Implant Reconstruction of the Proximal Femur: Modular Prosthesis

14

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14.1 Brief Clinical History

A 44-year-old female presented with a progressively painful left thigh for 3 months. She had night pain that was only mildly relieved by pain medications during the preceding month. She could not bear weight or walk on her left leg due to the pain. She denied any medical problems or history of cancer. A core needle biopsy was performed and revealed metastatic thyroid carcinoma (Figs. 14.1, 14.2, and 14.3). The patient subsequently developed a pathologic fracture at the lesion (Fig. 14.4).

14.2 Preoperative Problem List

(a) A large osteolytic lesion at the proximal femur with pathologic fracture.
(b) Metastatic bone tumor with hyper-vascularization.
(c) Need to preserve major neurovascular structures around bone resection area.
(d) Bone reconstruction following bone tumor resection to restore structural and skeletal stability.
(e) Need to preserve abductor mechanism and stability of the hip joint to maximize functional outcomes.

14.3 Treatment Strategy

(a) Patient with bone metastatic thyroid carcinoma, preoperative embolization to reduce intraoperative blood loss and blood transfusion (Fig. 14.5)
(b) Wide excision of solitary metastatic bone thyroid carcinoma can reduce the chance of tumor recurrence and prolong patient survival.
(c) Bone reconstruction with a modular prosthesis.
(d) Restore the gluteus medius as an abductor mechanism, repair the hip joint capsule, and use an attachment tube to enhance soft tissue attachment.

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14.4 Preoperative Clinical Photos and Radiographs

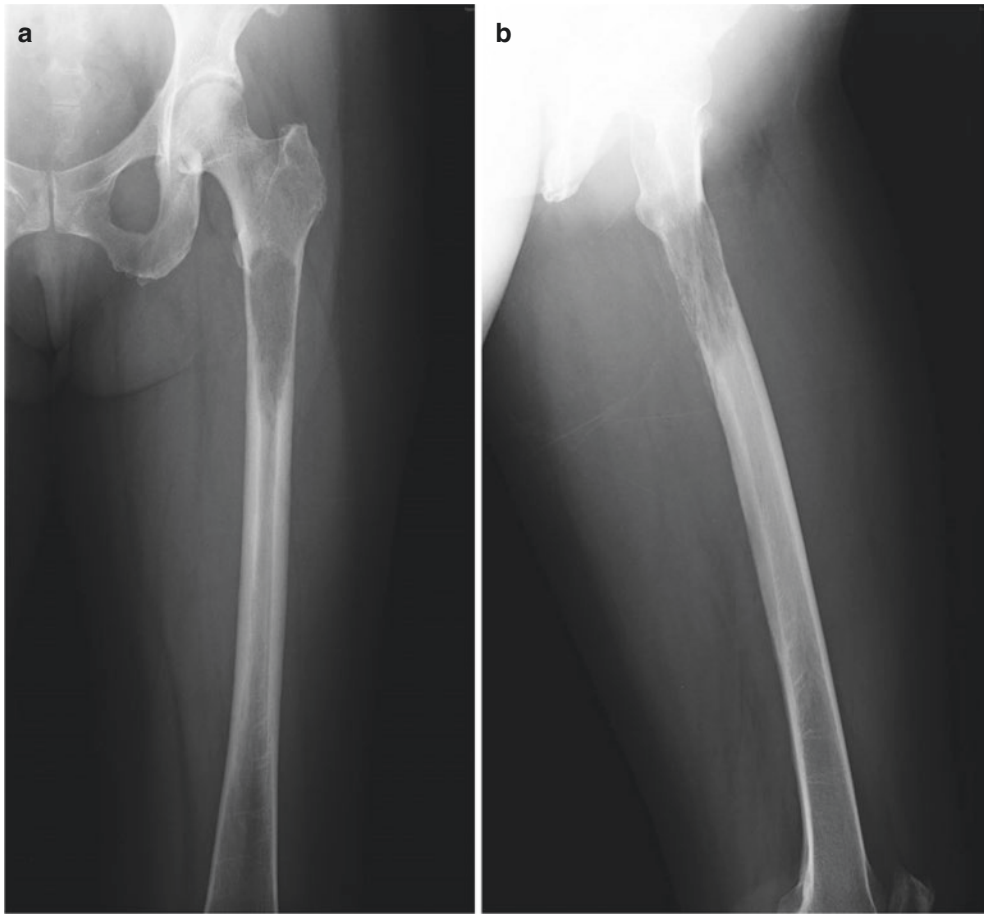

Fig. 14.1 Plain radiographs showing an extensively osteolytic lesion from metastatic thyroid carcinoma of the left proximal femur in anteroposterior view (**a**) and lateral view (**b**)

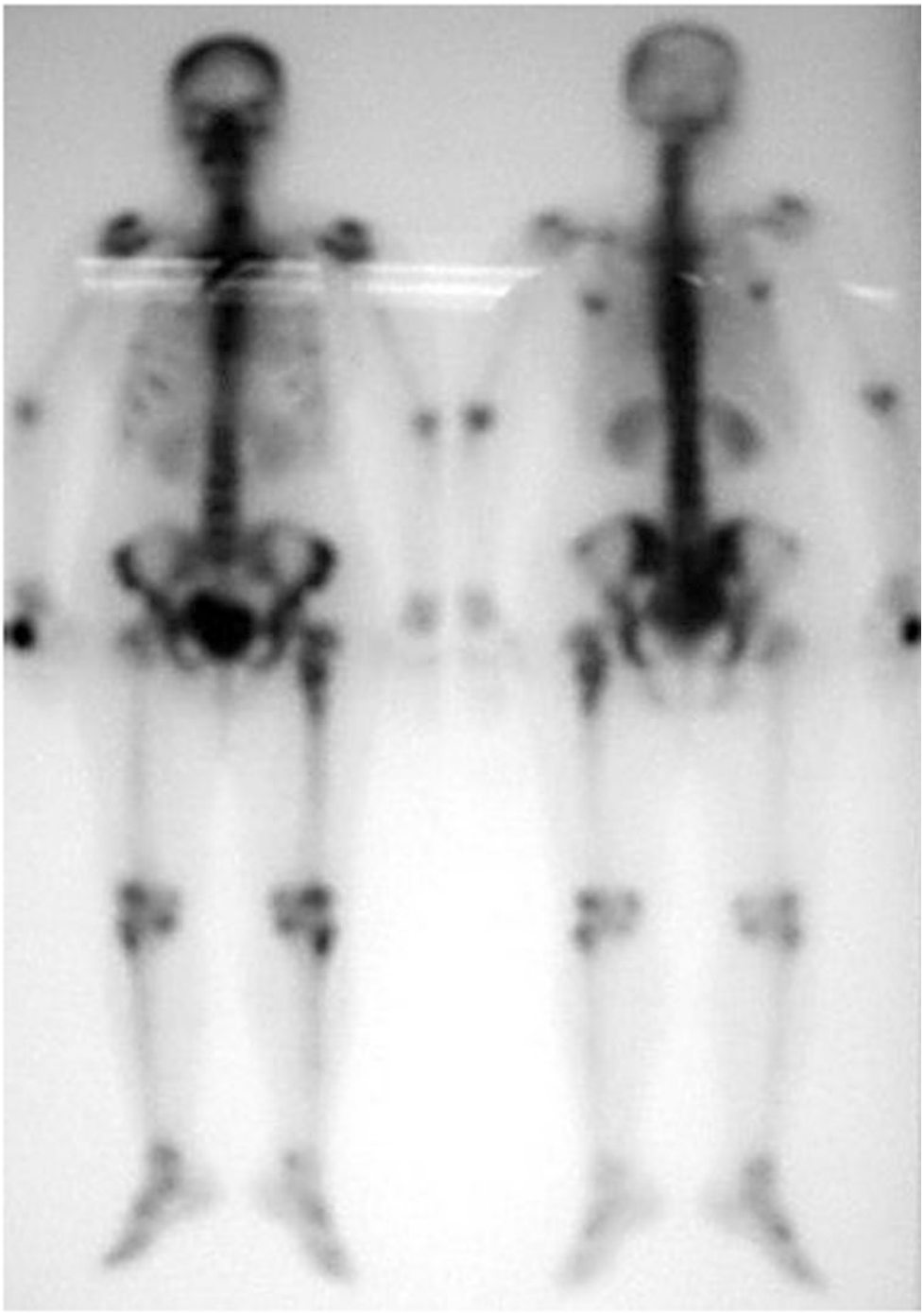

Fig. 14.2 Bone scintigraphy showing a single bone lesion at the left proximal femur

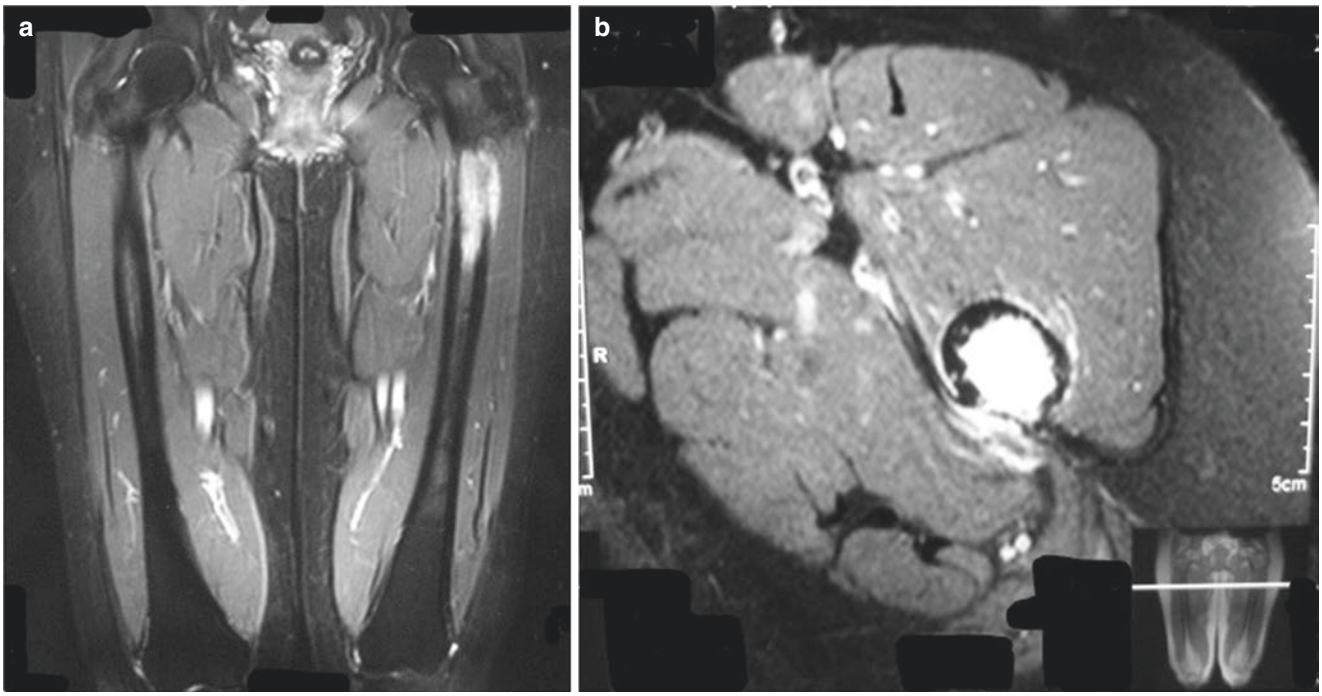

Fig. 14.3 MRI T1-weighted/GD/FS of the femur demonstrating a hyper-intense tumor, cortical destruction with minor soft tissue tumor extension at the left proximal femur in coronal view (**a**) and axial view (**b**)

Fig. 14.4 Plain radiograph showing pathologic fracture at the lesion

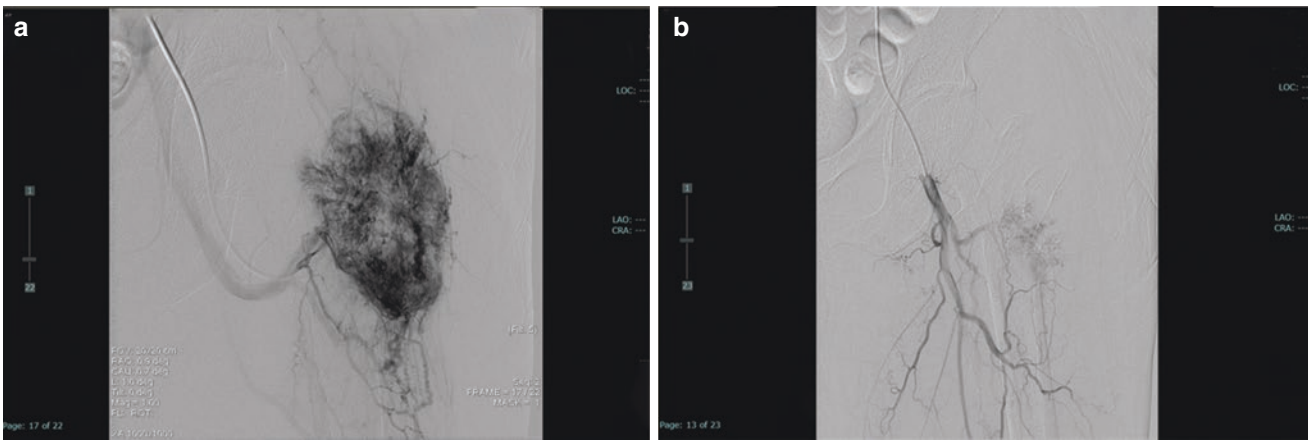

Fig. 14.5 Angiography of the lesion; pre-embolization (**a**) and post-embolization (**b**)

14.5 Basic Principles of Surgery

(a) Preoperative planning is the key to success for all objectives. Proper plain radiographs and MRI of the femur reveal the tumor extent, extraosseous soft tissue extension, and the major neurovascular structure relationships, all of which determine the level of bone osteotomy and the required component parts of the modular implant.

(b) The patient is placed in the lateral position, and a long lateral incision is made from 5 cm proximal to the greater trochanter to the level distal to the bone resection. An ilioinguinal extended incision may be added if the tumor has a medial soft tissue component extension along the proximal femur (Fig. 14.6).

(c) After opening the iliotibial band longitudinally, the gluteus maximus is exposed and detached from the femoral insertion. A posterior reflection of the gluteus maximus muscle allows ligation of the first perforating artery. Identify the sciatic nerve posterior to the external rotators and dissect it away from the proximal femur.

(d) Identify the gluteus medius, which inserts at the upper part of the greater trochanter and transects through the tendinous part, and retract. If there is no bone involvement at the greater trochanter, a bone osteotomy can be performed while maintaining the attachment of the gluteus medius (Fig. 14.7).

(e) Identify the rectus femoris and the vastus lateralis and reflect from their insertion distal to the tumor mass. The vastus intermedius must be resected en bloc with the tumor.

(f) Identify all of the hip rotator muscles and detach them from the insertion. Plan a longitudinal open arthrotomy of the joint capsule and preserve the joint capsule without tumor contamination and then dislocate the hip joint.

(g) Perform a distal femoral osteotomy 1–2 cm distal from the tumor and perpendicular to the femoral shaft (3–4 cm in a patient with a primary malignant bone tumor). During the osteotomy, soft tissue and neurovascular structures must be protected.

(h) Retract the tumor laterally to identify the psoas and adductor muscles and then dissect these muscles sequentially from their insertion.

(i) After excision of the proximal femoral lesion, the bone marrow from the femoral osteotomy site should be sent for a pathological study to confirm a negative tumor margin. Using the plain radiograph of the normal femur and the MRI of the affected femur, the resected tumor length, femoral head size, and the diameter of the distal femoral medullary canal are measured to select the proper parts of a proximal femoral modular tumor prosthesis and bipolar femoral head.

(j) Ream the femoral medullary canal to 2 mm larger than the chosen stem diameter.

(k) Modular trial prosthetic components should be assembled to match the length of the resected specimen (Fig. 14.8). These include a neck, body parts, a femoral stem, and a prosthetic femoral head. The leg lengths of both sides are next measured equally, and the hip joint stability is checked for flexion, adduction, and internal rotation (Fig. 14.9).

(l) The modular prosthesis is assembled before being cemented into the medullary canal. The cementing technique consists of a pulsatile lavage, use of an intramedullary cement restrictor, mixing of the cement by centrifugation, use of a cement gun, and pressurization of the cement. The modular prosthesis is replaced with 10° anteversion.

(m) The remaining hip capsule is sutured tightly with 2-0 Ethibond (polyester suture; Johnson & Johnson Medical

N.V., Belgium. If the hip capsule is totally excised with the tumor, a strip of tensor fascia lata, sized 5 × 15 cm, can be used as the hip capsule by suturing through the labrum and covering the neck of the prosthesis (Fig. 14.10). An attachment tube (polyethyleneterephthalate tube; Implantcast GmbH, Buxtehude, Germany) is applied on the prosthesis for the reattachment of the surrounding muscles and tendons (Fig. 14.11). The external rotator muscles are sutured to the posterolateral aspect of the hip capsule. The psoas muscle is reattached and tenodesed to the anterior hip capsule and the attachment tube to provide additional reinforcement.

(n) The remaining abductor tendon is attached to the lateral aspect of the prosthesis through metal holes and is attached as a reinforcement for the attachment tube. The vastus lateralis, rectus femoris, and adductor muscles are tenodesed through the attachment tube (Fig. 14.12). The remaining muscles are sutured to the vastus lateralis anteriorly and the hamstrings posteriorly.

(o) With adequate hemostasis, the wound is closed over a negative suction drain.

(p) Postoperative mobilization with the operative leg kept in a neutral rotation, slightly flexed, with an abducted position on a pillow is maintained. Using an abduction brace to limit adduction and allow flexion not more than 10 degrees, weight bearing as tolerated is continued for 6 weeks. When active hip abduction, flexion, and extension are achieved, full weight bearing can be allowed.

14.6 Images During Treatment

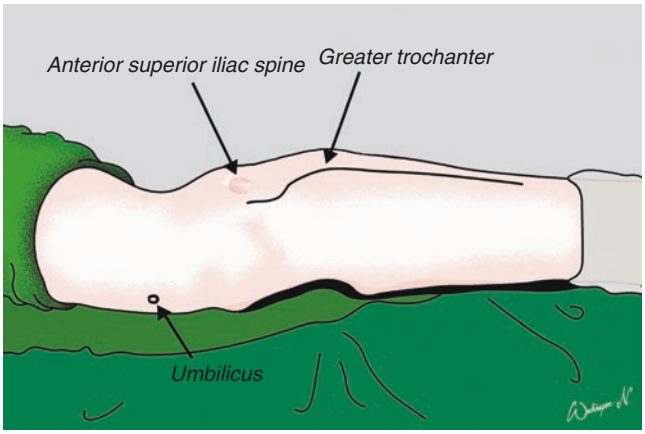

Fig. 14.6 Illustration showing the position of the patient and a long lateral incision used for resection of the proximal femur

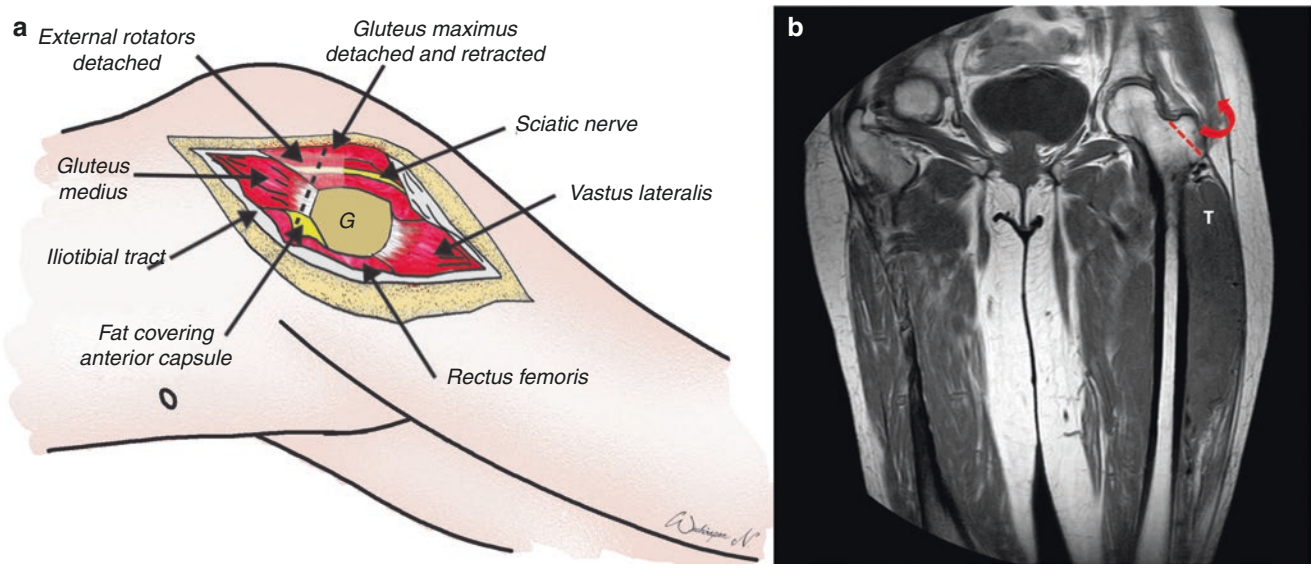

Fig. 14.7 Illustration showing transection through the tendinous part of the gluteus medius before proximal femur removal (dashed line) (*G* greater trochanter; **a**). If there is no bone involvement at the greater trochanter, a bone osteotomy can be performed while maintaining the attachment of the gluteus medius (*T* tumor; **b**)

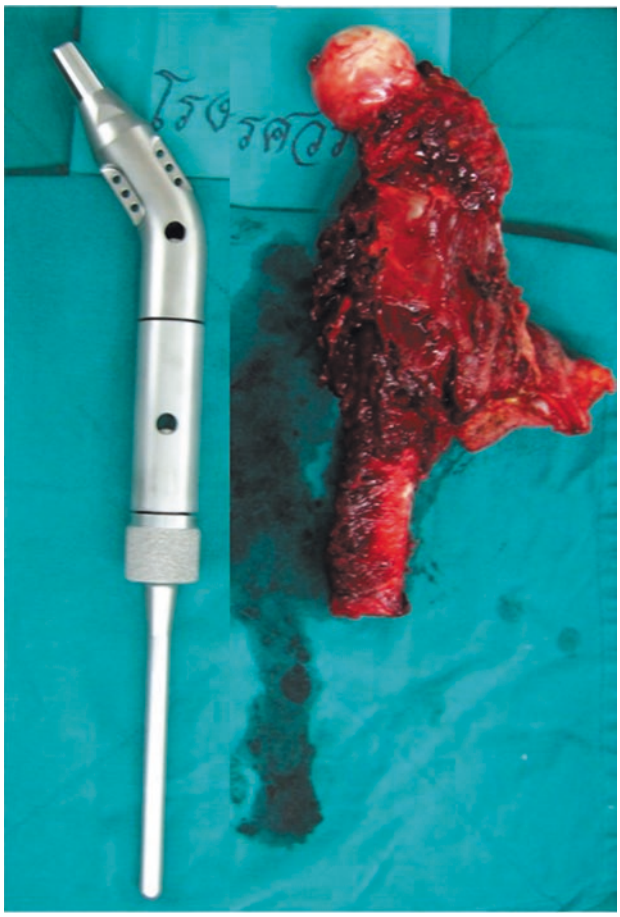

Fig. 14.8 Photograph showing the resected tumor and the matched modular prosthesis of the proximal femur

Fig. 14.9 Intraoperative photograph showing the hip joint stability test after bone and hip reconstruction of the proximal femur

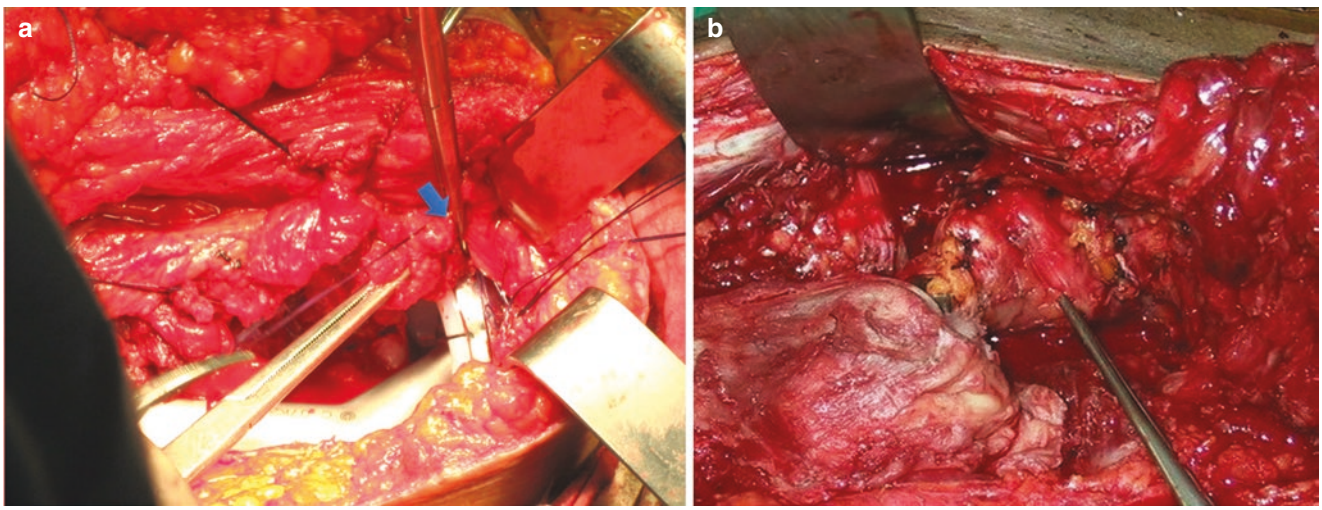

Fig. 14.10 Photograph showing hip capsule repair (arrow; **a**). A strip of tensor fascia lata using as the hip capsule reconstruction (**b**)

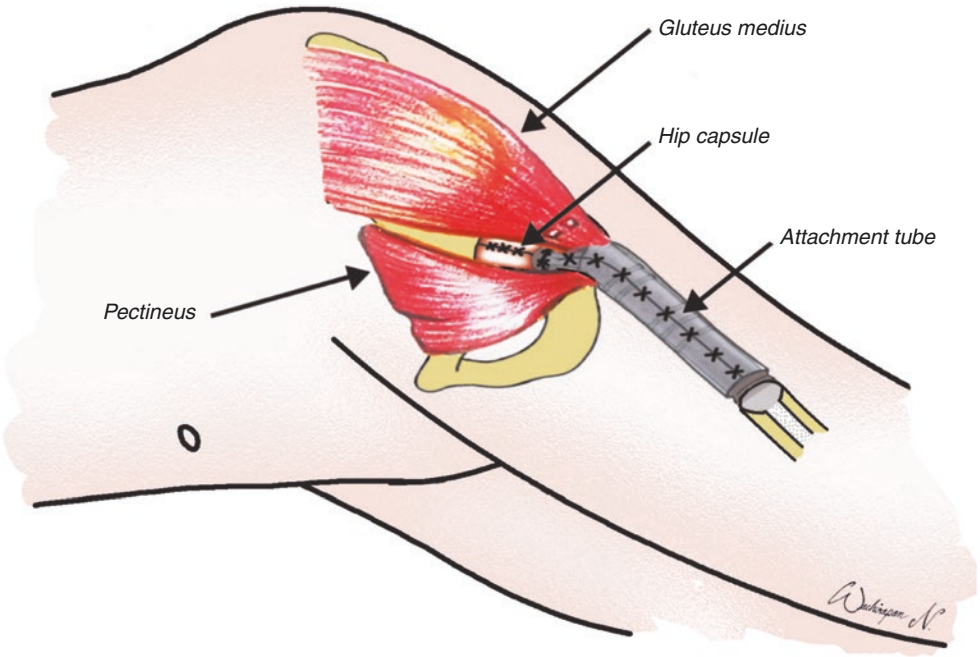

Fig. 14.11 Illustration showing an attachment tube applied on the prosthesis for reattachment of the surrounding muscles and tendons

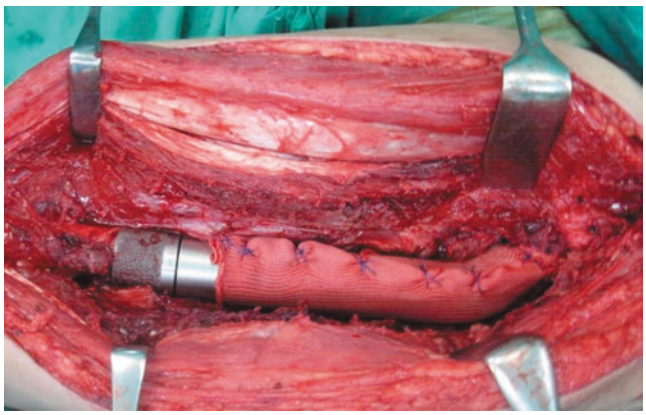

Fig. 14.12 Photograph showing the attachment tube with surrounding soft tissue attachment

14.7 Oncologic and Functional Outcomes

The immediate and 12-year postoperative plain radiographs revealed good position of the prosthesis without aseptic loosening. There was bone formation at the prosthetic-host bone junction (Figs. 14.13 and 14.14). At 12-year follow-up, the patient remained disease-free without local or distant relapse of the disease. No infection or wound complication occurred in this patient. The patient had regained a range of motion of hip abduction of 15° and a range of hip flexion of 15°. The functional analysis at the final follow-up according to the Musculoskeletal Tumor Society system was 89%. She had equal leg length and was able to perform most activities of daily living without any assistance. She could resume her work as a housewife and could walk without gait support. She also could participate in sports exercise such as swimming or bicycling (Fig. 14.15).

14.8 Outcome Clinical Images and Radiographs

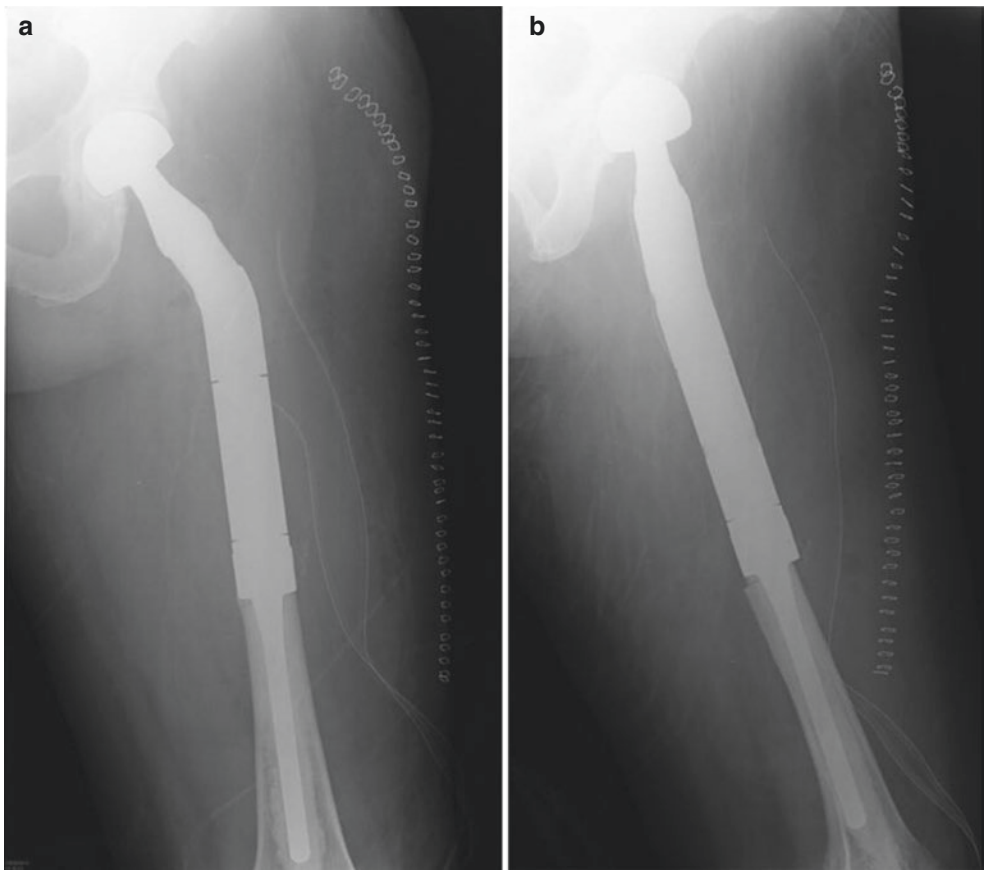

Fig. 14.13 Postoperative plain radiographs reveal a modular prosthetic reconstruction of the proximal femur in anteroposterior view (**a**) and lateral view (**b**)

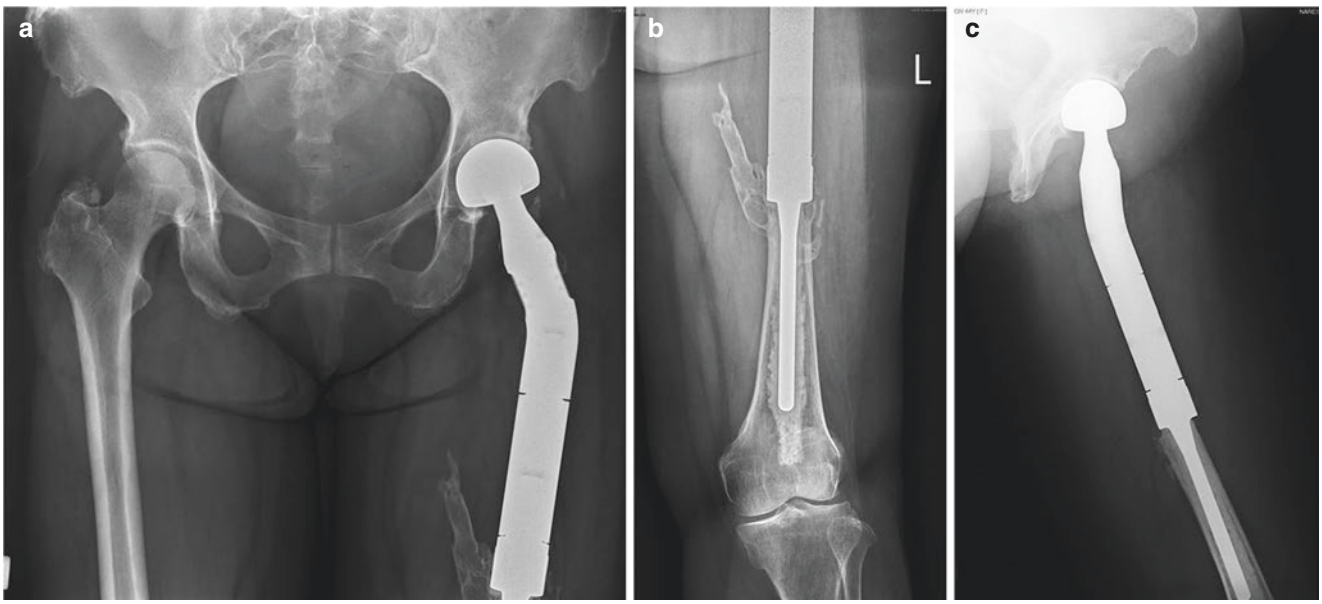

Fig. 14.14 12-year postoperative radiographs reveal intact prosthesis without aseptic loosening or hip joint instability in anteroposterior view (**a** and **b**) and lateral view (**c**)

Fig. 14.15 Photograph showing the functional outcomes 12 years postoperatively (**a** and **b**)

14.9 Technical Pearls

(a) Preoperative MRI must be reviewed to evaluate the intracapsular tumor extension as well as neurovascular bundle involvement when considering the possibility of sparing the greater trochanter in excision planning.
(b) With a large tumor size, the profunda vessels should be ligated at the trunk from the common femoral vessels to avoid bleeding.
(c) If possible, preserve the joint capsule during resection and suture around the prosthetic neck during reconstruction.
(d) After removal of the proximal femur, avoid distracting and placing tension on the sciatic nerve and femoral vessels.
(e) The proximal femoral prosthesis should be positioned in 10 degrees anteversion, with the linea aspera being the only remaining anatomic landmark.
(f) Reattach the abductors, psoas, and all muscle cuffs to the prosthesis and attachment tube reinforcement.

14.10 Avoiding and Managing Problems

(a) Dislocation of the prosthesis is rare due to the combined use of hip capsular repair and reconstruction of the abductor mechanism. Meticulous repair of the surrounding soft tissue will enhance the hip joint stability. For patients with a large tumor size and intracapsular tumor extension, the joint capsule must be excised en bloc with the proximal femur. The attachment tube must be used to replace the hip capsule by suturing around the labrum acetabuli and covering the prosthetic femoral head. Then, the abductor mechanism, psoas, and hip surrounding muscles are reattached with the attachment tube to reinforce the hip joint stability. In this circumstance, patients must use an abduction brace to prevent hip joint dislocation.
(b) For patients with extensive intramedullary tumor involvement extending to the distal femur or with skip lesions, preoperative planning for an appropriate implant (such as a custom-made short stem with anti-rotatory screws or a total femoral prosthesis) could be considered.
(c) Trendelenburg gait is common with this particular bone reconstruction. This can be improved by good abductor mechanism reconstruction and active strengthening exercises of these muscles.