

Approach to the Acetabulum (Enneking Type II Resection)

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Indication

1. Tumors of the acetabulum
2. part of internal and external hemipelvectomy
3. pelvic fractures

Technique

1. Positioning: The position of the patient for type II resection is the same as for type I resection.
2. Landmarks: One should palpate the entire iliac crest, posteriorly to the PSIS, and anteriorly to the ASIS. The symphysis with the pubic tubercles and the greater trochanter are marked out with a marking pen.
3. Incision: The incision is tri-radiate, centered posteriorly to the ASIS and includes an iliac, an ilio-inguinal and ilio-femoral component. This incision is a modification of the ilio-femoral incision and passes from the ASIS perpendicularly to the ilioinguinal incision, following the gluteal fold distal to the greater trochanter posteriorly. Medially, the ilioinguinal incision can be extended posteriorly to the perineum. This approach provides good exposure of the femoral neurovascular structures, the superior pubic ramus, and the spermatic cord or the round ligament.(Fig.1)
4. a: Intrapelvic anterior exposure: All abdominal wall muscles are transected off the iliac crest. Large fasciocutaneous flaps are raised and reflected medially and posteriorly. (Fig.2) The ilioinguinal ligament is detached from the ASIS and reflected medially. Immediately underneath the inguinal ligament, the anterior femoral cutaneous nerve is encountered, it may be transected. This nerve may be found adjacent to, or up to 3cm medial to, the ASIS. (Fig.3) The spermatic cord or the round ligament and the ilioinguinal nerve are mobilized, tagged and reflected medially. It may be necessary to incise a portion of the rectus abdominis tendon just above the insertion onto the pubis. Directly beneath the midportion lie the external iliac vessels. Exposure and tagging of the femoral neurovascular bundle within the lacuna vasorum. The inferior epigastric and the circumflex ilium vessels are ligated to facilitate mobilization, which is also eased by hip flexion. The more laterally situated lacuna musculorum is separated by the iliopectineal fascia, which is incised from the pectineal eminence posteriorly to the pelvic brim giving access to the lesser pelvis. (Fig.4).
5. b: In trauma surgery, this area is divided and visualized through three windows depending on the extent of the fracture: The first window is exposed by medial retraction of the iliopsoas and femoral nerves, which allows visualization of the entire internal iliac fossa, the sacroiliac joint, and the pelvic brim. Lateral retraction of the iliopsoas muscle and femoral nerve, combined with medial retraction of the external iliac vessels, opens the second

window. This window gives access to the pelvic brim, from the sacroiliac joint to the pectineal eminence, as well as to the quadrilateral surface for reduction of posterior column fractures. The third window of the ilioinguinal approach exposes the symphysis pubis and the retropubic space of Retzius by medial retraction of the vessels, while the spermatic cord or round ligament is retracted medially or laterally.

6. Intrapelvic posterior exposure: This is the same as described for type I resection. The vessels and femoral and obturator nerves are identified and followed proximally and retroperitoneally. The obturator nerve is transected if the foramen obturatum is resected in toto. The junction of the iliacus and psoas muscle is identified. The psoas muscle is transected such that it serves as a protection of the neurovascular femoral bundle. The ureter is identified, tagged and retracted medially. Then the sciatic notch, the SI-joint and the promontorium are identified. In front of the SI-joint and the lateral massa of the ala, the lumbar plexus with L4 and L5 nerve roots are identified, mobilized and retracted medially to give enough access for the osteotomy.(Fig.5)
7. The exposure of the externa of the pelvis includes the mobilization of the gluteus maximus flap centered on the pedicle of the inferior gluteal vessels. A large fasciocutaneous flap permits the release of the gluteus maximus muscle. This muscle is detached anteriorly from the iliotibial band and the femur, and is rotated posteriorly. The superior gluteal vessels may be sacrificed early to prevent inadvertent division and retraction into the pelvis where control of hemorrhage may be difficult. (Fig.6)
8. Extrapelvic exposure of the sciatic notch (Fig.7): The muscles of the external rotators (piriformis, obturator internus, gemelli superior and inferior, quadratus femoris) are transected so that the sciatic nerve is protected and that there is access to the ischium. At this step, the anatomy of the sacrospinous ligament requires special attention. The pudendal vessels and nerve exit from the greater sciatic notch and reenter the pelvis at the lesser sciatic notch in close proximity to the tip of the sacrospinous ligament. (Fig.8). Careful dissection is required to avoid injury to these structures. Dividing the ligamentous attachment on the broader part of the pelvic spinous process, then using a periosteal elevator to lift the ligament off the bone pushing it towards the tip of the spine will protect the pudendal vessels and nerve from injury as they are dissected off the bone and medially towards the pelvic cavity. Division of the sacrotuberous ligament will allow more space for the dissection and securing of the pudendal vessels if required. Both the sacrospinous and the sacrotuberous ligaments require complete release from the pelvis, otherwise delivery of the resected periacetabular segment of pelvis following osteotomy will be difficult. (Fig.9)
9. Extrapelvic anterior exposure: The greater trochanter is osteotomized and reflected back with the gluteus medius and minimus muscles (if not involved by tumor) while protecting the superior gluteal vessels. (Fig.10 and 11) The sartorius muscle is released (with a bone block for later reattachment) from the ASIS and reflected anteriorly, then the tensor fasciae latae and the rectus muscles are detached from their origins to expose the anterior capsule (Fig.12). The ascending branch of the lateral circumflex artery is ligated. Careful attention is given whether there is joint effusion. If an extra-articular resection is performed, the femoral neck is osteotomized (extracapsularly) in a routine fashion. If the resection is intra-articular,

the capsule is cut and the joint opened. Then, the tendon of the ilio-psoas muscle is identified and transected close to the lesser trochanter, which allows dislocation of the hip (Fig.13). Finally, the hamstrings and external rotators are released (Fig.14).

10. Antero-medial exposure: This approach is the same as described under type III resection. Under protection of the femoral neurovascular bundle, the superior pubic ramus is identified and the pectineus, obturator, gracilis as well as the adductor muscles are released from the pubis (under protection or sacrifice, depending on the extent of the resection) of the obturator nerve, which passes through the obturator foramen. Finally, the hamstrings (biceps femoris, semitendinosus and semimembranosus) are divided.
11. Osteotomies: The pelvis is osteotomized above the acetabulum with an oblique osteotomy passing from below the ASIS to the sciatic notch, using malleable retractors to protect neurovascular structures intra- and extrapelvically. (Fig.15) If this osteotomy is adjacent to the SI-joint, the inner cortex is cut with a chisel under protection of the L4 and L5 nerve roots. Then, from outside, the outer cortex is cut lateral to the foramina before going back to complete the osteotomy from inside the pelvis. A second osteotomy divides the symphysis or the superior pubic ramus, which is performed from below. It is critical that the hamstrings and adductor muscles are divided off their pubic origins because this allows a good view of the bone to be osteotomized. A third osteotomy (if only the superior pubic ramus is osteotomized) divides the ischium (or the inferior pubic ramus) above the level of the origin of the biceps femoris muscle but well below the acetabulum. Careful attention is required that this osteotomy won't be oblique but horizontal, which may be difficult to achieve because visualization may not be optimal. The specimen is completely freed from soft tissues, and delivered to pathology. After removing of the specimen, all three major nerves to the leg are exposed (Fig.16).

Pearls and Pitfalls

- We prefer to start with the intrapelvic exposure because blood loss may be greater if extrapelvic gluteal flap is raised while intrapelvic exposure is carried out.
- Involvement of femoral and sciatic nerves: Large iliac or psoas muscle tumors are known for involving the femoral nerve. Sciatic nerve involvement usually occurs at the level of the notch, which requires careful attention to the preoperative MRI.
- The obturator nerve is sacrificed when the foramen obturatorium is resected in its entirety by osteotomy through the symphysis, whereas it can be saved when the osteotomies are done through the anterior superior pubic ramus and the ischium.
- Patency of pelvic vessels: Preoperative MRI scans are helpful for determining if the iliac or femoral veins are patent or not. This may permit early ligation of the vein rather than time consuming dissection.
- Involvement of the hip joint: Tumors of the acetabulum and/or ilium may impinge on the capsule (including proximal femoral tumors), or erode through the medial wall of the acetabulum or may contaminate the hip joint and convert an intra-articular to an extra-articular resection.

- Visceral involvement: Most pelvic tumors arise as retroperitoneal masses. They tend to displace rather than invade the visceral contents of the bony pelvis. Nonetheless, careful attention should be paid to the bladder and the colon in either iliac fossa in tumors with large soft tissue components.
- If a rectus abdominis flap is used for postoperative wound closure, the inferior epigastric vessels may either be saved, or the flap needs to be raised from the opposite side.

Figures





Figure 1: The patient is positioned in the floppy lateral position. The incision is triradiate, centered at the ASIS and includes an iliac, an ilio-inguinal and ilio-femoral component.

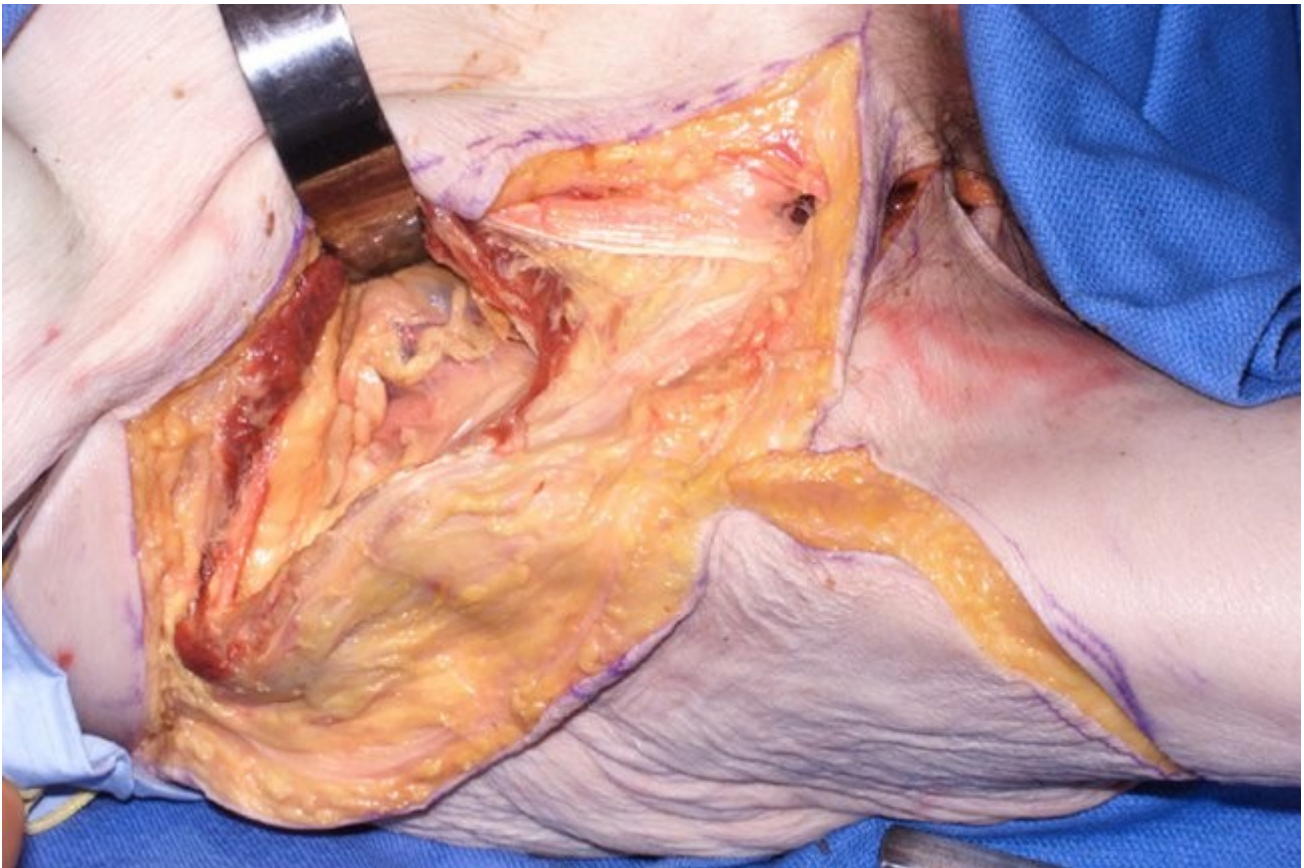


Figure 2: Large fascio-cutaneous flaps are raised exposing iliacus and psoas muscles.

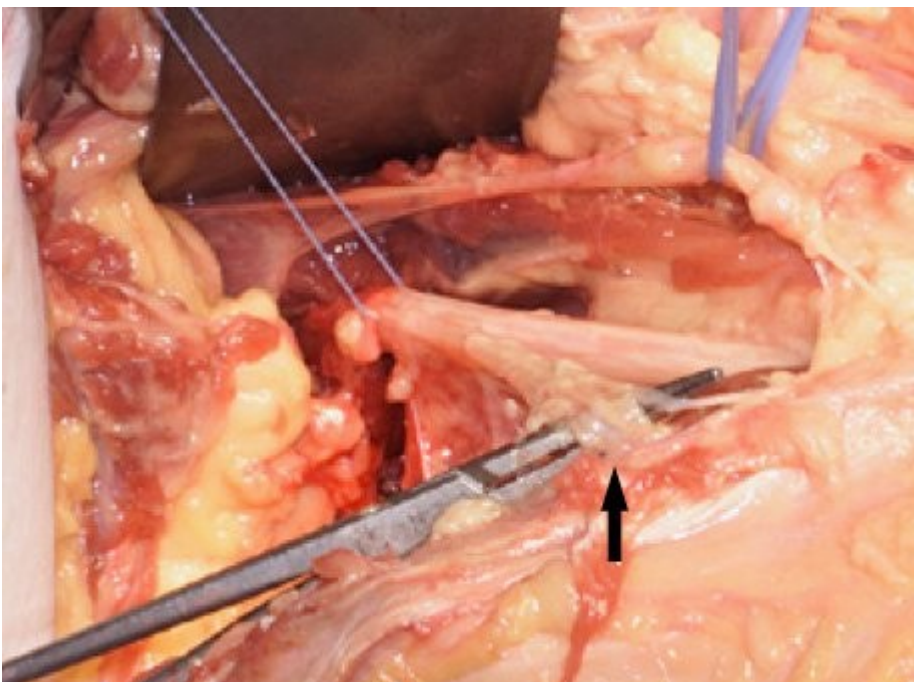


Figure 3: The antero-lateral femoral cutaneous nerve is identified and usually transected for easier exposure.

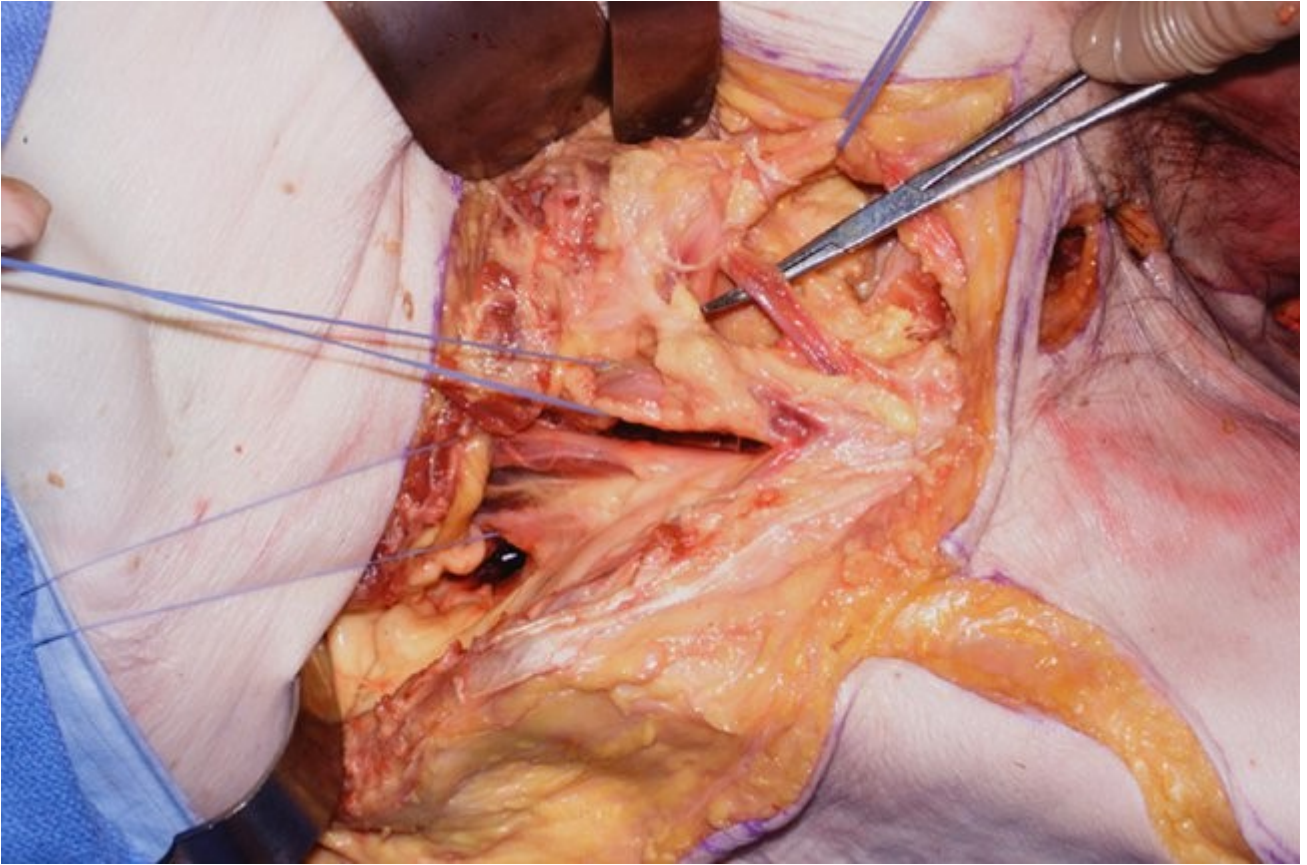


Figure 4: For full intrapelvic exposure, the psoas muscle is identified along with the femoral and obturator nerves, the spermatic cord (or round ligament) and the inferior epigastric artery.

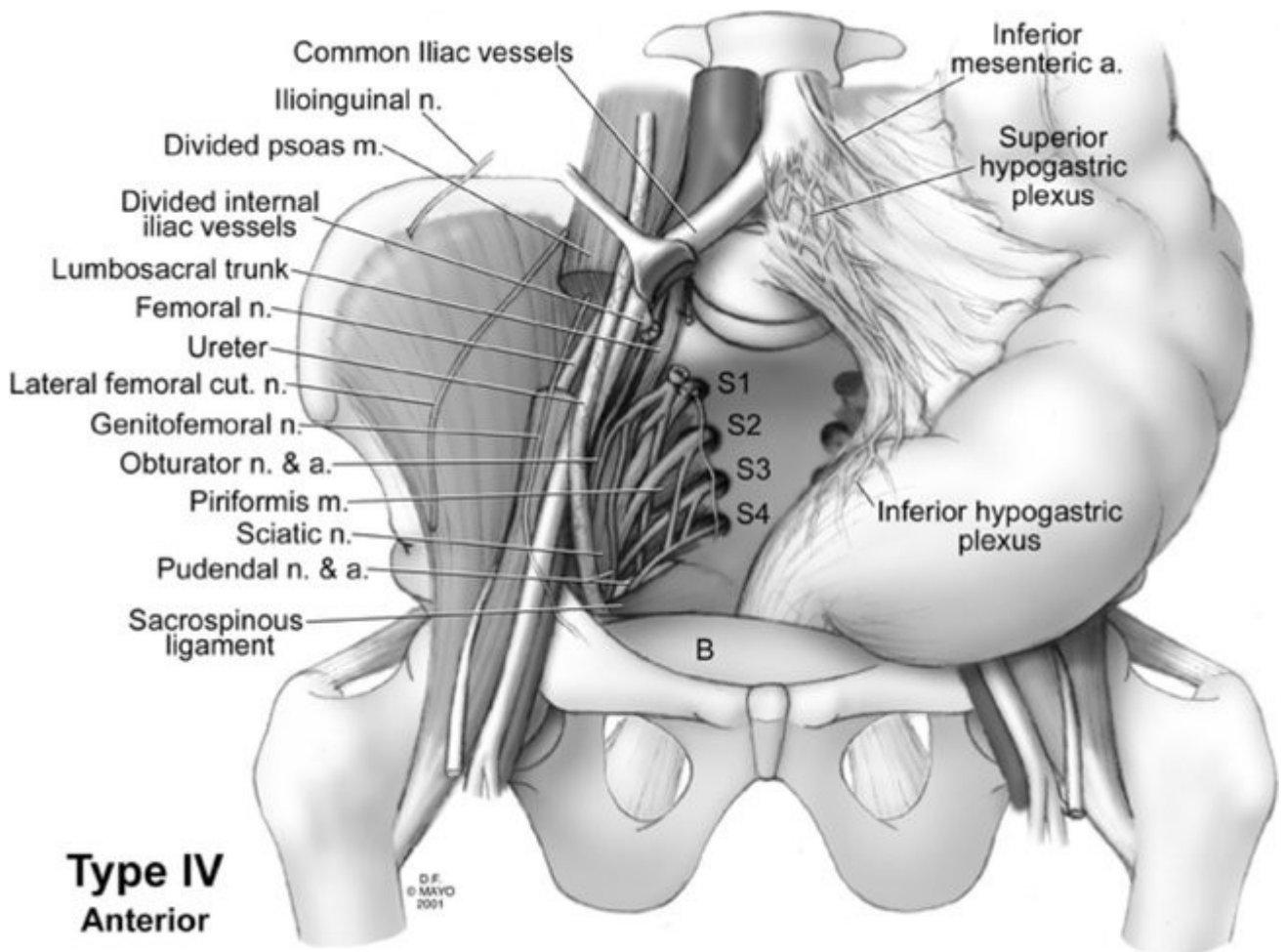


Figure 5: A full exposure also includes posterior intrapelvic mobilization to visualize the lumbo-sacral plexus.



Figure 6: The gluteus maximus flap is mobilized including the release from its insertion to the femur when necessary.



Figure 7: Exposure of the sciatic notch with the sciatic nerve exiting the pelvis underneath the piriformis muscle.

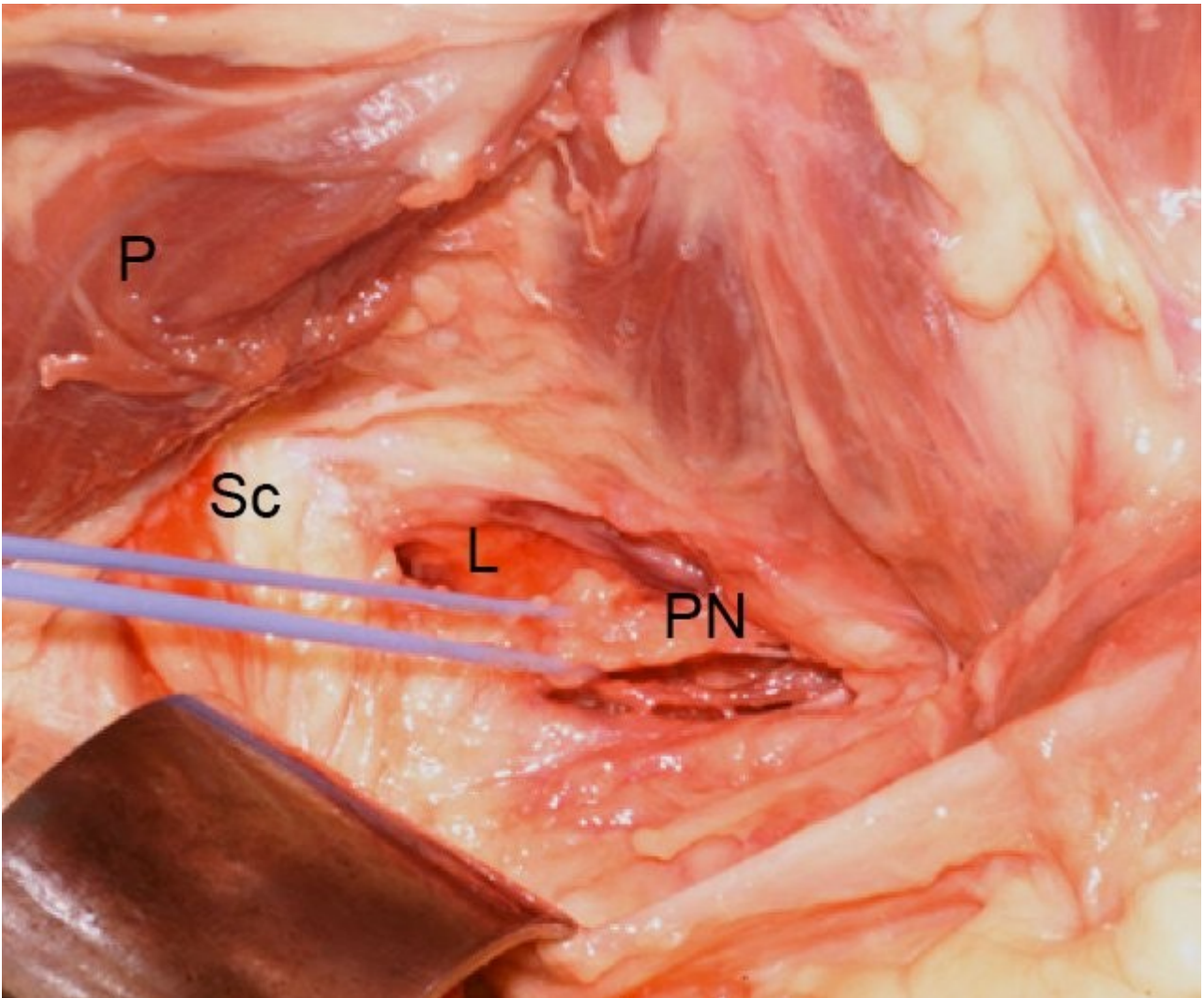


Figure 8: The sciatic nerve (SC, under retractor) is exiting the pelvis underneath the piriformis muscle (P). In close proximity, the pudendal nerve (PN) and the sacro-spinous ligament (L) is identified.

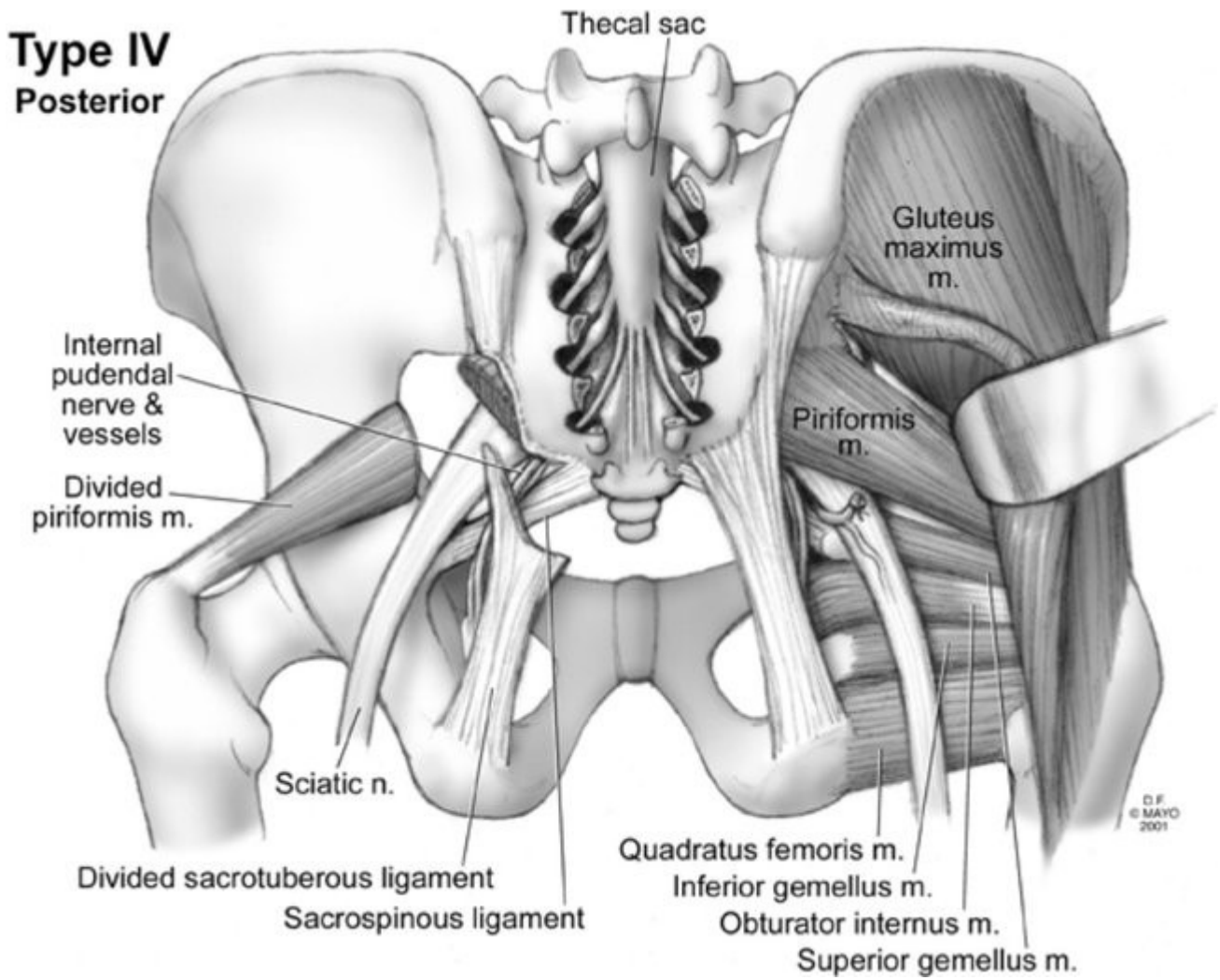


Figure 9: The relationship of the piriformis muscle, the sciatic nerve and the sacrotuberous and sacrospinous ligaments with the pudendal nerve is shown.

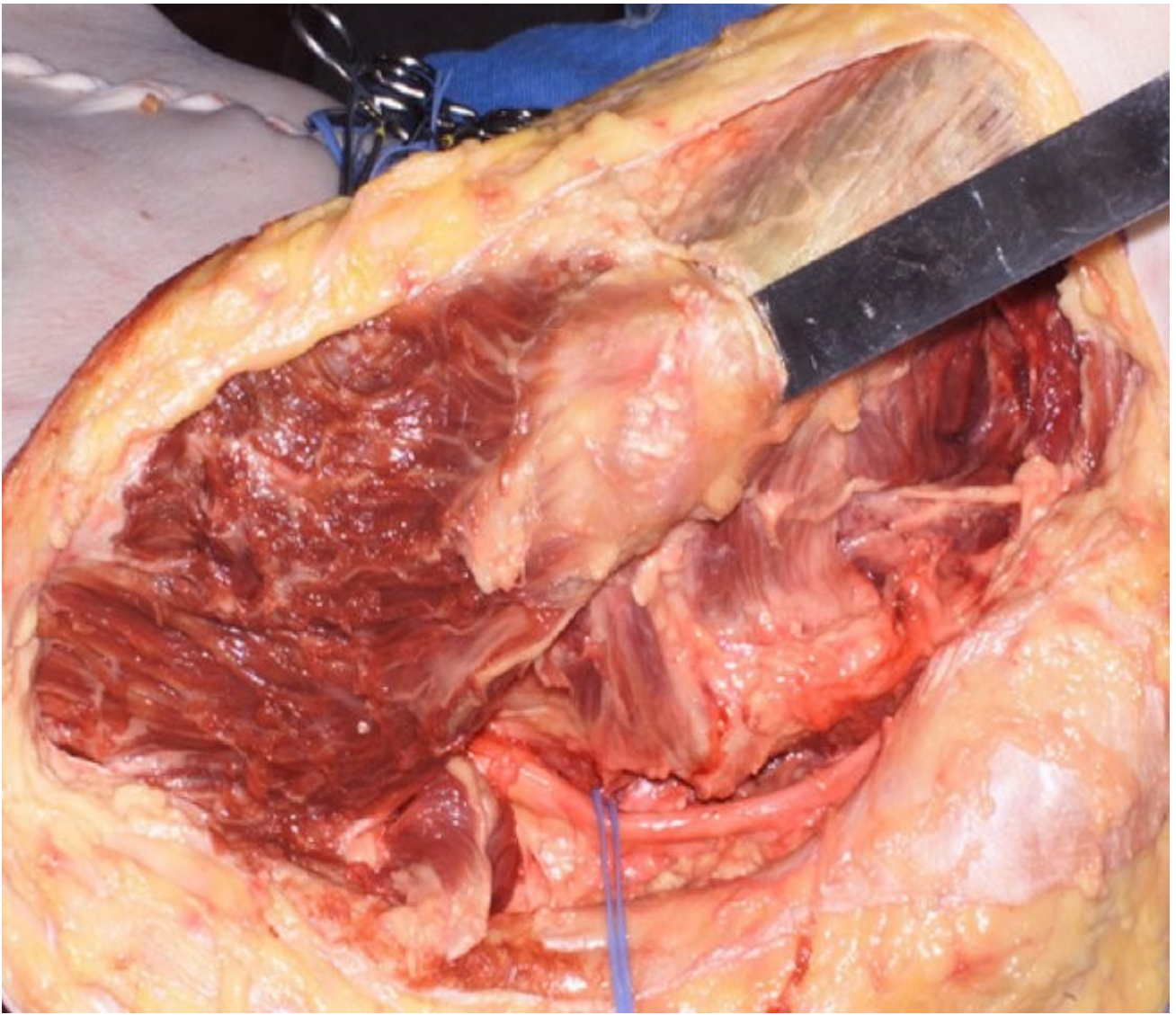




Figure 10: The greater trochanter is osteotomized and reflected back along with the gluteal musculature while care is taken not to injure the gluteal pedicle.

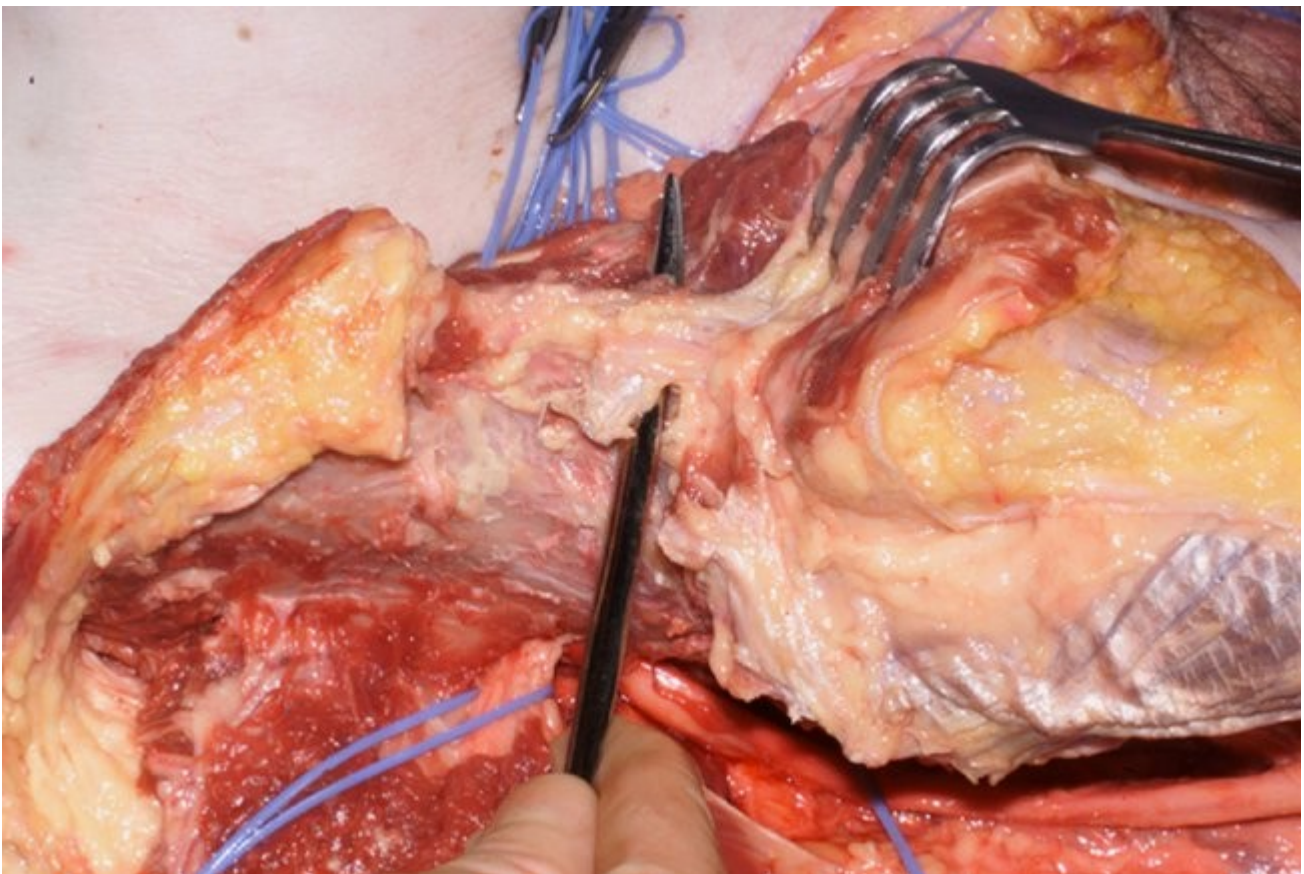
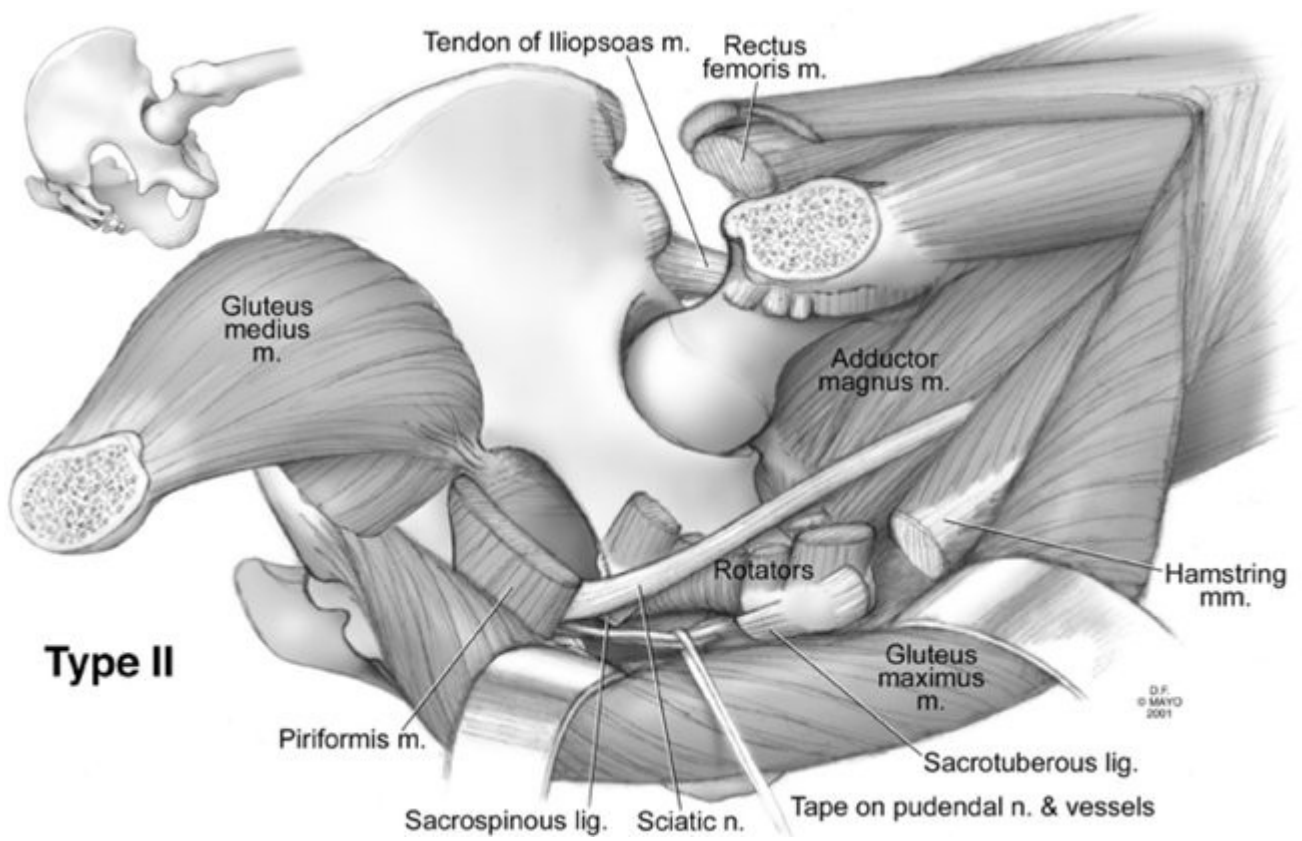


Figure 11: If the gluteal flap is completely mobilized, it is attached only through the superior gluteal vessels to the pelvis.

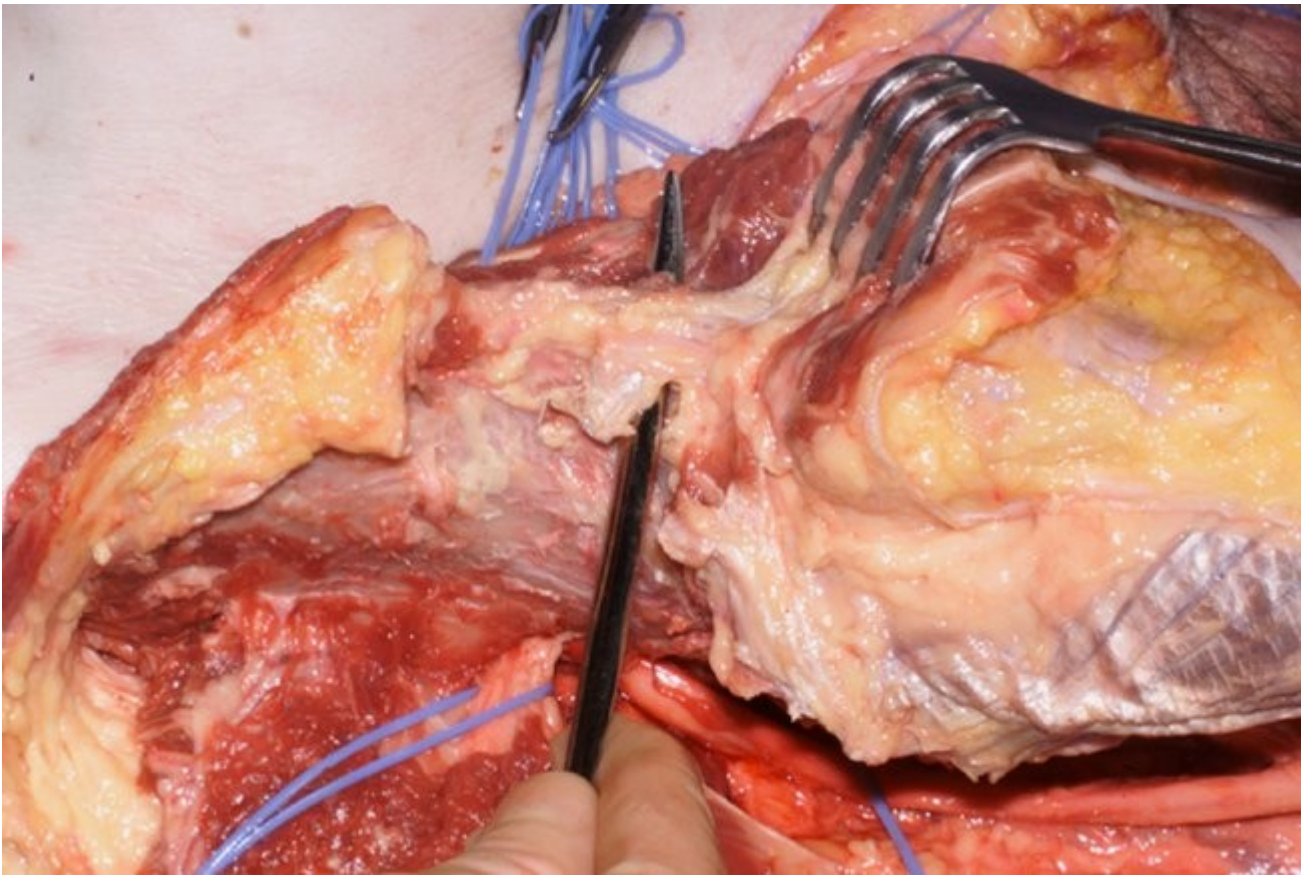
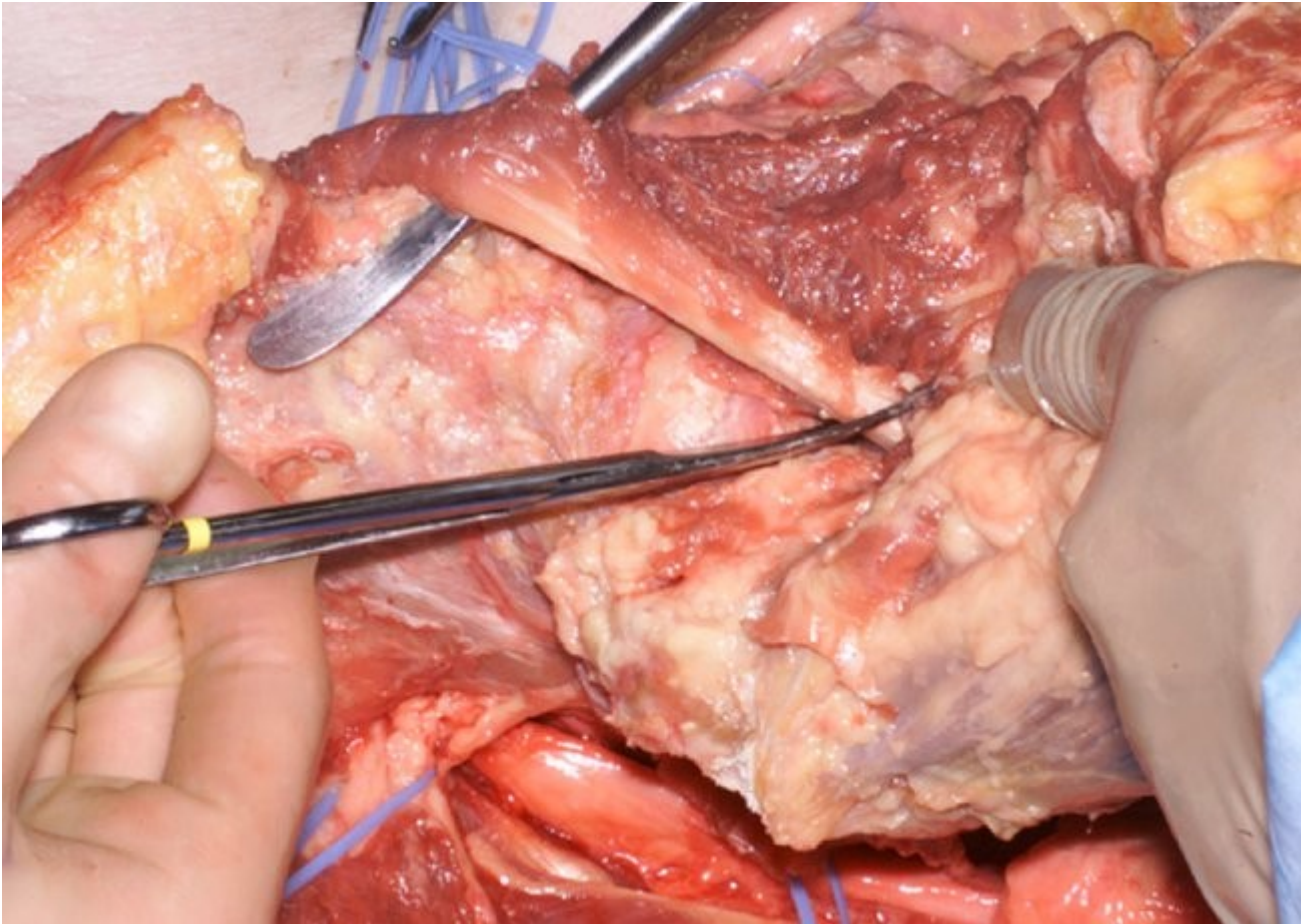


Figure 12: After mobilization of the anterior thigh muscles, the rectus origin is exposed and released from the AIIS to visualize the hip joint capsule.



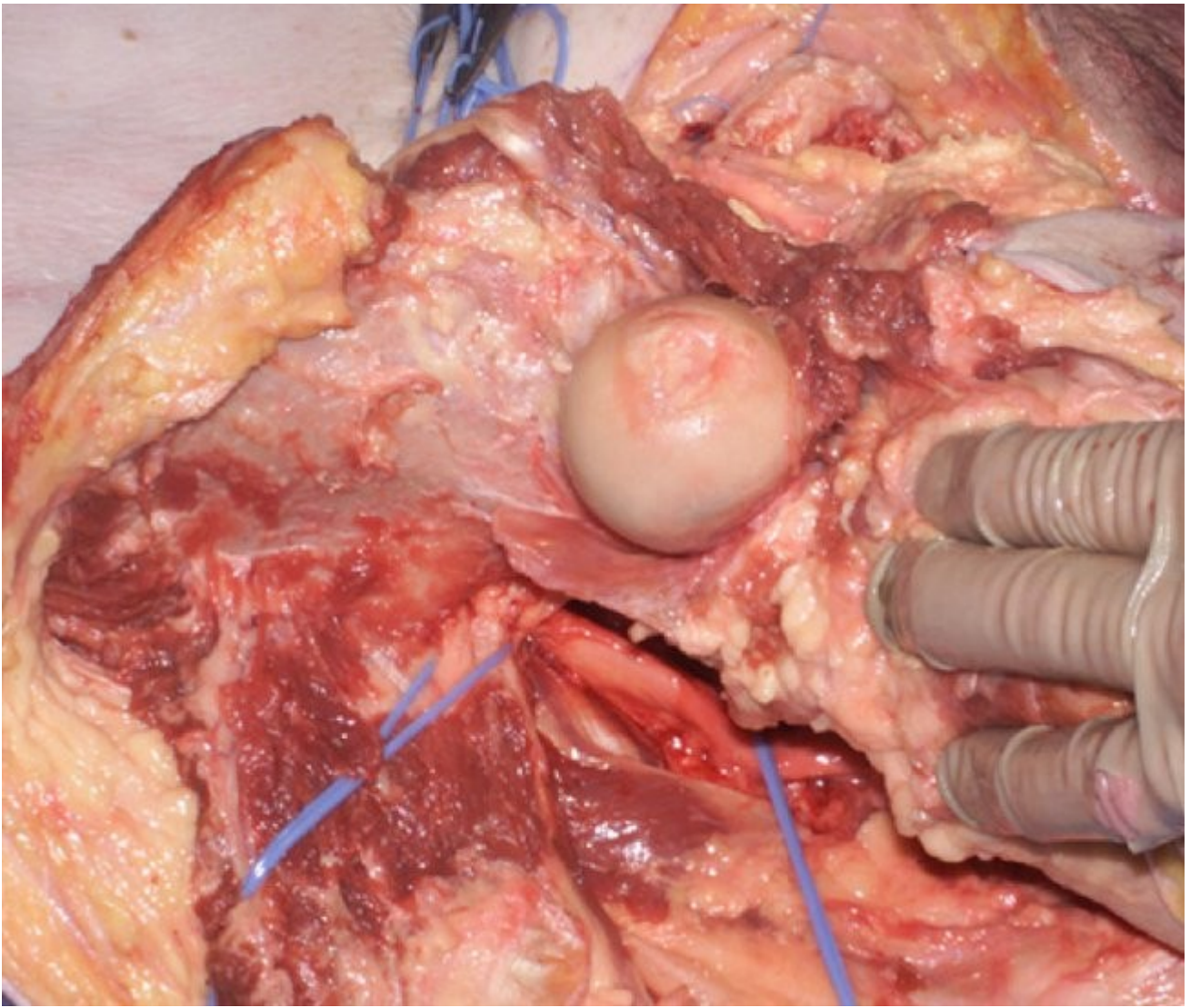


Figure 13: The psoas tendon is identified and transected as well as the capsule to dislocate the hip joint.

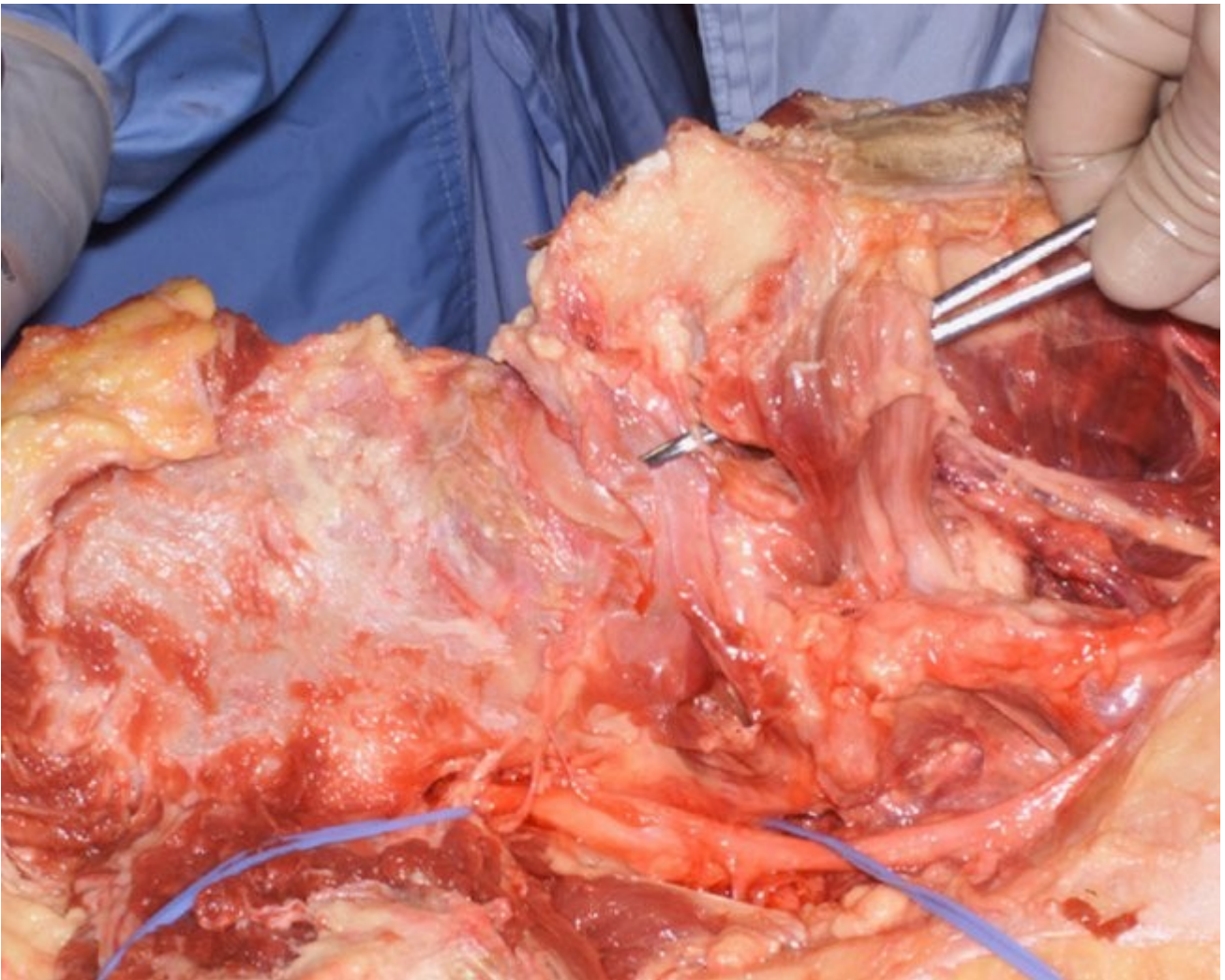


Figure 14: The last step includes the transection of the external rotators and the hamstrings.

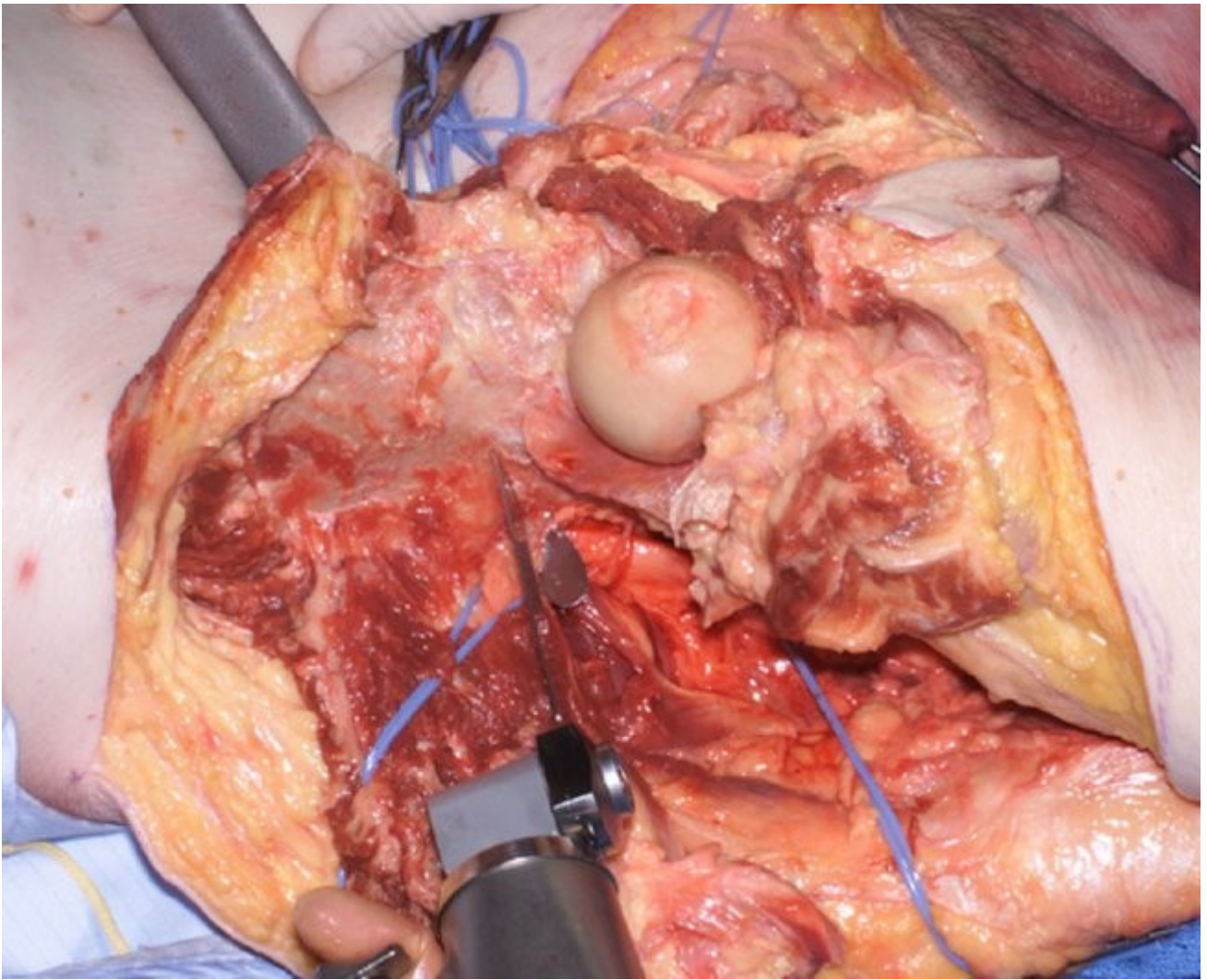




Figure 15: The osteotomy above the acetabulum is performed using a malleable retractor to protect the visceral structures.

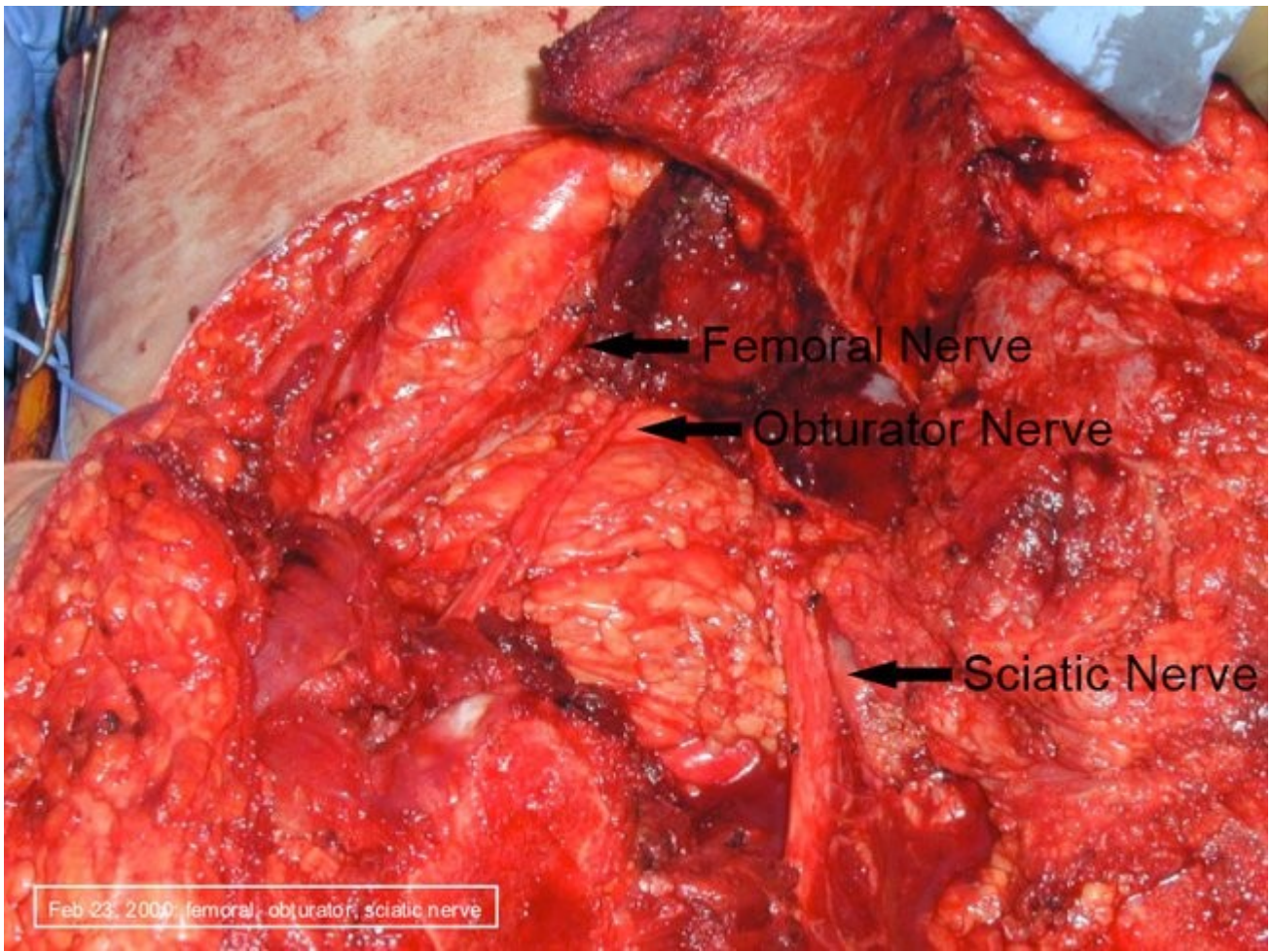


Figure 16: After removing of the specimen, the femoral, obturator and sciatic nerves are exposed.