



# Fused hip conversion to total hip arthroplasty with the direct anterior approach: surgical technique on a regular surgical table under fluoroscopic guidance

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## Abstract

**Purpose** Conversion of a fused hip to a total hip arthroplasty (THA) is technically challenging due to the loss of anatomical references. Here, a reproducible technique using the direct anterior approach (DAA) with a regular surgical table under fluoroscopic guidance is described, which has several advantages over traditional such as lateral or posterior approaches.

**Methods** There were reported 11 cases of ankylosis hip that were converted to THA using the same surgical technique protocol. Clinical and radiographic outcomes were recorded at 3.2 years of follow-up. A detailed preoperative evaluation was performed, including a pelvis radiological evaluation and magnetic resonance image (MRI) to assess the integrity of the periarticular soft tissue and flexor muscles.

**Results** The DAA has considerable advantages, such as allowing more precise targeting during surgery, avoiding the risk of pseudoarthrosis due to the absence of a trochanteric osteotomy, preserving the abductors, and allowing an easier-to-use of intraoperative fluoroscopy due to the supine position. Besides, the use of a standard table reduces surgical time and allows assessment of limb length, hip stability, and impingement in all planes in an intraoperative dynamic range, which decreases postoperative complications.

**Conclusion** Conversion from hip fusion to THA is a rare and complex procedure. The use of DAA with a standard table and fluoroscopy helps to avoid high complications since it allows a dynamic intra-operative examination of the range of motion to rule out impingements, reduces the risk of dislocation, and allows leg lengthening verification.

**Keywords** Hip arthrodesis · Total hip arthroplasty · Direct anterior approach · Fluoroscopy · Standard table

## Introduction

The fused hip has been used throughout orthopaedic history for treating complex hip injuries, especially in young patients [1, 2], with reproducible results in pain relief and improved function. Currently, it is a procedure that has fallen into disuse, mainly due to prolonged survival of total hip arthroplasty (THA), as well as the improvement of surgical techniques and implants in revision surgeries [1, 2].

The conversion of a fused hip to a THA is indicated when secondary degenerative involvement of the adjacent joints occurs, causing severe pain and affecting the patient's quality of life [3–6]. It is a technically challenging procedure due to secondary changes in soft tissue and bone, leading to a loss of anatomical landmarks.

Traditionally, the most used approaches for this surgical procedure have been lateral, or posterior, with greater trochanter osteotomy [1, 2]. Only a few studies have described the direct anterior approach (DAA) for converting a fused hip to a THA [1–3].

The DAA is an excellent option for several reasons. First, the patient's position in decubitus supine enables the use of fluoroscopy easily and reproducibly during the surgery in different steps. This allows checking and correcting errors related to the pre-operative plan about the acetabular reamer or femoral broach without massive irradiation to the patient

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or the surgeon [3, 7]. Furthermore, most patients with a hip fusion have a lot of previous surgeries, usually posterior; therefore, the anterior approach can allow an optimum vision of the bony fusion between the femur and iliac bone. Besides, the posterior approach also carries additional risks such as a trochanteric osteotomy, which could progress to a pseudarthrosis, or tissue damage in the posterior muscles of the hip [1]. Finally, the DAA gives more stability to the hip prosthesis in patients with a higher risk of dislocation due to weakness and atrophy related to the absence of articular mobility [1–3].

The following describes our surgical technique protocol for the conversion of a fused hip to a THA by the direct anterior approach (DAA) with a regular operating table and fluoroscopic guidance.

## Surgical technique

### Pre-operative planning

A detailed medical record is performed, including information on the reason for the hip fusion and surgical complications. A complete physical exam should include knee and spine evaluation and wait for analysis and leg length discrepancy.

Radiological evaluation includes a standing anteroposterior X-ray pelvis for digital THA templating (Fig. 1a, b) and telemetry of the lower extremities to evaluate for additional leg deformities. A pelvis computed tomography scan helps to confirm bone fusion and guide for femoral/acetabular

anteversion (Fig. 1). A non-anatomical position of the bone fusion can be ruled out, or the best approach for each case can be decided if it is present. Additionally, a pre-operative 360-degree 3D model is printed from the CT images to guide and evaluate the intra-operative femoral neck osteotomy. The model is sterilized to give support during surgery. A magnetic resonance image of the hip is included in the protocol to evaluate periarticular soft tissue integrity, especially hip abductor and flexor muscles (Fig. 1d).

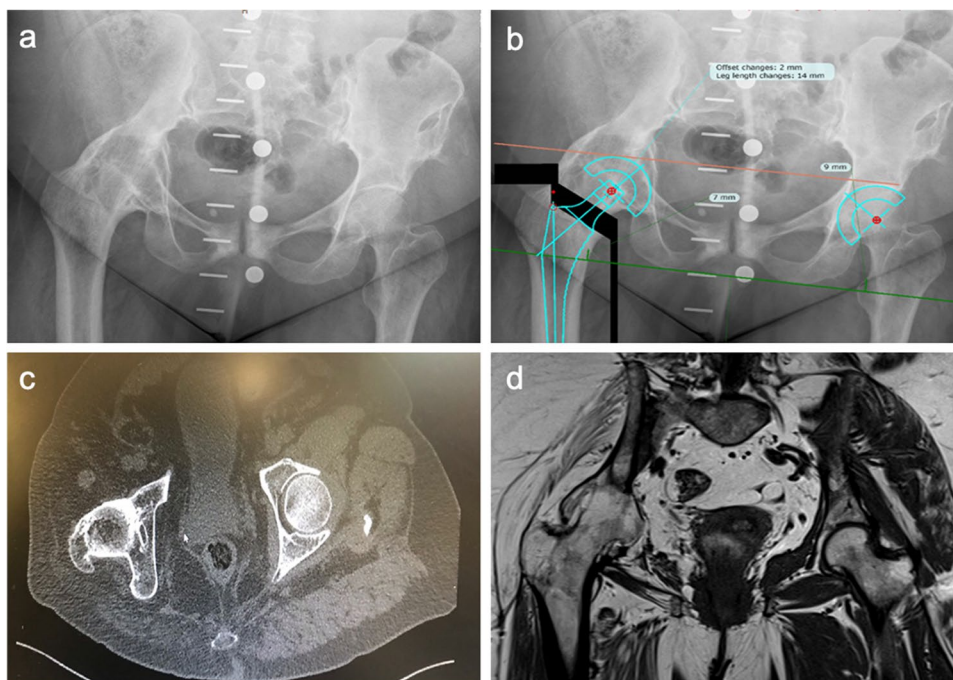
Finally, an electromyogram should be performed to check the function of the gluteal nerve and rule out damage during previous surgeries. In case of conduction abnormality or non-anatomical sciatic situation, it is preferable to perform a posterior approach to dissect the sciatic nerve.

### Surgical sequence

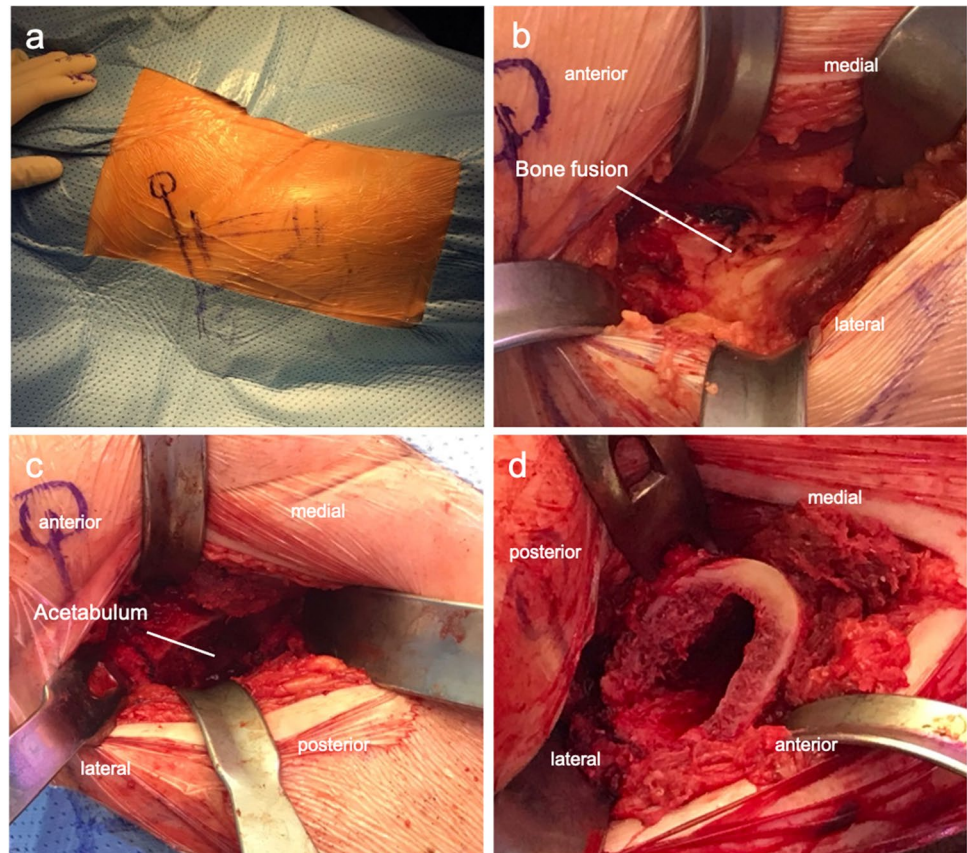
#### a. Positioning and approach

The patient receives general anaesthesia. Due to the complexity of these cases, antibiotic prophylaxis is performed with cephalosporin of first generation, such as cefazolin. The patient's position is supine, on a regular radiolucent table Maquet®. Both extremities are draped with an anterior approach draping EsySuit® by MedEnvision®. A standard straight incision of 8 cm is made, beginning in the middle point of the line between the anterior iliac superior spine and the tip of the great trochanter, following the way of the fibular head centred over the tensor fasciae latae (TFL) (Fig. 2). A standard DAA was completed like the paper by Ong and York [8, 9].

**Fig. 1** Pre-operative images. **a** AP view of the pelvis calibrated with KingMark®. **b** Planning with TraumaCad®. **c** Axial pelvis CT plane. **d** Coronal plane T1 MNR with atrophy of the abductors



**Fig. 2** Surgical images. **a** Skin landmarks, EIAS, great trochanter, inguinal fold, and skin incision line. **b** Mass bone of fusion without capsule. **c** Acetabular vision after the double neck osteotomy. **d** Femoral canal worked (femur approach)



The face of the proximal femur is exposed through a complete anterior H-capsulectomy. A peculiarity of this type of patient is a thin and atrophic capsule due to the lack of articular mobility. Once the anterior aspect of the bone mass of the fused hip has been exposed, locate the osteotomy level according to the pre-operative planning (Fig. 2). The main anatomic reference is the tip of the trochanter and its union with the femoral neck (lateral level of osteotomy), and the medial level of osteotomy is guided by fluoroscopy (Fig. 3). A double osteotomy with another sub-capital cut is made. The osteotomy is performed with an oscillating saw. However, if a close position of the sciatic nerve with the bone fusion has been confirmed, it is safer to carry out the osteotomy with a Gigli saw or osteotome.

#### b. *Preparation of acetabulum*

After the neck osteotomy has been performed, there is enough space to work the acetabulum. The main problems related to the acetabulum are locating its level and recognizing the correct way of reaming to avoid excessive reaming on the posterior or anterior wall. In this type of deformity, there is no true acetabulum and work must be done from a bone mass. If the previous fusion was made in anatomical position, the reference of the acetabulum is given by the femoral neck cut, but in the cases of non-anatomical position, it is useful de fluoroscopy to

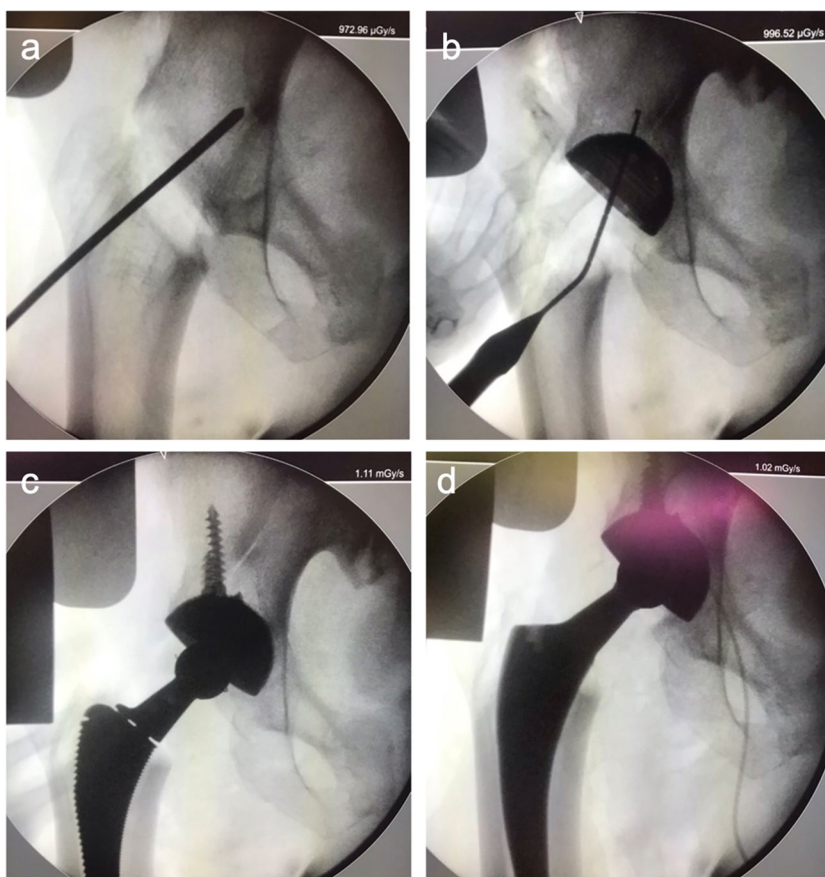
localize the true acetabulum. Retractors were placed on the posteroinferior wall, anteroinferior wall, and roof of the acetabulum (Fig. 2). To understand the true anatomy of the acetabulum a Steinman or K-wire and fluoroscopy is useful, which also guides the medial limit of the reaming, before starting and during the acetabulum reaming, it is very important to consider the bone reserve on the anterior and posterior wall for each case.

Direct fluoroscopy is preferred throughout acetabular reaming for optimum direction and medialization of reaming (Fig. 3).

#### c. *Femur preparation*

Fused hip patients present muscular and capsular atrophy due to a lack of joint movement. This feature is significant for the time of femur release. Femur preparation begins with the key step of releasing the superomedial capsule. An L-shaped release was performed with the aid of hook bone traction. When it is certain that capsule release is complete, the elevator retractor is placed below the greater trochanter, and two more retractors are placed on the posterior and anterior cortex of the femur. With the retractors placed, the lower extremity is positioned in adduction and external rotation under the contralateral extremity (4th position). If the femur raise is inadequate to work it, a leg drop can be done

**Fig. 3** Fluoroscopy intra-operative. **a** Steinman helps to localize true acetabulum with intra-operative fluoroscopy. **b** Definitive cup orientation. **c** Definitive broach. **d** Definitive prosthesis



to improve it. A slightly curved canal finder is used. Once it is achieved, the femoral broaching begins. The fluoroscopy is used when we have a mismatch of pre-operative planning and intra-operative sequence or in the final broach to check its orientation on AP and axial plane (Fig. 3). Once the definitive broach is in place, the limb length discrepancy, the articular tension, and the range of motion and stability are checked (Fig. 4).

### Clinical experience

A total of 11 cases of ankylosis hip were converted to THA by the hip surgeons of the Orthopaedic Surgery Department at one centre between 2017 and 2021 using the same surgical technique protocol. The mean follow-up was 3.2 years, with a minimum follow-up of 15 months. All patients were seen pre-operatively, then clinically and radiographically assessed post-operatively at six weeks, three months, six months, and then annually. This cohort was made up of 63.6% male (7 cases) and with a median age of 56 years (range 41–67). The most common reason for ankylosis were six post-traumatic lesions (54.5%), three infection sequelae (27.3%), and two tuberculosis



**Fig. 4** Post-operative X-ray

(18.2%). Six patients decided to undergo surgical treatment due the lumbar pain (86%), two were due to ipsilateral knee pain (71%), and three were due to lumbar and ipsilateral knee pain (27.3%). All cases described in this article followed the same post-operative protocol.

The medium time of surgery was 143 min (range 124–165). There were some complications during the

follow-up: one acute infection, one aseptic femoral stem loosening, and three patients presented mild periarticular ossifications. The acute infection was resolved by DAIR surgery, and aseptic loosening of the femoral stem required a single-stage revision surgery using a cemented hip stem.

The mean pre-operative Harris Hip Score (HHS) was  $31.3 \pm 7.6$  (range 18–50), and the mean HHS at the final follow-up was  $76.9 \pm 7.6$  (range 52–97) (Fig. 3). There was a statistically significant increase in HHS ( $p = 0.0001$ ). Trendelenburg sign was positive in nine hips. In 6 patients, there was inequality in limb length (mean 0.4 cm, range 1 to 3 cm). Thanks to intra-operative fluoroscopic control, no patient presented malposition of the femoral stem. The mean acetabular inclination angle was 39.6 (range 28–55).

## Discussion

Conversion from hip fusion to THA is a rare procedure, less than 1% of all THAs [1]. Besides, the most common indications for conversion to THA are back pain (60%), ipsilateral knee pain (30–75%), contralateral knee pain (15–30%), and contralateral hip pain (15–30%). Other consequences of hip fusion are limping, limb length discrepancy, and inability to sit [2, 5, 11].

This procedure is a highly challenging surgery with complication rates closer to revision THAs than routine THAs [4, 5]. Jain et al. have reported adverse event rates of up to 54% for fused hip conversions [4]. The most frequent complications are aseptic and septic loosening, as well as dislocations. Vascular and nerve injuries and fractures have also been observed [4, 6, 10].

The trans-trochanteric approach is the most used surgical approach for conversion [4]. However, we believe that the DAA signify an important advantage for the conversion procedure since implies the absence of trochanteric osteotomy, no damage to the abductors, and a lower dislocation rate. Likewise, the supine position allows easier-to-use fluoroscopy, which is a very useful tool in orthopaedic surgeries. For example, Ji and Stewart compared the orientation of implants assisted with fluoroscopy in the supine vs. posterior position, concluding that a more exact orientation is

achieved by DAA [3]. In this sense, previous studies show that without trochanteric osteotomy, the risk of pseudoarthrosis is avoided and immediate weight-bearing is allowed [1, 2]. However, in our cases, assisted walking has been allowed in the immediate post-operative, without any abduction brace, also showing optimal recovery results.

The DAA allows blank anatomy and preserves the abductors, decreasing the post-operative Trendelenburg walk, which according to Jain observations may even be at 45% [4]. In this sense, Scemama et al. concluded, only with 37 cases, that this approach is a good alternative because provides a better acetabulum view without trochanteric pseudoarthrosis risk [1]. Also, Tamaki et al. presented a case series of nine patients and concluded that DAA let a more precise implant orientation [2].

While Scemama et al. describe a DAA in hip fusion with a traction table [1], Tamaki et al. do it with a regular table [2]. Our surgical technique also is on a standard table and we think it has some important advantages in this procedure. The reduction of surgical time is very important in these complex surgeries that already involve long operating times. In a sense, a major systematic review of traction vs standard table in DAA indicates that mean operative time is almost 30 min shorter in the standard table compared to the traction table group [12]. As Sarraj commented, that difference was related to less blood loss because the estimated blood loss was 150 mL less in the standard table group [12].

Probably, the most important advantage of the regular table versus the traction table in these patients is the ability to assess limb length against the contralateral [6] and, especially, the ability to perform an intra-operative dynamic range of motion testing to assess hip stability and impingement in all dimensions. This can help to reduce the risk of dislocation, which is especially high in this type of patient. Although a fair amount of stability is inherent in the DAA from the preservation of critical muscular attachments around the hip, intra-operative assessment of hip stability and possible impingement is critical. Individual patient anatomy may necessitate more anteversion, offset, or length, which cannot be fully assessed while locked to orthopaedic table rails (Table 1) [13].

**Table 1** Comparison of benefits associated with bed selection for direct anterior approach in total hip arthroplasty (Adapted from ICJR REWIND) [13]

Benefits of orthopaedic traction table	Benefits of a regular OR table
<ul style="list-style-type: none"> <li>○ Allows for hip hyperextension</li> <li>○ Allow for hydraulic elevation of femur</li> <li>○ Can precisely dial, set and lock hip extension, rotation, and adduction</li> <li>○ Radiolucent</li> <li>○ Supine positioning facilitates fluoroscopy</li> <li>○ Can also be utilized for fracture and pelvic trauma cases</li> </ul>	<ul style="list-style-type: none"> <li>○ Allow for full, dynamic motion with the leg draped free, facilitating intraoperative assessment of hip stability, impingement, and ROM</li> <li>○ Allows for direct assessment of leg length at the ankle and heel</li> <li>○ No additional acquisition expenses</li> <li>○ No extra set up time</li> <li>○ Fluoroscopy can be used if table is radiolucent</li> </ul>

The main value of the traction table is the help of hydraulic assistance to expose the femur. In most of these patients, there is significant muscle and capsular atrophy around the fused hip, due to a lack of joint movement, so the release of the capsule and femur exposure is not usually a difficult step.

It should be noted that the anterior approach does not always provide a surgical solution to the hip fusion. Like other procedures in orthopaedic surgery, an individual evaluation must be considered. In this sense, as has been pointed out previously, a proper study of the hip abductor with a CT or MRI scan is essential in this procedure. Hip arthrodesis can be the consequence of multiple surgeries or adverse events, with some peculiarities or damages different from each case, so we must be able to adapt the best approach to each case. For example, in case you need to perform a muscle transposition or remove previous hardware, you can use a different approach or combine them.

## Conclusions

The hip fusion conversion to THA is an extremely rare and complex procedure that has high complication rates, higher than a routine THA. Therefore, any advance in the technique that facilitates the procedure and improves the results must be considered. In this sense, we think the DAA has significant advantages in these patients, such as preserving the abductor muscles, lower rates of dislocations, and the facility to use intra-operative fluoroscopy. Besides, our experience supports that the use of a standard table allows several technique advantages, such as performing a dynamic intra-operative examination of the range of motion to rule out impingements and reduce the risk of dislocation, in addition to checking the leg lengthening.

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**Data availability** Not applicable. This manuscript describes a surgical procedure, and no data is processed.

**Code availability** Not applicable.

## Declarations

**Consent for publication** The authors affirm that human research participants provided informed consent for publication of all images in Figs. 1, 2, 3, and 4.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

**Conflict of interest** The authors declare no competing interests.

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