Minimally Invasive Approaches to the Hip

Direct, Anterior, Single-Incision Approach

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Description of the Approach

The approach is intended to allow for the implantation of a standard total hip prosthesis by the use of standard instruments. Cemented as well as non-cemented implants can be used with this approach. However, the implantation process is facilitated with standard instruments that have undergone slight modification. In any minimally invasive approach the use of straight cup and stem inserters, straight cement-plug inserters and straight rigid reamers and broaches require more soft-tissue mobilization, which can cause excessive tension on these structures. Therefore, the use of instruments specifically developed for this approach is recommended.

The entire procedure is performed using a single-incision anterior approach. In a modified Smith-Peterson anterior technique, the gluteal muscles remain attached to the ilium, using a safe intermuscular and inter-nervous plane to gain direct, unimpeded access to the hip capsule. The capsulotomy is performed using an H-shaped incision and retained. The femoral neck is then osteotomized with two parallel cuts. After removal of the bony disc created by this maneuver, the femoral head can be easily removed without significant soft tissue distraction. Mobilization of the capsule from the femur and the placement of the specially designed retractors permit direct access to the femoral canal in the anterior approach by elevating the femur out of the wound. After implantation of the acetabular and femoral components and relocation of the femoral head in the acetabulum, the capsulotomy is closed to decrease the risk of dislocation.

Patient Selection

The direct anterior approach can be safely and adequately performed in over 95% of patients who undergo a total hip arthroplasty. Although obesity is not a contraindication because the anterior peri-incisional subcutaneous fat is usually not very thick, evaluation of each patient’s anatomy is suggested. However, it is also recommended to start the use of this approach with “ideal” patients, those with relatively thin anterior musculature and fat, and then proceed to the more difficult cases. In addition to the usual contraindications for hip arthroplasty, there are additional specific contraindications for the direct anterior approach:

Absolute contraindications:
- Destruction of the proximal femur: In the case of a per-trochanteric fracture or metastatic disease of the proximal femur, elevation of the femur out of the wound cannot be adequately accomplished.

Relative contraindications:
- Morbid obesity: The decision, if this means a BMI index of 30 or more, is entirely dependent on the experience of the surgeon.
- Decreased range of motion: If the hip joint is excessively stiff and range of motion is decreased, mobilization of the soft tissue to access the joint may be more difficult. This parameter is also dependent on the experience of the surgeon.
- Difficult and concomitant procedures: If additional procedures are necessary, e.g. the removal of a plate or of a dynamic hip screw, revision cases, or central dislocation of the hip, a degree of mobilization greater than that achieved with the anterior approach may be required.
Operative Technique

Equipment of the Theatre, Position of the Surgeon

A standard operating theatre can be used, without any special requirements. It is necessary to use additional devices for illumination, and a head-mounted lamp for the surgeon is sufficient.

The operation is conducted with the surgeon in the standing position on the side of the affected hip and the first assistant above or cranial to that position. The second assistant stands on the opposite side. During stem preparation, the surgeon and the first assistant can change places as necessary. The scrub nurse is positioned at the foot of the operating table.

Specialized Instruments

Retractors. To facilitate retraction and visualization, each instrument should be bent at the level of the skin as they exit from the wound, and the bend should approximate 90°. Fortunately, the thickness of soft tissue in the area of the approach does not demonstrate a high degree of variability. Even very obese patients do not have a thick subcutaneous fat layer in the area of this approach; otherwise it would be difficult for them to sit. Typically, one size of retractors is sufficient to handle patients of varying body habitus.

Oscillating Saw. A standard-size saw is too bulky in this minimally invasive approach. A small electric oscillating saw permits an osteotomy with adequate visualization.

Curved Acetabular Reamer Handle and Cup Inserter. They are not necessary, but the curvature of the instruments reduces the pressure and tension exerted on the skin.

Curved Broach Handle, Intra-Medullary Plug Inserter and Stem Holder. Without these curved instruments, femoral canal preparation and stem implantation may be impossible. In cemented stems, a curved or flexible intramedullary plug inserter is necessary.

Patient Position

The patient is placed in the supine position on the operating table without any support placed under the pelvis. Draping of the pelvis and both legs is required to accommodate the leg positioning used during the procedure. Preparation of the femoral canal requires a position where the operative leg is placed in external rotation and adduction behind the opposite leg (known as the figure-4 position). The draping of the legs must be sufficiently flexible to permit such movement. The anus and genitals are covered by a drape, and after prepping, both legs are placed in impervious sterile stockings up to the proximal aspect of the patella. A bilateral self-adhesive hip drape is used to cover the trunk and the genitals. Both anterior superior iliac spines (ASIS) remain uncovered to permit identification of the anatomic landmarks used during cup positioning. A self-adhesive drape is placed on each leg in order to fix the position of the drapes. After draping, the index hip is fully flexed to verify proper draping (Fig. 7.1).

Pre-Operative Planning

It is important to perform thorough pre-operative planning. For the acetabulum, the depth of reaming with relationship to the acetabular fossa must be determined. The acetabular fossa can be clearly recognized on pre-operative X-rays and intra-operatively in the acetabulum. If it is planned to ream deeper, the relation between the reamer and the acetabular rim can be determined as soon as the reamer has reached the fossa. Then the distance between the acetabular rim and the end of the reamer can be determined, which will diminish with
further reaming. Also the approximate size of the implant can be determined. The resection plane of the femur should be determined using the junction between the neck and trochanter and the lesser trochanter as landmarks. The size of the implant is important, as well as the distance between stem shoulder and the tip of the greater trochanter, in order to determine reconstruction of the leg length.

**Skin Incision**

The success of this approach is dependent on the exact positioning of the skin incision. The intermuscular space can easily be palpated. This space is formed by the muscles medial to the approach – the sartorius and femoral rectus which originate from the ASIS and the AIIS (anterior inferior iliac spine) – and the muscles lateral to the approach – tensor fasciae latae and medial gluteus – which originate from the lateral surface of the iliac wing. Abduction and external rotation of the hip will lateralize the lateral musculature and decrease tissue tension in the intermuscular space, facilitating palpation.

The incision starts two finger breadths below the ASIS and follows the intermuscular space. A skin incision placed too medial can cause damage to the lateral femoral cutaneous nerve. An incision placed too lateral will reduce this risk as well as the pressure on the skin during femoral preparation (Fig. 7.2). Alternatively, a skin incision parallel to the inguinal skin fold will result in a better cosmetic result and make the approach to the femoral canal easier on the surgeon and the soft tissues. However, this incision will cross the branches of the lateral femoral cutaneous nerve, and place undue tension on these branches resulting in a high likelihood of paresthesias of the anterior and lateral skin of the thigh. If patients wish to receive this optimal scar with regard to cosmetics, the increased risk of nerve damage must be discussed pre-operatively with the patient.

The length of the skin incision depends on the expected size of the acetabular component (Fig. 7.3). The skin can also be stretched, but the more the skin is stretched, the more likely a wound-healing problem will result. Ideally, there is an optimal balanced solution with regards to the goal of minimal damage to the patient with minimal incision length.

**Muscle Dissection**

After dissection of subcutaneous fat, which is normally quite thin, the fascia appears in the incision. Palpation of the structures is repeated at this point and the fascial separation is made at the site of the intermuscular space or
is slightly lateralized to provide greater protection of the lateral femoral cutaneous nerve. The fascia is split with either a scissors or by blunt finger dissection. The intermuscular space can be easily developed by blunt dissection until the capsule can be palpated. This preparation should be completed without force in order not to damage the lateral circumflex vessels within the operative field. A blunt retractor is placed laterally on the capsule proximal to the greater trochanter. A second retractor is placed around the greater trochanter. The medial musculature is retracted out of the field. The capsule is exposed and the lateral circumflex vessels are either cauterized or ligated, depending on the size of the vessel (Fig. 7.4).

Capsule Preparation and Femur Mobilization

With a Cobb elevator, the space between the rectus and vastus intermedius muscles on the one hand, and the femur on the other hand is prepared, and then a third Hohmann retractor is placed just proximal to the lesser trochanter on the medial side of the femoral neck. Then, the reflected head of the rectus, which forms a second anterior layer of the capsule close to the acetabular rim, is cut with the cautery. The origin of the rectus from the AIIIS, however, remains intact. The Cobb is used again to prepare the space between the origin of the rectus tendon above, and the capsule and superior acetabular rim below.

The capsulotomy is carried out using an H-shaped incision. This step starts with a longitudinal incision of the capsule anterior and longitudinal to the femoral neck. Then, the proximal incision is completed along the acetabular rim. The labrum or remnants of it are resected as well. It is not recommended to expose the space between the medial capsule and the psoas tendon, because bleeding can occur. The third incision is placed at the attachment of the capsule to the femur at the intertrochanteric line.

The joint is now exposed and by rotating the leg, a clear view can be achieved. The femoral neck is prepared with a Cobb, and the medial inferior and lateral proximal retractors are removed and repositioned on the medial and lateral aspect of the femoral neck inside the capsule. It is recommended that optimal femoral neck exposure is accomplished, especially the posterior aspect, to facilitate removal of the femoral neck disc as described below.

Removal of the Femoral Head

The femoral neck is osteotomized with two parallel cuts, using a small oscillating saw, producing a bone disc. This disc, approximately 1 cm thick, is removed first to facilitate the removal of the femoral neck prior to removal of the femoral head through this minimally invasive incision. This procedure not only makes removal of the femoral head easier but also reduces the risk of a femoral or sciatic nerve lesion due to reduced tension on the nerve during the dislocation procedure.

The cranial osteotomy is completed first, otherwise the proximal bone fragment would move excessively, followed by the second osteotomy which should be placed exactly where the femoral neck resection was planned. A 40°- to 45°-resection plane can be determined easily under direct visualization of the neck from the anterior field. The greater trochanter as well as the lesser trochanter can be palpated with a forceps. The femoral neck-bone disc is mobilized, using a Cobb elevator, and removed, using a blunt forceps. Then, the femoral head is removed, using an elevator or a corkscrew instrument (Fig. 7.5).

If the surgeon encounters any difficulty removing the femoral head, the proximal capsular incision may need to be enlarged or remaining labrum may be restricting the extraction. In some cases, removal of anterior osteophytes or a thickened femoral head ligament may be required. At this point, the femur is usually sufficiently mobile so that it can be rotated in both
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After an H-shaped capsulotomy, two retractors are placed around the femoral neck, one retractor in front of the acetabulum and the other below the greater trochanter. Two cuts with an oscillating saw create a femoral neck disc which can then be removed. By this procedure, enough space is created to remove the femoral head directions, the posterior attachments of the capsule to the femur can be resected and the femoral head can be removed from the field.

Cup Preparation

After removal of the femoral head, satisfactory exposure of the acetabulum is facilitated through the use of four properly placed retractors (Fig. 7.6):

- Medial anterior – the retractor on the superior acetabular rim. The previously cleared capsule permits the surgeon to easily place this retractor.
- Medial posterior – the retractor is placed either behind an osteophyte or the medial rim of the acetabulum, behind the transverse ligament.
- Lateral anterior – the retractor lies at the anterolateral acetabular rim.
- Posterior – the double-pronged retractor is placed with the tips behind the posterior rim of the acetabulum. As the posterior capsule has not been resected, it may be necessary to fashion a small rent in the capsule at this location to permit satisfactory capture of the retractor.

The acetabular fossa is cleared of soft tissue and osteophytes, and acetabular cysts are bone-grafted. Reaming is conducted with a curved or cranked reamer handle. Caution should be taken not to press the reamer too much against the posterior wall. The fossa is the best landmark for determining the depth of preparation during reaming. After reaming, the cementless cup is press-fit into position. In those cases in which a cemented cup is implanted, the bony bed is prepared in accordance with third-generation cementing techniques, including the use of anchor holes, pulsatile lavage and cement pressurization.

Stem Preparation

The capsular attachment to the femur has already been resected and should be re-checked to ensure appropriate femoral mobility. The proximal femur is elevated out of the field with a bone hook so that the greater trochanter is pulled laterally and anterior. The leg is placed in a figure-4 position, in 90° external rotation and slight adduction. Excessive adduction places undue stress on the medial gluteal muscle. A modified straight femoral elevator is placed behind the greater trochanter. The retractor is pressed down with caution to avoid excessive pressure on the greater trochanter which is levered out of the wound. The retractor is placed lateral to the iliac bone and the space in front of the retractor forms a working canal for stem preparation. Two retractors are placed lat-
Fig. 7.7. The femur is pulled out of the wound with a bone hook. A specially designed retractor is placed behind the greater trochanter. This retractor is kept in an oblique direction and compresses and protects the soft tissue during preparation of the femur. Two additional retractors keep the soft tissue medial and lateral, respectively.

In order to ensure that all the external rotators, including the piriformis and all gluteal muscles, remain intact, the femoral mobilization is critical to provide sufficient access to the femoral canal during preparation of the canal for implantation. The proximal femur must be positioned anteriorly with slight adduction. There are three major potential obstacles to satisfactory mobilization:

**Capsule.** The capsule can be thought of as a fibrous tube which has some rigidity due to the three-dimensional arrangement of its fibers. This rigidity is accentuated with the scarring that accompanies an arthritic hip joint. As long as capsule fibers remain intact, the proximal femur will rotate around the intact fibers. Mobilization of the femur anteriorly is therefore combined with a more medial and cranial position. This mobilization is facilitated with resection of all of the anterior, medial and lateral capsular attachments to the femur. Those capsule fibers which are attached to the acetabular rim can remain relatively intact with only the anterior portion of the H-shaped capsulotomy being necessary.

**External Rotators.** The external rotation of the figure-4 position stretches these structures, and anterior displacement of the femur will produce additional medialization of the proximal femur. We have found that the internal obturator tendon can be an impediment to femoral mobilization. The orientation of the other external rotators has not been found to significantly hinder the anterior movement of the femur.

**Gluteal Muscles.** Usually, these muscles do not hinder femoral mobilization. A femoral elevator can be placed behind the greater trochanter for appropriate positioning while the gluteal muscles are preserved.

**Wound Closure**

After relocation of the femoral head in the acetabulum with the final implants, a full range of motion is performed to verify the stability of the construct and to ensure that there is no soft-tissue interposition between the cup and the head. Capsular closure can be completed with two or three strong stitches. Wound drainage can be placed in front of the capsule. The fascia is sutured with running sutures while avoiding the branches of the lateral femoral cutaneous nerve. The subcutaneous tissue is closed with interrupted sutures and the skin is closed with a subcuticular suture.

**Risks and Sources of Complications**

The lateral cutaneous femoral nerve (LCF nerve) enters the thigh medial to the ASIS and typically divides into 4 or 5 branches. The branches demonstrate variability, therefore there is no zone for the skin incision that is completely safe. However, the more lateral the skin inci-
sion is located, the less likely is the risk of a nerve lesion. We recommend a longitudinal skin incision, slightly lateral to the entrance to the intermuscular space. If a branch of the nerve is detected, it is sometimes possible to mobilize the branch and to suture a layer of subcutaneous fat tissue around the mobilized and displaced branch, in order to protect it against pressure during the further procedure. On rare occasions, the course of one of the branches crosses the operating field and must be ligated and cut. The consequence of a lesion of the LCF nerve is either a neuropathy or anesthesia in an area of the anterior or lateral thigh, or both. Anesthesia is usually not a long lasting problem; the patient becomes accustomed to it. In neuropathy, infiltration of the nerve can help. The femoral nerve is well protected by the sartorius, the rectus and iliopsoas muscles. The sciatic nerve is out of the surgical field and is not endangered.

In patients with significant osteoporosis, the femoral retraction during canal preparation could result in a fracture of the greater trochanter which, if small, could be ignored or could be fixed with the use of two cables through the same approach.

**Salvage Procedures**

**Femoral stem fissure**: A fissure of the femoral shaft can also be addressed by the use of circumferential cables. If the fissure continues distal to the incision, an additional skin incision 8 cm in length and placed laterally is more sensible than to lengthen the original approach. The vastus muscles form a thick layer of muscles, which gets thicker the more the anterior incision is extended caudal.