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Proximal and Total Femur Resection with Endoprosthetic Reconstruction

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OVERVIEW

Proximal and total femur resections are limb-sparing options for most primary bone sarcomas, metastatic lesions, and a variety of nononcologic indications of the proximal and midfemur that were traditionally treated with a major amputation. However, proximal and total femur resections are highly complex surgical procedures. Meticulous surgical technique and proper postoperative management are mandatory for local tumor control and acceptable functional outcome. This chapter emphasizes the indications for surgery, preoperative evaluation, and surgical concepts and technique.

INTRODUCTION

The proximal femur and midfemur are common sites for primary bone sarcomas; approximately 16% of Ewing's sarcomas,[1] 13% of chondrosarcomas,[2] and 10% of osteosarcomas[3] develop at these locations. Metastatic tumors are the most common malignant lesion of the proximal femur, with carcinomas being the most frequent. The large majority of patients with metastatic lesions to the proximal femur respond well to radiation therapy. Of the 5–10% of these patients who require surgery, the most common reason is pathologic fracture, followed by tumor progression and intractable pain.

Patients who were candidates for extensive femoral resection because of malignant tumor were long considered a high-risk group for limb-sparing procedures because of the extent of bone and soft-tissue resection, as well as the use of adjuvant chemotherapy and radiation therapy. Hip disarticulation or hemipelvectomy was therefore the classic treatment for patients with large lesions of the proximal or midfemur. Both procedures were associated with a dismal functional and psychological outcome. Improved survival of patients with musculoskeletal malignancies, developments in bioengineering, and refinements in surgical technique have allowed the execution of limb-sparing surgeries in these extreme situations. As a result, proximal and total femur resection have become surgical options in the treatment of primary bone sarcomas and metastatic bone disease,[4–7] as well as of a variety of nononcologic indications, including failure of internal fixation, severe acute fractures with poor bone quality, failed total hip, osteomyelitis, metabolic bone disease, and various congenital skeletal defects.[8–10]

Methods of skeletal reconstruction include resection–arthrodesis,[11] massive osteoarticular allograft,[12] endoprosthetic reconstruction,[13,14] and prosthetic–allograft composites.[15] Osteoarticular allografts, which were popular in the 1970s and 1980s, attempt to restore the natural anatomy of a joint by matching the donor bone to the recipient's anatomy; however, over time they are associated with increased rates of infection, nonunion, instability, fracture, and subchondral collapse that lead to failure.[16,17]

Custom-made prostheses were initially used for reconstruction. The early prostheses were manufactured on the basis of radiographic estimates of the intended surgical resection (Figure 29.1). The preoperative design and manufacturing process lasted 8–10 weeks. In the era before the use of neoadjuvant chemotherapy, this caused a significant delay in the timing of surgeries for bone sarcomas. A second drawback of custom-made prostheses is the difficulty in determining the actual length and width of the resected bone on the basis of imaging modalities alone. Any deviation in the surgical plan, whether caused by underestimation of tumor extension or an error in the preoperative calculation, could jeopardize the planned reconstruction. Khong *et al*.[18] reported a 13.1% incidence of oversized implants in 82 patients treated with 84 proximal femur resections.

Introduced in the mid-1980s, modular prostheses revolutionized endoprosthetic reconstruction.[19] Components of these interchangeable systems include articulating segments, bodies, and stems in varying lengths and diameters. Design features include extensive porous coating on the extracortical portion of the prostheses for bone and soft-tissue fixation, as well as metallic loops to assist in muscle reattachment (Figure 29.2). The modular system enables the surgeon to measure the bone defect at the time of surgery and select the most appropriate components to use in reconstruction.[19] Modular systems also provide an element of expandability that is invaluable for skeletally immature patients. Finally, standardization of the modular components permitted a significant reduction in manufacturing costs and allowed the implementation of quality-control techniques that could not be used for custom orders.

This chapter describes the surgical technique of proximal and total femur endoprosthetic reconstruction and emphasizes acetabular and joint capsule preservation, capsulorraphy around the prosthetic neck, and reconstruction of the abductor mechanism as means of restoring hip joint stability. Proximal and total femur resections are grouped together because the surgical technique around the proximal femur, which is the more complex aspect of the surgery, and concerns of joint stability, are similar.

PREOPERATIVE EVALUATION

Proximal femur resection is performed for metaphyseal–diaphyseal lesions that: (1) extend below the lesser trochanter, (2) cause extensive cortical destruction, and (3) spare at least 3 cm of distal femoral diaphysis (Figures 29.3–29.5). Total femur resection is performed for diaphyseal lesions that: (1) extend proximally to the lesser trochanter and distally to the distal diaphyseal–metaphyseal junction and (2) cause extensive bone destruction (Figures 29.6 and 29.7). Most metastatic lesions of the proximal femur can be treated with an intra-articular resection of the femoral head and neck and reconstruction with long-stem bipolar endoprosthesis. Resection is considered when: (1) the tumor is extremely large, (2) the tumor has progressed significantly in spite of radiation or chemotherapy, (3) a previous operative procedure has failed, and (4) the lesion is a solitary metastasis. Nononcologic indications for proximal and total femur endoprosthetic reconstruction include failure of internal fixation, severe acute fractures with poor bone quality, failed total hip arthroplasty with segmental bone loss below the level of the lesser trochanter, chronic osteomyelitis, metabolic bone disease, and various congenital skeletal defects (Figures 29.8 and 29.9).

Proximal and total femur resections are major surgical procedures that necessitate a detailed preoperative evaluation. By means of physical examination and imaging studies the surgeon must determine: (1) the extent of bone resection and dimensions of the required prosthesis; (2) the extent of soft-tissue resection and reconstruction possibilities; and (3) the proximity of the tumor to the femoral vessels, femoral nerve, and sciatic nerve. Most complications can be avoided by predicting them prior to surgery and modifying the surgical technique accordingly.

A full range of imaging studies is needed, including plain radiography, computerized tomography (CT), and magnetic resonance imaging (MRI) of the whole femur and the hip and knee joints. CT and plain radiography are used to evaluate the extent and level of bone destruction, and MRI is used to evaluate the medullary and extraosseous components of the tumor. Three-phase bone scan is essential to determine the presence of metastatic bone disease.

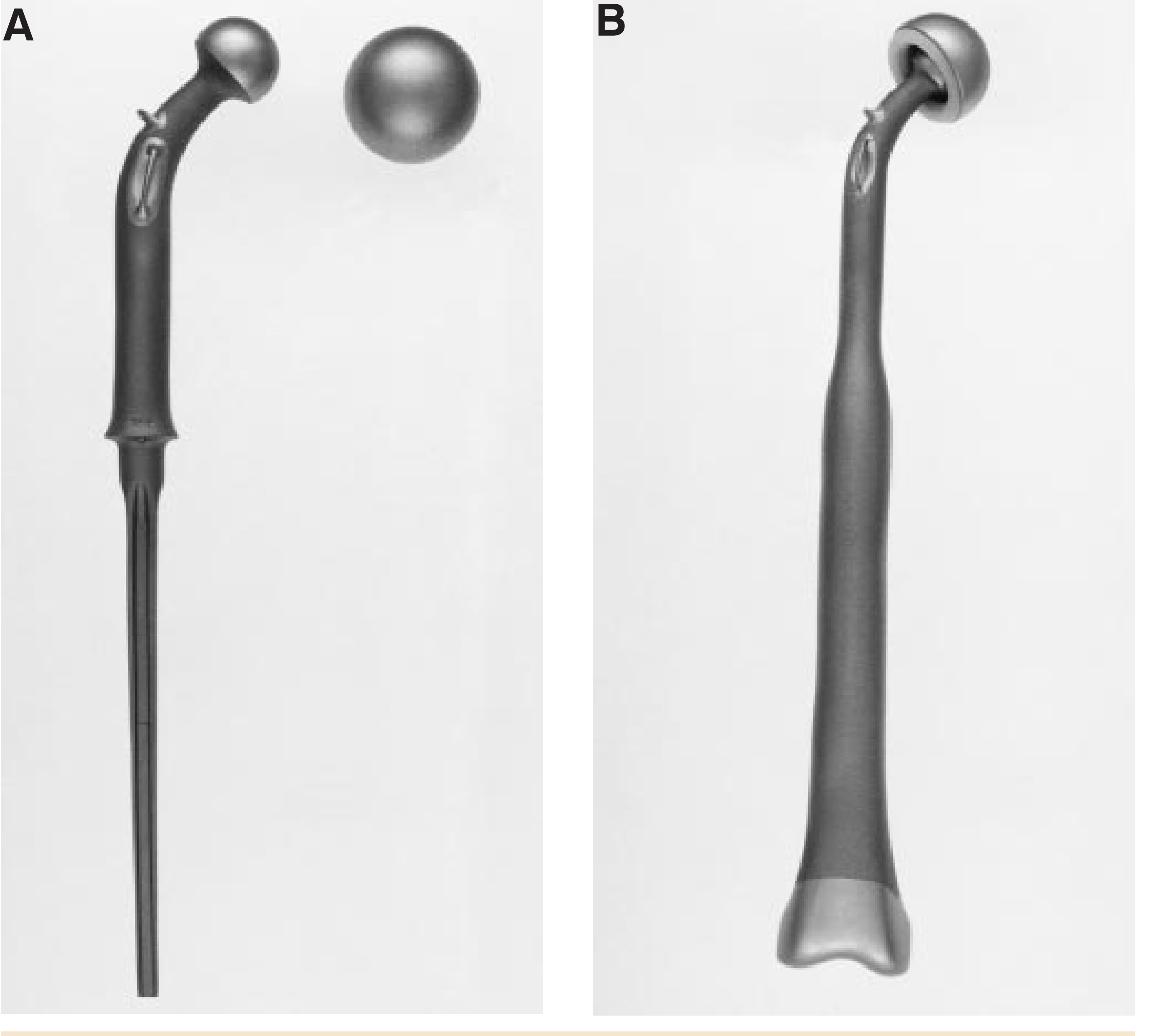

Figure 29.1 Custom-made prostheses. (**A**) Proximal femur, and (**B**) total femur (Howmedica, Rutherford, NJ).

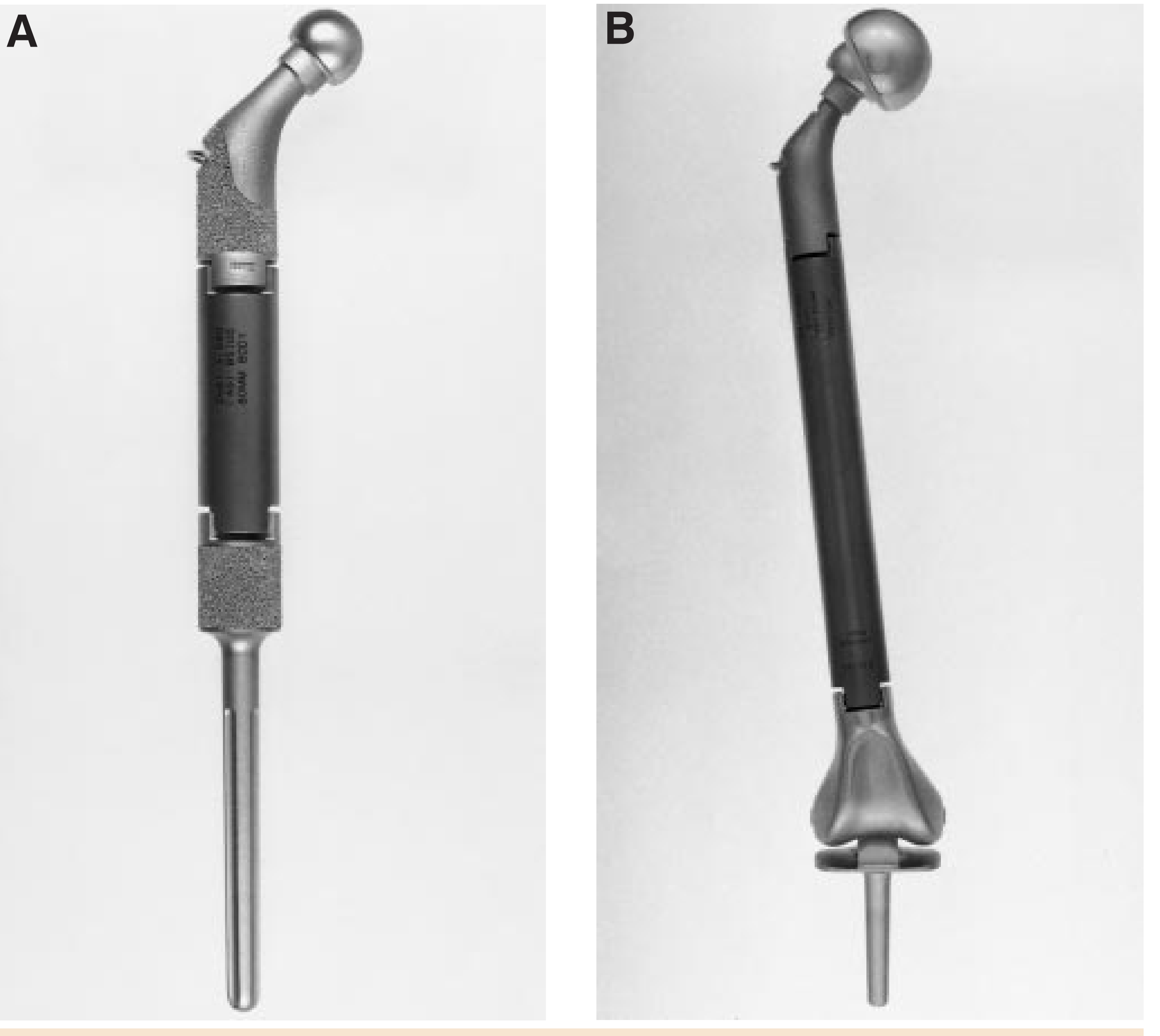

Figure 29.2 *(see also following page)* Modular prostheses. (**A**) Proximal femur, and (**B**) total femur (Howmedica, Rutherford, NJ). (**C**) Plain anteroposterior radiograph of the pelvis and lower extremities, showing a modular proximal femur prosthesis with a bipolar head in a 31-year-old patient with Ewing's sarcoma. The greater trochanter was spared and reconstructed with a cable grip system.

Angiography of the iliofemoral vessels is essential prior to resection of tumors of the proximal femur. Vascular displacement is common when tumors have a large, medial extraosseous component; the profundus femoral artery is particularly likely to be distorted or, less commonly, directly incorporated into the tumor mass. If the tumor has a large medial extraosseous component, and ligation of the profundus femoral artery is anticipated, a patent superficial femoral artery must be documented by angiography prior to surgery. Preoperative embolization may be useful in preparation for resection of metastatic vascular carcinomas if an intralesional procedure is anticipated. Metastatic hypernephroma is an extreme example of a vascular lesion that may bleed extensively and cause exsanguination upon the execution of an intralesional procedure without prior embolization.

In general, surgery for metastatic tumors to the proximal femur is practiced in the same manner as surgery for primary sarcomas of bone. The main differences are that metastatic lesions have a smaller extraosseous component than primary lesions, and the surrounding

Figure 29.2 C

muscles are usually invaded by the metastatic lesions (as opposed to the "pushing" border of bone sarcomas).[20] The intracapsular location of the femoral neck makes it biologically possible for tumors of the proximal femur to spread into the hip joint and adjacent synovium, hip capsule, and ligamentum teres. It also facilitates the possibility of extra-articular "skip" metastasis across the ligament teres into the acetabulum in the area of the fovea. Fortunately, intra-articular involvement is rare and usually occurs following a pathologic fracture. The capsule can therefore be preserved and an intra-articular resection of the femur performed in most cases. Fixed unipolar or bipolar heads are used because of the increased likelihood of hip dislocation following acetabular resurfacing.[17,21] In the case of capsular or acetabular involvement, extra-articular resection of the hip joint is performed and a saddle prosthesis is used for reconstruction.[22]

SURGICAL TECHNIQUE

Limb-sparing surgery that involves endoprosthetic reconstruction has three steps: tumor resection,

Figure 29.3 *(above)* Lesion of the proximal femur metaphysis that extends beyond the lesser trochanter; wide resection necessitates proximal femur resection.

endoprosthetic reconstruction, and soft-tissue reconstruction. The surgical technique of proximal femur resection with endoprosthetic reconstruction is described. The extra steps required for total femur resection are presented at the end of the appropriate sections.

Tumor Resection

Patient Positioning and Surgical Incision

The patient is placed in a lateral position on the operating room table to allow slight anterior and posterior rolling. A long posterolateral incision is made (Figure 29.10). This approach allows exposure of the proximal one-third of the femur, the retrogluteal area, and allows for identification of the superficial femoral

Figure 29.4 Osteosarcoma of the proximal femur. Following neoadjuvant chemotherapy the patient underwent proximal femur resection with endoprosthetic reconstruction.

Figure 29.5 Solitary lymphoma of the proximal femur. The patient underwent proximal femur resection with endoprosthetic reconstruction, followed by radiation therapy.

artery. An ilioinguinal extension to that incision is added if the tumor has an extensive, medial soft-tissue component along the proximal femur. This incision allows safe exposure of the femoral canal, femoral triangle, profundus femoral artery, and sartorial canal. *If total femur resection is performed*, the incision is brought distally to the anterolateral aspect of the patellar tendon and tibial tuberosity. If the tumor has a medial component along the distal femur, it is approached best through a medially curved incision (Figure 29.10, insert).

Gluteus Maximus and Medius Detachment

The iliotibial band is opened longitudinally to allow adequate anterior and posterior exposure and partial detachment of the femoral insertion of the gluteus maximus muscle. Posterior reflection of the gluteus maximus muscle allows ligation of the first perforating artery, which is in intimate apposition with the gluteal tendon attachment. The gluteus maximus is then further retracted in a posterior direction, exposing the retrogluteal area, external rotators, sciatic nerve, abductors, and posterior capsule (Figure 29.11). The sciatic nerve lies directly posterior to the external rotators. In general, as primary bone sarcomas expand, the external rotators are pushed outward and act as a protective barrier to the sciatic nerve. In these patients the sciatic nerve is therefore often not in its usual anatomic location. To prevent nerve damage it must be identified early, isolated, and mobilized posteriorly. The abductors are identified with their anterior and posterior intervals. If there is no tumor involvement, the greater trochanter or small bony attachment is osteotomized; otherwise the abductors are transected through their tendinous attachments and retracted, exposing the hip joint and acetabulum (Figure 29.11, insert).

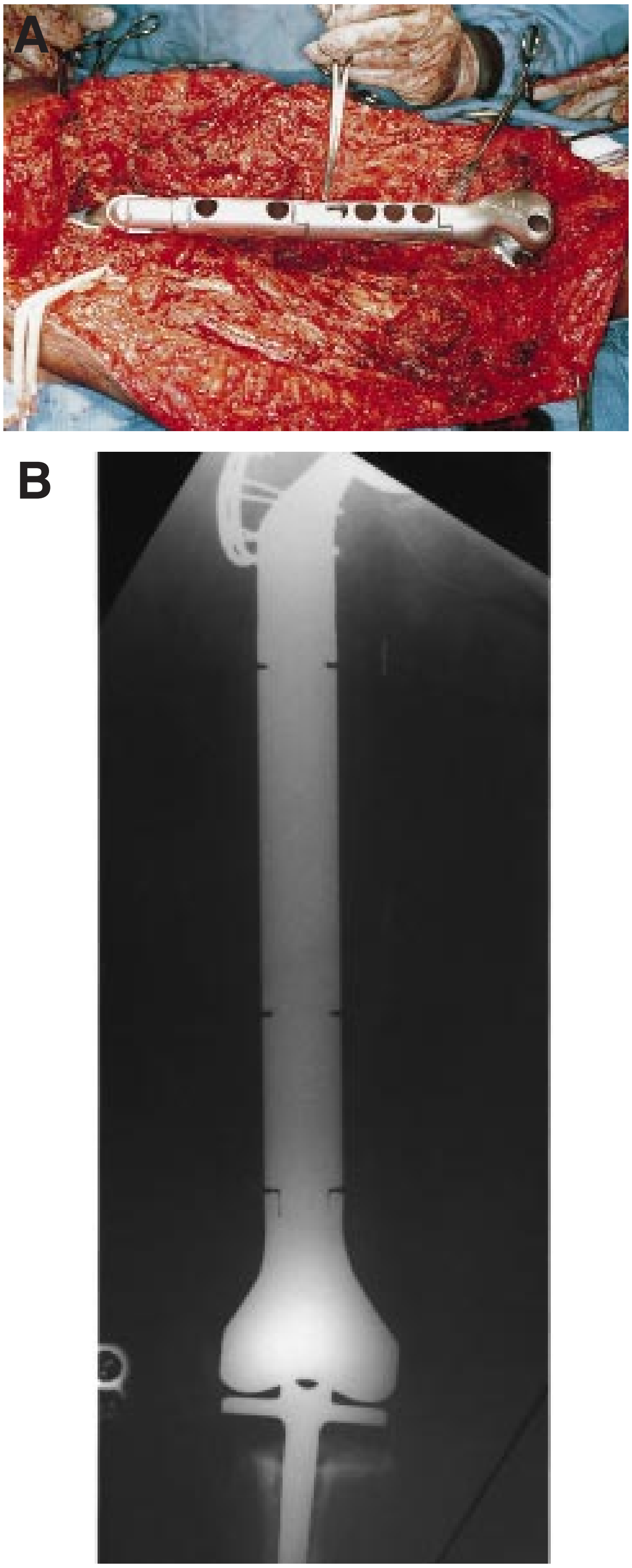

Figure 29.6 (**A**) Intraoperative photograph of a trial total femur prosthesis. (**B**) Postoperative radiograph showing the final total femur prosthesis.

Figure 29.7 Large Ewing's sarcoma of the entire femoral diaphysis, presenting with a pathologic fracture. Following neoadjuvant chemotherapy the patient underwent total femur resection with endoprosthetic reconstruction.

Vastus Lateralis Reflection

The vastus lateralis is reflected distally from its origin, and the posterior perforating vessels are ligated (Figure 29.12). The vastus lateralis has to be preserved because of its future role in soft-tissue coverage of the prosthesis; it will be advanced proximally and sutured to the abductors (see section on Soft-tissue Reconstruction). Care is taken not to ligate its main pedicle, which crosses anteriorly and obliquely along the rectus femoris fascia.

Figure 29.8 Plain radiograph. Infected total hip arthroplasty. A proximal femur resection was performed. The bone defect was reconstructed with a temporary spacer, composed of proximal femur prosthesis wrapped with cement and antibiotics. Following a prolonged course of intravenous antibiotics the spacer was replaced by a fixed cemented proximal femur prosthesis.

Figure 29.9 Extensive failure of internal fixation with a significant deformity and major functional deficit. Total femur resection and reconstruction with a modular prosthesis were performed.

Although the major neurovascular bundle is usually not involved by metastatic lesions of the proximal femur, it is often displaced by large medial extraosseous extension of primary bone sarcomas. In that case the neurovascular bundle must be identified and mobilized. The lateral interval of the sartorius muscle is opened, exposing a portion of the iliacus muscle as it passes over the superior pubic ramus. The femoral nerve is identified below the fascia (Figure 29.12). The superficial and profundus femoral artery and vein are identified in the sartorial canal and retracted. The profundus artery and vein may be ligated just distal to their takeoff from the common femoral vessel.

Detachment of Posterior Hip Musculature and Capsule

The retrogluteal area has been previously exposed. The rotator muscles are now detached en-bloc 1 cm from their insertion on the proximal femur. The hip joint capsule has a major role in securing and stabilizing the head of the prosthesis within the acetabulum and, if not invaded by tumor, it should remain intact and be left as a separate plane. The capsule is opened longitudinally along its anterolateral aspect and detached circumferentially from the femoral neck (Figure 29.13). *If total femur resection is performed*, through an anterolateral arthrotomy, the cruciate ligaments,

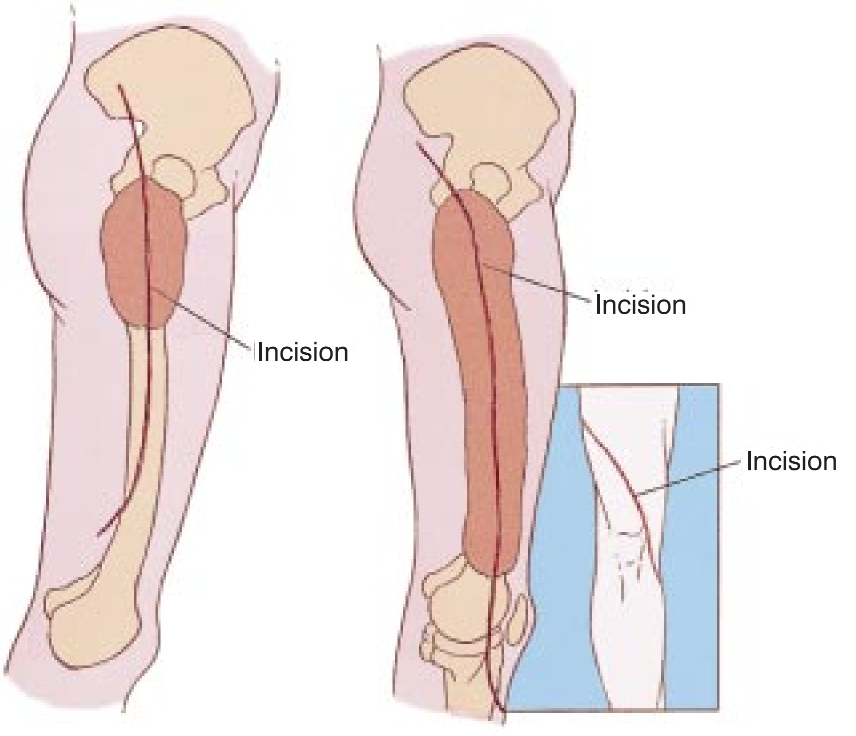

Figure 29.10 A posterolateral incision is routinely used for proximal femur resections. If a total femur resection is performed, the incision is extended to the anterolateral aspect of the patellar tendon. If there is a medial component of the tumor in the distal femur, the incision is curved to the medial aspect of the distal femur and knee joint.

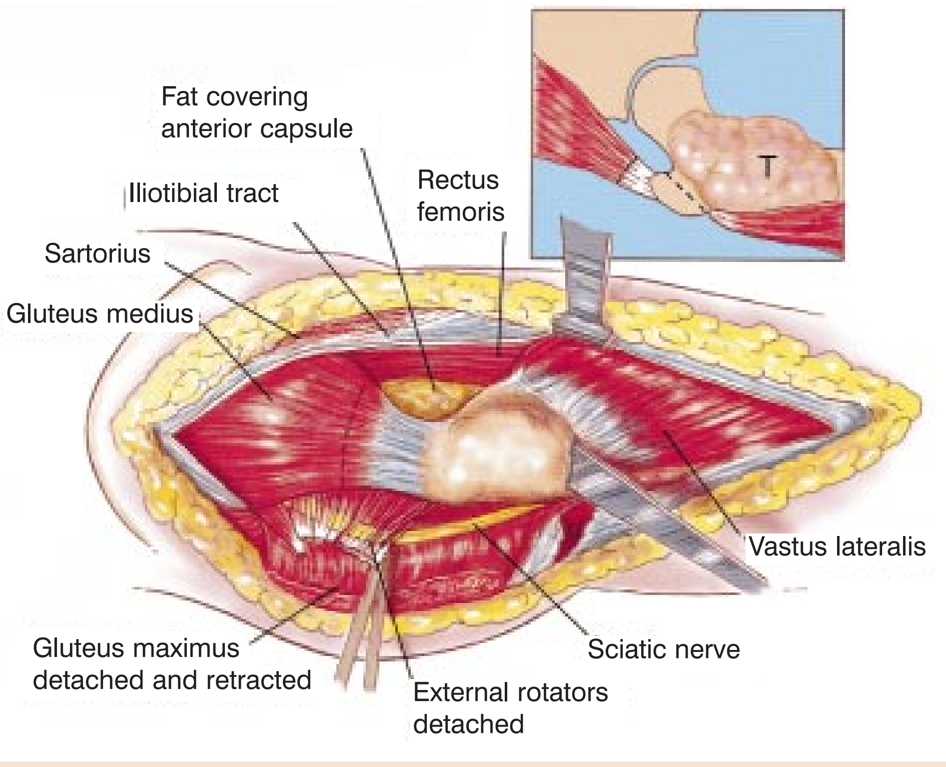

Figure 29.11 Detachment of posterior reflection of the gluteus maximus muscle. Identification of the sciatic nerve and detachment of abductor musculature.

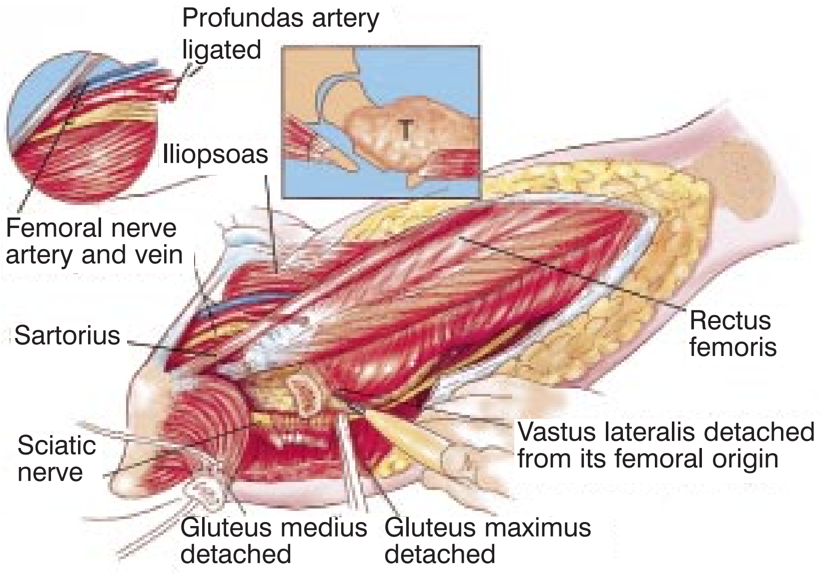

Figure 29.12 Reflection of the vastus lateralis muscle. Exploration and mobilization of the neurovascular bundle, if necessary.

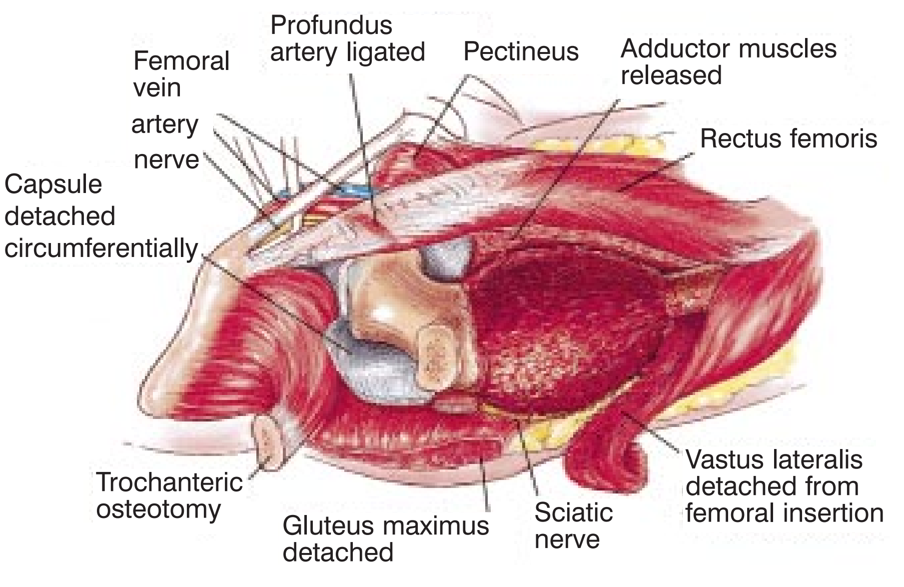

Figure 29.13 Detachment of the posterior hip musculature and capsule.

collateral ligaments, and menisci, as well as capsular and muscular attachments to the distal femur, are resected (Figure 29.14). The total femur is resected en-bloc with the vastus intermedius muscle; the vastus lateralis, rectus femoris, patella, and patellar tendon are preserved. Marcove *et al.*[7] reported a series of patients who underwent total femur resection. To preserve the extensor mechanism, they maintained the patellar tendon and split the patella in a coronal fashion so that the inner half remained with the surgical specimen and the outer half remained in continuity with the retained extensor mechanism. Malignant tumors of the distal femur rarely penetrate the vastus intermedius muscle or patellar surface; therefore the patella can be preserved in the large majority of the cases.

Dislocation of the Femur

The femur is dislocated anterolaterally. Care is taken not to fracture the femoral neck, especially if a primary bone sarcoma is being resected. The acetabulum is inspected for evidence of joint involvement.

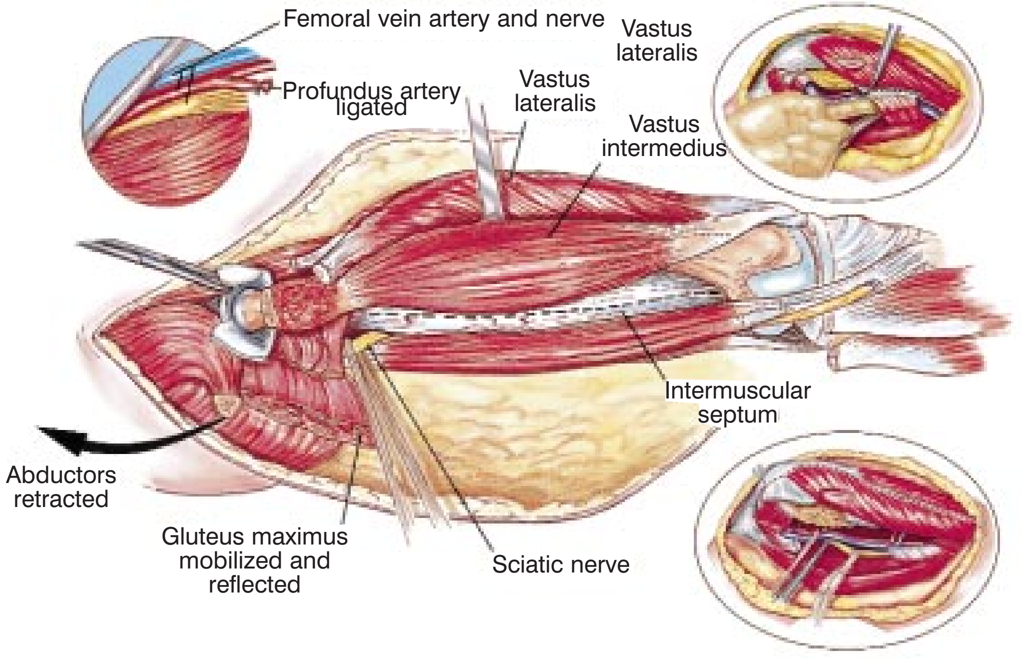

Figure 29.14 As in distal femur resection, the popliteal vessels, tibial nerve, and peroneal nerve are identified and mobilized prior to arthrotomy of the knee joint.

Distal Femur Osteotomy

Femoral osteotomy is performed at the appropriate location, as determined by the preoperative imaging studies. In general, 3–4 cm beyond the farthest point is appropriate for primary sarcomas and 1–2 cm for metastatic carcinomas. An oscillating saw is used for the osteotomy and a malleable retractor is placed medially to the femoral shaft to prevent inadvertent injury to the soft tissues. The cut should be at a right angle to the shaft (Figure 29.15). It is important not to distract the extremity following removal of the proximal femur, in order to avoid placing tension on the sciatic nerve and femoral vessels. *If total femur resection is performed*, a tibial osteotomy is performed in the same manner as a standard knee joint arthroplasty. Approximately 1 cm of bone is removed; the cut is perpendicular to the long axis of the tibia. The insertion of the biceps femoris muscle is retained. It may be divided during resection and subsequently sutured.

Release of Medial Structures

Following femoral osteotomy or disconnection of the entire femur after tibial osteotomy, the femur is retracted laterally. The remaining medial structures are now clearly visible; these consist of the psoas and adductor muscles, which should be identified at this point or before the femur is osteotomized. They are serially dissected, clamped with Kelly clamps, and tagged with Dacron tapes. Care is taken to dissect the profundus femoral artery. If oncologically indicated, and only after patency of the superficial femoral artery was documented, the profundus femoral artery may be ligated.

Endoprosthetic Reconstruction

Following resection of the proximal femur, the length of the femur, the size of the femoral head, and the diameter of the distal medullary canal are measured. A trial femoral head prosthesis is utilized to test the suction fit. The proximal end of the remaining femur should be kept well padded to avoid injuring the superficial femoral artery. Prior to reaming the femoral canal a frozen section from the canal is evaluated for evidence of residual tumor.

Reaming the Intramedullary Canal

The largest possible stem diameter should be chosen, especially for primary tumors. A 1-mm cement mantle is required around the stem. The intramedullary canal is therefore reamed 2 mm larger than the chosen stem diameter (Figure 29.16).

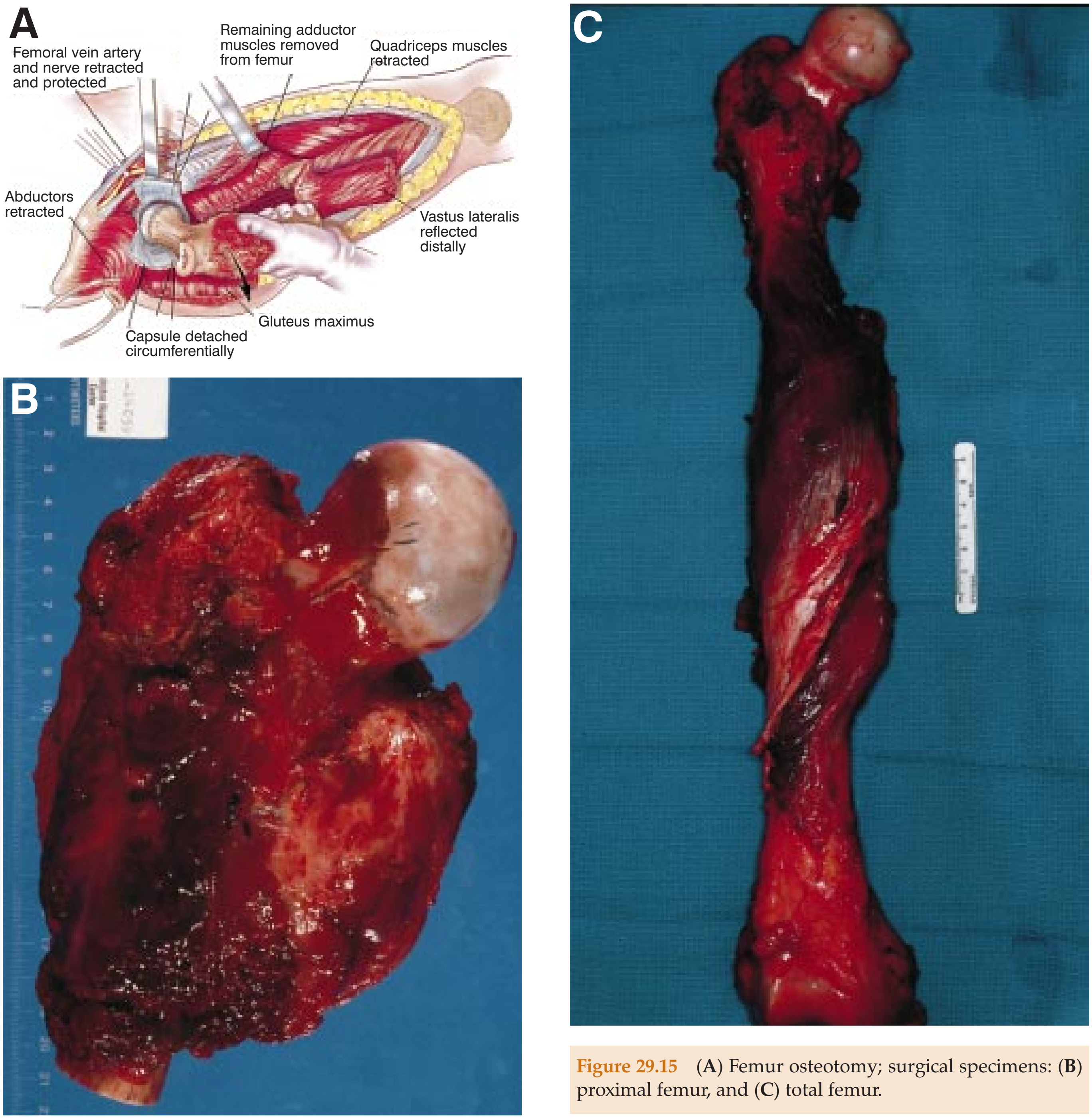

Figure 29.15 (**A**) Femur osteotomy; surgical specimens: (**B**) proximal femur, and (**C**) total femur.

Trial Articulation

Three parts must be assembled to articulate the proximal femoral component and match the length of the resected specimen: neck, body, and head (Figure 29.17). Total femur prostheses are mated to the tibial component via a rotating hinge mechanism (Figure 29.18). Following trial positioning of the prosthesis, the pulses are palpated distally; if diminished, a shorter prosthesis is required. The joint capsule is pulled over the femoral head component, and the range of motion of the hip joint is tested. The prosthesis should be stable in flexion, adduction, and internal rotation.

Prosthetic Assembly and Implantation

The modular prosthesis is assembled and cemented into the medullary canal. The orientation of the prosthesis is critical. With the linea aspera as the only

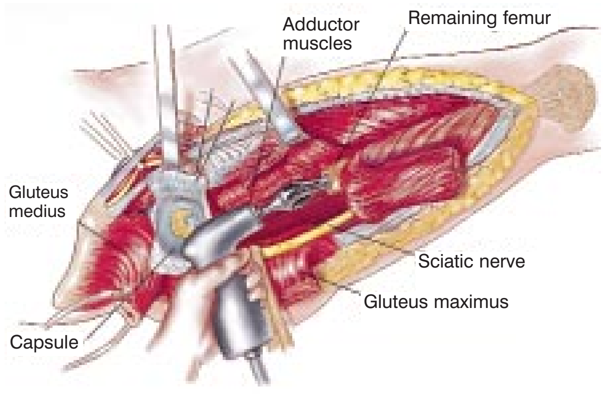

Figure 29.16 Reaming of the intramedullary canal.

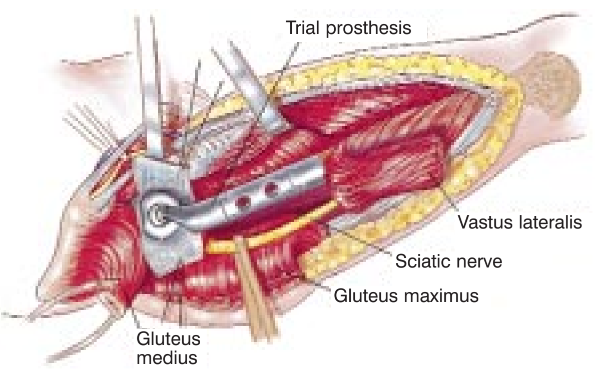

Figure 29.17 Trial articulation. Leg length must be evaluated and neurovascular bundle assessed for excessive tension.

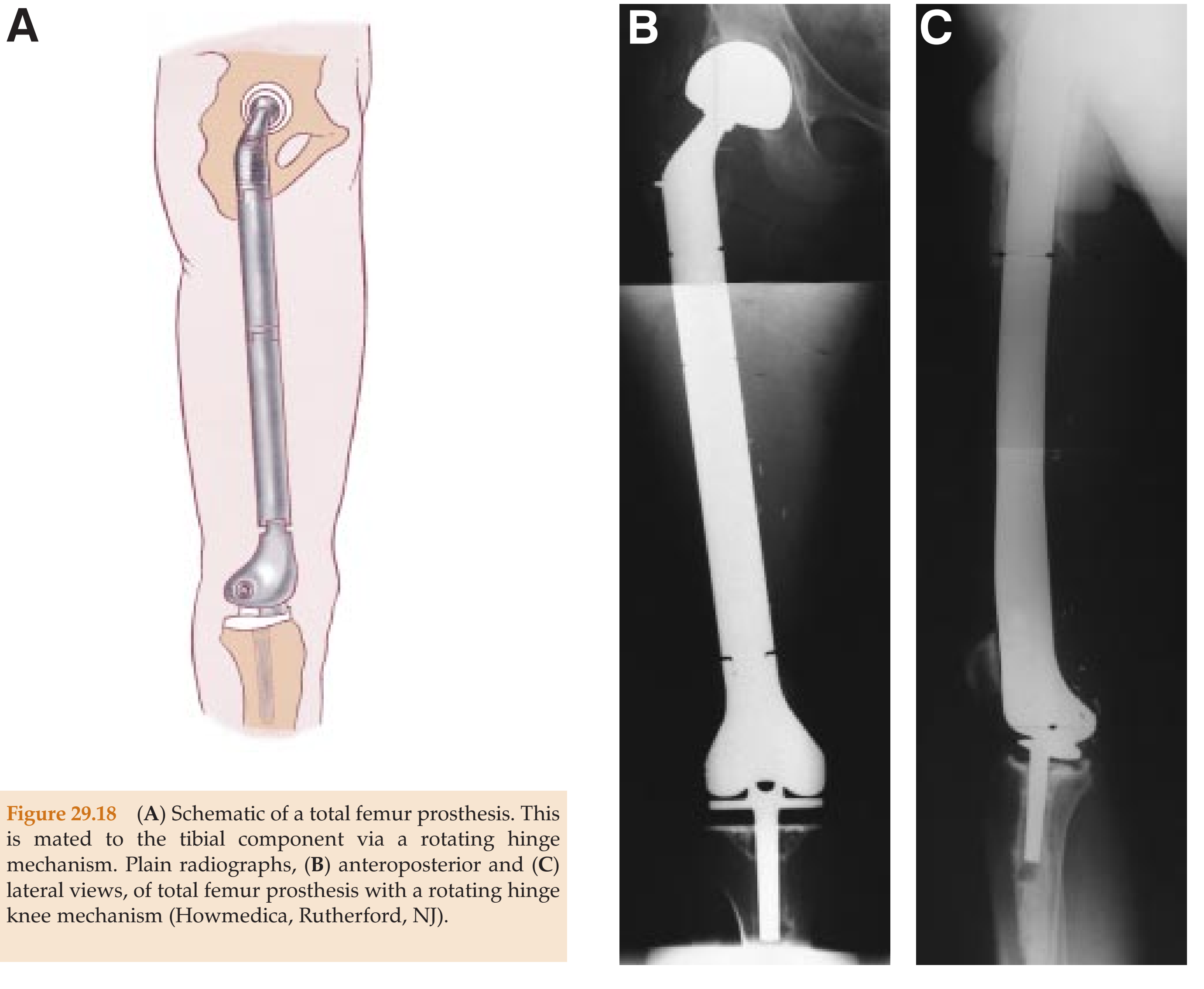

Figure 29.18 (**A**) Schematic of a total femur prosthesis. This is mated to the tibial component via a rotating hinge mechanism. Plain radiographs, (**B**) anteroposterior and (**C**) lateral views, of total femur prosthesis with a rotating hinge knee mechanism (Howmedica, Rutherford, NJ).

remaining anatomic guideline the prosthesis is placed with the femoral neck anteverted about 5–10° with respect to an imaginary perpendicular line from the prosthesis and a line drawn from the linea aspera through the body of the prosthesis (Figure 29.19). Leg length is evaluated and the neurovascular bundle is assessed again for excessive tension. Patellar resurfacing is not routinely performed in patients who undergo total femur resection because its contribution to the functional outcome is questionable,[23,24] and because most patients with primary sarcoma of bone are young and have minimal degenerative changes in the patellofemoral joint.

Cementation

Two bags of Simplex–P bone cement (Howmedica, Rutherford, NJ) are usually required. A third-generation cementing technique, which involves pulsatile lavage, use of intramedullary cement restrictor, reduction of the cement by centrifugation, use of a cement gun, pressurization of the cement, and enhancement of the prosthesis–cement interface by precoating the proximal portion of the femoral or tibial stem with bone cement, is employed.[25] While the bone cement hardens, the surgeons continuously verify the correct positioning of the prosthesis.

Soft-tissue Reconstruction and Extracortical Bone Fixation

Special attention is given to re-establish hip and knee joint stability and provide adequate muscle coverage of the prosthesis. This allows good function and prevents contamination and deep periprosthetic infection, should there be a superficial wound infection or dehiscence.

Reconstruction of the Hip Capsule

Once the prosthesis is cemented into place, the remaining hip capsule is sutured with a 3-mm Dacron tape (Deknatel, Falls River, MA) around the neck of the prosthesis. This forms a noose around the neck of the prosthesis and provides immediate stability (Figures 29.19B insert, 29.20 and 29.21). Dacron is a nonabsorbable synthetic polyester (polyethylene terephthalate) that allows approximation of the cut ends of the joint capsule under significant tension, and provides the initial mechanical support which is required for scarring of the capsule. When the capsule is adequately closed, the surgeon cannot dislocate the prosthesis. The capsule is reinforced by rotating the external rotator muscles proximally and suturing them to the repaired

Figure 29.19 (**A**) Assembly of the definitive modular prosthesis. It should match the length of the resected specimen. Note the bipolar head and the rotating hinge knee mechanism. (**B**) The prosthesis is positioned in 5–10° of anteversion with the linea aspera being the only remaining anatomic guideline for proximal femur endoprosthetic replacements and the tibial tuberosity for total femur endoprosthetic replacements.

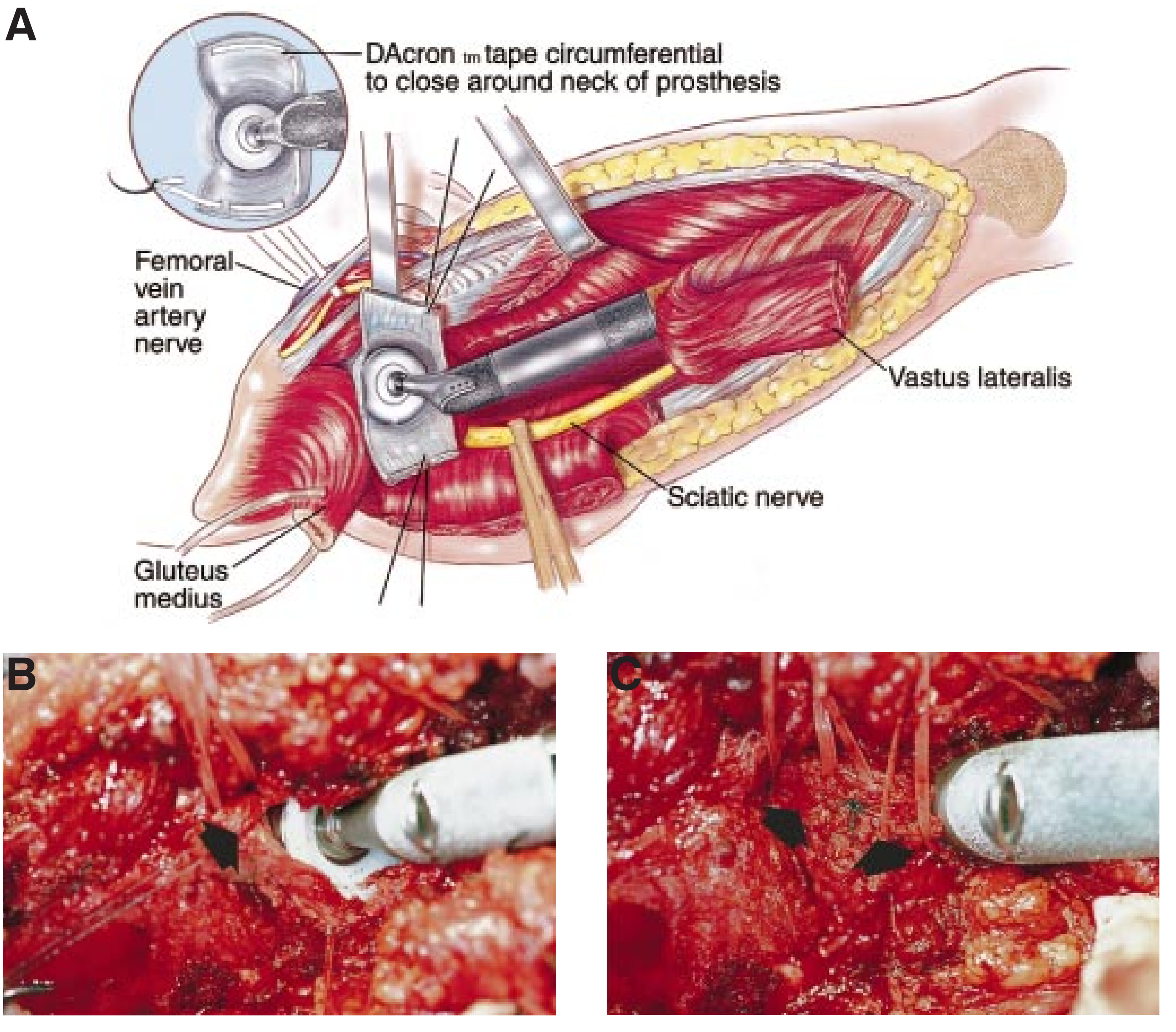

Figure 29.20 (**A**) The remaining capsule is brought over the head and neck of the prosthesis. This is reinforced by circumferential Dacron tape to the vastus lateralis muscle. (**B**) Operative photograph showing Dacron capsular reconstruction (arrow) prior to complete closure of capsule. (**C**) Completion of Dacron capsular repair. Note the head and neck of the prosthesis are completely closed by this reconstruction (arrows). The prosthesis should not be dislocatable at this stage.

capsule. The remaining psoas muscle is rotated anteriorly to close and reinforce the capsular repair.

Extracortical bone and soft-tissue fixation

The extracortical component of the prosthesis can be utilized for additional bone and soft-tissue fixation in the form of a noose around the prosthesis. Bone struts are circumferentially held with Dacron tapes to the prosthesis–host bone interface (Figure 29.22). Theoretically, this will prevent debris from entering the bone–cement interface and reduce the possibility of aseptic prosthetic loosening (Figure 29.23).[21,26]

Reconstruction of the Abductor Mechanism

If the greater trochanter was resected en-bloc with the surgical specimen, the remaining abductors may be

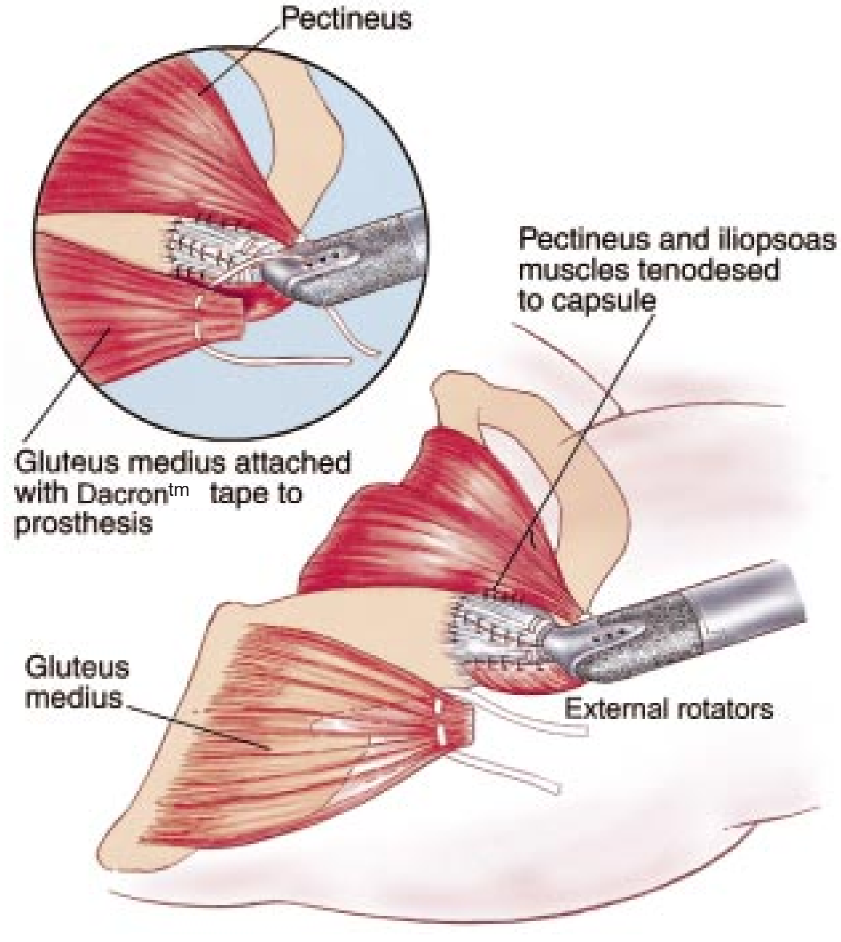

Figure 29.21 The capsule is tightly sutured with a 3-mm Dacron tape. When the capsule is adequately closed, the surgeon cannot dislocate the prosthesis. The capsule is then reinforced by tenodesing the pectineus and psoas muscles to the anterior capsule and the external rotators to the posterior capsule. The abductors are then advanced to the prosthesis with Dacron tape and tenodesed.

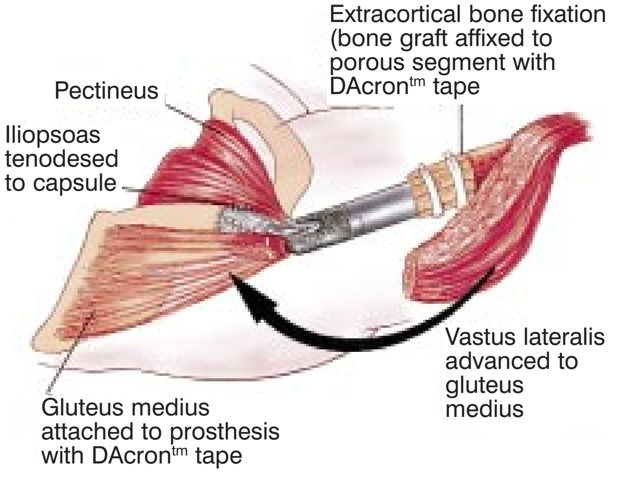

Figure 29.22 Extracortical bone fixation. Bone struts are circumferentially held over with Dacron tapes over the prosthesis–host bone interface.

Figure 29.23 Thick rim of bone bridges the prosthesis–host bone interface (arrow); 42 months following proximal femur endoprosthetic reconstruction and extracortical bone fixation.

brought down to the proximal aspect of the prosthesis and attached to a metal loop with a Dacron tape (Figure 29.22A). If a fragment of the greater trochanter remains, it can be fixed to the prosthesis with a cable grip system (Figure 29.24). The vastus lateralis is rotated proximally to overlie the abductor muscle fixation. The remaining muscles are sutured to the vastus lateralis anteriorly and the hamstrings posteriorly. The hip and knee are tested for stability, the degree of which should guide the postoperative management. *If total femur resection is performed* and a soft-tissue defect exists around the knee joint, an interposition gastrocnemius flap can be performed.[7]

Wound Closure

The wound is closed over a 28-gauge chest tube that is attached to a continuous suction and superficial Jackson–Pratt drains (Figure 29.25). The pulse is checked following wound closure and prior to removing the patient from the table. The patient is then placed in balanced suspension and the hip is elevated and abducted in 20°.

Postoperative Management

1. To prevent postoperative edema and prosthetic dislocation the extremity is kept elevated and abducted in balanced suspension for at least 5 days. When swelling around the hip and thigh are resolved, an abduction brace is then customized for the patient.
2. Isometric exercises are started on the day after surgery.
3. Continuous suction is required for 3–5 days after surgery, to prevent fluid collection. Perioperative intravenous antibiotics are administered until the drainage tubes are removed.
4. Postoperative mobilization with an abduction brace and partial weight-bearing are required for about 3–4 weeks, depending on the extent of the soft-tissue resection and of satisfactory soft-tissue reconstruction. Active hip abduction is required before the brace is removed and full weight-bearing allowed.

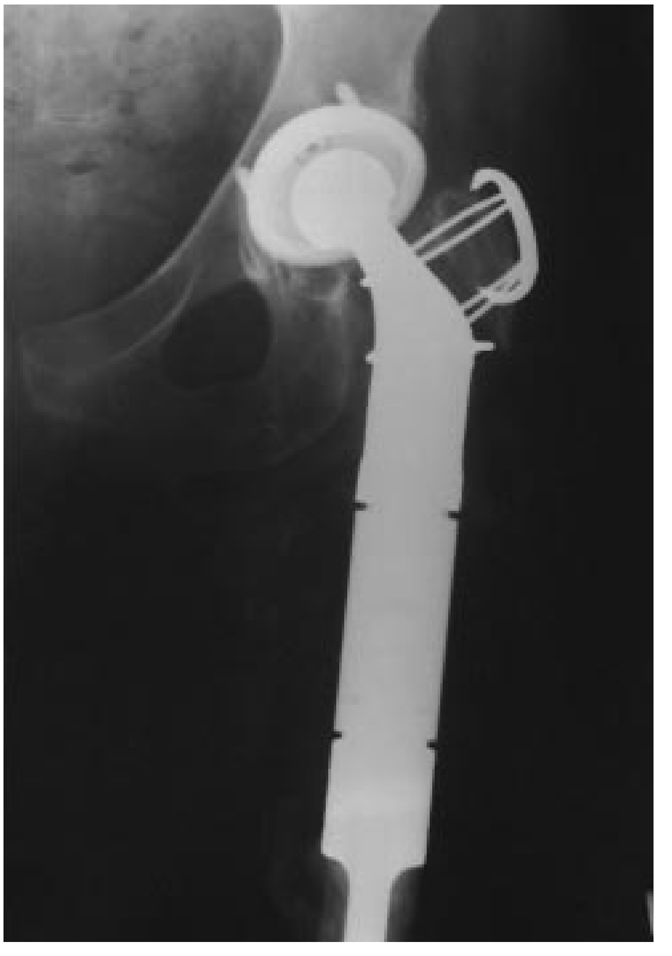

Figure 29.24 A proximal femur endoprosthetic reconstruction in a 35-year-old patient, performed as a two-stage salvage procedure for infected total hip arthroplasty. The greater trochanter and acetabular component were spared, and reconstruction of the abductor mechanism was performed with a cable grip system.

DISCUSSION

Preservation of the acetabulum and hip joint capsule and capsulorraphy over the prosthetic head are major factors in stabilization and prevention of dislocation. Stability is also enhanced by attaching of the abductors and psoas muscle to the prosthesis. There is a greater tendency for hip dislocation after massive proximal femur resection than after total hip arthroplasty, in which the abductor mechanism is preserved.[27,28] It is therefore important that these muscles be preserved following resection. Muscle group tenodesis provides a balanced tension from the lateral and medial aspects of the femur, reinforces stability, and allows range of motion.[22] A final factor in stabilization is the formation of scar tissue that bridges the joint capsule and adjacent musculature. In early series, in which capsular preservation was not emphasized, joint stability was based on muscle reconstruction and scar formation. Patients were placed in a long-leg brace with a pelvic band or skeletal traction for 6 weeks to 5 months.[4,7]

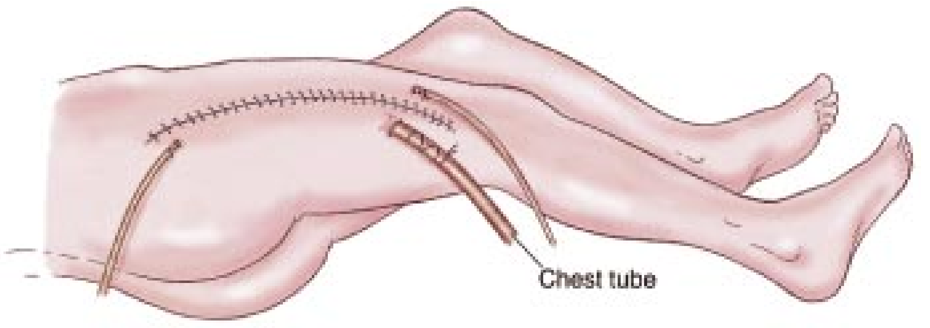

Figure 29.25 Surgical wound is closed over a deep-seated chest tube and superficial Jackson–Pratt drains.

Dislocation is the most frequent complication following proximal and total femur resection, ranging from 11% to 14%.[17,21,29,30] Malkani *et al.*[10] reported a series of 50 total hip arthroplasties performed in 49 patients for nononcologic indications. Dislocations were the most common complication; they occurred in 11 patients (22%), four of whom required revision surgery. This dislocation rate is exceedingly high, considering that proximal femur resections for nononcologic indications require minimal soft-tissue resection, and that it is therefore easier to achieve adequate soft-tissue coverage and prosthetic stability than following those resections which are performed for malignant tumors. Kabukcuoglu *et al.*[30] reported 54 patients who underwent proximal femur resection with endoprosthetic reconstruction. In that series an attempt was made to preserve the joint capsule, but the acetabulum was resurfaced and no attempt was made to repair the hip abductors to the prosthesis; instead, they were sutured to the fascia lata.[30] They reported six dislocations (11%), two of which necessitated surgical revision.[30] Bickels *et al.* reported a series of 64 patients who underwent proximal or total femur endoprosthetic reconstruction with emphasis on the three elements of re-creating joint stability: preservation of the acetabulum, preservation of joint capsule and capsulorraphy, and, finally, reconstruction of the abductor mechanism to the neck of the prosthesis.[31] Only one patient in that series (1.6%) had a dislocation.

There have been few reports on the longevity of proximal femur replacement prosthesis. Dobbs *et al.*[32] reported 81 patients who underwent proximal femur resection and reconstruction with a custom-made prostheses. Event-free survival rates were 73% and 63% at 5 and 10 years, respectively. Unwin *et al.*[33] reported a series of 263 patients who underwent proximal femur resection with endoprosthetic reconstruction. They reported a 93.8% probability that patients would not experience aseptic loosening during the 10 years following surgery. This rate compares favorably with the 67.4% and 58% survival rates of distal femur and proximal tibia endoprosthetic reconstruction, respectively.[33] The favorable outcome of proximal femur replacements was also noted by Horowitz *et al*.,[13] who hypothesized a positive correlation between prosthetic survival and the availability of soft tissue for coverage. Aseptic loosening of proximal femur prostheses was found to be highest when the percentage of the removed bone was low; there were no incidents of aseptic loosening following resection of more than 60% of the bone length.[33] The main factor underlying this phenomenon may be the extent of cement interdigitation, which is related to the amount of cancellous bone and the shape of the medullary canal. For short proximal femoral replacements much of the stem is within the reamed canal, where the amount of cancellous bone is minimal and cement interdigitation is poor. In long proximal femur replacements, on the other hand, a significant part of the stem is located within the flared canal and the metaphysis, where the amount of cancellous bone is sufficient to achieve adequate cement penetration.[33] The use of extracortical bone fixation over the prosthesis–host bone interface has a role in prevention of aseptic loosening and is practiced by the authors in all endoprosthetic reconstructions.

SUMMARY

Proximal and total femur resections with endoprosthetic reconstruction are complex surgical procedures that are usually executed only in orthopedic oncology referral centers. Preoperative evaluation and planning, meticulous surgical technique, and postoperative management are essential. Preservation of the acetabulum and joint capsule, Dacron tape capsulorraphy, and

reconstruction of the abductor mechanism are major determinants of joint stability. Because of their safety and good functional outcome, such resections can also be used for a large variety of nononcologic indications, especially for major revision surgeries and persistent infection.

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