BACKGROUND

- Ralph C. Marcove (Memorial Sloan Kettering Cancer Center) and Kenneth C. Francis (New York University Medical Center) introduced limb-sparing resection in the early 1970s for the management of malignant bone tumors, initially for osteosarcoma of the distal femur. The introduction of effective chemotherapy agents (doxorubicin [Adriamycin] and methotrexate) at the same time was a major impetus to the development of these procedures. These surgeons hoped by combining surgery with chemotherapy, either preoperatively or postoperatively (termed adjuvant chemotherapy), limb-sparing surgery would be safe for the patient and would permit a limb-sparing resection.

- Distal femoral endoprosthetic reconstruction has undergone an evolution of surgical techniques and manufacturing changes (initially by Howmedica, Inc., Rutherford, NJ), making it one of the most satisfying orthopaedic oncology procedures available today. Forging of components has greatly diminished mechanical failure problems, and modularity has increased the indications for its use. Muscle-sparing and soft tissue coverage techniques have minimized wound healing problems.

- The three major steps in limb-sparing surgery—wide excision with good oncologic margins, reliable reconstruction of the skeletal defect, and adequate muscle transfer and good prosthetic coverage—have formed the basis for reliable and safe limb-sparing resections and reconstruction for both low- and high-grade bone sarcomas. Most clinical experience has been gained in treating osteosarcoma of the bone. The most common site is the distal femur and the proximal tibia. These techniques have subsequently been used for other bony sarcomas and recurrent benign tumors and more recently in the treatment of failed allograft and complicated, multifailed total knee arthroplasties.

- The goal is to have an adequate oncologic resection while maintaining enough muscle to permit a painless functional result. The techniques outlined in this chapter are based on the senior authors’ (MM, JJE) 51 years of combined surgical experience, with approximately 440 distal femoral reconstructions since 1979.

ANATOMY

- The surgeon must be extremely knowledgeable of not only the bony anatomy and the specific endoprosthesis to be used but also the vascular anatomy, soft tissue structures, and potential local muscle flaps and the many techniques involved in a limb-sparing resection (**FIG 1**).

Sartorial Canal

- The sartorial canal occupies the space between the vastus medialis, sartorius, and adductor magnus muscles in which the superficial femoral artery passes the medial aspect of the thigh (adductor hiatus) and then enters the popliteal space. In patients whose tumors are longer than 13 cm, the sartorial canal is often displaced. The vessels within the canal are usually protected by the deep fascia of the vastus medialis and a tough fascia surrounding the vessels. This fascia border is rarely penetrated by tumor.

Knee Joint

- The knee joint is rarely directly involved by sarcoma. The main mechanisms of knee joint contamination are inappropriate biopsy, extension of tumor along the intra-articular cruciate ligaments, and pathologic fracture. The knee joint can reliably be evaluated by computed tomography (CT) and magnetic resonance imaging (MRI). If the physical examination reveals any evidence of effusion, the knee joint should be aspirated and histologic samples obtained. A hemarthrosis usually indicates tumor involvement of the synovium. This is a rare event but not an indication for amputation.

Popliteal Space

- The popliteal space contains the popliteal artery and vein and the sciatic nerve. The popliteal vessels enter the popliteal space from the medial aspect through the adductor hiatus as the vessels exit the sartorial canal. The popliteal vessels are evaluated by CT with contrast, MRI, and plain angiography.

- It is rare to have direct vessel involvement by tumor. The vessels may be displaced as the tumor grows posteriorly, but usually there is a normal border or margin of popliteal fat.

- Exploration of the popliteal space is the first step in determining the feasibility of a limb-sparing procedure. The popliteal vessels are dissected out and the geniculate vessels are ligated. If the vessels are free of tumor, resection can usually be performed safely.
FIG 2 • A. Evolution of the distal femoral endoprosthesis. Composite No. 1: The Waldius knee mechanism, introduced in 1951, had a fixed metal on hinge. No. 2 The Spherocentric distal femoral endoprosthesis was developed by Harry Matthews, MD, in 1975 and first implanted in 1977. A metal ball and polyethylene cupola connected the tibial and femoral components. No. 3: The original kinematic rotating-hinge knee was introduced in 1980. The vitalium hollow body was casted by the lost-wax method, and a custom Zickle nail stem was welded to it. No. 4: Circumferential porous ingrowth beads were introduced in 1985 to allow for bone incorporation. In reality little bone ingrowth occurred, but protective soft tissue ingrowth did. No. 5 Modularity was introduced in 1988. The condyles and femoral stems were forged and were coupled to titanium segments by Morse taper locks. Since its introduction in 1980 by Peter Walker for Howmedica, the kinematic rotating-hinge knee mechanism has remained virtually unchanged except for a slight increase in the diameter of the axle and the polyethylene bushings. The rotating-hinge knee concept has now been universally adopted as the preferred knee mechanism for distal femoral endoprosthetic reconstructions. B. A Guepar prosthesis (simple hinge) was used in the early 1970s before the development the rotating-hinge prosthesis. C. Custom prosthesis used during the 1980s. The knee joint is a rotating hinge consisting of bushings, axles, and a rotating poly component that is inserted into the tibia. D. The modular replacement system was first used (National Cancer Institute) in 1988 and was approved by the U.S. Food and Drug Administration in 1991. This system consists of a joint component, multiple body segments, and stems of various diameters. This system can replace the proximal femur, distal femur, total femur, or proximal humerus. The original system was developed by the senior author (MM) in conjunction with the engineers (lead engineer George Corsi) at Howmedica (Rutherford, NJ). This system, now known as the Global MRS system, is manufactured by Stryker Orthopedics (Mahwah, NJ).
• A frozen section of the popliteal fat or adventitia of the popliteal vessels should be obtained intraoperatively. If there is obvious vascular involvement, the vessels can be replaced by vascular graft.
• The popliteal vein is usually not repaired because it rarely stays patent after surgery.

Anterior and Posterior Cruciate Ligaments
• The cruciate ligaments are occasionally involved by direct tumor extension from the distal femur. This occurs through the bone–tendonous junction of the intercondylar notch of the distal femur. There is no cartilage in this area to act as a barrier to tumor growth.
• MRI is occasionally helpful in determining cruciate ligament involvement.
• Tumor nodules of the anterior and posterior cruciates occasionally present with a hemarthrosis. The most common finding at resection is tumor nodule involvement of the cruciates. This does not rule out a limb-sparing procedure. The cruciate ligaments as they attach to the proximal tibial plateau can be resected en bloc with the proximal tibial cut. This is a safe procedure that avoids the need for a true extra-articular resection.

INDICATIONS
• Endoprostheses were initially used solely for reconstruction after resection of malignant bone tumors. Manufacturing time could be as long as 3 months, an interval that permitted induction chemotherapy. Endoprosthetic reconstructions proved to be enduring, and the designs have evolved (FIG 2). Modularity, which made for immediate availability, permitted the expansion of the indications for distal femoral endoprosthetic reconstruction to some stage 3 giant cell tumors of bone; metastatic disease where conventional intralesional procedures cannot reasonably be done, possibly 10% of metastatic cases; complex supracondylar fractures in elderly osteoporotic patients; failed internal fixation of distal femoral fractures; failed allograft or total knee reconstructions; and as a primary knee replacement system in patients with a severe flexion contracture.
• Tumor when a Codman triangle is present.

PATIENT HISTORY AND PHYSICAL FINDINGS
• The average age of patients with high-grade osteosarcomas is 5 to 30 years; the median is 16 to 21 years. Surface osteosarcomas occur in the third decade and are more common in women.
• Patients with high-grade osteosarcoma almost always initially complain of pain during the day that is not associated with activity. All patients complain of a dull aching pain and only later of night pain.
• Thirty to 40% of patients have a history of local trauma. There is no causal relationship of trauma to the tumor except that it brings the patient to medical attention and the physician orders a radiograph, which always shows the tumor. This has been termed “traumatic determinism.”
• Classic high-grade osteosarcoma presents with pain. Parosteal osteosarcoma (surface osteosarcoma) usually presents with a mass and not pain (FIG 3).
• Parosteal osteosarcomas are most common in the posterior aspect of the distal femur. They represent less than 4% of all osteosarcomas. Popliteal fullness is a common finding. Plain radiographs can often distinguish a classic from a parosteal osteosarcoma.
• There may be tenderness on examination. The regional lymph nodes are normal. Osteosarcomas spread hematogenously. Infection is rarely a consideration.
• Pathological fracture occurs in less than 1% of osteosarcomas. Fractures usually occur through the purely osteolytic variant (about 25% of all osteosarcomas), which has minimal mineralized tumor matrix.
• A soft tissue, extraosseous mass occurs in more than 90% of high-grade osteosarcomas.
• An effusion usually indicates tumor involvement of the joint or pathological fracture.
• Distal pulses are usually normal and symmetrical. Decreased pulses may represent tumor involvement.
• Leg edema may represent popliteal vein occlusion or thrombus.
• Enlarged groin lymph nodes may represent lymph node metastasis, but this is rare. Biopsy should be considered.
• Popliteal lymph node enlargement is extremely rare (except for Ewing sarcoma or lymphoma).

IMAGING AND OTHER STAGING STUDIES
• Diagnostic imaging should include plain radiographs, a technetium-99 bone scan, an MRI of the entire femur, and a CT scan of the distal femur (FIG 4), as well as angiography. Three-dimensional CT angiograms have recently replaced routine angiography. Preoperative staging studies focus on the four anatomic structures discussed above. This permits the surgical team to determine the type of surgery, placement of the incision, the need for intra- or extra-articular resection, and the biopsy site and technique.
• Plain radiographs correlate very well with the extent of the tumor when a Codman triangle is present.
• A technetium-99 scan shows the extent of the tumor within the femur as well as the presence of skip metastases. Multicentric disease or metastases to other bones can be determined from this test as well. The early and pool phases of the bone scan demonstrate the vascularity of the tumor and tend to correlate with the chemotherapeutic effect (ie, tumor necrosis).
FIG 4 • A. Schematic illustration depicting the preoperative studies needed for sarcomas of the distal femur. MRIs, CT scans, bone scans, and angiography are required. B,C. Anteroposterior and lateral radiographs of a patient with a secondary chondrosarcoma arising from an osteochondroma. D. Posterior projection of a technetium-99 bone scan in a patient with a sarcoma of the distal femur. No skip metastases are noted. The uptake on the scan correlates well with the extent of tumor within the bone. E. The CT scan of the patient in Fig. 4B,C clearly shows the medial osteochondroma stalk from which the secondary chondrosarcoma arose. A posterolateral osteochondroma is also noted. Although soft tissue extension of the tumor is apparent, it is less well delineated than on the MRI. F,G. Coronal and cross-sectional MRIs of the patient.
A femoral MRI best shows the extraosseous extent of the tumor as well as its proximal and distal extent within the medullary canal. This study is the most accurate in detecting skip metastases.

CT scans are complementary to MRI scans and can show the quality of the bone stock at the intended level of resection.

Angiography or three-dimensional CT angiography can be used to evaluate the superficial femoral and popliteal arteries. This is especially important if there is a large posterior or medial extraosseous component. The late arterial phase of the angiogram or venous phase will show residual tumor blush. The degree of remaining vascularity correlates well with the tumor necrosis (Fig. 5A,B). An unresponsive tumor as shown by a tumor blush requires a wider margin than a good responder (no tumor blush). More recently, three-dimensional CT angiography has replaced traditional angiograms; it shows the vascular anatomy well (Fig. 5C-F).

**Fig 5** A. Angiography after induction chemotherapy. A. Anteroposterior view. B. Lateral view showing the absence of a tumor blush. This is the most reliable finding of all preoperative staging studies that can predict tumor response. This patient had 100% chemonecrosis. C. Three-dimensional angiography is being evaluated in the treatment of bony tumors. C,D. Lateral and posterior views of the distal sarcoma. The popliteal artery is displaced. The extraosseous component is not visualized because there is no bony formation. E,F. Secondary chondrosarcoma of the proximal tibia. Lateral and posterior views showing excellent visualization of the popliteal artery and its trifurcation (arrows). A 64- or 246-slice CT scanner is required, similar to coronary angiography.
A, B, C. CT scans of a sclerotic osteosarcoma of the distal femur. A needle biopsy is performed under CT guidance. Needle biopsies are routinely performed to establish a diagnosis; less than 5% to 10% require an open biopsy. B, C. Radiographic response after induction chemotherapy for a distal femoral osteosarcoma. B. Preoperative CT scan shows an extracortical component. C. CT scan shows reossification of the entire lesion. CT scans are extremely valuable at determining tumor response (the percentage of tumor necrosis) and are routinely performed before and after induction chemotherapy.
confirm that there is adequate bone stock left to accept the femoral stem, in terms of both length and width. The distal femur should be resected with a safe oncologic margin (3 to 4 cm of normal marrow). The extremity lengths should be equal to within millimeters. To achieve this, intraoperative marks and measurements are made to ensure that the length before resection equals the reconstruction length.

- When planning the primary resection and reconstruction, the surgeon should also be planning an amputation or revision. Ideally the level of amputation should be at the same level it would have been had amputation been chosen as the original procedure to achieve local control. The surgeon should plan how he or she will revise this reconstruction in the event of infection or mechanical failure. The real goal would be to retain the patient’s own hip and not go to a total femur replacement unless necessary, as this requires rehabilitating two joints in series, which is always a greater challenge for the patient.

**Positioning**

- In the preoperative area or as anesthesia is being induced, the patient is given intravenous antibiotics. One gram of vancomycin is slowly infused over 1 hour, and this is repeated every 12 hours until the drains are removed. A single 80-mg dose of gentamicin or tobramycin is also given. An epidural catheter is routinely used for postoperative pain management.
- After anesthesia is induced, a urinary catheter is placed. For the medial approach the patient is placed in the supine position with the entire leg, including the inguinal area, prepared. This provides adequate access to the proximal femoral vessels.
- A tourniquet is not used. A folded sheet placed transversely under the sacrum can elevate the pelvis to permit better access for draping. If the lateral approach is used, then the patient is placed in the lateral decubitus position on a beanbag with an axillary roll. A standard 10-minute preparation is performed, generally iodine-based.

**Approach**

- The preferred approach is a medial longitudinal approach with exploration of the superficial femoral and popliteal vessels. All vessels that feed the tumor and distal femur are tied off. The saphenous nerve is identified and protected. Any biopsy tract should be kept in continuity with the underlying tumor. Because the routine approach for primary tumors is medial, lateral or anterior open biopsy tracts need to be ellipsed and kept in continuity with the underlying tumor. The saphenous nerve is identified and protected.

**RESECTION AND RECONSTRUCTION OF THE DISTAL FEMUR THROUGH A LONGITUDINAL MEDIAL APPROACH AND PREPARATION FOR CEMENTING THE TIBIA, PATELLA, AND FEMORAL COMPONENTS**

**Position and Dissection**

- The patient is in supine position with the leg and inguinal area prepared out.
- The incision is longitudinal, following the sartorius muscle from proximally in the thigh distal to beyond the tibial tubercle.
- Any biopsy tract should be kept in continuity with the underlying tumor. Because the routine approach for primary tumors is medial, lateral or anterior open biopsy tracts need to be ellipsed and kept in continuity with the underlying tumor.
- The saphenous nerve is identified and protected.
- The interval between the sartorius and the vastus medialis is opened, exposing the superficial femoral artery and vein along with the saphenous nerve.
- The vessels and the saphenous nerve are dissected from proximal to distal and are reflected posterior and medial along with the sartorius muscle.
- All vessels (geniculates) are tied off with 2-0 or 3-0 silk ties as they course from the vessels toward the distal femur and tumor. The surgeon must not ligate the medial or lateral sural vessels, which are the main blood supply to the respective gastrocnemius muscles. These vessels are the basis of a gastrocnemius flap if required.
- The surgeon should be careful at the canal of Hunter because the vessels are just deep to the adductor tendon.
Part 4 ONCOLOGY • Section IV LOWER EXTREMITIES

TECHNIQUES

TECH FIG 1 • A. Right leg with large secondary chondrosarcoma. B. A medial incision follows the sartorius proximally in the thigh to below the tibial tubercle. This allows immediate and very adequate visualization of the femoral and popliteal vessels. C. After the incision through the skin and subcutaneous tissue, a large posteromedial flap is developed deep to the fascia. The first vital structure identified and protected is the saphenous nerve. It accompanies the femoral vessels proximally in the thigh and follows the sartorius into the leg. Cutting the nerve results in numbness over the medial calf and occasionally a painful neuroma. D. In the middle and distal thigh, retracting the sartorius posteromedially exposes the superficial femoral vessels. E. In the proximal thigh, retracting the sartorius anterior and lateral allows exposure of the femoral vessels, all the way to the inguinal ligament if necessary. F. All vessels coursing toward the distal femur and tumor are tied with 2-0 or 3-0 silk sutures before they are cut. This minimizes blood loss, improves exposure, and guarantees the integrity of these structures. G. At the canal of Hunter, the adductor tendon is identified and cut. The main vessels are just beneath this structure, and care and patience at this point in the dissection are necessary. Several collateral vessels come off the femoral vessels at this point, coursing toward the femur and tumor. They need to be tied off. The saphenous nerve is seen accompanying the sartorius muscle.
Chapter 25 DISTAL FEMORAL RESECTIONS WITH ENDOPROSTHETIC REPLACEMENT

- Distal to the canal of Hunter the popliteal vessels are dissected free and reflected posterior and medially (TECH FIG 1G). The short head of the biceps muscle is now seen coursing proximal to distal to join the long head laterally in the thigh.
- The sciatic nerve is exposed and protected.
- Proximal and medial in the thigh above the tumor, the junction between the adductors and vastus medialis can be opened to the femur to reflect the quadriceps laterally off the femur (TECH FIG 2A).
- Deep to the medial intermuscular septum is the terminal profunda artery and vein, which may be ligated.
- The superficial femoral vessels, along with the saphenous nerve and popliteal vessels, are dissected free from the tumor throughout its length to below the joint line (TECH FIG 2B,C).
- The medial gastrocnemius muscle can be incised. The surgeon must not ligate the medial sural vessels (TECH FIG 2D,E).
- With the femoral vessels completely dissected and reflected, the quadriceps or a portion of it, along with the patella and patellar tendon, are now reflected over the tumor, leaving the vastus intermedius as a very satisfactory oncologic margin.
- Intra-articular resections are usually performed.
  - The joint capsule is opened and the anterior and posterior cruciate ligaments, the popliteus tendon, and the collateral ligaments are cut with an electrical cauter.
  - The posterior capsule is incised, with the popliteal vessels kept in direct view or under the operator’s finger to prevent injury.

A. Proximally in the thigh, above the tumor the adductor fascia meets the fascia of the vastus medialis. This interval is opened to permit exposure of the femur. The profunda vessels course just below the adductor fascia and follow the linea aspera. B. Saphenous nerve proximally in the thigh accompanies the superficial femoral vessels as the sartorius has been retracted posteromedially. The adductor tendon has not yet been cut, but the popliteal vessels have been exposed and mobilized to below the knee joint to guarantee their integrity. C. Completed medial dissection. The saphenous nerve follows the sartorius from proximal in the field. The femoral and popliteal vessels have been dissected and accompany the sartorius muscle and the saphenous nerve distally in the thigh. D. Medially at the knee, the medial gastrocnemius muscle is dissected and cut. E. Medial geniculates are identified and cut. (continued)
F. An arthrotomy has been made. The quadriceps had been dissected and mobilized over the tumor mass, leaving the vastus intermedius muscle as an oncologic margin on the tumor. G. Cortical marks have been made on the femur and tibia above and below the planned resection levels to establish the length before resection that should be re-established with the reconstruction. The anterior cortical mark is placed at this time to help with rotation orientation.

- Intra-articular extension of the tumor is rare; when it occurs, it is covered with synovium. Local recurrence, when it occurs, is generally along the neurovascular dissection plane and not anterior in, or in the level of, the knee joint.
- The quadriceps is reflected over the tumor, leaving a cuff of muscle on top of the tumor as the oncologic margin. The vastus intermedius is left as an oncologic margin over the tumor (TECH FIG 2F).
- Cortical marks are as follows:
  - Before dislocating the knee, cortical marks are placed proximally on the femur and on the tibia, and the distance before resection is measured.
  - This distance should be the same after the prosthesis is implanted.
  - An anterior cortex is marked on the proximal femur to help with rotatory alignment during femoral stem insertion. This, along with the linea aspera, is used to determine appropriate rotatory position of the stem (TECH FIG 2G).
- The knee is dislocated and the short head of the biceps and the remaining posterior lateral capsule are cut.

Osteotomy and Preparation of the Femur, Tibia, and Patella
- The femur is cut with a saw at the predetermined level (TECH FIG 3A–C). One more centimeter than the assembled length of the femoral component is removed, and then only 7 mm is taken off the tibia. This 1.7 cm makes up for the distance between the prosthetic condyle and the undersurface of an 8-mm all-poly tibial component when assembled. This ensures leg-length equality (TECH FIG 4A). Alternatively, 17 mm can be taken off the tibia with jigs provided by the manufacturer, and the femur

TECH FIG 3 • A. The femur is cut with a Gigli or oscillating saw at the planned resection level and below the cortical marks. B,C. Anterior and posterior views of the specimen alongside the trial prosthesis.
can be cut exactly at the proximal level of the segmental component. While this may place the patella in a more anatomic location, it makes no difference in functional outcome (TECH FIG 4B).

- The proximal marrow is sampled and sent to pathology for frozen section analysis.
- The femur is reamed to accept the largest stem possible. This concept is “fit and fill.” Curved stems may add to rotational stability. Stems smaller than 13 mm should be avoided in adults. The cut end is then chamfered (with a facing reamer) and cleaned with an irrigating brush (TECH FIG 4C-E).
- A proximal cement restrictor can be placed at this time if cement fixation is to be used.
- The tibia is osteotomized with an oscillating saw with a very slight posterior slope (TECH FIG 4F,G). This cut can

**TECH FIG 4 • A.** With this author’s (JJE) technique, the femur is cut 1 cm longer than the planned femoral replacement.  
**B.** Only 7 mm is removed from the proximal tibia. This gives the largest platform for the tibial component. An 8-mm all-polyethylene tibial component is routinely used in primary reconstructions. The distance from the metal condyle to the inferior surface of an 8-mm poly tibial component is 1.7 cm. This ensures extremity-length equality to within millimeters. No effort is made to keep the patella right at the knee joint. Patellar tracking and postoperative function, which is what is important, are routinely excellent.  
**C.** After the marrow frozen section report has returned as negative for tumor, reaming the canal can commence, with the femur stabilized with a large locking clamp. Sharp reamers are used and the reaming is done slowly and gently, with copious irrigation to prevent a fat embolus. The canal is reamed to whatever level is necessary to permit the largest stem to fit easily.  
**D.** A chamfer reamer is used to prepare the osteotomy site.  
**E.** The canal is cleaned again slowly and gently with an irrigating brush.  
**F.** A freehand oscillating saw removes 7 mm from the upper tibia. Manufacturers now provide tibial cutoff instrumentation to permit the removal of larger amounts of tibia to keep the patella at the joint line.  
**G.** The tibial cut is usually perpendicular when the distal end points to the second metatarsal. The tibial cut should have a slight posterior slope to ensure full extension when the prosthesis is fully extended. If the slope is anterior, the patient will be left with a built-in flexion contracture. (continued)
Techniques

H. An intraoperative radiograph is taken to ensure that the cut is perpendicular. Slight varus or valgus does not seem to interfere with function or lead to loosening. I. The undersurface of the patella is removed with an oscillating saw. J. It is prepared for a central peg all-polyethylene component by undercutting the hole with a burr. K. Instrumentation is available to prepare the tibia to receive the tibial component. The prepared patella and tibia are seen. L. The trial patella component overhangs the patella and should be replaced with a smaller component. M. The reconstruction length is measured from the tibial to the femoral mark to ensure equality with the length before resection. Ankle pulses are checked at this time.

Selection and Placement of the Components

- The patellar component should not overhang the cut surface of the patella. A central peg poly component is used and the surface of the bone is undercut to aid in fixation. The rationale for resurfacing the patella is that it allows immediate and vigorous rehabilitation without concern that any knee pain may be due to the patellar cartilage grinding on the metal distal femoral prosthesis. This is more important given that the goal is an active range of motion of 120 to 130 degrees of

be done freehand, though instrumentation is now available. Our routine is to take off only 7 mm, just below the cartilage. This leaves the largest surface area to support the reconstruction. An anterior slope will leave the final reconstruction with a knee flexion contracture. A distal bone plug or cement restrictor can be placed at this time. A trial all-poly tibial prosthesis is then inserted. An intraoperative radiograph is taken to ensure that the cut is perpendicular to the shaft and not in varus or valgus. The seating of the trial prosthesis is also determined to avoid varus or valgus tilt (TECH FIG 4H).

- The undersurface (50%) of the fat pad is removed to prevent impingement. This can be painful in the immediate postoperative period.

- The patella undersurface is removed and it is prepared (undercut with a burr) to receive the patellar component. One of the senior authors (MM) routinely resurfaces all patellae with a single central peg component. Alternatively, if the patella appears normal (as in most adolescents), there is no need to replace it (TECH FIG 4I–L).

- A trial reduction is made and a measurement is taken to be sure that the post-reconstruction distance is the same as the pre-resection distance (TECH FIG 4M).

- Range of motion is tested: the quadriceps and patella should track nicely without a tendency for lateral dislocation.

- A lateral release should be made at this time if there is a tendency for patellar subluxation or dislocation.

- The tension of the superficial femoral vessels is also checked. The distal pulses at the ankle are checked with a Doppler with the reconstruction in full extension. Overlengthening can cause excessive tension and compression of these structures.

- Overlengthening should be avoided. It is harder to rehabilitate a lengthened extremity. Leg-length inequalities in the growing child can be made up at a later date with an exchange of one of the segmental modules rather than overlengthening at the time of the initial resection. Some adolescent patients never need a lengthening. Overlengthening also increases the risk of sciatic or peroneal nerve palsy.
DISTAL FEMORAL RESECTIONS WITH ENDOPROSTHETIC REPLACEMENT

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Chapter 25

TECH FIG 5 • A. Final reconstruction. B. Final reconstruction and resected specimen.

TECH FIG 6 • Closure: Two large flat 10-mm drains are placed and exit proximally. The sartorius is sutured to the remnants of the vastus medius. The distal capsule is closed.

Cementing of Components

- All components are cemented.
- Before cementing, 100 mg of hydrocortisone (Solu-Cortef) is given intravenously to protect against fat embolism. The deleterious effects of a fat embolism are due to a massive inflammatory response in the lungs. Steroids are the best anti-inflammatory agent.
- Antibiotic-impregnated cement is routinely used.
- The tibial component and the patella are cemented first.
- The cement is injected while it is still fairly liquid, and the femoral canal is pressurized.
- The femoral stem is inserted slowly. Rapid insertion can lead to a fat embolism.
- Once the stem is placed, rotatory changes are avoided because they will lead to poor fixation and early loosening. No last-minute adjustments should be made on the femoral side.
- A final measurement is made once the final components are in place.
- The final reconstruction with and without the resected specimen can be seen in TECH FIG 5A,B.

Closure and Postoperative Care

- Before closure, homeostasis should be meticulous.
- The wound is irrigated copiously with antibiotic solutions, with all final rinses with saline solutions.
- The joint capsule is closed to the remaining capsular tissue about the proximal tibia.
- The sartorius is sutured to the vastus medialis over a deep 10-mm flat drain with a #1 absorbable suture (TECH FIG 6).
- The subcutaneous tissue is closed over a superficial 10-mm flat drain.
- The drains are sutured in place and are kept in place until the 24-hour drainage is less than 30 to 40 cc per hour.
- Skin closure can be with staples or a subcuticular suture.
- Gastrocnemius flaps are necessary in less than 1% of cases but can be useful to cover an endoprosthesis if adequate tissue is not available. More common use of the gastrocnemius flap reflects an individual surgeon’s resection philosophy and technique.
- Sterile dressings and an Ace wrap are applied.
- The patient is placed in the bed with a continuous passive motion machine, flexing to 30 degrees and extending to 5 degrees for 3 days. The range of motion is then advanced rapidly to achieve 90 degrees of flexion before discharge.
- Sequential compression boots are applied to the feet.
- The next technique, from an anterior (transadductor) approach, may be used as an alternative.
RESECTION AND RECONSTRUCTION OF THE DISTAL FEMUR THROUGH A LONGITUDINAL LATERAL APPROACH AND PREPARATION FOR CEMENTING THE TIBIA, PATELLA, AND FEMORAL COMPONENTS

- Indications for the lateral approach:
  - All revision cases
  - Total femur reconstructions
  - Primary distal femoral tumors that extend so far proximally that cross-pin stem fixation, either at 90 degrees to the shaft or 135 degrees into the femoral neck, is necessary to achieve a stable reconstruction
  - Patient preparation for the lateral approach is identical to the medial approach.
  - Once anesthesia is administered, the urinary catheter is placed, and the vancomycin and gentamicin are administered, the patient is rolled to the lateral decubitus position, with all pressure points carefully protected.
  - The entire leg is draped and prepared, from above the iliac crest to the foot.
  - A tourniquet is not used.
  - A longitudinal lateral incision is made from the tibial tubercle to as far proximal as necessary. It can be extended to the tip of the trochanter and then on to the anterior superior iliac spine if a total femur endoprosthesis is planned.
  - The skin and subcutaneous tissues are incised with an electrical cautery knife. The fascia lata is incised in line with its fibers.
  - The lateral intermuscular septum is identified and the entire vastus lateralis can be released from its posterolateral insertion after tying all the perforators before cutting them. Then the entire vastus lateralis can be flipped up over the femur, exposing the entire length of the bone. A cuff of muscle can be left on the tumor as oncologic needs dictate.
  - Because the tibial tubercle is a somewhat laterally placed structure, care needs to be taken to avoid avulsion of the patellar tendon.
  - The remainder of the procedure is identical to the medial approach.

TECH FIG 7 • A–C. Surgical approach using the newly described anterior (transadductor) approach to the distal femur. This approach was developed to avoid postoperative skin flap necrosis. The vastus medialis remains attached to the overlying skin, essentially forming a myocutaneous flap. A. Wide skin flaps are developed, and the interval between the rectus (RF) and the vastus medialis (VM) is carefully opened. B. The RF and VM interval has been opened, showing the fibers of the vastus intermedius tendon. (continued)
TECH FIG 7 • (continued) C. The distal aspect of the VM is developed. D. The surgical approach shown in A–C. E. The vastus intermedius tendon is opened and the medialis is mobilized. F–H,K. Operative photographs showing the transadductor approach. F. The interval between the RF and VM has been opened and the vastus intermedius has been mobilized. G. The termination of the sartorial canal containing the superficial femoral artery and vein is dissected free. H. The sartorial canal has been opened. I. The remaining attachment of the adductor magnus tendon to the distal femur is released. J. Relationship of the superficial femoral artery to the popliteal space and the adductor magnus tendon. (continued)
Kawai et al reported a flap necrosis incidence of 30% in a series of 40 patients who underwent distal femoral resection and endoprosthetic reconstruction, and Safran et al concluded that perioperative chemotherapy and intraoperative flap devascularization were the major causes of infection after limb-salvage procedures. In an attempt to decrease the occurrence of flap necrosis and to improve soft tissue coverage of the endoprosthesis, the senior author (MM) has developed the following modified surgical approach for distal femoral resection using a well-vascularized posteromedial myocutaneous flap:

Position and Incision

- With the patient in the supine position and the surgeon standing on the medial side of the knee (opposite side of the table), a long, medial paramedian skin incision is made. The incision extends proximally along the junction of the rectus femoris and vastus medialis muscles and curves distally around the medial border of the patella to the level of the pes anserinus.

Proximal Interval and Creation of Musculocutaneous Flap

- The interval between the rectus femoris and vastus medialis muscles is identified and opened to expose the underlying vastus intermedius muscle. The fibers of the vastus intermedius are then carefully divided. It is important not to separate the overlying muscle from its fasciocutaneous coverage, which would defeat the purpose of this approach. This can be ensured by suturing the vastus medialis to the overlying skin.

Exposure of Intermuscular Septum and Adductor Hiatus

- The plane between the vastus medialis and the medial femoral condyle is identified distally (similar to the subvastus approach). The vastus medialis muscle is dissected off the medial femoral condyle in an extra-articular fashion and retracted medially, away from the knee capsule. By sweeping the fibers of the muscle from the intermuscular septum with a sponge, the intermuscular septum, the adductor hiatus, and the adductor magnus tendon are exposed.

Identification of the Superficial Femoral and Popliteal Vessels

- The sartorius muscle, which crosses over the proximal portion of the vastus medialis, is mobilized posteriorly by opening the thin fascia between the vastus medialis and its superior border. The superficial femoral artery and vein are identified proximally at the level of the adductor hiatus. With the surgeon’s finger placed into the adductor hiatus to protect the underlying vessels, the distal portion of the adductor magnus tendon is dissected and released from the distal femur and adductor tubercle, partially exposing the popliteal space. The superficial femoral vessels are carefully dissected and mobilized along their sheath, and vessel loops are placed around them as they enter the popliteal fossa.

Completion of Popliteal Exposure

- The knee is placed in 90 degrees of flexion. With the vastus medialis musculocutaneous flap retracted posteriorly, the entire popliteal space is visualized and the popliteal vessels are identified distally between the two heads of the gastrocnemius muscle. After the identification of the
The popliteal vessels, the medial head of the gastrocnemius is released from the femoral condyle; this should be performed with the surgeon’s finger placed underneath the muscle, protecting the popliteal artery and vein. In addition, care should be taken to preserve the medial sural artery, which is the sole vascular supply to the medial head of the gastrocnemius (TECH FIG 8).

**Mobilization of the Popliteal Vessels and Sciatic Nerve**
- Mobilization of the popliteal vessels is facilitated by individually ligating their geniculate branches from the level of the adductor hiatus to the junction of the gastrocnemius muscle. A downward traction maneuver of the vessels allows better identification of the geniculate branches.
- The sciatic nerve is then exposed over the proximal portion of the popliteal fat and followed distally to its bifurcation into the tibial and common peroneal nerves. The popliteal vessels are then covered by a sponge soaked in papaverine to prevent potential vasospasm.

**Lateral Structures Release**
- After complete exposure of the popliteal space, including release of the medial head of the gastrocnemius and mobilization of the popliteal vessels, the lateral head of the gastrocnemius muscle, the short head of the biceps muscle, and the entire posterior capsule are released.

**Anterior (Intra-articular) Release and Distal Femoral Osteotomy**
- To complete the soft tissue dissection of the distal femur, the anterior capsule is opened transversely and both cruciate ligaments are divided. With the superficial femoral vessels mobilized, the femoral osteotomy, which is usually made 15 to 20 cm proximal to joint line, above the level of the adductor hiatus, can now be safely performed. The following steps to complete the resection and reconstruction are identical to those discussed above:
  - Intra-articular resections
  - Cortical marks
  - Osteotomy and preparation
  - Trial reduction
  - Selection and placement of the components
  - Cementing
  - Closure

**Medial Gastrocnemius Muscle Transfer**
- The medial gastrocnemius muscle is the mainstay of muscle transfers of the distal femur. The technique of medial gastrocnemius transfer for difficult and complicated distal
femoral resections was initially described by Malawer and Price in 1985 (TECH FIG 9).

- This muscle transfer provides excellent coverage for small and large medial and anterior defects after distal femoral resection. It has been our experience that a free flap has never been required after distal femoral resection and endoprosthesis replacement.
- The medial gastrocnemius muscle is dissected free of its tendinous and midline insertions in the calf after cementing of the prosthesis. It may then be rotated transversely or proximally, depending on the area to be covered. Usually the skin can be closed directly over the transferred muscle, but if there is any skin tension or swelling, the skin flaps are sutured directly to the muscle transfer and the remaining defect is closed with a split-thickness skin graft onto the muscle directly at the time of surgery.
- There is a thick fascia covering both the anterior and posterior surfaces of the medial gastrocnemius muscle. These fascia coverings are routinely removed with a sharp blade. This permits the muscle to expand about 150% larger than normal. The muscle can then be rotated either proximally to cover large medial defects or anteriorly to cover the entire exposed knee joint. The arc of rotation may be increased by releasing the sartorius and the other pes muscles. These muscles are then tenodesed to the vastus medialis muscle, the patella, and the soleus muscle distally.

- The medial gastrocnemius muscle is fed by one major branch: the medial sural artery off the popliteal artery. The origin of this branch is at or below the knee joint line. At the time of popliteal exploration and dissection, it is essential to preserve this branch and not mistake it for a geniculate vessel. Geniculate branches pass anterior from the popliteal artery, whereas the medial sural artery passes posterior and medial. This vessel usually takes off at about the level of the inferior geniculate pedicle. The lateral gastrocnemius is rarely used because it is a much smaller muscle and its arc of rotation is decreased by the peroneal nerve and the fibula.

### Pain Control

- Silastic epineural catheters are routinely placed (MM) in the femoral nerve sheath and a 10-cc bolus of 0.25% bupivacaine is infused before the patient is transferred to the recovery room. Four to 8 cc per hour is administered using an infusion pump for up to 72 hours postoperatively. This provides excellent pain control and decreases systemic narcotic requirements by more than 50% (TECH FIG 10).
POSTOPERATIVE CARE
- In the operating room the patient is placed in the bed with a continuous passive motion machine, flexing to 35 degrees and extending to 5 degrees. That range of motion is maintained until the third day, when it is advanced 10 to 15 degrees a day to achieve 90 degrees before discharge.
- The inpatient stay is generally 7 to 10 days.
- A towel roll is placed under the heel three times a day for 60 minutes to ensure that full extension is achieved and that a flexion contracture is avoided. This practice is continued for the first 4 weeks after surgery.
- The patient is mobilized out of bed on the third postoperative day and ambulated initially with a walker and then crutches and with a knee immobilizer, which is kept on for 4 to 8 weeks when out of bed.
- Before discharge the patient should be able to flex to 90 degrees and do 10 straight-leg raises with the knee immobilizer on, should be in and out of bed independently, and able to go up and down stairs.

- The drains are removed when the drainage in a 24-hour period is less than 30 to 40 cc in each drain; generally this is in 5 to 6 days.
- Intravenous antibiotics are continued until the drains are removed.
- Anticoagulation after surgery is based on the patient’s risk factors.
- A circumferential compression Ace wrap is used for 2 months, and sometime a Neoprene knee brace is used for several months.
- Outpatient physical therapy is begun 4 to 6 weeks after surgery and lasts for 12 weeks. The goals are to maximize knee flexion, motor strength, and gait. Most patients achieve more than 120 degrees of flexion, have full extension without a lag, and walk without a limp. By 4 months the patient should be able to walk down the hall and most observers would not be able to tell that he or she has had surgery.
### Pearls and Pitfalls

<table>
<thead>
<tr>
<th>Pitfall Description</th>
<th>Pitfall Details</th>
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<tbody>
<tr>
<td>Difficulty closing the wound</td>
<td>Difficulty in wound closure usually occurs as a result of significant muscle resection due to the oncologic need for adequate margins. A too-long leg can cause this problem. The level of the patella should be checked. A medial gastrocnemius muscle flap should be used if there is any question about the viability of the medial closure or if a significant amount of the vastus medialis has been resected. Occasionally, the sartorius muscle can be rotated to close a small defect instead of the gastrocnemius muscle.</td>
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<tr>
<td>Identifying surgical planes medially and the subvastus interval</td>
<td>The surgeon should carefully identify the vastus medialis and rectus femoris interval and the subsequent vastus intermedius below it. The vastus medialis is mobilized extra-articularly from the femoral condyle.</td>
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<tr>
<td>Mobilization of the superficial femoral vessels</td>
<td>These vessels are identified within the sartorial canal and traced to the adductor hiatus. The surgeon places a finger into the hiatus before releasing the adductor fibers and intermuscular septum.</td>
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<tr>
<td>Difficulty identifying the popliteal vessels, especially distally</td>
<td>The surgeon should release the medial gastrocnemius muscle within 1 to 2 cm from its insertion onto the medial condyle. The popliteal vessels are found between the two heads of the gastrocnemius muscles.</td>
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<tr>
<td>Injury to or ligation of the medial sural artery</td>
<td>The medial sural artery is the main pedicle to the medial gastrocnemius muscle. This branch medial sural artery comes off medial and posterior from the popliteal artery. The geniculants take off anteriorly. The surgeon must not ligate any &quot;geniculate&quot; if it appears to be running medial or posterior.</td>
</tr>
<tr>
<td>Injury to the sciatic nerve, especially the peroneal branch</td>
<td>The sciatic nerve is easily identified in the popliteal space covered by fat posterior to the popliteal vessel sheath. The peroneal nerve runs lateral to exit the popliteal space and runs lateral to the lateral gastrocnemius muscle. The nerve can easily be injured at this level, especially when the lateral gastrocnemius is released from the femoral condyle.</td>
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<tr>
<td>Injury to the popliteal artery and vein</td>
<td>Although these vessels are initially identified and mobilized, they can be iatrogenically injured later in the procedure. The surgeon must be careful when releasing the posterior capsule. The popliteal vessels are tied down to the capsule at the joint line by the most inferior geniculate vessels. These vessels should be ligated early in the procedure so that the popliteal vessels fall away from the entire femur and capsule. Occasionally the popliteal vessels are punctured by the distal end of the osteotomized femur. The surgeon should pack off the distal femur with a laparotomy pad to avoid this.</td>
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<tr>
<td>Absent pulses after closing the wound</td>
<td>This is most common in young patients with small-diameter vessels. It is often due to severe vascular spasm, usually secondary to small vessels, long length of vessels exposed, and exposure to the cold operating room air. It is best to avoid this situation by placing papaverine (vasodilator)-soaked sponges and warm laparotomy pads on the vessels throughout the procedure. If this does occur, the surgeon must ensure that the vessels are intact and not kinked off or thrombosed secondary to traction, intimal damage, or iatrogenic ligation. An intraoperative angiogram and a vascular surgeon consultation should be obtained. In most cases, the wound should be opened and the popliteal vessels quickly explored. The vascular surgeon may choose to pass Fogarty catheters to make sure there is no thrombus, but this technique is also a good means of opening a severely spasmed artery.</td>
</tr>
<tr>
<td>Unequal leg lengths</td>
<td>Taking careful measurements before resection and after implantation ensures leg-length equality to within millimeters.</td>
</tr>
<tr>
<td>Fitting and filling the femoral canal</td>
<td>Ream up the femoral canal to maximize fit.</td>
</tr>
<tr>
<td>Tying vessels before cutting</td>
<td>Tying vessels before cutting minimizes blood loss and improves visibility.</td>
</tr>
<tr>
<td>Cementing all components, including the patella and all-poly tibia</td>
<td>We have had no patellar or proximal tibia poly failures in 25 years. Cementing permits aggressive rehabilitation.</td>
</tr>
<tr>
<td>Preventing fat embolism</td>
<td>Ream the canal slowly, insert the stem slowly, and pretreat with 100 mg of hydrocortisone (Solu-Cortef) before cementing.</td>
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<tr>
<td>Preventing patellar dislocation</td>
<td>Ensure soft tissue balance; perform a lateral release if necessary before closure.</td>
</tr>
<tr>
<td>Unwillingness to plan for and do the revisions</td>
<td>A surgeon unwilling to plan for and do revisions should probably not be doing the primary resections and reconstructions.</td>
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OUTCOMES

- In a study by Bickels et al, 110 patients diagnosed between 1980 and 1998 with lesions of the distal femur underwent distal femur resection and endoprosthetic reconstructions. Extrarticular resection of the knee occurred in only two of these patients, both of whom were diagnosed with a primary bone sarcoma with tumor extension into the knee along the cruciate ligaments.
- Reconstruction implants included 73 modular prostheses, 27 custom-made prostheses, and 10 expandable prostheses. Only eight patients had a constrained knee mechanism (earlier edition); the remaining patients had reconstruction with a rotating-hinge knee mechanism prosthesis. Twenty-one medial, three lateral, and one bilateral gastrocnemius flaps were used after resection for soft tissue reconstruction. Ten patients with expandable prostheses had 14 lengthening procedures performed.
- Patients who had reconstruction with a rotating-hinge knee mechanism were more likely to have a good to excellent functional outcome (91%) than those who had reconstruction with a constrained knee mechanism (50%).

COMPLICATIONS

- Complications in the above study included six deep wound infections (5.4%), three of which resulted in amputation, two prosthetic revisions, and one wound débridement. Overall, there were 15 revision surgeries; they entailed replacement of a failed polyethylene component in six patients and prosthetic revision in nine patients (aseptic loosening, six; deep infection, two; radiation bone necrosis, one) (FIG 9).
- Two of the polyethylene component failures occurred in the same patient; the first occurred 2.5 years after the initial surgery and the second occurred 3.8 years later. Polyethylene failures occurred after an average of 3.7 years (range 1.25 to 7.25 years) and aseptic loosening occurred after an average of 5.5 years (range 3.2 to 10.3 years).
- During revision of their prostheses, all patients who underwent additional surgery because of a loosened prosthesis were found to have concomitant failure of a polyethylene component.

Local Recurrence

- The risk of local recurrence is surgeon-dependent. It occurs independent of the type of reconstruction (arthrodesis, allograft, or endoprosthesis).

Infections

- Infections are related to the local environment at surgery, bacteremias in the immediate postoperative period, length of the surgery, and soft tissue coverage problems. Infections are also generally independent of the type of reconstruction, though the rate is significantly higher in allograft reconstructions (FIG 10).
- Twenty-five to 30% of deep periprosthetic Staphylococcus aureus or Staphylococcus epidermidis infections can be salvaged.
if treated early with aggressive and radical débridement, including prosthesis removal, implantation of antibiotic-impregnated cement spacers, and 6 to 8 weeks of intravenous antibiotics, followed by reinsertion of the components if aspirations are negative. Most other bacterial infections and all the gram-negative infections are difficult to cure and can lead to amputation.

- An exposed prosthesis is another cause of infection. Although needed infrequently by one author (JJE), rotation flaps and free flaps have been advocated and used to solve this problem. Their frequent application in primary cases reflects the individual surgeon’s resection philosophy and techniques.³

**Fat Embolism**

- Fat embolism can result from a number of factors, alone or in combination. Reaming the canal should be done slowly and gently with sharp reamers and frequent irrigation and suction. Although cement restrictors and pressurization of the cement are regularly used, stem insertion is again done gently and slowly. Patients should be well hydrated and oxygenated before insertion of cemented femoral stems.

- Fat emboli cause a massive inflammatory reaction. Because steroids are the best anti-inflammatory medication, 100 mg of hydrocortisone (Solu-Cortef) is routinely administered before cementing and insertion of long intramedullary stems.

- Massive fat emboli can be fatal.

**Mechanical Failures**

- Mechanical failures includes fatigue fracture of any endo-prosthetic metal or polyethylene component, aseptic loosening, disassociation of modular components, and polyethylene wear synovitis (FIG 11).

- Most mechanical failures can be revised. The key to success is to analyze the failure mode and not do the same reconstruction. Although the literature suggests that revisions have a 50% failure rate at 5 years, if you analyze the failure mode and correct it, the revision should last longer than the original reconstruction.¹³

- The rotating-hinge knee was introduced in December 1980 and has become the international standard knee mechanism for distal femoral knee reconstructions. Anteroposterior stability and mediolateral stability are built into the mechanism, which permits complete resection of all the knee ligaments, a necessity in all tumor resections. The capacity to rotate slightly with loading defuses stress at the bone-prosthesis or the bone-cement-prosthesis interfaces, diminishing aseptic loosening and fatigue fracture.⁶

**FIG 10** Deep prosthetic infection. A. Gross purulence in the knee joint. B. It is important to remove the synovium and pseudocapsule. The prosthesis is typically removed as well. C. A large vacuum-assisted closure (VAC) sponge covers the defect. The sponge is sutured to adjacent muscles. D. VAC after application of suction. The dressing must be changed every 1 to 2 days.

**FIG 11** Overall results of 110 cases of distal femoral replacement. There was a 96% overall limb salvage rate and an 85% good to excellent results. The overall deep infection, aseptic loosening, and poly failure rates were each 5%.
The development of modular components with forged stems has greatly reduced the incidence of fatigue fracture, especially of the femoral stems, compared with casted stems. This is unless there is a mismatch between the patient size and the implant size: an 11-mm stem in a 250-pound patient is a recipe for failure.

**Bushing Failures and Pseudomeniscus Formation**

Bushing failures are heralded by the sudden onset of knee joint pain and a sense of instability to the point that ambulatory aids are necessary. Only on rare occasions, when there is complete disintegration of the bushing and extensor stop, will the radiographs be positive with medial or lateral protrusion of the axle. Surgical exploration, therefore, is done because of a high index of suspicion. This tends to be a late complication: the median time to failure in a series of seven cases was 84 months (range 30 to 112 months; **FIG 12**).

**FIG 12**  
**A.** Breakage of medial bushing.  
**B.** Close-up of residual bushing.  
**C.** Delamination of a bushing and bumper.  
**D.** Delamination of a poly bumper removed 17 years after surgery.  
**E.** Clinical photograph showing gross instability to a varus stress test. This instability is characteristic of worn or broken bushings.  
**F,G.** Patients with pseudomenisci present with localized pain, lack of full extension, and no effusion.  
**H.** Gross specimen of a pseudomeniscus. This is formed by thick fibrous collagen without an inflammatory component. Pseudomeniscus rarely occurs before 5 to 7 years after surgery.
Pseudomeniscus and Internal Derangement of the Knee

- The term “pseudomeniscus” refers to scar tissue formation between the moving components of the femoral condyles on the tibial bearing component as well as under this component and the cemented all-poly (within the tibia). Scar tissue over time and with constant motion will form a true fibrocartilage type of scar that takes the shape of a true meniscus.
- Pseudomeniscus formation occurs frequently but is symptomatic in only a few patients. The symptoms are usually subtle, often presenting as an internal derangement of the knee. The most suggestive signs are a feeling of instability, combined with slight valgus instability (more than 5% on a stress test), and with or without a small effusion. There are no real diagnostic tests. Suspicion is the key to diagnosis. These symptoms may mimic those of a bushing failure, but with less instability and a smaller effusion.
- The true incidence of symptomatic pseudomeniscus is 5% to 7%. The treatment is resection of the pseudomeniscus as well as the pseudocapsule in the hope of preventing a recurrence.

Stem Fracture

- The incidence of femoral stem fractures has been reduced significantly with the introduction of forged stems, but they can occur, especially if the stem is undersized compared to the weight of the patient. Stem loosening usually precedes catastrophic fatigue fractures and may present as an actual displaced bone fracture.
- If the stem cracks but does not displace, the patient will have pain at the site of fracture, but the radiographs will remain negative until enough motion exists to cause displacement of the metal fracture pieces. Pain is significant and the patient will seek ambulatory aids. The older casted stems tended to break about 2 cm proximal to the forged junction with the body.

Disassociation of Morse Tapers

- Disassociation of the Morse taper locking mechanism is exceedingly rare and most likely due to failure to impact the components adequately. Surgical exploration and reassembly of the components and full impaction are required.

Aseptic Loosening

- The incidence of aseptic loosening of the femoral stems has been reduced by the incorporation of extramedullary porous ingrowth beads at the junction of the segmental replacement and the stems. Soft tissue ingrowth into these beads in the diaphysis isolates the joint debris from the bone–cement–prosthesis composite, creating a “biologic purse-string” effect. Hydroxyapatite coatings can also enhance fixation. Cross-pin stem fixation requires a custom component but permits the use of a short stem or a metaphyseal position that would normally lead to early aseptic loosening.
- On rare occasions patients develop a polyethylene debris synovitis. Exploration of the reconstruction, resection of the “pseudosynovium” or periprosthetic capsule, and exchange of the bushings and extensor stop can manage this. JE never revises the all-poly tibia or poly patellar components if they are well cemented unless there is an infection. If the cemented tibial poly is removed, then at reconstruction a metal-backed tibial component is used. Recementing an all-poly tibia component in revision situations risks early aseptic loosening, as the cementation is never as good as the primary reconstruction.

REFERENCES