Total Knee Arthroplasty for Severe Valgus Deformity

Five to Fourteen-Year Follow-up

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Background: In 1985, the senior author (C.S.R.) developed a new soft-tissue release technique to balance valgus knees to avoid unacceptably high rates of late-onset instability and the need for primary constrained implants. This report describes the soft-tissue release technique and its long-term results when performed in primary total knee arthroplasty in patients with a severe valgus knee deformity.

Methods: Four hundred and ninety consecutive total knee arthroplasties were performed by one surgeon between January 1988 and December 1992. In this group, seventy-one patients (eighty-five knees) had a valgus deformity of ≥10°. Thirty-two patients (thirty-six knees) died, and four patients (seven knees) were lost to follow-up, leaving thirty-five patients (forty-two knees) followed for a minimum of five years. These twenty-seven women and eight men had a mean age of sixty-seven years at the time of the index operation. The technique included an inside-out soft-tissue release of the posterolateral aspect of the capsule with pie-crusting of the iliotibial band and resection of the proximal part of the tibia and distal part of the femur to provide a balanced, rectangular space. Cemented, posterior stabilized implants were used in all knees. Clinical and radiographic evaluations were performed at one, five, and ten years postoperatively.

Results: The mean modified Knee Society clinical score improved from 30 points preoperatively to 93 points postoperatively, and the mean functional score improved from 34 to 81 points. The mean range of motion was 110° both preoperatively and postoperatively. The mean coronal alignment was corrected from 15° of valgus preoperatively to 5° of valgus postoperatively. Three patients underwent revision surgery because of delayed infection, premature polyethylene wear, and patellar loosening in one patient each. There were no cases of delayed instability.

Conclusions: The inside-out release technique to correct a fixed valgus deformity in patients undergoing primary total knee arthroplasty is reproducible and provides excellent long-term results.

Level of Evidence: Therapeutic study, Level IV (case series [no, or historical, control group]). See Instructions to Authors for a complete description of levels of evidence.

A primary total knee arthroplasty for a knee with a valgus deformity is a formidable surgical challenge. A valgus knee often has both bone and soft-tissue abnormalities, including contracted lateral capsular and ligamentous structures with or without medial laxity, contracted or lax posterior soft tissues, osseous deficiency of the lateral femoral condyle and/or tibial plateaus, external rotation deformity of the distal part of the femur, secondary remodeling of the femoral and tibial metadiaphyseal region, and patellar maltracking[1]. Despite advances in instrumentation for bone resection and alignment, correcting a valgus deformity without relying on the use of a constrained implant continues to be difficult for many surgeons[2].

After correct osseous alignment and positioning of the articular surfaces have been achieved at the time of surgery, a strategy is necessary to ensure correct soft-tissue balance throughout the range of motion. A surgical technique should provide both immediate and long-term stability and cause no notable increase in component loosening or wear rates. The structures most commonly released in a valgus knee include the iliotibial band, the posterolateral aspect of the capsule, the lateral collateral ligament, the popliteus tendon, and the lateral head of the gastrocnemius muscle. In addition, the medial collateral ligament may need to be shortened or advanced. At present, there is no consensus regarding the sequence in which one or all of these structures should be addressed.

In 1985, the senior one of us (C.S.R.) developed a new soft-tissue release technique for valgus knees to address inherent instabilities that had been noted with his earlier technique, originally described in 1979[3]; the intent of this new release was

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to avoid late-onset instability and the need for a constrained implant[4]. The current report presents the five to fourteen-year follow-up results of total knee arthroplasty performed with use of this updated technique.

Materials and Methods

We included all primary total knee replacements performed by the senior one of us (C.S.R.), between January 1988 and December 1992, in knees with a preoperative valgus angulation of ≥10° seen on standing anteroposterior radiographs. Indications for surgery included pain and disability resulting from knee arthritis as confirmed by radiographic evaluation. The goals of surgery were to eliminate pain, correct the deformity, increase the range of motion, and improve function. A total of 490 replacements were performed during this time-period, and seventy-one patients (eighty-five knees) had a preoperative valgus angulation of ≥10°. Thirty-two patients (thirty-six knees) died, and four patients (seven knees) were lost to follow-up. The remaining thirty-five patients (forty-two knees) formed the basis of this study.

A bilateral procedure was performed in seven patients. Twenty-seven of the patients were women, and eight were men. The average age of the patients at the time of the surgery was sixty-seven years (range, twenty-seven to eighty-two years). The preoperative diagnosis was osteoarthritis in twenty-eight patients, rheumatoid arthritis in six, and posttraumatic arthritis in one. Five patients had had a previous arthroscopy, two had had an open meniscectomy, and one had had a supracondylar femoral osteotomy.

The PFC Modular total knee implant (DePuy Orthopaedics, a Johnson and Johnson company, Warsaw, Indiana) was used in thirty-two knees, and the Insall-Burstein-II implant

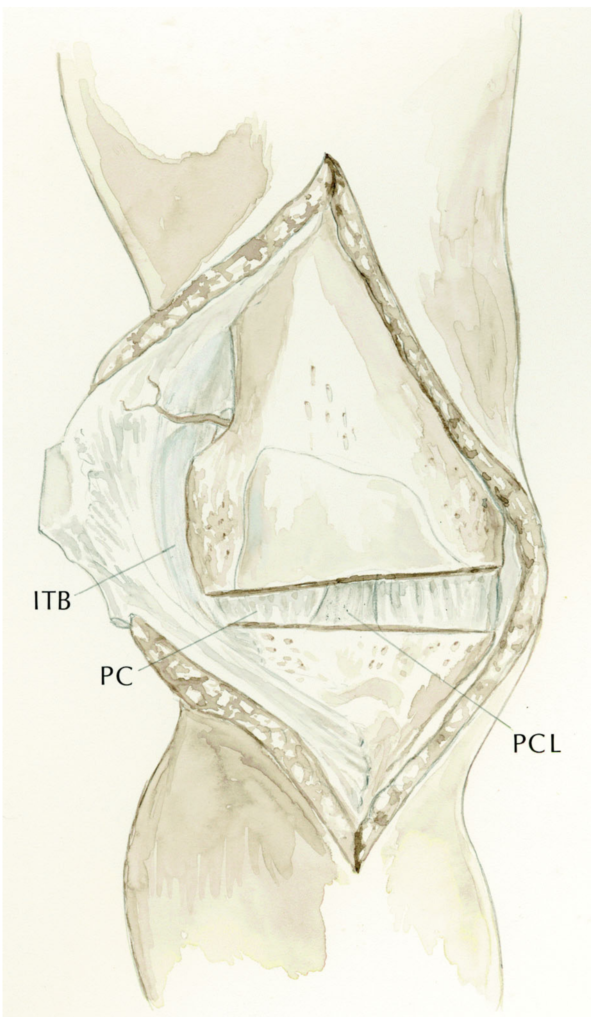

Fig. 1-A

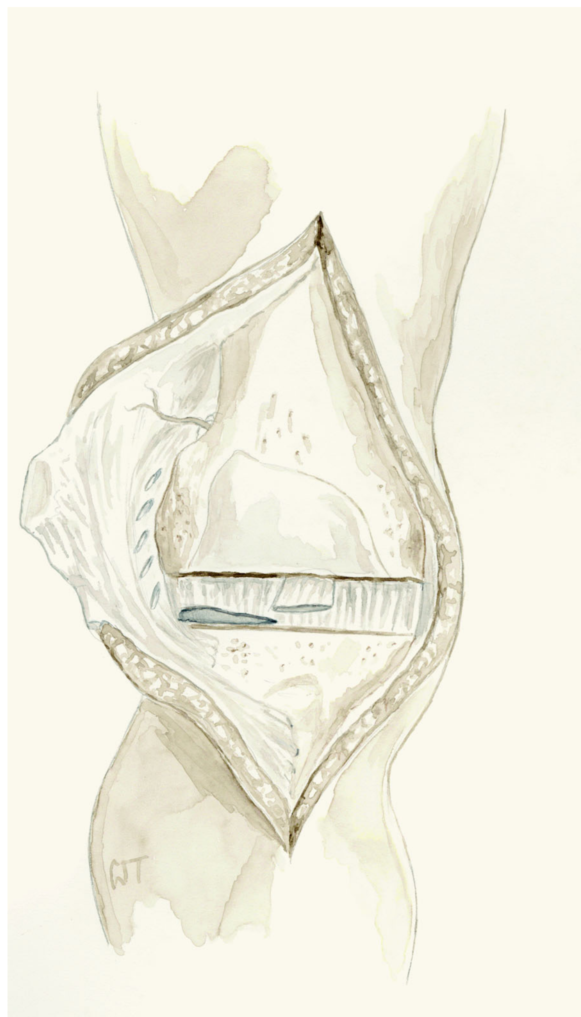

Fig. 1-B

Fig. 1-A Schematic view of a knee with valgus deformity before intra-articular release of the posterolateral aspect of the capsule (PC). Note the trapezoidal extension gap. ITB = iliotibial band, and PCL = posterior cruciate ligament. **Fig. 1-B** Schematic view of the knee with correction of the deformity after release of the posterolateral aspect of the capsule and pie-crusting of the iliotibial band (ITB). Note the resulting rectangular extension gap.

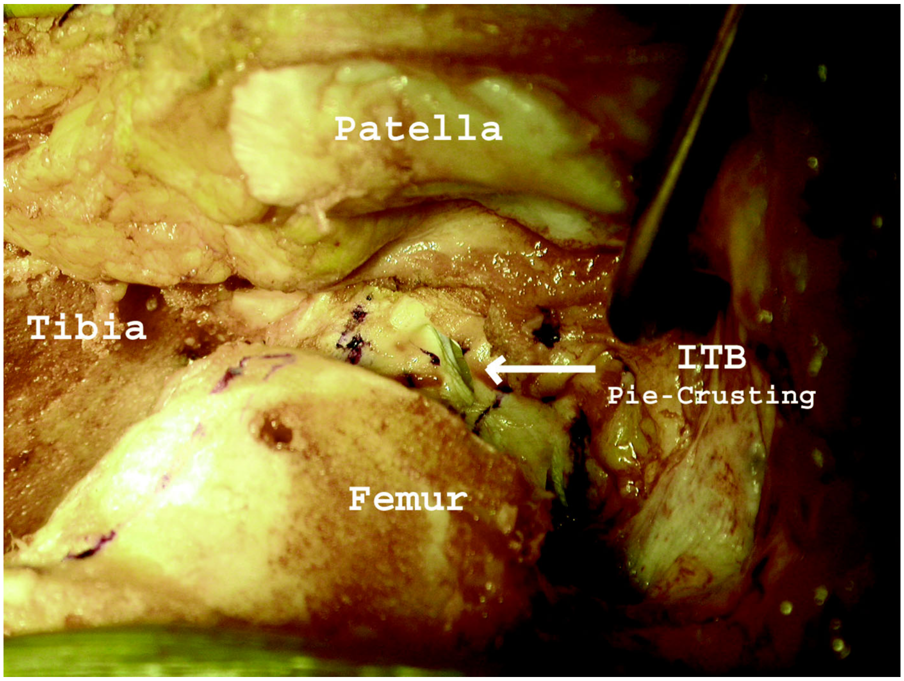

Fig. 2

Intraoperative photograph showing pie-crusting of the iliotibial band (ITB).

(Zimmer, Warsaw, Indiana) was used in nine knees. Both implants include a cam-post mechanism to substitute for the posterior cruciate ligament and are of similar design. One knee with a severe valgus deformity was treated with a constrained insert because mild midflexion instability (defined as >5 mm of medial opening) was detected intraoperatively.

Surgical Technique

If the medial joint space is >1 cm on anteroposterior weight-bearing radiographs, less bone than is typically removed should be resected from both the distal part of the femur and the proximal part of the tibia in order to allow for soft-tissue balancing without elevation of the joint line or creation of too large an extension gap. The tibial surface is cut at 90° to its longitudinal axis, and the distal femoral resection is performed in 3° of valgus in relation to the anatomical axis as opposed to the typical 5° to 7° of valgus used for a varus knee; 3° of valgus is used in order to protect against undercorrection of the underlying deformity. After the proximal tibial and distal femoral bone cuts are made, the knee is extended and is distracted with a lamina spreader, bringing the posterolateral capsule complex under tension. Doing this should demonstrate a trapezoidal extension gap. The tight soft-tissue capsular structures in the lateral compartment are released intra-articularly, with use of electrocautery, at the level of the tibial cut (Fig. 1-A). The release is performed transversely, from the lateral edge of the resected posterior cruciate ligament to the posterior margin of the iliotibial band, to create a rectangular extension gap. Electrocautery is used to avoid injury to the peroneal nerve, which is usually located <1 cm from the articular side. Both medial and lateral soft-tissue sleeves should have an equal, 2 to 3 mm opening when a valgus or varus stress is applied with a spacer block in place.

If the extension gap remains unbalanced after the intra-articular release, the iliotibial band is lengthened in a controlled manner as necessary from inside with use of the so-called pie-crusting technique, which consists of multiple oblique stab incisions 1 cm above the joint line (Figs. 1-B and 2). This process continues until a balanced extension gap has been achieved.

Attention is then turned to the flexion gap. No soft-tissue releases are performed with the knee in flexion; rather, femoral bone cuts are made to attain the correct soft-tissue balance in flexion. The rotational alignment of the femoral component is determined by placing an anteroposterior cutting block parallel to the tibial cut surface while a lamina spreader separates the posterior edge of the cutting block from the tibial cut surface (Fig. 3). Prior to cutting the posterior femoral condylar bone parallel to the tibial cut surface, it is necessary to verify that the tibial cut is in fact 90° to the long axis of the tibia and that the soft tissues are balanced in extension. A varus tibial cut or over-release of the medial side will lead to internal rotation of the femoral component and possibly to patellar tracking problems. If rotational malalignment is suspected, alignment can be checked by referencing the cutting block with respect to the anteroposterior axis of Whiteside or the transepicondylar axis[5].

Forty of the forty-two knees underwent the extensive lateral soft-tissue release as described above. The two remaining knees were relatively well balanced after routine exposure and the bone cuts and did not require extensive releases.

Method of Evaluation

Preoperatively, each involved knee was evaluated for weight-bearing alignment, flexion contracture, and ligamentous instability. Preoperative radiographic analysis included standing anteroposterior, lateral, and sunrise views of the affected knee as well as an anteroposterior view of the pelvis. Full-length radiographs were made when the knee had complex triplanar deformities. Radiographs were evaluated for osseous deformity, patellar thickness and position, and alignment of the ipsilateral hip. (A varus hip necessitates cutting the distal part of the femur into more valgus.) Additionally, anteroposterior radiographs were scrutinized for soft-tissue laxity such as medial-lateral opening and/or tibial subluxation.

The Knee Society clinical rating system was used for preoperative and postoperative clinical evaluation, with a slight modification of the knee alignment scoring as originally proposed in our previous paper[4]. With the Knee Society score, points are deducted when the anatomic alignment of the knee is <5° or >10° of valgus. However, because the goal in this series of valgus knees was to obtain an alignment of 3° to 5°, the scoring system was changed so that deductions were made for an alignment of <2° or >7° of valgus. Clinical and functional scores of ≥85 points were categorized as excellent; 70 to 84 points, as good; 60 to 69 points, as fair; and <60 points, as poor.

At the time of the latest follow-up, the tibial and femoral components were evaluated radiographically with use of the Knee Society roentgenographic evaluation system[6]. Lateral and skyline radiographs were used to assess the patella for tilt, displacement, residual bone thickness, coverage ratio, and radiolucency. In addition to component positioning, each radiograph was assessed for the presence of osteolysis, which was defined as an expanding area of focal radiolucency measuring ≥1 cm in diameter. Any component with a circumferential radiolucency at the bone-cement or component-cement interface was considered to be loose.

Kaplan-Meier survivorship analysis was performed with use of revision for any reason as the end point. A second survivorship analysis was done with mechanical failure (aseptic loosening or instability) as the end point. Survivorship curves were created with use of commercially available software (GraphPad InStat; GraphPad Software, San Diego, California).

Results

Clinical Results

The thirty-five patients (forty-two knees) were followed for an average of nine years (range, five to fourteen years). The mean preoperative pain score was 8 points, which improved to 48 points at the end of the first postoperative year, 48 points at five years, and 47 points at ten years. The mean preoperative and latest postoperative ranges of motion were both 110°. The mean score for stability of the knee improved from 17 points preoperatively to 24 points at one year, 24 points at five years, and 24 points at ten years. There were no cases of late-onset instability. The mean score for walking ability improved from 20 points preoperatively to 44 points at one year, 44 points at five years, and 42 points at ten years. The score for stair-climbing improved from a mean of 17 points preoperatively to 43 points at one year, 43 points at five years, and 41 points at ten years. The clinical score improved from a mean of 30 points preoperatively to 94 points at one year, 94

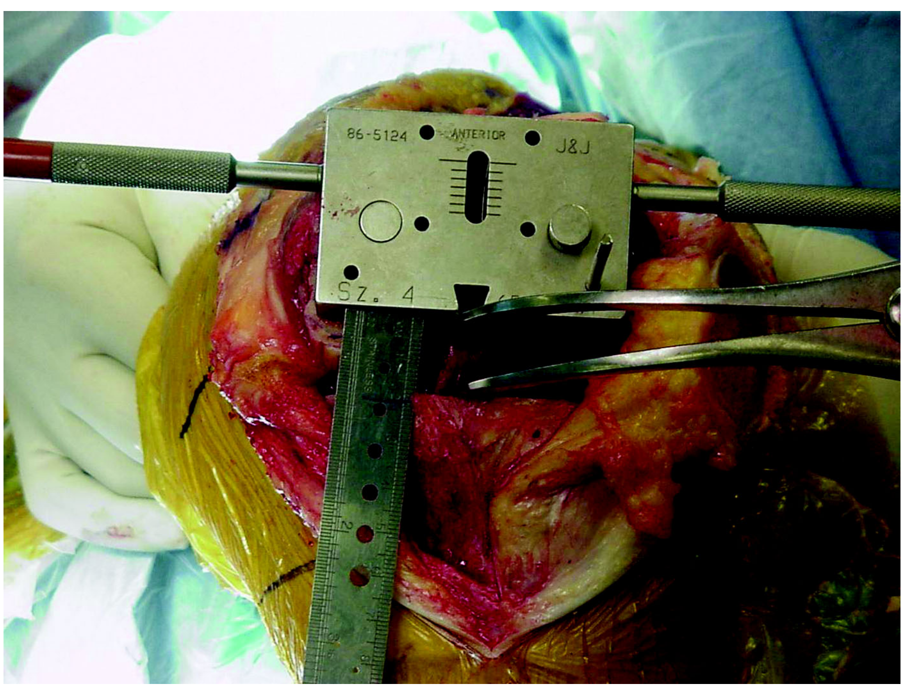

Fig. 3

Rotational alignment of the distal femoral cutting block is determined with use of a lamina spreader to create a rectangular flexion gap balanced with the extension gap.

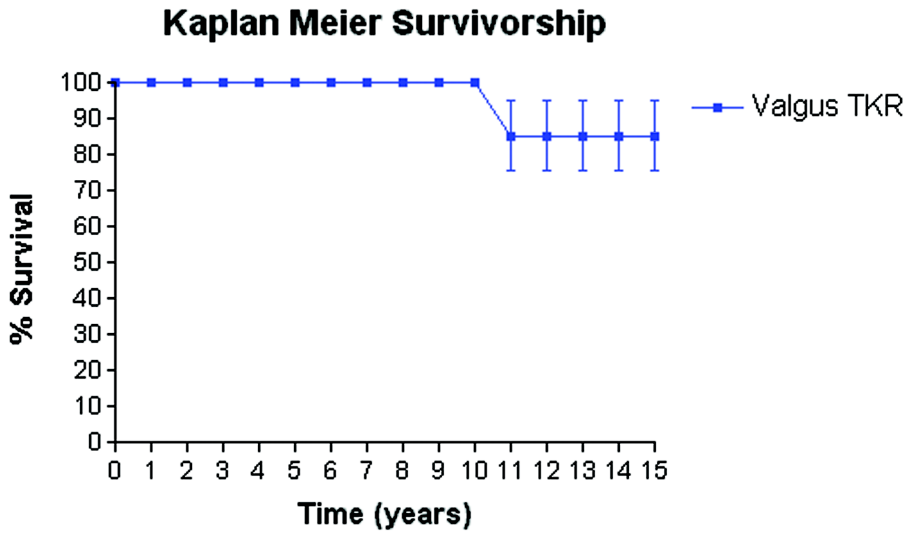

Fig. 4

Kaplan-Meier survivorship curve with only mechanical failure as the end point. The I-bars represent the 95% confidence intervals. TKR = total knee replacement.

points at five years, and 93 points at ten years. The functional score improved from a mean of 34 points preoperatively to 85 points at one year, 85 points at five years, and 81 points at ten years. Of the nine patients for whom the score for function was <80 points, all but one had either severe spinal stenosis or a minimum of two other lower-extremity joint arthroplasties.

Radiographic Results

The mean preoperative anatomic valgus angle was 15° (range, 10° to 32°), which was corrected to a mean of 5° of valgus (range, 0° to 10° of valgus) at the time of the latest follow-up. Correction to between 2° and 7° of valgus was achieved in thirty-seven of the forty-two knees. None had a varus alignment, and two patients had a valgus alignment of >8°. The mean femoral (α) angle was 4°, and the mean tibial (β) angle was 1°. The mean flexion (χ) angle was 7°, and the mean lateral tibial (δ) angle was 5°. Postoperative residual patellar thickness averaged 19 mm, with a mean difference of 2 mm between the medial and lateral sides. The mean amount of patellar component tilt in relation to the femoral component was 5°, and the mean postoperative displacement of the patella from the center of the trochlea was 7 mm.

No radiolucencies were noted adjacent to any of the forty-two femoral or tibial components at the time of the latest follow-up. No tibial or femoral component was associated with osteolysis or had radiographic evidence of loosening. Patellar loosening with displacement was noted in one knee five years after the surgery. This patient became symptomatic eleven years after the index surgery and underwent revision.

Complications

An early superficial infection that required débridement and irrigation developed in one patient, who then had an uneventful postoperative course. One patient with polyarticular rheumatoid arthritis had a small area of skin necrosis over the patella. Although the final outcome was unaltered, her rehabilitation was delayed. Deep venous thromboses in the calf developed in two patients, and one patient had a nonfatal pulmonary embolus. There were no peroneal nerve palsies or patellar dislocations.

Three of the thirty-five patients required revision surgery. One revision was done to treat loosening of the patellar component as mentioned above. The second revision was performed because of excessive wear of the articular insert associated with synovitis but not osteolysis in a heavy, active patient. This patient was treated with exchange of the tibial polyethylene insert and has since done well. The third revision was performed to treat a deep infection one year after the index operation. This patient underwent staged revision, and had good stability and range of motion (0° to 95°) at ten years postoperatively.

Kaplan-Meier survivorship analysis revealed a survival rate (and 95% confidence interval) of 83% ± 9.6% at fifteen years with revision surgery for any reason as the end point. When only mechanical failure was the end point, the survival rate was 85% ± 9.6% at fifteen years (Fig. 4).

Discussion

The most challenging aspect of primary total knee arthroplasty in a valgus knee is achieving soft-tissue balance. Over the last twenty years, numerous approaches and soft-tissue procedures have been advocated[5,7-12]. Whiteside recommended sequential releases of the iliotibial band, popliteus, lateral collateral ligament, and lateral head of the gastrocnemius[5]. He also performed a tibial tubercle transfer when the Q angle (the angle subtended by the quadriceps and patellar tendons) was >20°. Buechel[7], Fiddian et al.[8], and Keblish[10] suggested using a lateral capsular approach for the treatment of valgus deformity. Healy et al.[9] and Krackow et al.[11,13] recommended medial soft-tissue advancement combined with lateral soft-tissue releases. Stern et al. advised that constrained femoral components be used in severely valgus knees in which the ligamentous balancing is tenuous, to allow for easy conversion to a constrained insert if late-onset instability occurs[12].

In 1979, Insall et al. described their technique of soft-tissue balancing[3]. In this technique, the iliotibial band is divided transversely above the joint line while the lateral aspect of the capsule, the lateral collateral ligament, and the popliteus tendon are detached from the lateral femoral condyle. The lateral retinaculum is routinely released longitudinally as well. The senior one of us (C.S.R.) thought that this technique led to an unacceptably high rate of late-onset instability, which prompted him to develop a less extensive soft-tissue release, thereby potentially reducing the need for a constrained prosthesis[4]. He discourages the routine use of a constrained prosthesis, which he believes should be utilized for only the most complex valgus deformities.

The revised technique, in use since 1985, involves an intra-articular release, in extension, of the contracted posterolateral aspect of the capsule in a graduated, stepwise fashion along with so-called pie-crusting of the iliotibial band[4]. We believe that the technique is reproducible and is less technically demanding than many other procedures, such as a lateral approach or medial soft-tissue imbrication. In our study, pain relief, joint stability, and correction of the alignment did not decline with time. In series of total knee replacements ranging in size from twenty-five to 134, the rates of peroneal palsy and patellar dislocation have ranged between 1% and 4% for knees treated for valgus deformity[3,12,14-17]. There were no peroneal palsies in our study.

In conclusion, total knee arthroplasty for the treatment of valgus deformity requires correction of both osseous and ligamentous abnormalities. Recent advances in instrumentation have made bone resection and alignment easier but do not address ligamentous balancing. The soft-tissue release described herein for valgus deformity is not technically demanding and has consistently produced excellent long-term clinical and radiographic results. We recommend the technique for the management of valgus knees undergoing total knee arthroplasty. ■

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