Acetabular Orientation

Anterolateral Approach in the Supine Position

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Abstract The anterolateral approach in the supine position provides excellent visualization of the acetabulum. The main advantage of the approach, a low dislocation rate, has been demonstrated in the literature, while the purported disadvantage of abductor dysfunction has not been clearly delineated in the literature. The technique requires meticulous attention to preservation of the gluteus medius and minimus tendons. Impingement and dislocation are avoided by careful attention to the preparation of acetabulum, critical assessment of the implanted components, and intraoperative trialing. Leg lengths are assessed through direct palpation of the malleoli. Routine use of postoperative hip precautions is not necessary when this approach is utilized. The anterolateral approach in the supine position allows for a reproducible result with a low dislocation rate. **Level of Evidence:** Level V, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

Total hip arthroplasty is one of the most successful operations performed today. The positioning of the acetabular

component is a key to the success of the procedure. The goals of proper acetabular component placement are to optimize hip biomechanics, minimize the incidence of dislocation, and avoid impingement. These goals are affected by the surgical approach, the design of the implants, and the head-neck ratio of the femoral component. The design of the implants and the head-neck ratio are independent of the surgical approach. The approach is determined by the surgeon and is subject to his or her inherent biases based on training and experience. Therefore, the effect of the surgical approach on patient function, range-of-motion, and the incidence of impingement and dislocation is the subject of much debate in the literature.

The purported advantage of the anterolateral approach in the supine position is the low dislocation rate as compared to the other approaches. The main purported disadvantage is an increased incidence of abductor dysfunction and limp. The low incidence of dislocation has been clearly demonstrated in several studies [3, 6, 7, 14, 15], while the issue of abductor dysfunction and limp has not been convincingly proven [1, 3, 5–8, 10, 14, 19, 22].

In the literature, the surgical exposure and rationale for the approach is commonly described separately from the techniques of acetabular preparation, intraoperative assessment, and postoperative care. This article is a compendium of the rationale for the anterolateral approach in the supine position, a detailed description of the approach, the technique of acetabular preparation, intraoperative assessment, and postoperative care as it relates to this approach.

Principles and Goals

The goal of total hip arthroplasty is to relieve the patient's pain and to optimize their function. Appropriate placement

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of the acetabular component is paramount to this goal. Improper acetabular component positioning can lead to instability, accelerated wear, leg-length inequality, and impingement [2]. Instability can manifest as dislocation, a clearly measurable and identifiable endpoint. Impingement or subtle subluxation due to acetabular malposition may be more difficult to identify and their clinical significance is unknown. Some authors have theorized impingement can lead to increased rates of osteolysis and loosening [21, 25]. Acetabular positioning is particularly important in hard-on-hard bearing surfaces where edge loading may result in stripe wear [23] and squeaking [24].

The target for acetabular component orientation, in terms of reducing instability, has been quoted as $40 \pm 10^\circ$ of inclination and $15 \pm 10^\circ$, largely based on the study by Lewinnek et al. [9]. The version of the femur also plays an important role in stability and impingement. Ranawat and Maynard [18] suggested that the combined anteversion of both the acetabular and femoral components be 45° in women and 20° to 30° in men. The ideal inclination and anteversion is different for each patient, differing even between men and women [12]. This is especially true in patients with either acetabular or femoral deformities associated with dysplasia, the sequelae of pediatric hip disease, in patients with spinal deformities, or in post-traumatic degenerative joint disease. D'Lima et al. [4], based on computer simulation data, suggested that inclination between 45° and 55° when combined with "appropriate acetabular and femoral anteversion" maximized range of motion and stability. The optimal position of the acetabular component has yet to be determined; however, the goals of stability, range of motion, and avoidance of impingement remain paramount.

The operative approach also affects the planned orientation of the acetabulum, primarily anteversion. Patients in whom the posterior approach is utilized may benefit from a relatively increased anteversion angle whereas patients in whom the anterior approach is performed may benefit from a relatively decreased anteversion angle. Barrack [2] suggested that cup anteversion of 20° to 40° is more appropriate for the posterior approach and anteversion of 5° to 25° is more appropriate for the anterolateral approach. A study by Nishii et al. [16] found nine unstable hips performed through a posterior approach had a decreased anteversion angle as compared to 181 hips without instability. The type of bearing surface may also alter the ideal orientation of the component. Hard-on-hard bearing surfaces such as ceramic-on-ceramic and metal-on-metal may be more sensitive to edge loading [23]. Therefore, a more horizontal inclination angle with increased anteversion may be advantageous for these types of bearings.

However, for the vast majority of arthroplasty patients, our planned position is 40° of inclination and anteversion

of 15° . We define the acetabular component position in terms of the operative orientation as recommended by Murray [15]. The other definitions of orientation are the radiographic and anatomic, which can be converted via nomogram to the operative definition. How the definition of inclination and anteversion is reported is particularly relevant. For example, Lewinnek et al. [9] concluded that dislocation was more likely if the cup was anteverted more than 25° . However, as Murray states [15], if this was reported as the operative definition, this should have been reported as an increased incidence of dislocation with cup anteversion of more than 38° . This is an example of a paper widely quoted as the standard for acetabular component positioning which needs to be critically evaluated in order to draw valid conclusions.

Our starting point for our planned acetabular position is 40° of inclination and 15° of anteversion. However, if during intraoperative trialing there is evidence of impingement, instability, or leg-length discrepancy, the acetabular component position may need to be adjusted. Our technique for adjusting the acetabular component position will be documented in the operative technique section.

Anterolateral Approach (Supine Position)

One advantage of the anterolateral approach is that it provides a 360° view of the acetabulum and allows preservation of the integrity of the posterior capsular structures and short external rotators. The surgical approach may be extended for additional exposure if necessary. The reported dislocation rate with this approach has been reported as 0 to 2% [3, 6, 7, 11, 14], with an overall dislocation rate of 0.55% [13]. So-called "hip precautions" are not necessary when utilizing this approach for primary arthroplasty [17]. The purported disadvantage of limp has not been clinically substantiated. The incidence of limp for the posterior approach is 0 to 16% and 4% to 20% for the anterolateral approach [1, 3, 5–7, 14, 22]. The effect of the anterolateral approach on abductor function has been evaluated in several studies. Ritter et al. [19], in a clinical study, could not demonstrate a statistically significant difference in limp between the anterolateral and posterolateral approaches. However, another paper by Madsen et al. [10] examined the gait of THA patients 6 months after surgery as compared to control patients without hip pathology. This study demonstrated that 30% of patients who underwent THA via the posterolateral approach had a normal gait pattern while none of the patients who underwent THA via the anterolateral approach demonstrated normal gait patterns. The authors concluded that the clinical significance of this is unknown. A Cochrane Database review, in which only four

studies met the inclusion criteria, found that there was no difference in dislocation (only reported in two of the four studies) or presence of postoperative Trendelenburg gait between the posterior and anterolateral approach. The only significant difference was that of internal rotation in which the mean difference was 3° more for the posterior approach group [8].

Operative Technique

The authors prefer the use of spinal anesthesia [20]. The patient is positioned supine on the operating room table. A bump is placed under the sacrum with careful attention paid to avoiding pelvic tilt. There are several distinct advantages of the supine position over that of the lateral decubitus position. The supine position reduces pelvic tilt that is commonplace in the lateral decubitus position, it allows for easy intraoperative approximation of leg lengths by simple palpation of the malleoli, and it facilitates management of the patient by the anesthesia team. The floor, operating room table, and pelvis all serve as reference points for the orientation of the acetabulum. The operating room table must be able to be elevated to the eye level of the surgeon (approximately 160 cm). The acetabulum is templated prior to the start of the procedure. The planned position is 40° of inclination with the inferomedial edge of the cup at the inferior margin of the acetabular (cotyloid) notch (radiographically projected as the teardrop in the frontal projection) and the superolateral edge of the cup at the outer rim of the native acetabulum. It is important to remember that this template serves as a general guide to the size and position of the component. The surgeon must adjust to the 3-D environment of the patient's pelvis, rather than blindly commit to the templated component size. For example, some patients have less native acetabular coverage superolaterally and therefore the exact area of contact of the superolateral edge of the component with the native acetabulum will vary from patient to patient. Furthermore, variation in the magnification of the radiographs and the templates may not allow for accurate templating of the size of the component. It is important to utilize both templating and intraoperative landmarks to position the cup as accurately as possible for each patient.

We use an initial incision extending from the anterior third of the tip of the greater trochanter to a point several centimeters distal, along the diaphysis of the femur. This initial incision can be extended proximally (for femoral exposure) or distally (for acetabular exposure) as needed. The initial incision is made through skin down to the level of the fascia. At this point the subcutaneous fat is dissected bluntly off the fascia to maximize visualization of the fascia. Hemostasis is obtained. A Hibbs retractor is utilized

to retract the anterior soft tissues. The fascia is then split just anterior to the most prominent lateral aspect of the greater trochanter. The fascia lata is split distally and the fascia of the gluteus maximus is split proximally in line with the incision. The plane between the fascia lata/fascia of the gluteus maximus and the gluteus medius/vastus lateralis is developed. Slight external rotation of the hip allows for this plane to be more easily developed. The Hibbs retractor is utilized to retract the anterior fascia anteriorly. The anteroposterior aspect of the gluteus medius muscle is identified. The gluteus medius muscle is bluntly split at the junction of the anterior one-third and posterior two-thirds close to the greater trochanter. A blunt Hohmann retractor is placed behind the femoral neck, thus retracting the posterior two-thirds of the gluteus medius muscle. The Hibbs retractor is utilized to retract the anterior one-third of the gluteus medius anteriorly. Care should be taken not to extend the gluteus medius split more than 5 cm proximal to the tip of the greater trochanter to avoid damaging the superior gluteal nerve. The gluteus minimus is then identified. This usually requires removal of fat from the surface of the gluteus minimus. The superior capsule is incised along the posterior aspect of the gluteus minimus. This technique, capsular incision rather than capsular excision, maximizes exposure and stability and minimizes the potential for leg-length discrepancy. The Hibbs retractor is then moved to retract the fascia anterior to the vastus ridge. A 1-cm incision is made in the vastus lateralis, just distal to the vastus ridge and a blunt Hohmann retractor is placed anterior to the femur. The musculo-tendonous junction of the gluteus medius should be carefully identified. It is of paramount importance at least 2 mm of gluteus medius tendon should be left on the gluteus medius muscle. Failure to do so will compromise the repair of the gluteus medius. If necessary, the tendon can be taken directly off the greater trochanter and repaired through drill holes. The anterior third of the gluteus medius, the entire gluteus minimus, and the anterior half of the hip capsule are elevated anteriorly in one flap using electrocautery. External rotation and adduction of the hip in the so-called "figure of four" position help serve to place the anterior soft-tissues on tension and facilitate use of the electrocautery. The femoral head is then dislocated anteriorly and the neck osteotomized. Acetabular retractors are placed in the following sequence: anterior, superior, inferior. The anterior retractor is placed with the hip flexed so as to relax the anterior neurovascular structures, allowing safe placement of this retractor. The superior retractor (#5 Hohmann) is best positioned at the 10 o'clock position on a right hip (2 o'clock on a left hip). The initial inferior retractor is a double-angle type and is best placed into the ischium. The medial capsular structures are placed on stretch by this retractor. The medial capsule is then incised,

taking care not to violate the iliopsoas tendon. The visualization of the acetabulum is then assessed, and if deemed suboptimal, the double-angle is replaced with a double-footed retractor placed as medial as possible onto the ischium. An additional retractor, placed carefully under the posterior wall, is useful to completely visualize the acetabulum. The labrum and transverse acetabular ligament are then circumferentially excised. At this juncture, the surgeon should be able to visualize the entire periphery of the acetabulum prior to reaming (Fig. 1). Osteophytes must be resected to avoid misinterpretation of the acetabular anatomy and deflection of the reamers.

Once adequate visualization is obtained, the acetabulum is prepared to accept the acetabular component. First, the reamer is medialized to the medial wall of the acetabulum (Fig. 2) utilizing a smaller reamer (roughly 44 mm). Next, the location of the center of the acetabular component is determined and reaming proceeds in a sequential fashion until the inferomedial edge of the reamer is at the level of the inferior margin of the cotyloid notch, the medial aspect of the reamer contacts the medial wall, and the anterior and

posterior walls provide for a good press fit (Fig. 3). One should be able to move the patient's pelvis with the reamer in place. Furthermore, the bone should be assessed for a bleeding cancellous surface. If adequate cancellous bone is not exposed throughout the majority of the acetabular bed, ingrowth or ongrowth of the component may not be achieved. Once again, the surgeon should utilize the templated component size as a general guideline. The reamer should be 1 to 2 mm smaller than the anticipated size of the final acetabular component. The surgeon must be aware of the geometry of the acetabular component and the actual diameter of the final implant: the acetabular component may have an elevated peripheral rim or the stated diameter of the component may not include the thickness of the porous coating. Failure to recognize these details may lead to poor "scratch-fit," or conversely, to iatrogenic fracture.

Once the reamer has achieved two-point fixation, meaning the pelvis can be essentially moved anteriorly and posteriorly with the reamer handle, in a bed of bleeding bone it serves as the trial (Fig. 4). As aforementioned, the intraoperative reference points for acetabular orientation in

Fig. 1 360° exposure of the acetabulum is shown. A curette is placed in the teardrop.

Fig. 3 Sequentially larger reamers are utilized until two-point fixation is obtained in bleeding bone.

Fig. 2 The first reamer is medialized to optimize hip biomechanics.

Fig. 4 The reamer serves as a trial and is assessed for position and stability.

the supine position are the pelvis, the operating room table, and the floor. The anterosuperior iliac spines and pubic symphysis (which establish the pelvic plane) are palpated to assess for pelvic tilt. If pelvic tilt is noted, the patient's position is adjusted either by tilting the bed or adjusting the patient's pelvis. The reamer is then assessed for operative inclination and anteversion using the anterosuperior iliac spines, pubic symphysis, operating room table, and floor as reference points. The reamer is then evaluated to ensure that the medial wall is contacted, that the inferomedial edge is at the level of the inferior margin of the cotyloid notch, and that it is seated within the anterior and posterior walls. A reamer that has sufficiently large holes is necessary to assess contact with the medial wall or one can use a trial acetabular component.

Once the surgeon is satisfied that the trial is in optimal position in bleeding bone, the reamer is removed and the acetabulum is irrigated to remove any soft-tissue and bone fragments. The authors prefer a final component with clustered screw holes so that the press fit can be augmented with screws if necessary. The implant is checked for the correct size. A long-handled inserter is useful in that the handle serves as a means to assess the inclination and anteversion insertion angles (Fig. 5). Once the cup is impacted, the handle can be torqued anteriorly and posteriorly, as was done with the reamer, to test stability. The pelvis should be able to be moved with the insertion handle before the surgeon is satisfied that an adequate press fit is achieved. If there is difficulty achieving a press fit the acetabulum should be reassessed to ensure a hemispherical bed has been prepared. A trial component can be helpful in this regard. The acetabulum should also be inspected for fracture if the implant does not achieve press-fit stability. In the situation that the reaming is felt to be hemispherical and no fracture is found then supplemental screw fixation may be necessary to achieve a stable construct.

Fig. 5 The use of a long-handled impactor aids in orienting the surgeon to inclination, anteversion, and flexion in reference to the patient's pelvis, the operating room table, and the floor.

Once stable initial fixation is obtained, the inserter is removed and complete seating is confirmed through the inserter hole. The final component is assessed in same way as the trial. Suboptimal positioning should be corrected by adjusting the acetabular component position rather than through the use of an elevated rim liner. Elevated rim liners decrease the range of motion and may lead to impingement of the trunion on the elevated rim. This is often discovered during intraoperative trialing once the trial femur is placed. The position of the acetabular component needs to be critically assessed if the femur is impinging upon the acetabular component, if there is instability during the trialing process, or if an excessive leg-length discrepancy exists. Once the surgeon is satisfied with the orientation of the acetabular component, the final liner is then inserted. The femoral head size is determined by the bearing surface, patient-related factors, and the preference of the surgeon. The liner is impacted into place and the locking mechanism is checked (Fig. 6). The rim of the acetabulum is inspected for any residual osteophytes and attention is then turned to the femoral component.

Once the femoral component is implanted the hip is assessed for stability, impingement within a functional range of motion, and leg lengths. The hip is tested for stability and impingement in full abduction-external rotation, adduction-external rotation, and hip flexion-adduction-internal rotation. The surgeon's index finger is placed between the liner and head to assess for impingement and subluxation of the hip while these maneuvers are being performed. Leg lengths are easily assessed in the supine position without calipers or pins by directly palpating the medial malleoli. If the hip is unstable, impinges, or a leg-length discrepancy is present, the position of the acetabular and femoral component should be reassessed (Fig. 7). Malpositioned components should be corrected before lengthening the limb to achieve stability. Inclination and anteversion can be adjusted by using an impactor to

Fig. 6 The final liner is inserted.

Fig. 7 The components are evaluated for combined anteversion.

adjust the position of the component (if no screws have been placed). Superior, lateral, or inferior positioning of the component may require removal of the implant and repeating the reaming and trialing process.

Once acceptable stability, range of motion, and leg lengths have been achieved, careful attention is paid to closure. The anterolateral arthrotomy is approximated with absorbable sutures. The incision is closed in layers with careful attention paid to the gluteus medius and minimus tendon repair. The gluteus medius tendon and vastus lateralis is repaired to the cuff of tendon left on the greater trochanter and the gluteus minimus is repaired directly to the trochanter. If the gluteus medius was taken directly off of the greater trochanter then it is repaired to its insertion through drill holes in the greater trochanter. The fascia of the gluteus maximus and the fascia lata is repaired using interrupted sutures. The subcutaneous fat is approximated and the skin is closed with absorbable suture and staples or a running suture.

Postoperative Protocol

The patient may be mobilized rapidly after the surgery, bearing weight as tolerated. Weight bearing is not thought to have any effect on the gluteus medius and minimus repair as the majority of the gluteus medius is left intact with this approach. Traditional hip precautions are unnecessary when utilizing this approach: Peak et al. [17] reported a dislocation rate of 0.33% among 265 patients (303 hips), the sole dislocation occurring in a patient randomized to a hip precaution group. The vast majority of our patients are discharged to home on the second or third postoperative day solely based rehabilitation goals and progress to a cane by 2 weeks postoperatively. Most patients are able to discontinue the use of assistive devices by 6 weeks.

Discussion

This is a compendium of the technique for acetabular component implantation via the anterolateral approach in the supine position, the rationale for this approach, the rationale for the planned acetabular positioning, and a review of the literature related to dislocation and abductor function as it relates to this approach. The limitations of the literature include a lack of prospective, randomized studies that directly compare this approach to the posterolateral approach utilizing the same prosthesis in a similar population of patients. The literature also is inconclusive as to the ideal component position that should be planned for each individual patient. The literature available does demonstrate a low dislocation rate without clinically significant abductor dysfunction [1, 3, 5–7, 11, 14, 19, 22]. So-called hip precautions are not necessary when utilizing this approach [17]. Gait analysis has demonstrated that all patients who undergo THA via the anterolateral approach do not have a gait comparable to patients without hip pathology but the clinical significance of this is unknown [10]. As is the case with all surgical techniques, careful dissection and adequate exposure are keys to the success of the procedure. Intraoperative trialing to assess for impingement, stability, and leg lengths is essential and component positioning may need to be altered to optimize the outcome for the patient.

Based on this review, the anterolateral approach in the supine position offers excellent exposure, a low dislocation rate, and no clinically significant difference in abductor function or limp for patients undergoing total hip arthroplasty.

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