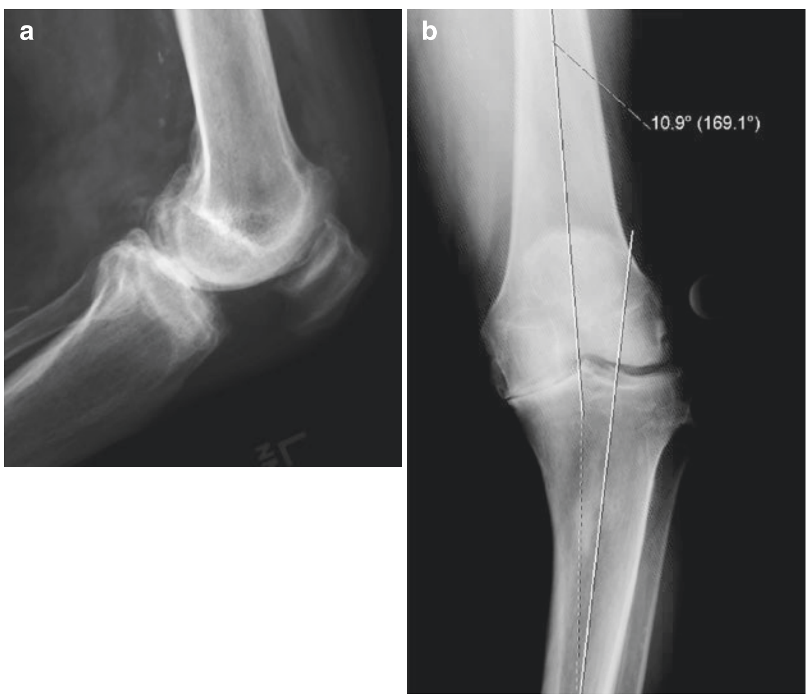

Fig. 1.1 Anteroposterior (AP) (**a**) and lateral (**b**) views of the patient's knee demonstrate a significant varus deformity

Surgical Approach

Spinal anesthesia is given along with a saphenous nerve block. The patient is then positioned supine on the operating table with a high-thigh tourniquet. A post is placed at the level of the tourniquet for support, and a sandbag is placed at the mid-tibia to assist with positioning in flexion. A straight midline incision is drawn in extension from two fingerbreadths above the patella to the bottom of the tibial tubercle. The initial exposure is performed without the use of the tourniquet. The knee is then flexed up and the skin incision is made utilizing a scalpel. Electrocautery is used for hemostasis and further dissection. A standard medial parapatellar arthrotomy is performed with electrocautery to aid in further hemostasis. We raise the medial soft tissue sleeve in flexion and take care to protect the superficial medial collateral ligament (sMCL) and the pes anserinus insertion. The cruciates and remaining menisci are resected. The patella is everted, and the tibia is then subluxed anterior to the femur utilizing the "Ran-sall" maneuver, which involves hyperflexion and external rotation of the knee (Fig. 1.2). These maneuvers allow visualization of the entire articular surface of the tibia.

We utilize a PFC SIGMA posterior-stabilized (PS) implant (DePuy Synthes, Warsaw, IN, USA). Following exposure the extramedullary tibial cutting jig is placed to make a 90° cut to the long axis of the tibia. We take an 8–10 mm cut from the high point of the less affected lateral tibial plateau. If there is evidence of >1 cm lateral soft tissue elongation, i.e., a varus thrust on ambulation or medial femoral subluxation on anteroposterior (AP) radiographs, then a lesser depth cut (6–8 mm) is utilized. Making a thick tibial cut in the setting of a large deformity may result in a very large extension gap that may become difficult to balance in flexion. The tibial cut is then assessed with a drop rod to check the alignment is indeed 90°. If correct we then perform a reduction osteotomy of medial osteophytes. The patella is then prepared in the usual fashion.

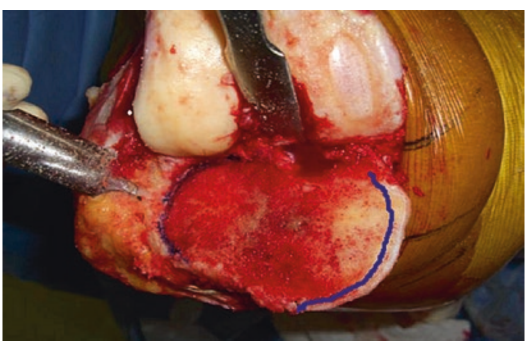

Fig. 1.2 Exposure of the entire articular surface of the tibia utilizing the "Ran-sall" maneuver of hyperflexion and external rotation. The lateral cortex is colored in, and the medial osteophytes identified by the digital blue line are resected

The intramedullary femoral alignment guide is then placed, and a 5° valgus cut is made in the majority of cases. The depth of the cut is set to 8–10 mm, and only in rare circumstances of severe flexion contracture is more bone resected because this may raise the joint line and cause midflexion instability.

At this point the knee is brought into extension and a spacer block is placed into the extension gap. If bleeding is excessive at this point, the tourniquet may be utilized. The key point is to recognize that if the spacer block can fit in the lateral side of the knee, then the depth of bone resection is deemed appropriate. The challenge then lies in releasing the medial soft tissue sleeve. This is accomplished by placing a laminar spreader into the extension gap which is trapezoidal in shape due to the tight medial structure (Fig. 1.3) and performing the release. The posterior cruciate ligament (PCL) remnant and posteromedial capsule are released at the level of the tibia using electrocautery. This resection is carried forward as anterior as the posterior border of the sMCL (Fig. 1.4). A periosteal elevator is utilized to check completeness of the release.

The spacer block is then placed in the knee and now should fit in easily. At this point varus and valgus stability is checked, and in the varus knee continued medial structure tightness is often noted. In this case the knee is placed under valgus stress, and digital palpation is utilized to identify tight bands of tissue of the sMCL. These are incised in a pie-crust fashion with an 11 blade scalpel in an oblique fashion (Fig. 1.5). Three to five oblique stabs are made. The knee is then

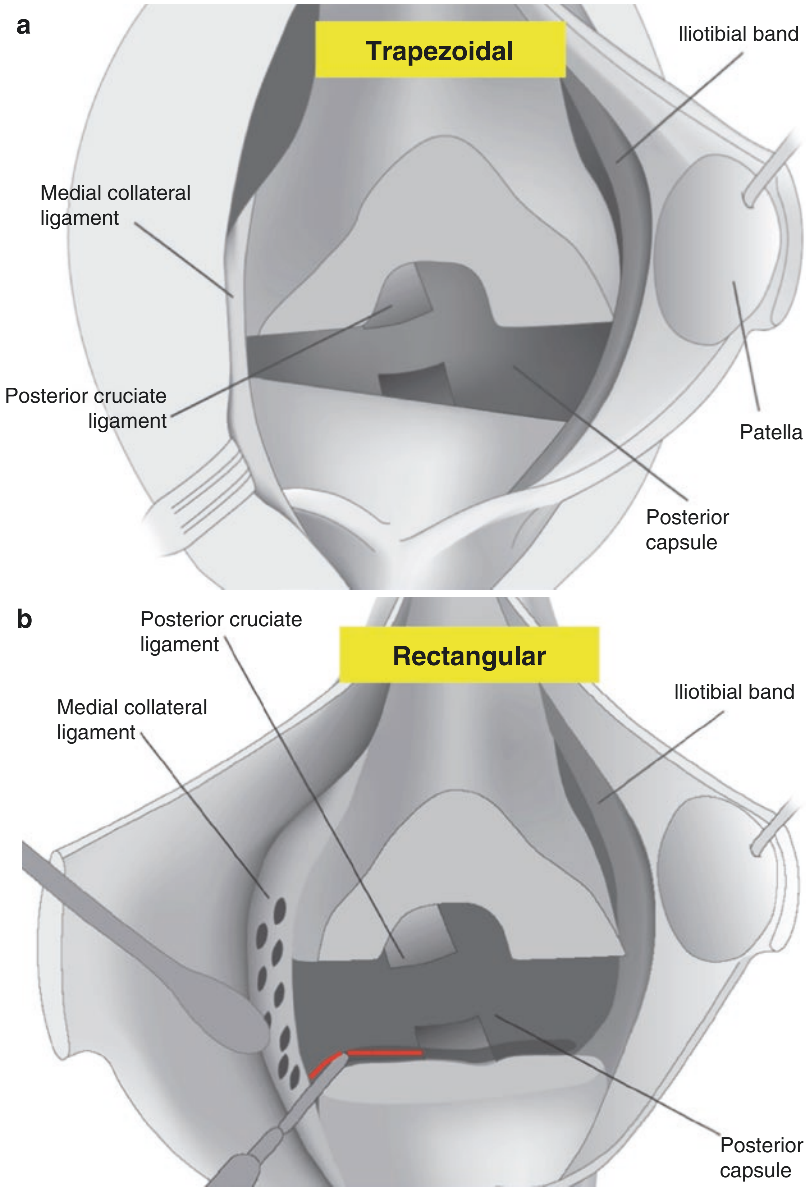

Fig. 1.3 (**a**) The contracted medial soft tissue will result in a trapezoid-shaped extension gap. (**b**) Demonstrates the posteromedial capsular release to create a rectangular extension gap

manipulated under valgus stress and extension with the spacer block is in place. Our goal is 2–3 mm of springy give equally both medially and laterally (Fig. 1.6). Slightly increased lateral laxity is accepted if equivalent balance cannot be obtained.

Finally, the knee is brought to 90° of flexion, and utilizing a posterior referencing cutting guide, the "parallel to the tibial" cut technique is utilized for the AP femoral cut (Fig. 1.7). Care is taken not to notch the anterior femur. Posterior femoral osteophytes are resected at this point. The remaining aspect of the knee replacement is completed in standard fashion.

Postoperatively a sterile dressing is placed, and ASA is used for DVT prophylaxis unless the patient has risk factor for a thromboembolic event in which case Coumadin is utilized. Twenty-four hours of perioperative antibiotics are given. The patient is weight bearing as tolerated and ambulates with physical therapy on postoperative day 0 or 1.

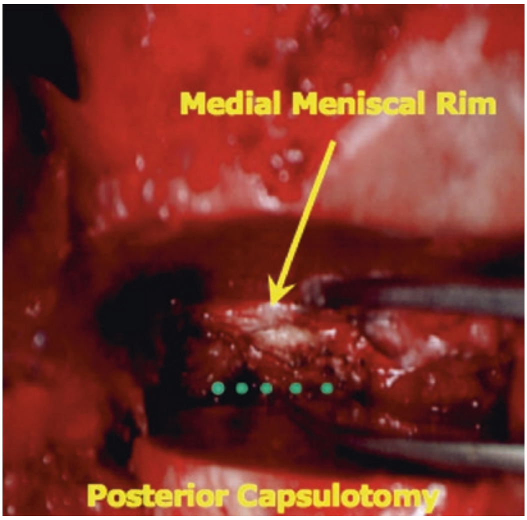

Fig. 1.4 Medial release is performed at the level of the tibia along the posterior medial capsule. Release may be brought as far anterior as the posterior border of the sMCL

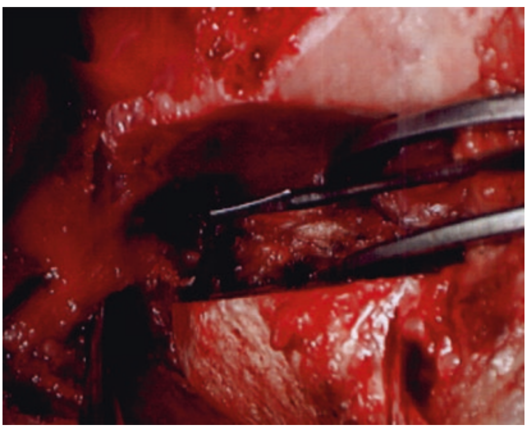

Fig. 1.5 A laminar spreader may be used to place the knee under tension in extension, alternately a spacer block may be used, and an 11 blade is utilized for oblique stab incisions into contracted bands of the sMCL

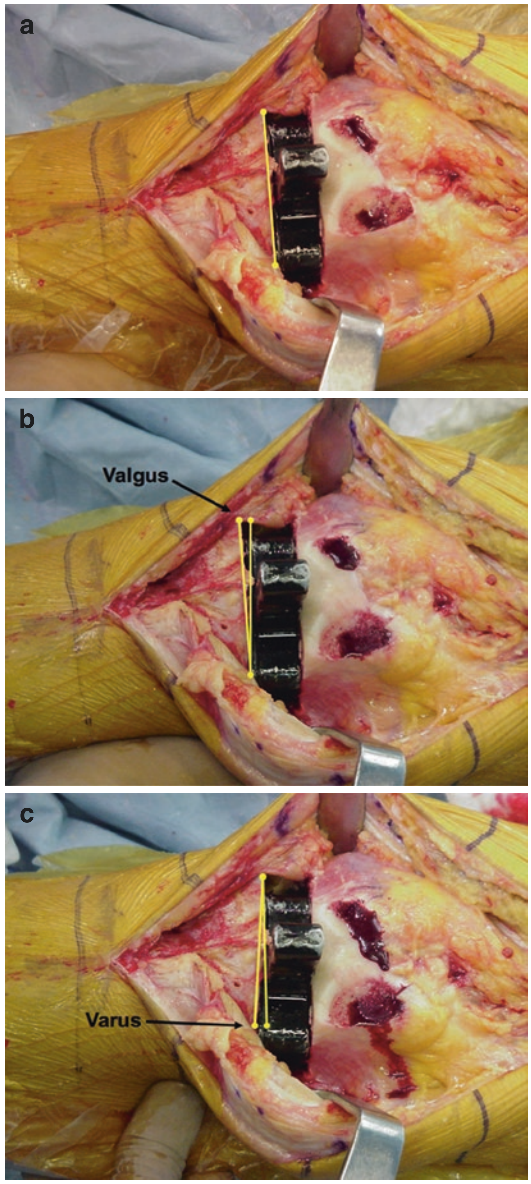

Fig. 1.6 (**a**) The knee following releases with spacer block in place. (**b**) Demonstrates 2–3 mm of medial "springy give" under valgus stress. (**c**) Demonstrates 2–3 mm of "springy give" laterally under varus stress

Postoperative Result

The patient underwent an uneventful postoperative course and was discharged from our facility on postoperative day 3. He transitioned to ambulation without aid at 6 weeks. Radiographs at his first postoperative visit demonstrate well-aligned TKA, and physical exam demonstrated no medial or lateral instability (Fig. 1.8).

Clinical Results

Varus deformity is the most commonly encountered alignment abnormality in total knee arthroplasty, and it often presents with concomitant flexion deformity. The three most basic principles of total knee arthroplasty include establishment of equivalent and rectangular flexion and extension gaps, neutral alignment of the knee, and equivalent medial and lateral soft tissue tension. In knees with minimal deformity, this is often relatively straightforward and may be achieved simply by correct placement of bone cuts. However, in more severe disease, a combination of bone loss from the medial tibial plateau and medial femoral condyle and contracture of the medial soft tissue sleeve and sometimes elongation of the lateral soft tissue can make it impossible to achieve these goals by bone cuts alone [4]. Traditionally this was addressed using the method described by Insall et al. in 1979 which involved subperiosteal release of the posteromedial capsule, the semimembranosus tendon, the distal attachment of the superficial MCL, and occasionally the pes anserinus insertion [6]. However this technique has been noted to potentially result in over-release of medial structures as it can be challenging to correctly titrate the release. Further it has been suggested that the subperiosteal release may result in hematoma, postoperative pain, and elevation of the joint line. Moreover it provides limited ability to control flexion versus extension contractures and may result in a need for a constrained prosthesis if over-release occurs [4, 7]. This may be because in severe varus deformity the medial sleeve release often involves both distal attachments of the sMCL, which have been shown to contribute to stability of the medial aspect of the knee [7, 8].

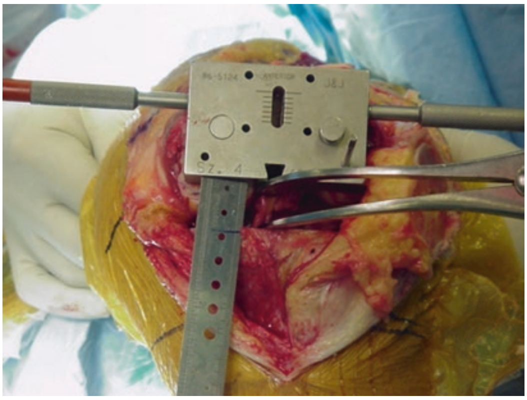

Fig. 1.7 "Parallel to the tibia" technique for rotation of the femoral component

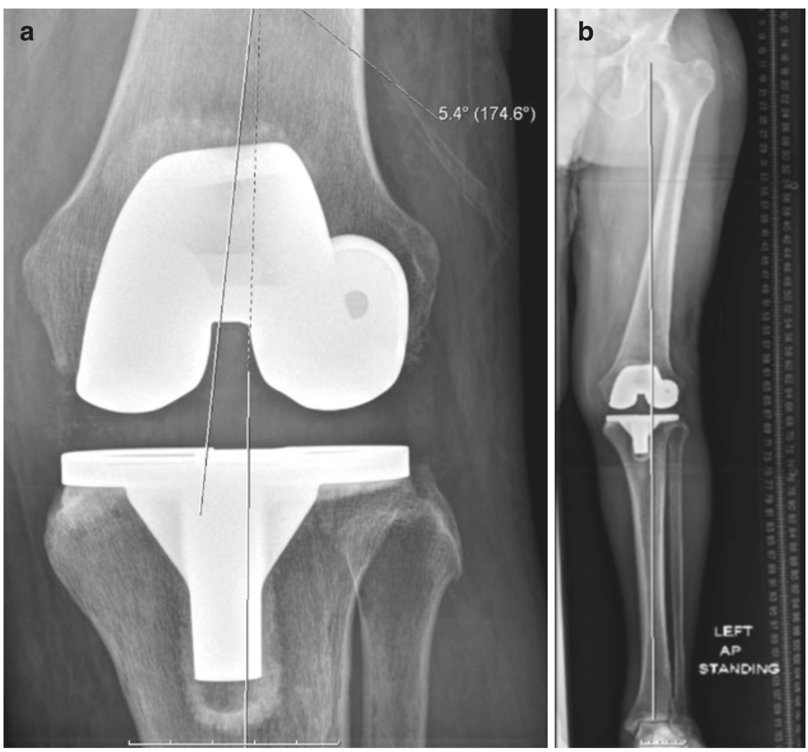

Fig. 1.8 Postoperative radiographs demonstrating well-aligned components

The senior author has extensive experience with pie crusting of tight lateral soft tissue structures in valgus flexed knees [9]. In order to address the concerns with the traditional medial release, we have applied these principles to medial release in fixed varus knees. In a study of 31 knees treated with this technique, we found that we were able to improve preoperative alignment from a mean of 21.1° ± 4° of varus and 10° ± 3.5° flexion contracture to 4.5°± 1.6° of valgus and complete resolution of the flexion contracture in all but three patients (each of whom had less than 5° residual contracture). In that study only two TC3-constrained polyethylene inserts were required, both of which were for residual lateral-sided laxity [4].

Other authors have advocated similar pie-crusting techniques. Engh suggested a similar technique of releasing the sMCL at the joint line in 2003, though he emphasized doing this in isolation as opposed to combining it with release of the posterior medial capsule [10]. Verdonk et al. recommended pie crusting of the sMCL with an 11 blade scalpel in mildly varus knees that needed less than 6–8 mm of release; if greater release was needed, they proceeded to subperiosteal release of the sMCL. Though in their paper they did not directly address flexion contractures, they did note that 63% of the knees in the study required release of the semimembranosus for residual flexion deformity. Their study of 359 knees with relatively mild preoperative varus of less than 11° found their algorithm to reliably reproduce neutral coronal alignment and Knee Society Score (KSS) improvement [3]. Bellemans et al. advocated a similar technique utilizing a 19 gauge needle for outside-in pie crusting of the sMCL and dMCL though in keeping with their surgical technique, they performed pie crusting in either flexion, extension, or both depending upon which position the knees was tight [11]. With this technique they found they were able to correct the alignment of 34/35 knees with an average preoperative deformity of 12.5° though they did identify one case of over-release [11].

We continue to believe that soft tissue balancing should be performed in extension. A recent cadaver study of the pie-crusting technique of just the MCL demonstrated that pie crusting in extension resulted in relatively equivalent increase in flexion and extension gap laxity medially, whereas pie crusting in a flexion position resulted in preferential release of the flexion gap and may be more likely to result in over-release [12].

One concern with medial pie crusting is over-release and potential rupture of the sMCL. Meneghini et al. performed a cadaver study examining pie crusting of the MCL with a 15 blade and did find that unlike traditional release the MCL after pie crusting tended to fail at the joint line in a stepwise mechanism. However, there was no difference in mechanical strength of the MCL between the traditional release group and the pie-crusting group. Of note they also performed this study in cadavers in which the only residual medial soft tissue was the MCL, and they used a 15 blade as opposed to an 11 blade [13]. Further in a different biomechanical cadaver study by Mihalko et al., there was no difference in failure between traditional subperiosteal release and pie-crusting technique, and knees that had undergone pie crusting demonstrated significantly less internal rotation instability [14]. Clinical studies have demonstrated few cases of intraoperative over-release with this technique, and to the best of our knowledge, there have been no reports of late failure of the medial soft tissue [3, 4, 7, 11, 15]. In fact one recent paper demonstrated a significant difference in the need for less constrained polyethylene tibial inserts with the pie-crusting technique than a traditional release, a finding which was more marked with greater degrees of deformity (Fig. 1.9) [7].

In summary pie crusting of the sMCL and release of the posterior medial capsule at the tibial cut surface are safe and effective procedures for dealing with all but the most significant cases of varus and allow reliable correction of varus and flexion malalignment.

Key Points

- Varus knees with flexion contracture are a commonly encountered knee deformity.

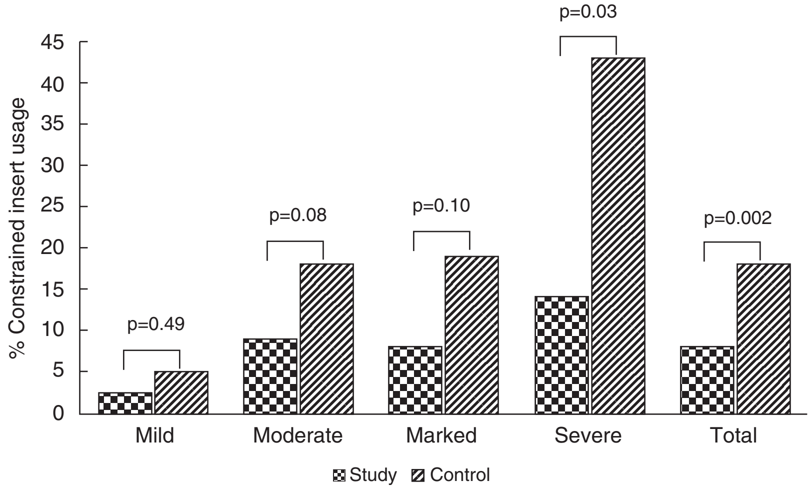

Fig. 1.9 Bar chart demonstrates the use of constrained inserts in the study group and the control group by preoperative varus deformity (From Goudarz Mehdikhani et al. [3], with permission)

- Release of the posterior medial capsule from the tibial border and pie crusting of the sMCL in extension with an 11 blade can reliably and safely correct both flexion and varus deformity without late instability.

Option 2: Medial Release for the Varus Knee

Chad D. Watts and Walter B. Beaver

Case Presentation

History

The patient is a 66-year-old male who has a 30-year status post-open medial meniscectomy of his left knee. He has increasing pain and varus deformity over the last 5 years. He now has difficulty ambulating over two city blocks and a recent reduction in ability to perform activities of daily living. He has had appropriate conservative measures which include NSAIDs, multiple injections, and physical therapy. Recent steroid shots lasted less than 2 weeks. He now presents for surgical consideration.

Physical Exam

Height 5′7″, weight 188 lbs, and BMI 29.5 kg/m^2. He walks with an antalgic gait with a varus thrust and has a moderate effusion. Range of motion is 10°–95°. He has a fixed varus deformity of 7° which does not correct with valgus stress. Stable end points are present with varus/valgus stress. His patella tracks in midline with crepitus through range of motion. He has severe pain with squatting and getting out of a chair. Quadriceps strength is 4/5.

Radiographs and Imaging

Preoperative templating is performed using long-leg standing radiographs to measure the angle of divergence between the anatomic and mechanical femoral axes, which is used to determine the distal femoral resection angle (Fig. 1.10).

Surgical Approach

In the present case, a standard medial parapatellar approach was used leaving a 1 mm cuff of medial quadriceps tendon proximally. The arthrotomy was extended distally to the level of the tibial tubercle. The anterior horn of the medial meniscus was incised, and a triangular tissue flap was developed subperiosteally from the medial tibia, allowing for access to the deep medial collateral ligament (MCL), which is typically the tightest structure contributing to fixed varus deformity (Fig. 1.11).

A curved osteotome was driven along the medial joint line using a small mallet to release the meniscotibial fibers of the deep MCL (Fig. 1.12). With the osteotome still in place and

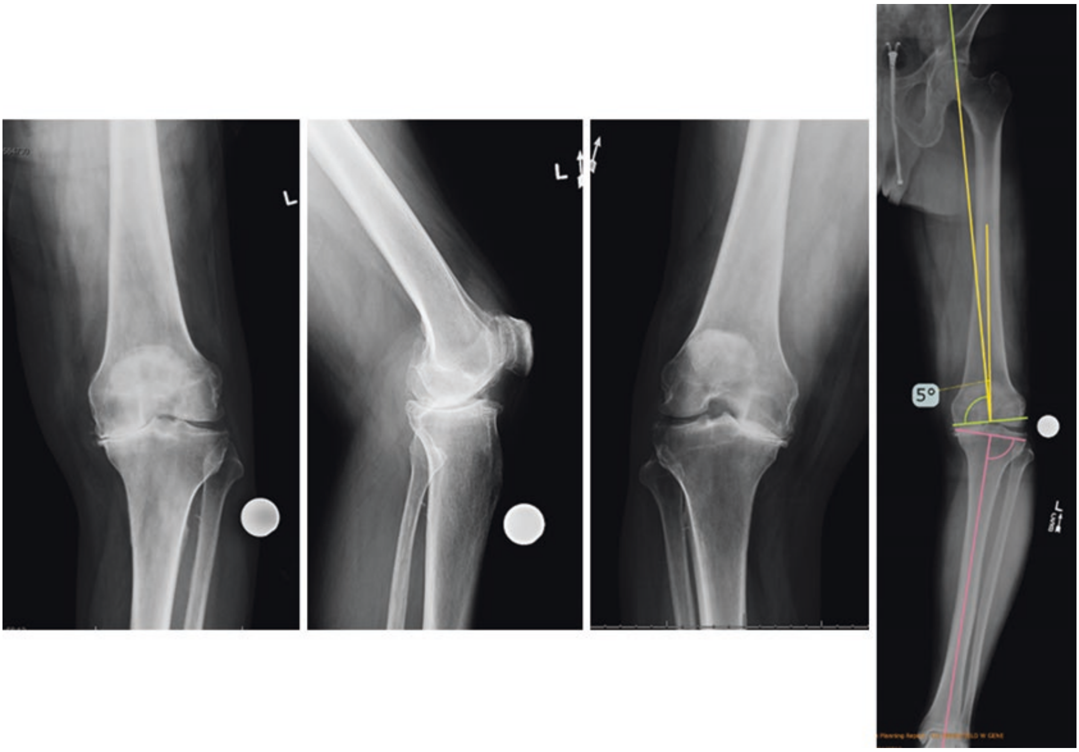

Fig. 1.10 Anteroposterior, lateral, posterior cerebral arteries, and long-leg views of the left knee prior to surgery (left to right). A varus deformity with medial tibial bone loss is present. On a long-leg standing view, we measured a 5° divergence between patient's mechanical and anatomical femoral axes

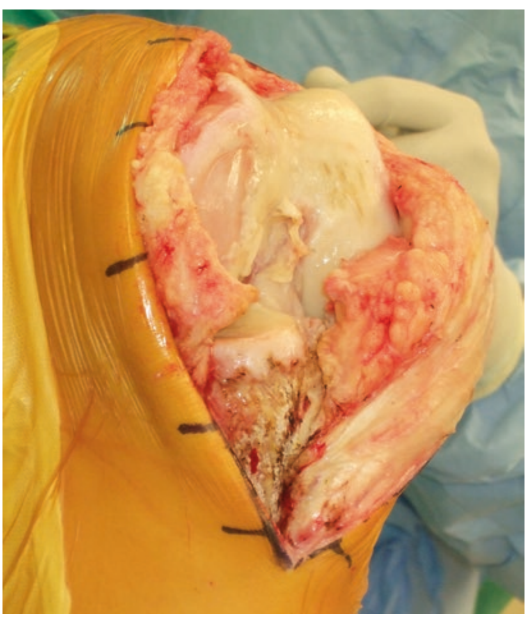

Fig. 1.11 Medial parapatellar arthrotomy

Fig. 1.12 Deep medial collateral ligament release

acting as a retractor, electrocautery was used to complete the release of the deep MCL.

The distal femur was then cut at 5° of valgus, as determined preoperatively using a long-leg standing radiograph. The anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) were then released from the notch. The tibia was then translated forward and externally rotated, while further medial capsule was released just below the joint line. It is imperative to keep the medial capsular release at or near the joint line. Extending the medial release distally toward the pes insertion may result in over-release, resulting in a loose medial flexion gap. A posterior Meckel retractor was used to assist with anterior translation of the tibia, and a sharp Hohmann retractor was used to apply tension to the medial capsular structures during their release. Once the proximal tibia has been translated forward and exposed, it was then cut perpendicular with the axis of the tibia using an extramedullary guide (Fig. 1.13).

A spacer block was then placed with the knee in extension. During this step, a drop rod was placed to confirm appropriate coronal and sagittal tibial resection (Fig. 1.14). Varus and valgus stress was applied, and we found that the medial extension gap was slightly tighter than the lateral gap. The tibia was again subluxated and externally rotated, and medial tibial osteophytes were removed with a rongeur. The medial subperiosteal release was extended around the posterior aspect of the knee, incrementally releasing the posteromedial corner, posterior oblique ligament, and posterior capsule. A spacer block was again placed in extension and our medial and lateral gaps were symmetric. If there is symmetric laxity, incrementally larger spacer blocks are placed until there is no liftoff with varus/valgus stress. In severe fixed deformities, such a release may not adequately correct coronal alignment in extension. If we remain unbalanced following these maneuvers, our next step is to perform a medial tibial reduction osteotomy, wherein medial tibial bone is progressively removed with a saw or rongeur. If this maneuver still proves insufficient, only then will we consider releasing the pes

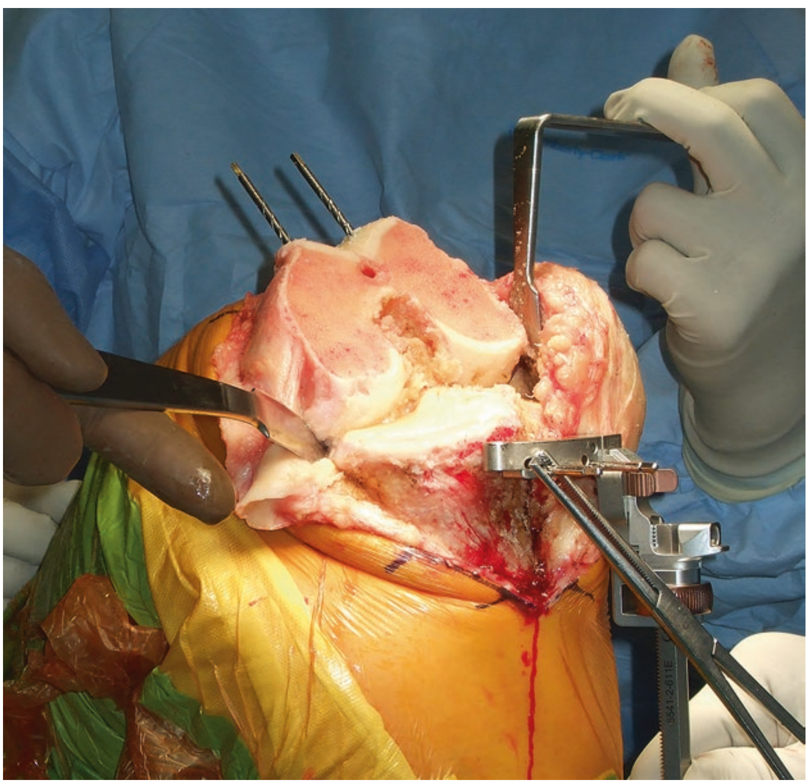

Fig. 1.13 Exposure for cutting of the proximal tibia

Fig. 1.14 Knee in extension with spacer block and alignment rod

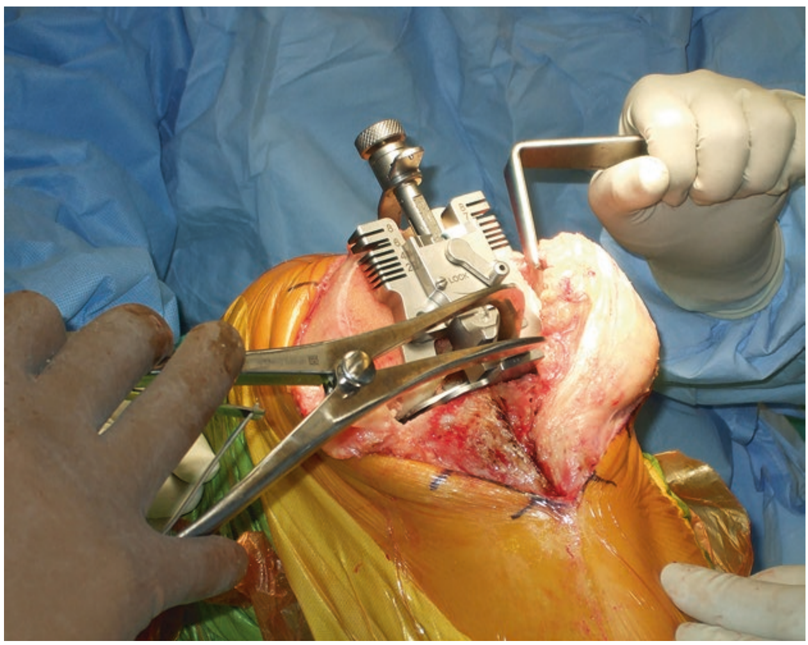

Fig. 1.15 A gap-balance device is used to tension the collateral ligaments and set femoral rotation

anserine tendons or pie crusting the superficial MCL. At this point a constrained prosthesis may be necessary.

The knee was then flexed to 90°, and a gap-balancing tension device was used to set the rotation of the femoral cutting block, with a gap equal to that which we determined in extension (Fig. 1.15).

Prior to making any femoral cuts, a spacer block was inserted posterior to the 4-in-1 cutting block with the knee in flexion, and the hip was internally and externally rotated to ensure that medial and lateral gaps were balanced in flexion, without any liftoff (Fig. 1.16).

The anterior, posterior, chamfer, and box cuts were then made in the femur. The tibial preparation was made with appropriate external rotation. In this case, there was a medial defect in the tibial plateau that was not fully removed with the proximal tibial cut. Rather than preparing for a medial augment, two cancellous screws were

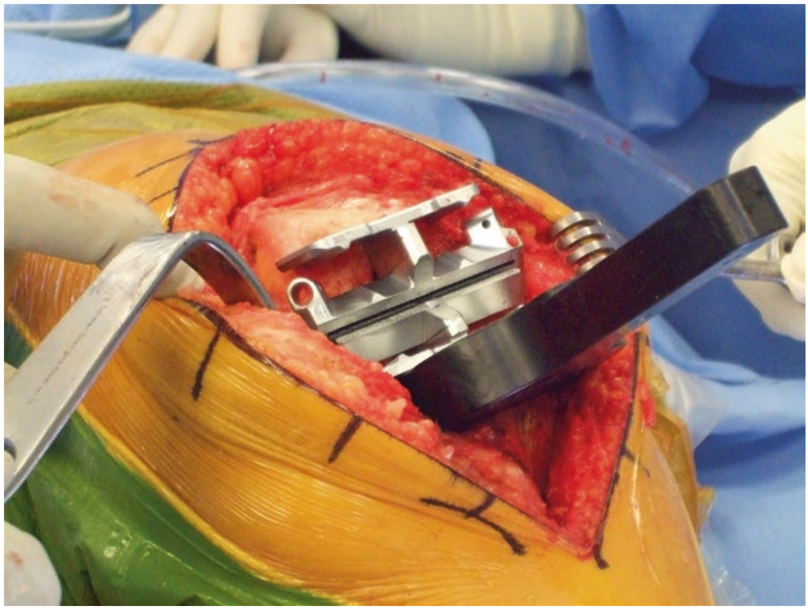

Fig. 1.16 A spacer block is used to check flexion gap balance prior to cutting through the 4-in-1 block

Fig. 1.17 Trial implants are placed to evaluate motion, stability, and patellar tracking

placed into the defect to help supplement medial support of the tibial tray. Trial implants were placed and the patella prep was completed (Fig. 1.17).

The trial patella tracked in midline. All trials were removed, and after preparing the bone for cementation, the implants were cemented into appropriate position (Fig. 1.18).

Postoperative Result

The patient progressed well and at 3 months had regained all abilities for activities of daily living with a walking tolerance of 2–3 miles. His knee was stable in all planes with 0–128° (Fig. 1.19).

Clinical Results

Primary total knee arthroplasty results in excellent outcomes for the majority of patients. While multiple techniques have been described to correct fixed varus deformities in primary total knee arthroplasty, there is little scientific evidence to support any one particular method over another. Krackow and Mihalko described the relative effects of releasing various structures on the