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Overview of Pelvic Resections: Surgical Considerations and Classification

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OVERVIEW

The bony pelvis and its enveloping soft tissues are a common site for bone and soft-tissue tumors. Extensive pelvic surgeries, either for oncologic reasons or following trauma, are highly demanding because of the irregular and complex shape of the bony pelvis, numerous muscle attachments, and the proximity of major blood vessels, nerves, and visceral organs (Figure 10.1).

Until the late 1970s most pelvic tumors were treated with hemipelvectomy, a procedure that was associated with a significant percentage of complications and a dismal functional and psychological outcome. Because of the availability of more accurate modalities for imaging of the pelvis, use of neoadjuvant chemotherapy, improved resection techniques, and prosthetic reconstruction, limb-sparing procedures are now performed in the majority of these cases. An important consideration, because of the use of adjuvant chemotherapy and, occasionally, radiation therapy, is that the patient's postoperative recovery period be short and uncomplicated. This chapter discusses specific anatomic and clinical considerations, related to surgery in the pelvic area, as well as the various classifications of pelvic resections.

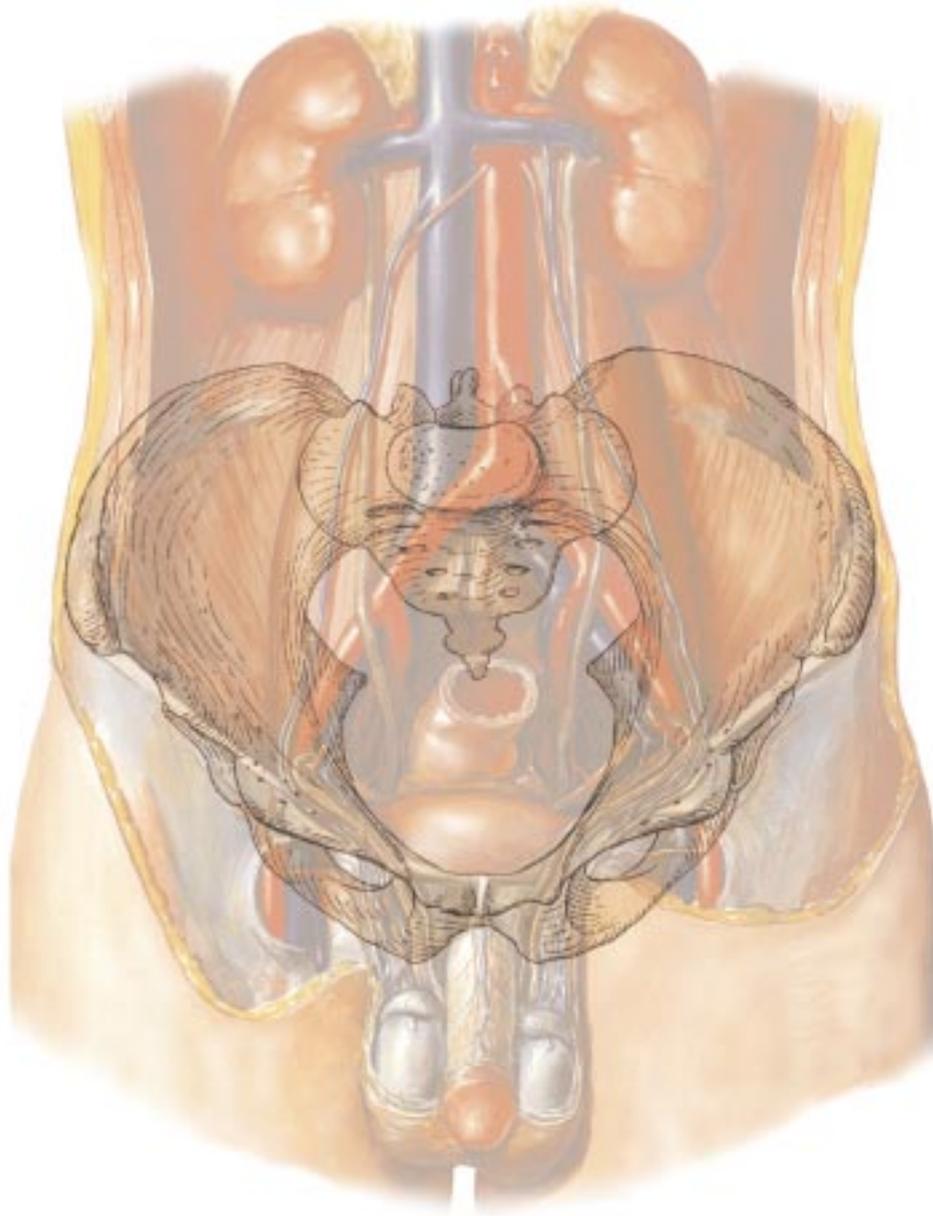


Figure 10.1 The bony pelvis and its relation to the major blood vessels, nerves, and visceral organs

INTRODUCTION

Lesions in the pelvis usually attain considerable size before they are diagnosed. Most patients with lesions of the iliac crest that extend into the pelvis, or lesions that arise in the pelvic fossa, complain initially of vague abdominal pain or fullness. Patients may present with symptoms that are related to pressure on a specific anatomic structure within the pelvis. Rarely do patients present with systemic signs of advanced malignancy. Occasionally, a large, asymptomatic mass is felt on abdominal or pelvic examination.

In most cases a wide excision of a pelvic or proximal thigh tumor may be performed without compromising any vital structure of the lower extremity. Hemipelvectomy is indicated in cases where a severe compromise following wide excision is inevitable. A functionally impaired lower extremity is preferable to an amputation, and even patients whose sciatic or femoral nerves have to be sacrificed do well with proper training, orthoses, and physical therapy. A local recurrence of a previously resected soft-tissue or bone sarcoma is no longer a clear indication for an amputation, because its impact on survival is questionable. Local

recurrences are, therefore, treated with wide excision, and amputations are performed with the same indications as for primary tumors.

IMAGING OF THE PELVIS

Staging studies for pelvic lesions, as for those elsewhere in the musculoskeletal system, are aimed at determining local tumor extent, its relation to the specific anatomic structures within the pelvis, and the presence of metastatic disease. The combination of these findings, along with the histopathologic diagnosis, will determine whether surgery is indicated and, if so, to what extent. The extent of a pelvic tumor can be evaluated only by combining multiple imaging modalities, and even then the full extent of most tumors is underestimated (Figure 10.2).

Plain Radiography

Plain radiography is of limited value in the assessment of pelvic girdle lesions. The images are frequently obscure and confusing. The pelvis, and particularly the sacrum, is a difficult structure in which to recognize early bone lesions because of the almost universal presence of overlying intestinal gas. Many lesions are overlooked initially. For these reasons there should be a low threshold for performing computed tomography (CT), magnetic resonance imaging (MRI), or bone scan

in patients presenting with deep pain around the pelvic girdle or an atypical pattern of sciatic pain (Figure 10.3).

CT and MRI

Contrast CT is the key modality for assessment of bony lesions of the pelvic girdle. The extent of bone destruction, cortical breakthrough, characteristics of the tumor matrix, and reactive changes in the host bone and soft tissues can be determined. MRI is used to evaluate soft-tissue tumors and the extent of medullary and extraosseous components of bone tumors. It is accurate within approximately 1 cm of the tumor margin. A notable exception is chondrosarcoma, which is typically understaged when it occurs in the pelvis. CT was shown to underestimate their size by up to 40–50% (Figure 10.4). Great caution should therefore be used in the surgical planning of resection of these tumors. It is also important to note that chondrosarcoma is the most common primary bone sarcoma of the pelvic girdle. Any chondroid-containing tumor of the pelvis is extremely likely to be a chondrosarcoma, and any diagnosis of an enchondroma should be seriously questioned.

Angiography

Angiographic studies are valuable in evaluating the relation of the major blood vessels to a tumor, their patency, as well as assessing tumor vascularity. These

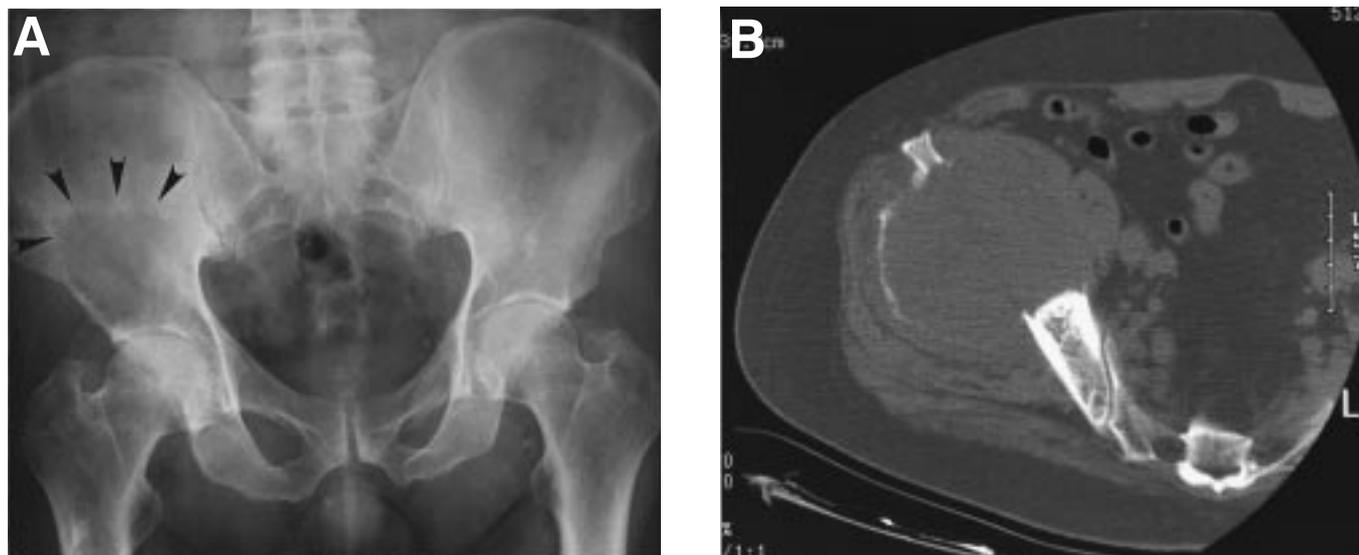


Figure 10.2 A 75-year-old patient with a 1-year history of right hip pain. Past medical history includes a subtotal thyroidectomy that was performed for an unclear diagnosis. The patient was told that the lesion was benign, and no further treatment was indicated. The patient was referred for total hip replacement and plain radiographs revealed a large lytic lesion of the right periacetabular region (A – arrows). On the basis of this radiograph one might assume that the cortices are intact. (B) CT showed extensive bone destruction and extension of the tumor to the pelvis and the right gluteal region. Complete staging demonstrated two lung metastases, and CT-guided core needle biopsy revealed a metastatic thyroid carcinoma. Following preoperative embolization the patient was treated with resection–curettage (curettage and meticulous burr drilling) and cementation.

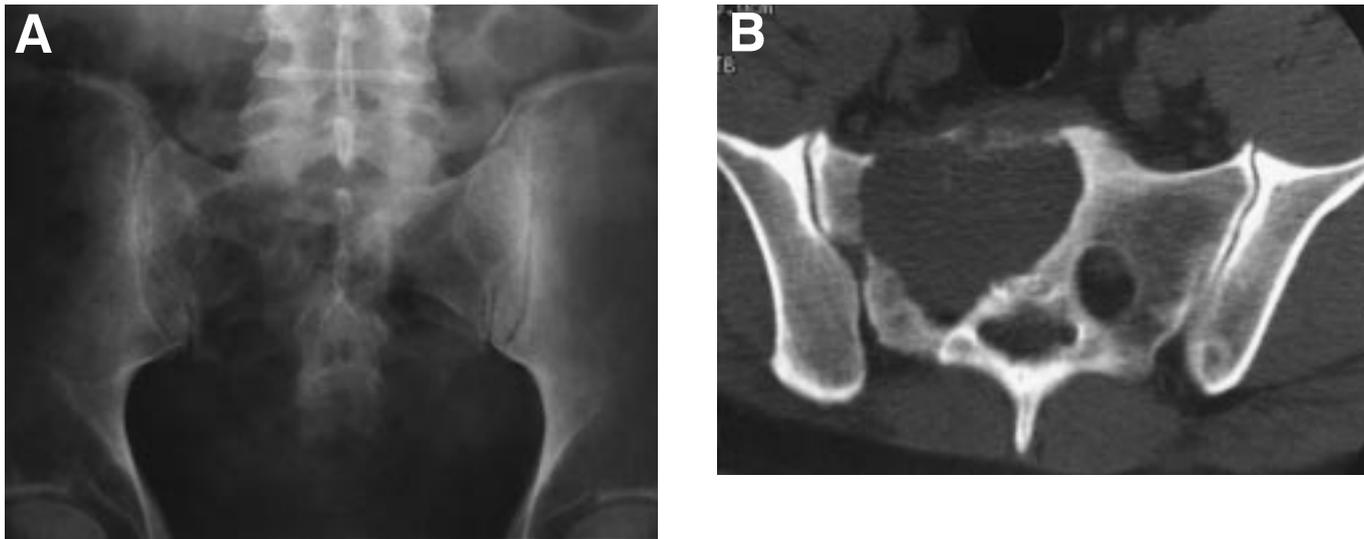


Figure 10.3 A 55-year-old male with a low back and posterior thigh pain. (A) Anteroposterior plain radiograph of the pelvis was read as normal. (B) CT of the pelvis revealed a large destructive lesion of the sacrum. CT of the abdomen revealed a renal mass, and a CT-guided core needle biopsy of the sacral lesion confirmed the diagnosis of metastatic hypernephroma. Complete staging revealed additional asymptomatic vertebral metastases. The patient was treated with embolization of the sacral lesion with complete resolution of his pain.

data are crucial in planning the resection of deep-seated pelvic tumors, especially large tumors that may displace the major blood vessels. These tumors occasionally form mural neoplastic thrombi, the presence of which must be confirmed prior to surgery. In addition, reduction in tumor vascularity, as revealed by serial angiographs, was shown to be indicative of good response to preoperative chemotherapy. Embolization of highly vascularized lesions, e.g. metastatic hypernephromas, can significantly reduce tumor size, blood loss in surgery, and alleviate symptoms in patients who are not candidates for surgery (Figures 10.5 and 10.6).

ANATOMIC CONSIDERATIONS

Evaluation of the full anatomic extent of a pelvic tumor cannot be based on a single imaging modality. Combined data, gained from two or more imaging modalities, allow a realistic appreciation of the exact anatomic extent. Even when that information is available, however, the full extent of a pelvic tumor is commonly underestimated preoperatively. The review of any imaging study of the pelvis, because of the numerous anatomic details, must be performed very methodically. The authors review the structures from the back (midsacral region) and follow the pelvic girdle to the front (symphysis pubis), as described in the following paragraphs.

1. *Sacrum, sacral alae, and sacroiliac joint.* Most patients who undergo extended hemipelvectomy, which

necessitates transection of the sacrum through the ipsilateral neural foramina, regain function of the gastrointestinal and genitourinary tracts. Adding a contralateral compromise of the sacral nerve root will create a severe dysfunction. Tumors that penetrate the sacrum and cross the midline are considered unresectable because of the involvement of bilateral nerve roots (Figure 10.7). The tumor can be resected, but the morbidity will outweigh the questionable oncologic benefit from surgery.

The common iliac vessels are just anterior to the sacral ala, and any cortical breakthrough by a tumor in that site may be expected to extend directly to the blood vessels. The sacroiliac (SI) joint is a key anatomic landmark. The major nerves and blood vessels are medial to it; therefore, any tumor or pelvic resection that is lateral to the SI joint may be expected not to violate the major neurovascular bundle. Involvement of the SI joint must be documented prior to surgery by using the combination of CT, MRI, and bone scan.

2. *Major pelvic blood vessels and structures.* The common iliac artery bifurcates along the sacral ala, and the ureter crosses the bifurcation in each side. Large tumors around the sacral ala frequently displace and occasionally invade these structures. The mere presence of a major blood vessel or a pelvic viscus involvement is not an indicator of unresectability. If curative resection is planned, both structures can be excised en-bloc with the tumor and be repaired with a graft. However, when a compound resection (bony

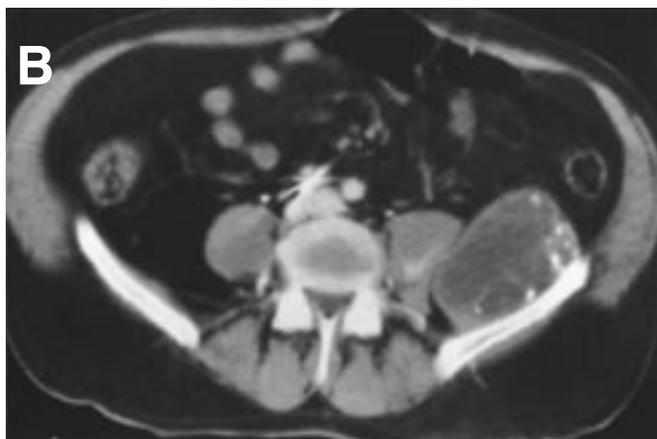


Figure 10.4 A 44-year-old patient presented with left flank pain. (A) Plain radiographs revealed a cartilage-forming lesion in the left ilium. On the basis of that study alone it seemed that this was an intraosseous lesion. (B) CT showed an extensive tumor on the medial aspect of the ilium with destruction of the outer table and extension to the gluteal region. CT-guided core needle biopsy showed intermediate- to high-grade chondrosarcoma and the patient underwent en-bloc resection of the ilium with the large extraosseous component.



Figure 10.5 Preoperative angiography and embolization of the metastatic lesion, shown in Figures 10.1A and 10.1B. Embolization of a vascular lesion, performed at least 6 h prior to surgery, is expected to significantly reduce intraoperative blood loss.

- pelvis and viscus resection) is anticipated, the patient has to be informed and the surgical assistance and necessary equipment have to be prepared in advance.
3. *Sacral plexus.* Current imaging techniques cannot accurately identify nerves. Nerve involvement is therefore assumed on the basis of the pain pattern, physical examination, and the presence of the tumor in close proximity to a site in which a major nerve or plexus is usually located. Clinical evidence of femoral or sciatic nerve dysfunction usually means direct tumor involvement. In most cases the presence and extent of nerve involvement is established only in surgery. Sacral plexus invasion by tumor has the same significance in terms of resectability as tumor invasion of the sacrum; bilateral involvement is an indicator of unresectability.
 4. *Sciatic notch and nerve.* The sciatic notch is the site of pelvic osteotomy in resections of the ilium or peri-

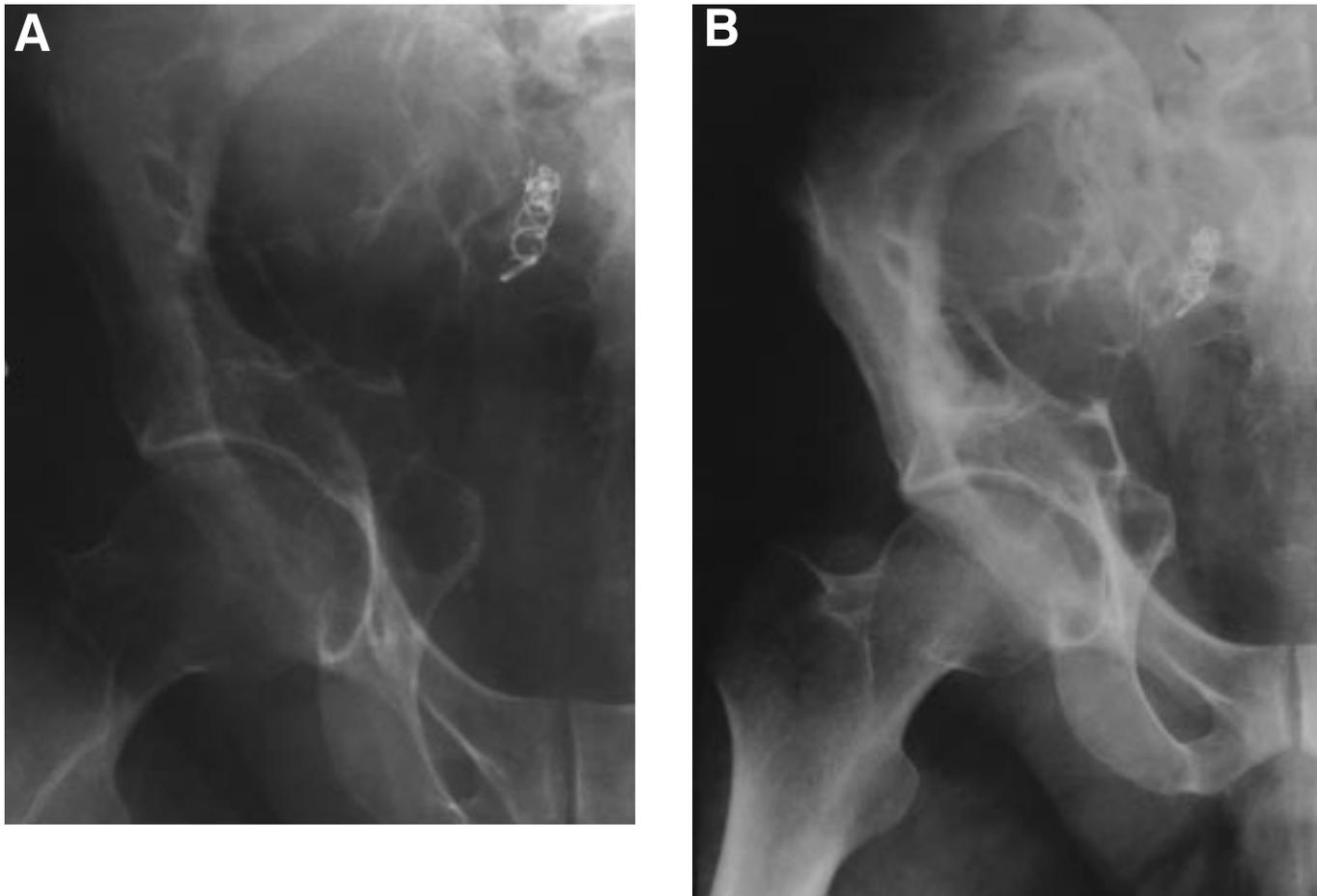


Figure 10.6 A 45-year-old patient presented with excruciating right flank and sciatic pain. Plain radiographs revealed a large destructive lytic lesion of the innominate bone, and staging studies revealed a right renal mass and showed that the sacral lesion crossed the midline to the contralateral sacral foramina. The significance of that finding is that even extended hemipelvectomy would not achieve tumor-free surgical margin. CT-guided core needle biopsy of the sacral lesion established the diagnosis of metastatic hypernephroma and embolization was performed with near-complete resolution of pain after 36 h. (A) Plain radiograph, performed 24 h after the procedure (note the coil); and (B) after 6 weeks. Note the thick sclerotic rim of bone in the periphery of the lesion, which is the response of the host bone and indirect evidence of a significant decrease in tumor progression.

acetabular region and in modified hemipelvectomy. CT establishes tumor extension to the sciatic notch, a tight space through which the sciatic nerve and superior gluteal vessels and nerve pass (Figure 10.8). The piriformis muscle, which divides the sciatic notch, is a key structure because the sciatic nerve exits the pelvis underneath it and the superior gluteal artery exits the pelvis above it. The patency of the superior gluteal artery, which supplies the gluteal vasculature, is established by angiography. Adequate blood supply of the gluteal region is a major consideration in flap design and the artery has to be preserved in any pelvic resection, if oncologically feasible. The artery is located only few a

millimeters from the periosteum of the sciatic notch roof, and it should be dissected carefully.

5. *Ilium*. The inner aspect of the bone is covered by the iliacus muscle, which originates from the iliac crest. The iliacus is “pushed” by a growing bone sarcoma and serves as a barrier to direct extension of tumor to the anatomic structures of the pelvis. The iliacus can therefore be used as a safe oncologic margin for resection. In contrast, metastatic carcinomas to the pelvis tend to invade the covering muscle layer in their early growth stage, and a surgical plane between the tumor and near structures cannot be easily defined (Figures 10.9 and 10.10). Although any pelvic organ can be infiltrated by a tumor, structures

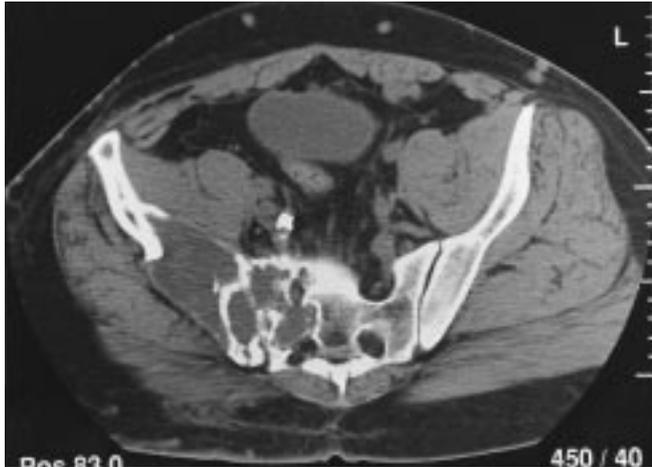


Figure 10.7 High-grade chondrosarcoma of the right sacrum, ilium, and periacetabular region, encasing the ipsilateral sacral foramina. Wide excision would necessitate resection through the contralateral sacral foramina, resulting in an unacceptable functional impairment.

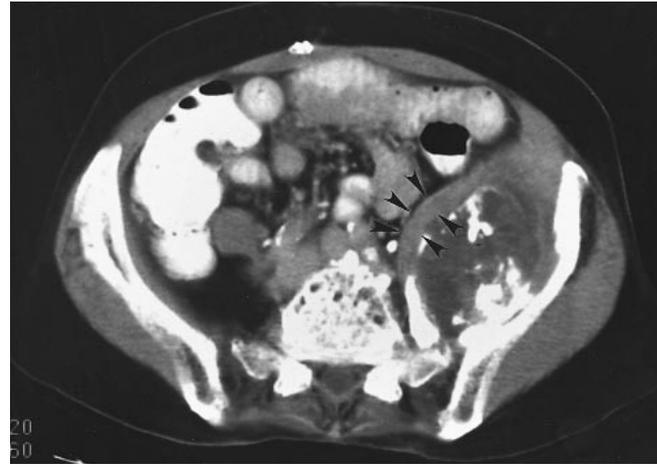


Figure 10.9 The iliacus muscle is “pushed” by a growing bone sarcoma and serves as a barrier to direct extension of the tumor to the pelvic viscera. Metastatic carcinomas to the pelvis tend to invade the covering muscle layer in their early stages.

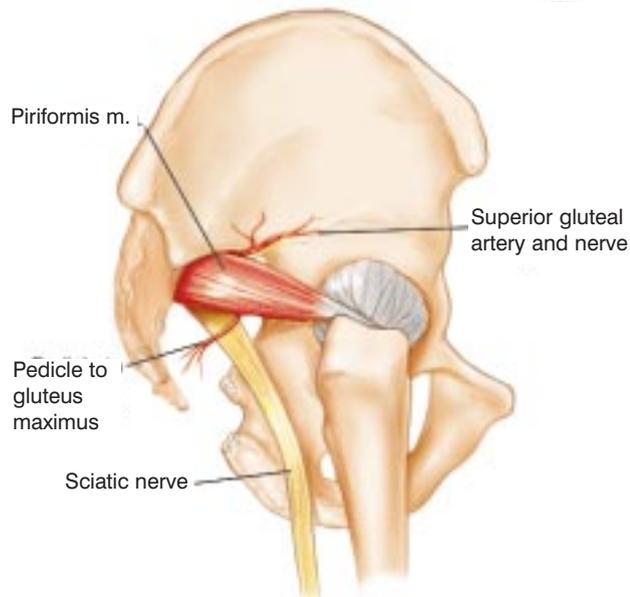


Figure 10.8 The sciatic notch is a tight space through which the sciatic nerve and superior gluteal vessels and nerve pass. The sciatic nerve exits the notch underneath the piriformis muscle and the superior gluteal vessels exit the notch above it.

that are anterior and posterior to the flare of the muscle (i.e. sacral plexus, sciatic notch and nerve, femoral vessels and nerve, bladder, and prostate) are at a greater risk of direct tumor extension.

6. *Extension to pelvic viscera.* Direct involvement of a pelvic viscus by a pelvic girdle tumor is rare. Left-sided tumors are more likely to involve a component of the gastrointestinal tract because of its close

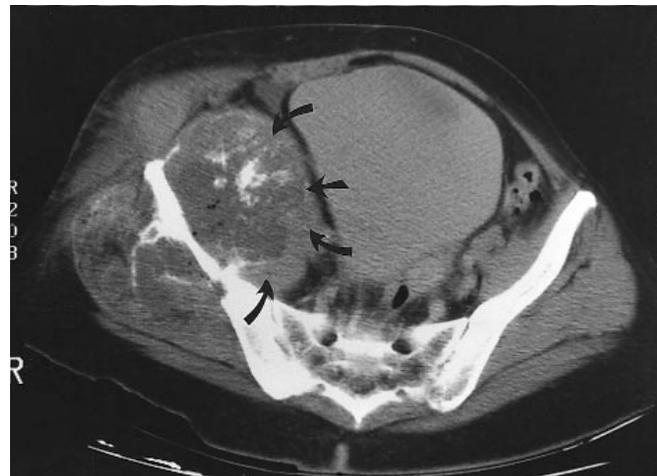


Figure 10.10 High-grade sarcoma of the left ilium “pushing” the iliacus muscle (arrows) towards the midline.

proximity to the pelvic girdle at that point. A rectal tube is inserted preoperatively during any pelvic resection to facilitate identification of the rectum during dissection.

7. *Acetabulum and hip joint.* Wide resection of any bone tumor in the periacetabular region, unlike a resection of the ilium or the pubis, imposes a major impairment on the function of the hip joint. It usually necessitates en-bloc resection of the proximal femur and a complex prosthetic reconstruction.
8. *Pubis.* The neurovascular bundle passes just anterior to the superior pubic ramus, and tumors extending to or arising from the pubic ramus are close to the femoral artery, vein, and nerve. In addition, the

urethra passes straight underneath the symphysis pubis. Vulnerable structures such as a major blood vessel, nerve, or a viscus must be identified and mobilized prior to resection. Doing that, the surgeon does not have to assume that these structures are remote and dissection is, therefore, safe; he *knows* that. Establishing the relation of these vulnerable structures to the tumor allows the surgeon to decide whether to proceed with a limb-sparing procedure or perform an amputation, make the necessary preparations for a vascular graft (if needed), and perform a safer resection.

CLASSIFICATION OF PELVIC RESECTIONS

Hindquarter amputation (hemipelvectomy, classical hemipelvectomy), using a posterior subcutaneous flap, was for a few decades the standard of treatment for large bone or soft-tissue tumors involving the proximal thigh, groin, or the periacetabular region. *Extended hemipelvectomy* includes sacral transection through the neural foramina (Figure 10.11). If a part of the iliac crest is spared, the procedure is referred to as *modified hemipelvectomy* (Figure 10.12). Hemipelvectomy can be performed using either the standard *posterior* or *anterior* myocutaneous flaps. If the tumor mass is located in the buttock or high in the posterior thigh, and does not involve the femoral vessels, an anterior flap hemipelvectomy should be performed. In this procedure the surgical defect created by resection of the hemipelvis is covered by a rectus femoris myocutaneous flap. Resection of a viscus in addition to any pelvic girdle specimen is termed *compound hemipelvectomy*.

Internal hemipelvectomy involves resection of part or all of the innominate bone with preservation of the extremity. The classification of these resections is attributed to Enneking¹ and is based on the resected region of the innominate bone, from posterior to anterior: *Type 1* (ilium – Figure 10.13); *Type 2* (periacetabular region – Figure 10.14); and *Type 3* (pubis – Figure 10.15). En-bloc resection of the ilium and sacral ala is classified as an extended *Type 1* or *Type 4* resection.

THE UTILITARIAN PELVIC INCISION

The most useful approach to pelvic biopsy or resection is the utilitarian pelvic incision. All or part of the incision can be used for adequate exploration and resection of the majority of pelvic girdle tumors.

The incision begins at the posterior inferior iliac spine and extends along the iliac crest to the anterior superior iliac spine (Figure 10.16). It is separated into two arms: one is carried along the inguinal ligament up to the



Figure 10.11 Extended hemipelvectomy. Transection is performed through the neural foramina.



Figure 10.12 Modified hemipelvectomy. Transection is performed lateral to the sacroiliac joint. Ipsilateral sacral foramina are, therefore, spared.

symphysis pubis, and the other turns distally over the anterior thigh for one-third the length of the thigh and then curves laterally just posterior to the shaft of the femur below the greater trochanter and follows the insertion of the gluteus maximus muscle. Reflection of the posterior gluteus maximus flap exposes the proximal third of the femur, the sciatic notch, the sacrotuberous and sacrospinous ligaments, the origin of the

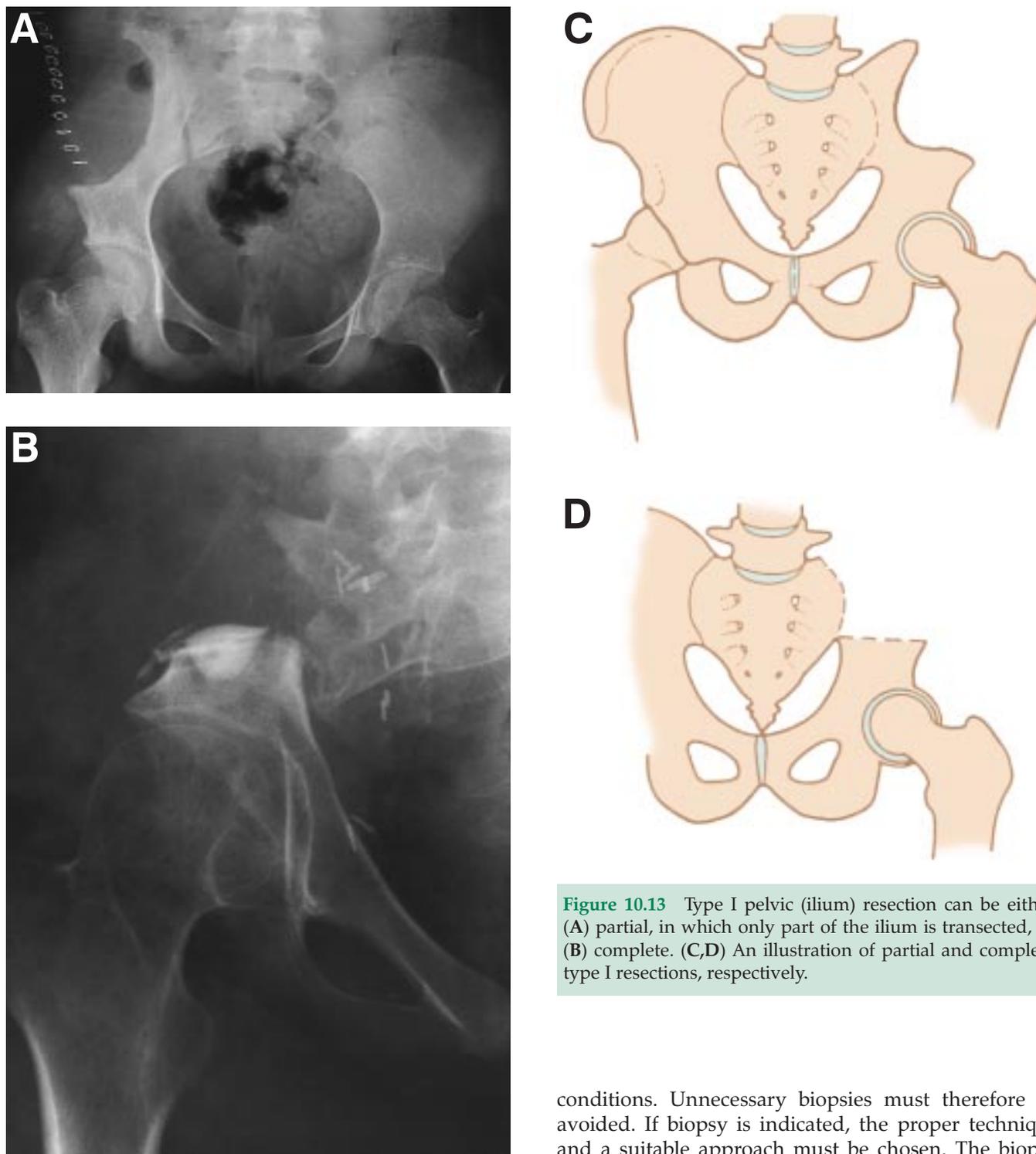


Figure 10.13 Type I pelvic (ilium) resection can be either (A) partial, in which only part of the ilium is transected, or (B) complete. (C,D) An illustration of partial and complete type I resections, respectively.

hamstrings from the ischium, the lateral margin of the sacrum, and the entire buttock.

A significant concern exists regarding the possible extracompartmental implantation of tumor cells following biopsy or resection of a pelvic tumor, procedures that are difficult to perform under optimal hemostatic

conditions. Unnecessary biopsies must therefore be avoided. If biopsy is indicated, the proper technique and a suitable approach must be chosen. The biopsy tract has to be positioned along the line of the future utilitarian incision, remote from the major neurovascular bundle and the abductors. CT-guided core needle biopsy is considered to be an accurate and safe diagnostic tool in the diagnosis of musculoskeletal tumors and is the preferred modality used by the authors. Guidelines for performing a biopsy were presented in Chapter 2.

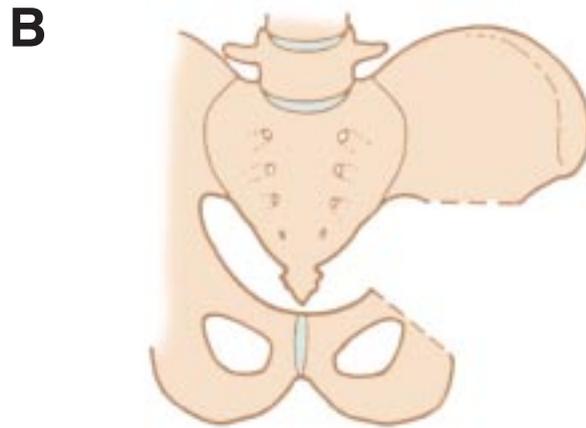


Figure 10.14 (A) Type II pelvic (periacetabular) resection. Reconstruction was performed with a saddle prosthesis. (B) An illustration of Type II pelvic resection.

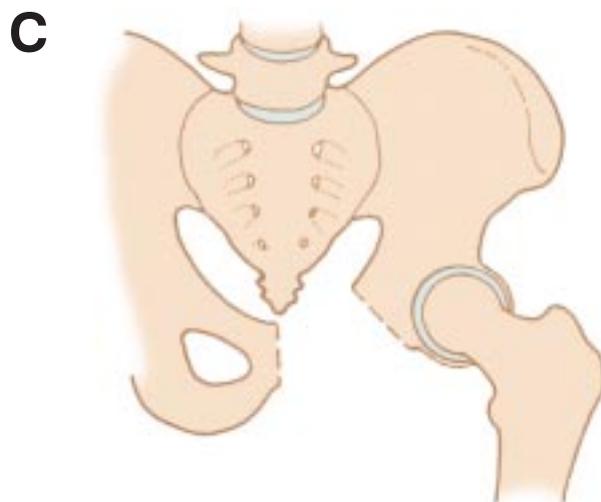
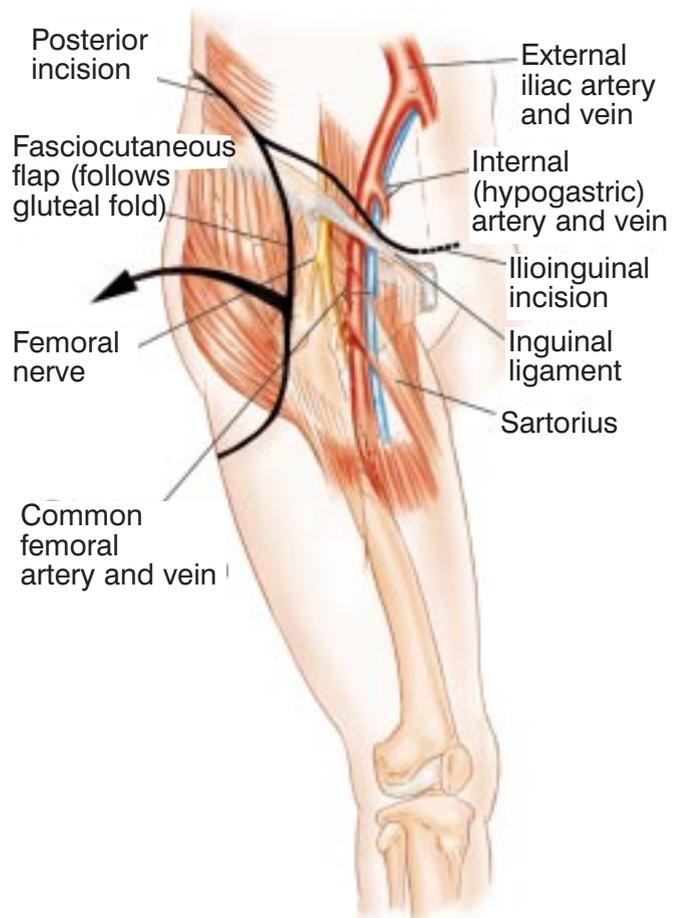


Figure 10.15 Type III pelvic (pubic) resection. These resections may include the (A) superior pubic ramus, inferior pubic ramus, or (B) both rami. (C) An illustration of type III pelvic resection.



The utilitarian incision may be used for hemipelvectomy by continuing the distal portion of the primary incision posteriorly around and behind the thigh and bringing it anteriorly along the inferior pubic ramus to the symphysis, thus encircling the thigh but still allowing the large posterior flap to be used for primary wound closure.

Figure 10.16 The utilitarian pelvic incision.

References

1. Enneking WF. The anatomic considerations in tumor surgery: pelvis. In: Enneking WF, editor. *Musculoskeletal Tumor Surgery*, Vol. 2. New York: Churchill Livingstone. 1983:483–529.

