



# Renew of the DAA [Direct Anterior Approach] to the Hip Joint

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## Abstract

This research was initially carried out at the University of Liverpool, UK in 1981. This is a posterior trochanter splitting approach to the Hip Joint by maintaining all the advantages of the Posterior Approach with excellent visualization of the Hip Joint. This was then used in patients with a fracture neck femur for insertion of an endoprosthesis. The “word dislocation” has been looked as a unacceptable/inadequate/ banned as constituting a risk/ not acceptable to mention associated with mainly the Posterior Approach in Surgical Approaches to the Hip Joint over 5 decades. The DAA [Direct Anterior Approach] can be done on a plain table or a fracture table according to each Surgeons wishes. The anterior approach has a slight advantage when it comes to early recovery, no infection or dislocation and minimal degree of muscle damage. The younger generations of Orthopaedic Surgeons in the world should embrace the DAA [Direct Anterior Approach] even for the most commonly seen Fracture neck of femur initially instead of straight embarking on Primary or Revision Total Hip Arthroplasty. The DAA may appear to have a very steep and difficult learning curve in the beginning, but with practice and using this DAA, it appears as an excellent substitute for the Posterior Approach to the Hip Joint.

**Keywords:** Hip Joint; Trochanter; Endoprosthesis; Arthroplasty; Bipolar Hemiarthroplasty

**Abbreviations:** DAA: Direct Anterior Approach; TO: Trochanteric Osteotomy; THA: Total Hip Arthroplasty; AAOS: American Academy of Orthopaedic Surgeons ; HOD's: Heads of Departments.

## Introduction

When the viability of the femoral head is needed/required such as in Fracture repair or Hip Resurfacing, the medial circumflex artery and its ascending branches must be protected as much as the muscles Piriformis, Obturator internus and the Gamelli along with the attachments of the Obturator externus and Quadratus femoris.

This modification was named by my respected teacher Mr. FH Beddow, Senior Consultant Orthopedic Surgeon, University of Liverpool, UK as the Iyer modification of the Posterior

Approach to the Hip Beddow FH, et al. [1]. Thomas Stahelin of Zurich, Switzerland quoted in his article [2]. Emiritus Robert H Cofield, et al. [10]; when he was earlier before he settled permanently as a Shoulder Surgeon in the USA was extremely happy with this approach. Surgical approaches to the hip may be broadly classified as: anterior; anterolateral; lateral; posterior; medial; lateral subtrochanteric and proximal femoral shaft Ranawat CS, et al. [4].

A number of approaches such as Gibson, Henry, Kocker and Langenbeck are classified as posterior which involve posterior retraction of the gluteus maximus to enter the posterior aspect of the hip and the release or section of the short external rotator muscles to enter the hip joint. The posterior approach is unanimous in offering the advantages of reduced blood loss, early post-operative recovery and a reduced hospital stay. The main argument against the use

of posterior approach is an increased risk of dislocation following hip replacement surgery Steven AS, et al. [5].

This was the only reason why at that time in 1981, a cadaveric study was undertaken as described later on in this article. The Modified Posterior approach offers excellent exposure while preserving stabilizing soft tissues [3]. The results of our study showed that the incidence of complications were much lower after bipolar hemiarthroplasty Stanley H, et al. [6]. I would also embrace the DAA [Direct Anterior Approach] approach to replace the traditional Posterior surgical to the Hip Joint.

The posterior approach is the most common and practical of those used to expose the hip joint. Popularized by Moore, it is often called the southern approach. The traditional Posterior surgical approaches Somashekar, et al. [7] leave the abductors undisturbed but have been associated classically with a higher rate of postoperative instability [8].

The author's original paper K Mohan Iyer, et al. [9] written over 40 years ago presented an original technique devised to confer greater stability to the hip joint posteriorly to minimize the greater incidence of dislocation which has been reported extensively in literature.

The author started with his research in 1981 and is seen in many textbooks of repute such as

1. The Year Book of Orthopaedics 1982-Mark B. Coventry, pages 371-373.
2. Campbell's Textbook of Operative Orthopaedics, 12th Edition, by S. Terry Canale and James H. Beaty, Page No.331. Terry CS [16] had also given me a forward for my book The Hip Joint[1st edition] as seen on his website at kmohaniyer.com.
3. Surgery of the Hip, Elsevier, Mosby/Saunders, Volume 2, by Daniel J. Berry and Jay R. Lieberman, Page No.269.
4. The Adult Hip(Lippincott-Raven)(1998), Volume 1, Callaghan, Rosenberg and Rubash, Pages:700-701,718.
5. The Hip by Richard A. Balderston [Lea & Febiger: My original work has been quoted on page no.90.
6. Surgery of the Hip Joint by Raymond G Tronzo: Ref. no.187: (Page no.333): Fractures of the Hip in Adults: My original research on the Hip Joint has been quoted.
7. William J Hozak, Martin Kirsmer, Michael Hogler, Peter M Bonutti, Franz Rachbauer, Jonathan L Scaffer, William J Donnelly(Editors).

## Methods

A cadaveric study was undertaken with Dr. Martin Elloy, PhD, University of Liverpool, UK was mainly to compare, with respect to stability of the hip joint, this approach with that

after the Southern Approach as described by Austin Moore (1957). The pelvis was fixed to a device which measured the ranges of flexion and extension, adduction and abduction and internal and external rotation of the hip being tested. The strength of fixation of the reattached trochanter was assessed by applying the standard dislocation manoeuvre. Figure 1-3 show the test being carried out in 3 cadavers obtained within 15 hours of death with prior permission of the relatives.



**Figure 1:** Device used to test stability of the hip joint showing pelvis fixed and protactors to measure the angle of flexion/extension, adduction/abduction and internal/external rotations (Courtesy: Photograph reproduced with the kind permission of Injury/Elsevier).

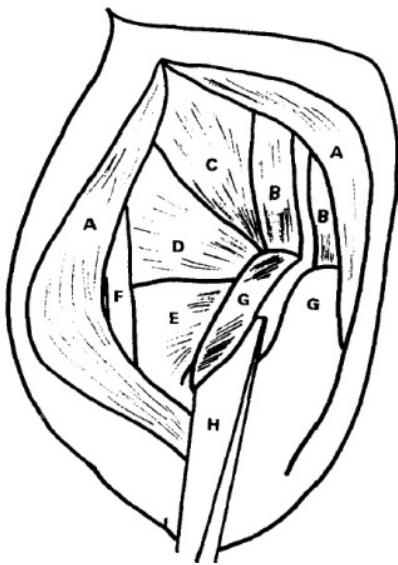


**Figure 2:** Device used to test stability of the hip joint showing pelvis fixed and protactors to measure the angle of flexion/extension, adduction/abduction and internal/external rotations (Courtesy: Photograph reproduced with the kind permission of Injury/Elsevier).



**Figure 3:** Internal rotation torque being applied when the hip joint was standardized to a fixed angle of flexion and adduction (Courtesy: Photograph reproduced with the kind permission of Injury/Elsevier).

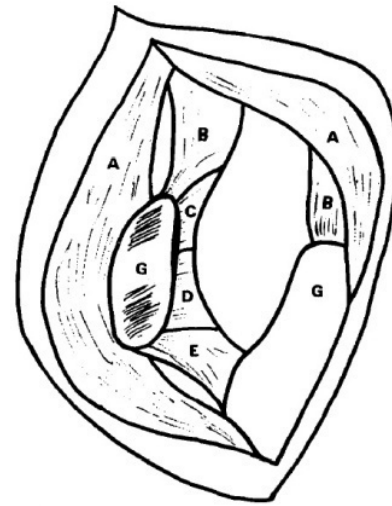
Results of the cadaveric study: In one cadaver the hip exposed by the Southern approach disrupted at 30 Nm with breakage of all sutures in the lateral rotators together with dislocation of the prosthesis, while the other hip exposed by this approach withstood a torque of 50 Nm after which it dislocated, leaving the trochanteric fixation and the sutures in the gluteus medius intact.



**Figure 4:** Line Diagram showing the osteotomy of the posterior overhanging part of the greater trochanter: (Courtesy: Line Diagram reproduced with the kind permission of Injury/Elsevier): A: Gluteus Maximus; B: Gluteus Medius; C: Piriformis; D: Triradiate Tendon; E: Quadratus Femoris; F: Sciatic Nerve; G: Greater Trochanter; H: Osteotome.

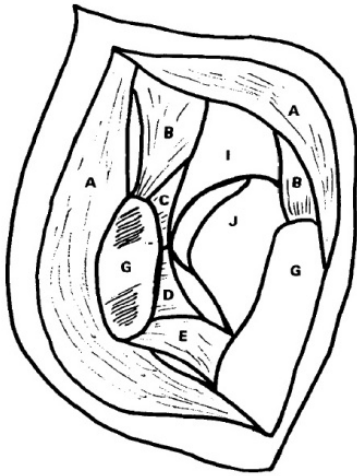
The muscles now seen converging on the greater trochanter from above downwards are Gluteus Medius; Piriformis; Obturator Internus, flanked by the superior and inferior gaemelli; quatratus femoris, and the upper edge of the adductor magnus. All these muscles lie edge to edge, with the sciatic nerve well away from the insertion of the short lateral rotators (Figure 4).

The posterior borders of the gluteus medius in the upper part and the quadrate tubercle with the lower border of the quadrate femoris in the lower part are then identified. The greater trochanter is cut through so that the detached part includes the insertion of the following structures. From below upwards these are quatratus femoris, obturator internus with the inferior and superior gaemelli, piriformis and the posterior third of the fibres of the gluteus medius. The osteotomy extends from the junction of the posterior third and anterior two-thirds of the lateral border of the greater trochanter obliquely downwards and posteriorly to the shaft of the femur just distal to the quadrate tubercle (Figure 5).

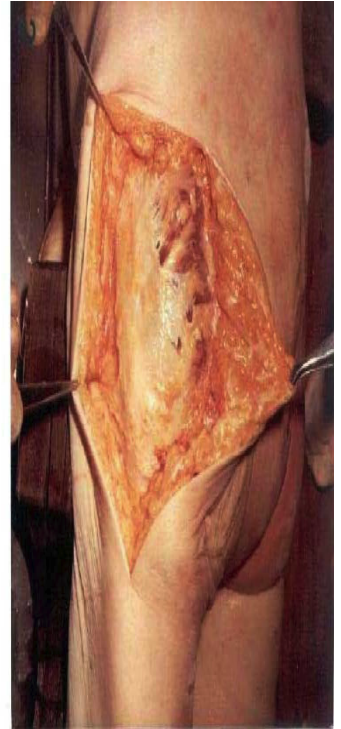
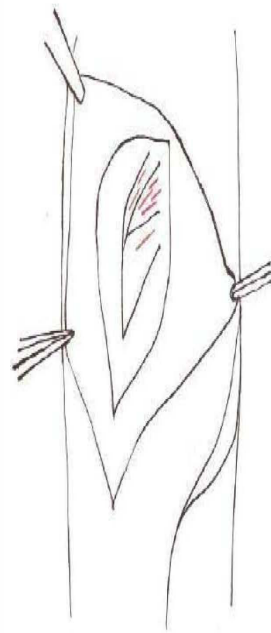


**Figure 5:** Line Diagram showing the osteotomy completed and the flap retracted. (Courtesy: Line Diagram reproduced with the kind permission of Injury/Elsevier); A: Gluteus Maximus; B: Gluteus Medius; C: Piriformis; D: Triradiate Tendon; E: Quadratus Femoris; G: Greater Trochanter.

The posterior triangular flap containing the overhanging posterosuperior part of the greater trochanter at its apex is then dissected free and turned down to expose the capsule of the hip joint (Figure 6).



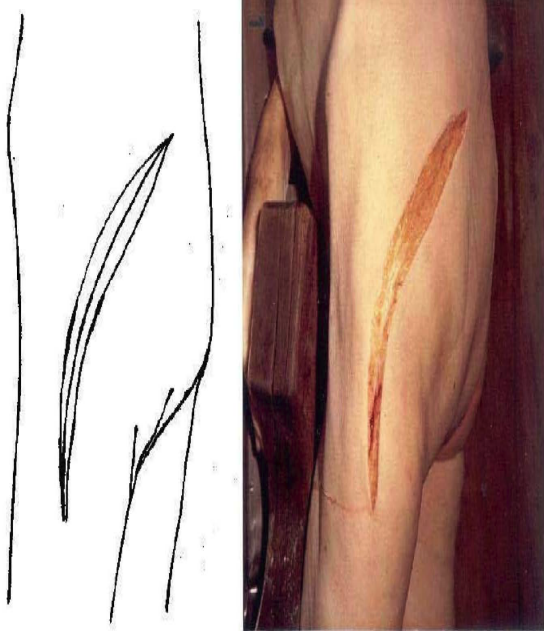
**Figure 6:** Line Diagram to show that the Osteotomy is completed and the flap retracted, after incising the capsule to expose the Hip Joint, (Courtesy: reproduced with the kind permission of Injury/Elsevier) Line diagram showing the following structures: A: Gluteus Maximus; B: Gluteus Medius; C: Piriformis; D: Triradiate Tendon; E: Quadratus Femoris; G: Greater Trochanter; I: Acetabulum; J: Femoral Head.



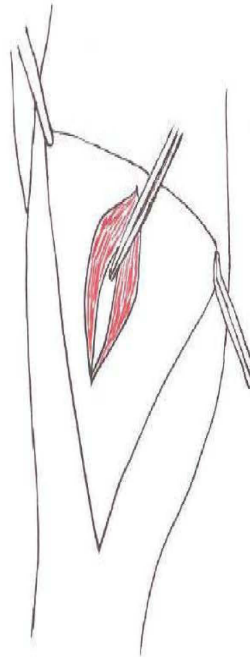
**Figure 8:** Step 2-Gluteal Fascia.

### Clinical Technique

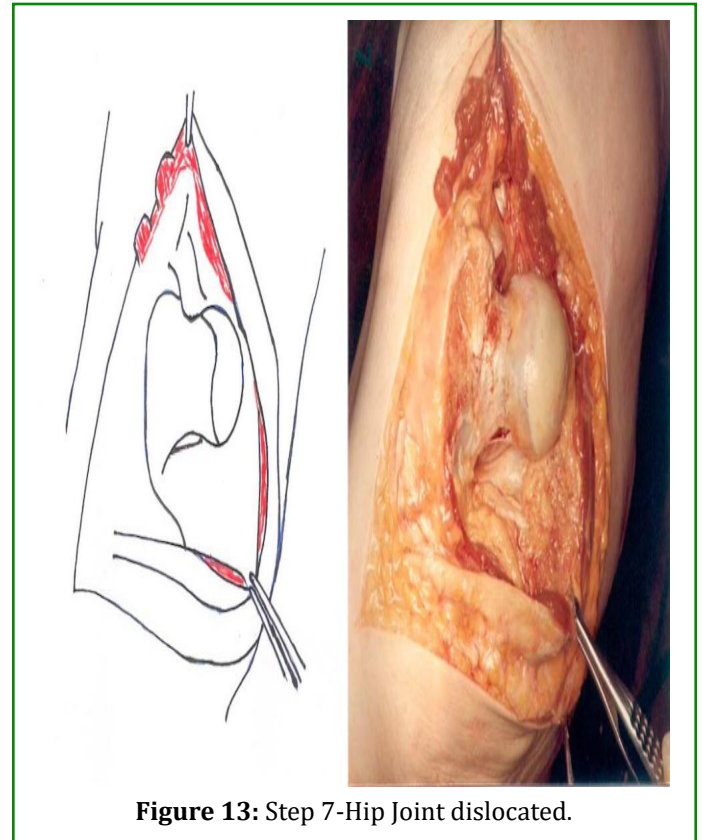
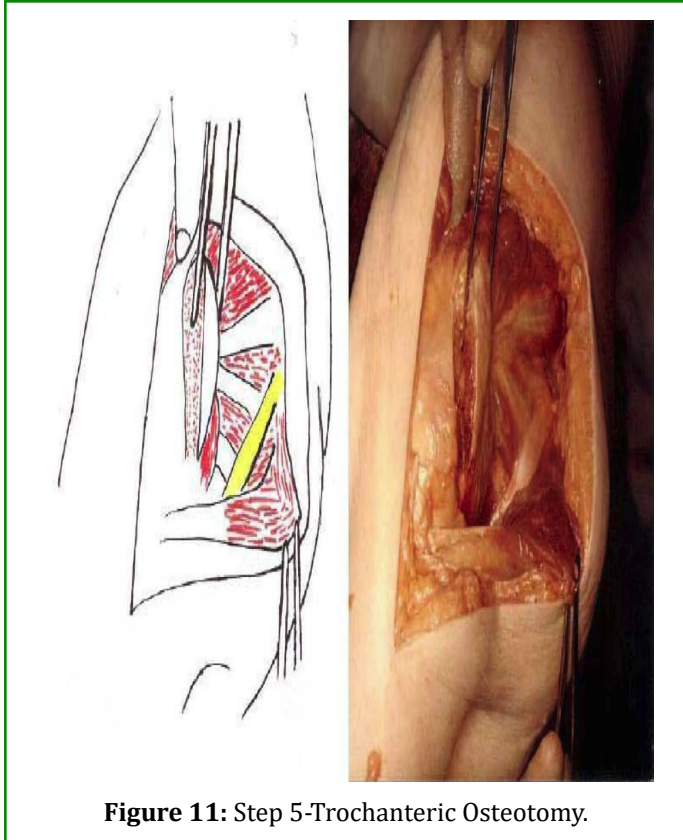
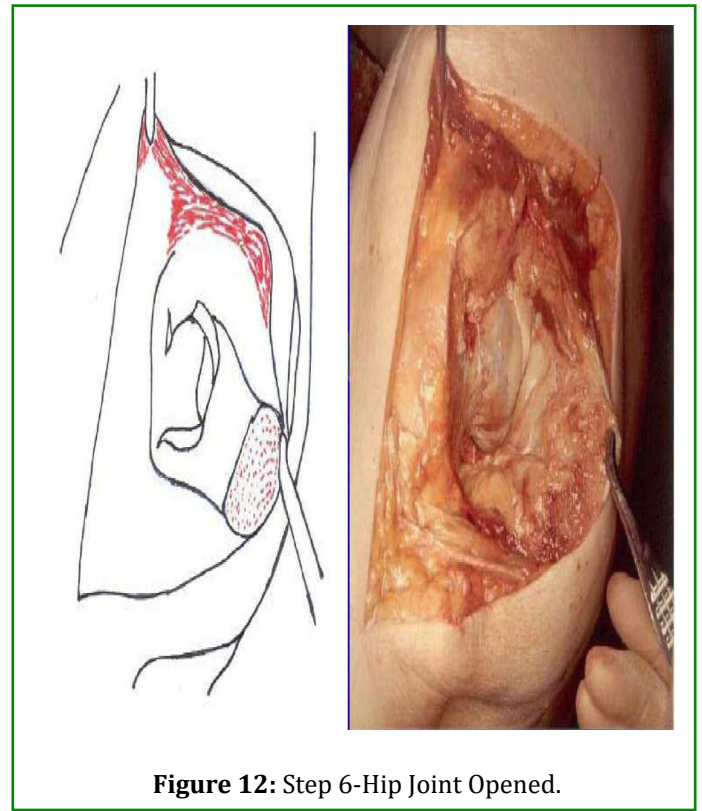
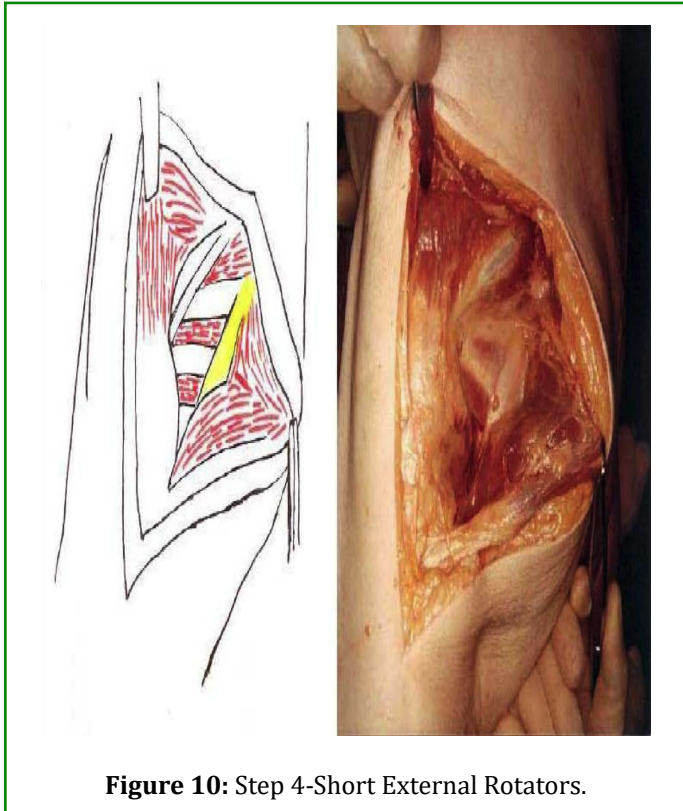
The detailed Clinical Technique stepwise in 11 steps is as described as below:

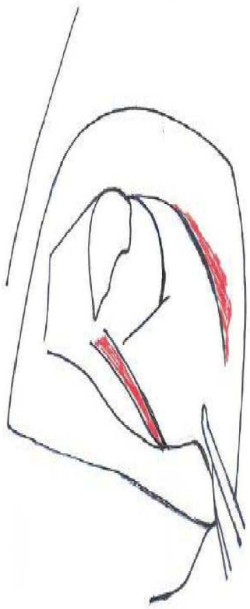


**Figure 7:** Step 1-Skin Incision.

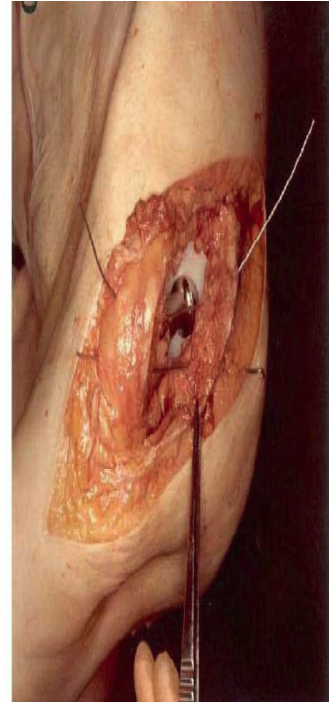
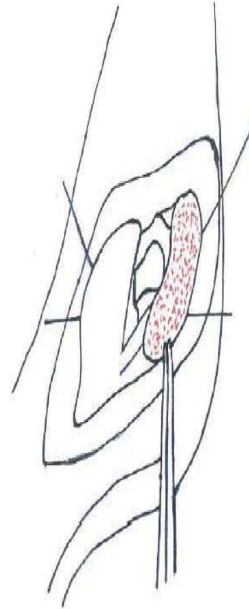


**Figure 9:** Step 3-Gluteus Maximus.

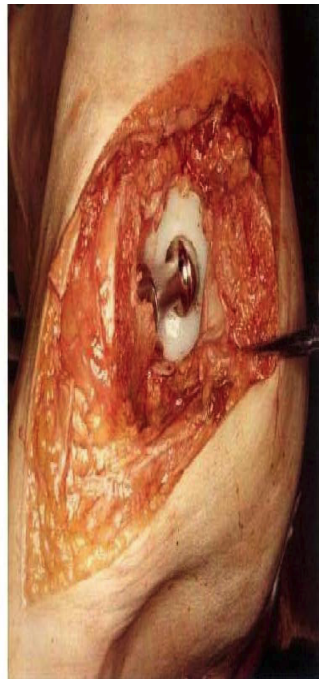
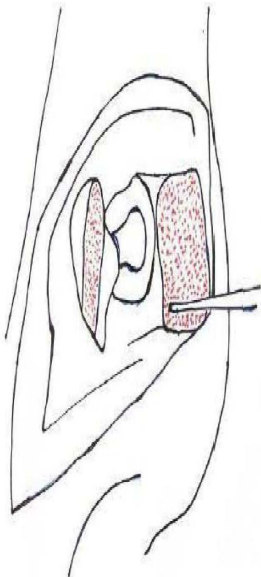




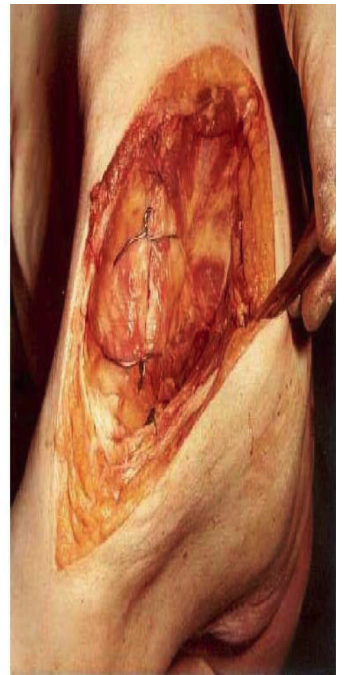
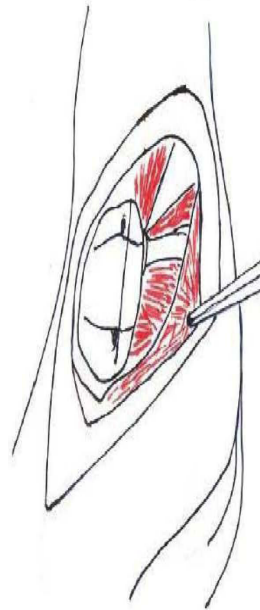
**Figure 14:** Step 8-Head and Neck resected.



**Figure 16:** Step 10-Wiring of Trochanteric Fragment.



**Figure 15:** Step 9-Total Hip Prosthesis inserted.



**Figure 17:** Step 11-Hip Joint Reconstituted.

## Results

Check X-Rays were taken at the end of the operation.



**Figure 18:** Radiograph of Total Hip Prosthesis.



**Figure 19:** Radiograph of a Thompson's Hemiarthroplasty.



**Figure 20:** Radiograph of a Bipolar Prosthesis.

It was first published by Jaoquin S, et al. [10]. Total no of patients: 44. Dislocation- Nil. Thomas S, et al. [2] confirmed that dislocations were extremely high at 70% which occurred within the first postoperative day. They also concluded that bone to bone reattachment as done in this approach is more secure, as proved by the cadaveric study.

Mayo Clinic Robert C, et al. [10] Figure 10 conducted a study of 68 consecutive cases by the Modified Posterior Approach to the Hip Joint. There were no cases of late instability. Posterior approach to the hip joint through a posterior trochanteric osteotomy is associated with high union rates and a low rate of late instability after hip replacement.

Trochanteric Osteotomy techniques can be generally divided into standard, slide, and repeat osteotomy groups. The standard osteotomy may be oblique or posterior. The standard TO be originally popularized for use in hip arthroplasty by Charnley J, et al. [11,12].

## Discussion

The Hip Joint is very weak at the posterior envelope which contains the short lateral rotators. This point has been reinforced by various authors on dislocation of the Hip Joint. There are numerous anatomical variations in the tendons of piriformis and obturator internus which could result in

piriformis sparing approaches to the hip [13,14].

Mark BC, et al. [15], (Campbell's Operative Orthopaedics, 9th Edition, 1992) Terry CS, et al. [16], (The Adult Hip, 1998) Callaghan JJ, et al. [17] stress on the excellent exposure of both the acetabulum and femoral shaft achieved with this approach in being applicable to both revision arthroplasty and complex primary arthroplasty. Beddow and Tulloch reported on their experience using this approach in 220 cases of primary total hip replacement in which there were only 2 cases of dislocation [1].

In procedures where the femoral head is not sacrificed, such as drainage of the hip, reduction of a posterior dislocation, removal of fragments from the joint, repair of acetabular fractures, or resurfacing procedures, special care must be taken to avoid injury to the medial circumflex and retinacular vessels.

In this Modified Posterior Approach to the Hip Joint, bleeding is minimal, because the plane of cleavage through the gluteus maximus is through its middle thus leaving intact the branches of the superior gluteal artery in the proximal half and branches of the inferior gluteal artery in the distal half, and hence there is no need to worry about the amount of blood lost. Bleeding is further reduced as the leash of vessels which lies at the inferior border of the short lateral rotators is neither cut nor handled.

The concept of trochanteric osteotomy (TO) was mainly used in difficult exposures and soft tissue tensioning. Contemporary THA [Total Hip Arthroplasty] accentuates a streamlined approach to surgery and recovery while maximizing long-term success. Hamblin estimated that 10% to 20% of hips require TO for restoration of normal joint anatomy [17].

Complications of trochanteric osteotomy can be divided into two broad categories: those related to osteotomy healing and those related to the mode of fixation. Nonunion or a fibrous union of the trochanter is not necessarily a complication with clinical significance. If the trochanter does not heal by bony bridging, however, associated issues of pain, hardware breakage, or abductor dysfunction may manifest as impaired gait, Trendelenburg lurch, subluxation, or dislocation of the hip replacement. Even when union of the trochanter occurs, the patient may still have problems. Trochanteric pain and bursitis may be related to a prominent trochanter or to irritating hardware. Fraying and breakage of hardware can lead not only to pain, but also to wear and the need for early revision.

Though Surgeons may adopt any approach to the hip joint in which they are familiar or trained, this modification may

be helpful when the greater trochanter is intact in cases when treating a dislocated hip joint, when the blame for the dislocation may be avoided on the posterior approach to the hip joint. Instability following weakening of the already weak posterior capsule and short lateral rotators of the Hip leading to dislocation has been a cause for concern and controversy in the past. The main purpose of this modification is to overcome this danger and yet retain the advantages of the posterior approach.

Bleeding is slight in this approach because the plane of cleavage through the gluteus maximus is through its middle, which leaves intact the branches of the superior gluteal artery in its proximal half and branches of the inferior gluteal artery in its distal half. The blood loss is reduced considerably, as the leash of blood vessels which lies at the inferior edge of the lateral rotators is neither cut nor handled.

The other advantage is that the sciatic nerve need not be isolated at any step in this modification, and corresponding to the level of the greater trochanter the sciatic nerve lies well medially. Secondly, it is held between the piriformis and the triradiate tendon when the greater trochanter is turned posteriorly, thus preventing movement of the nerve. Union of the trochanteric fragment should occur because the osteotomy is through cancellous bone and in close proximity to the anastomosis in the trochanteric fossa. With this modification, though turned aside, the gluteus medius is cut neither at its insertion nor its origin, thus leaving the abductor mechanism intact.

There are certain disadvantages which we have to bear with and which is not in every case treated by this modification, such as heterotrophic ossification, trochanteric Osteotomy where the bone takes more time to unite resulting in non-union or fibrous union along with greater trochanteric bursitis and also breakage of the wires.

### **The DAA[Direct Anterior Approach] can be done on a Plain Table or a Fracture Table as per the wishes of the Surgeon**

Herewith I have also reproduced an article on the principles of the DAA written by Dr. Alessandro Geraci ; MD, PhD, BBM; Orthopaedic Department, CaFoncello Hospital, Treviso, Italy from the publication of my book The Hip Joint 2nd Edition which is the Research performed at Orthopedic Department, San Giacomo Apostolo Hospital, Castelfranco Veneto, Italy Orthopaedic Department, CaFoncello Hospital, Treviso, Italy Treviso, Veneto, Italy.

Hip prosthetic surgery today offers solutions aimed at saving the bone patrimony and respecting muscles and tendons in order to reduce complications and reduce recovery times.

The goal of hip replacement surgery is to eliminate the pain often caused by a degenerative disease such as arthrosis, restore good range of motion and allow the patient to carry out his/her daily activities in the gradual functional recovery. The anterior approach to the hip uses two internal nervous planes: superficial and deep. The deep plane passes between the rectus femoris and the tensor of the fascia lata and the gluteus medius. The anterior approach to the hip is a way that uses the anterior region of the hip to be able to attack the joint. The real counter-indication to this technique is a major deformity of the patient's acetabulum or femoral neck, which can make it difficult to manoeuvre the limb during surgery.

The goal of hip replacement surgery is to eliminate the pain often caused by a degenerative disease such as arthrosis, restore good range of motion and allow the patient to carry out their daily activities in the gradual functional recovery.

The anterior approach route, in association with dedicated instruments, allows hip replacement with a minimally invasive approach, opening and not removing the muscle fibers. The anterior approach was first described in 1881 by Hueter C, et al. [12] who was a German Surgeon and an assistant to Langebeck. Thereafter in 1917, Marius N Smith-Peterson wrote this in JBJS as Smith-Peterson access [18]. Peterson and Judet used the approach for surgical access to Hip Replacement [19]. Judet in 1980s improved upon this access by developing a traction bed which helped in moving the lower limb during surgery [20]. Thereafter Matta JM, et al. [21], Laude F, et al. [22], and Moreau P, et al. [23] perfected this to make it less difficult and invasive. The main landmark is the anterior superior iliac spine which was described by Lesur and Laude.

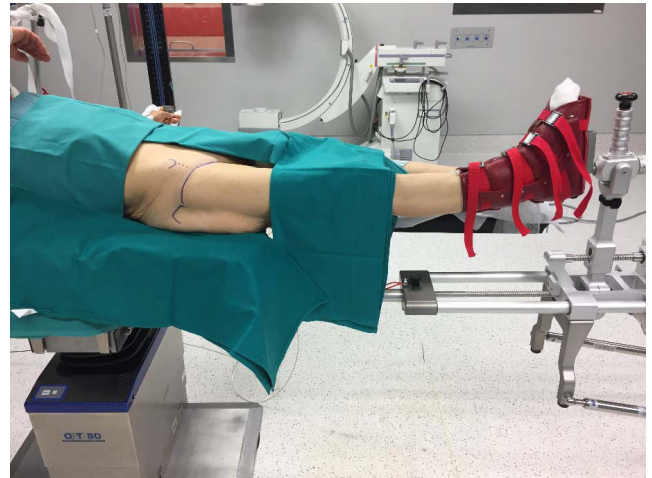
### Surgical technique:



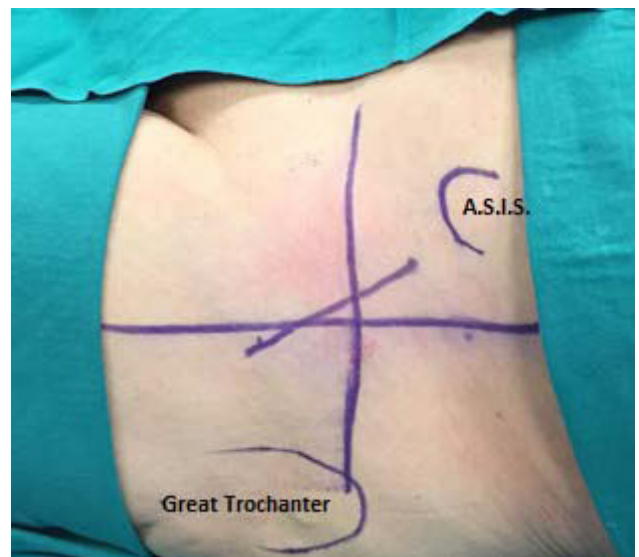
**Figure 21:** The anterior approach to the hip is a way that uses the anterior region of the hip because it is an easily accessible bony landmark.

The anterior approach to the hip uses two internal nervous planes: superficial and deep. The more superficial plan does located between the sartorius muscle (innervated by the Femoral nerve), placed medially, and the tensor muscle of the fascia lata (pertaining to the Gluteus Superior nerve), placed laterally. The deep plane passes between the rectus femoris (Femoral nerve) and the tensor of the fascia lata and the gluteus medius (Superior Gluteus Nerve).

The patient is positioned supine on the table surgery.



**Figure 22:** The obese subject has no fat in the anterior region of the hip. [Courtesy: fig reproduced with kind permission from Alessandro Geraci].

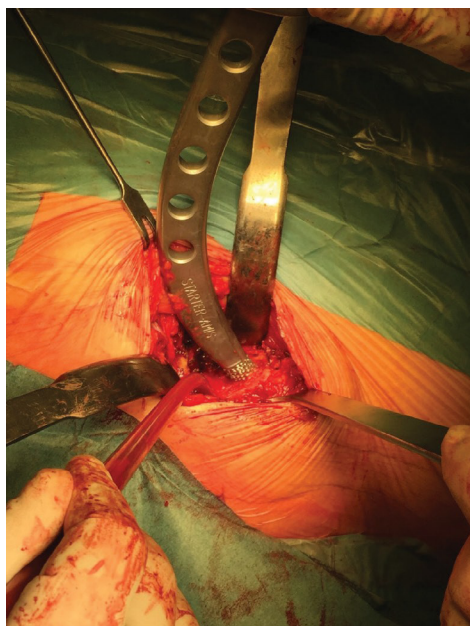


**Figure 23:** An operating table with dedicated traction for the anterior approach to the hip. [fig reproduced with kind permission from Alessandro Geraci].



**Figure 24:** The important points of the iliac crest, greater trochanter, and the anterior superior iliac spine are first marked. The skin incision begins 2 cm distal and 2 cm lateral compared to the superior anterior iliac spine and extends lengthwise for about 7 cm pointing to the fibular head. [Figure reproduced with kind permission from Alessandro Geraci].

The femoral preparation is carried out by the use of the traction table. A considerable amount of dedicated surgical instruments like curved femoral broach handles [figure 25] and curved acetabular reamers along with intra-operative digital imaging



**Figure 25:** The “bikini” variant described by Leunig M, et al. [24], has the incision at the level of the inguinal skin fold, groove highlighted flexing the hip, and extends two-thirds laterally and one third medial to the anterior iliac spine upper with oblique course. [Courtesy: fig reproduced with kind permission from Alessandro Geraci].

The advantage of the anterior approach is that the normal gait is not dependent on tendon healing, since no tendons have been removed and repaired, as they have in the direct lateral approach and posterolateral approach. This is not a particular technique but a ‘surgical philosophy’, consisting in a maximum respect for soft tissues and bone, including reduction of operative invasiveness and the use of minimally invasive surgical solutions.

I had done a few cases in Hemiarthroplasty only [without using a fracture table] in selective patients which is not ideal and enough to write this chapter which has a difficult learning curve and specialised surgical skills with special instruments including a special operation table for this type of Surgery.

## Conclusion

1. The anterior approach has a slight advantage when it comes to early recovery and degree of muscle damage.
2. Infection is a problem with all approaches, but wound complications are most troublesome with the anterior approach.
3. The lateral approaches provide the most stability.
4. Overall, it can be said that each approach has its advantages and disadvantages. In line with this, the American Academy of Orthopaedic Surgeons (AAOS) guidelines state that there are no clinically significant differences related to surgical approach for patients undergoing primary total hip replacement.
5. In the end, a surgeon’s skill and experience are by far the most important factors.

The features of DAA should be shared actively with physio/ occupational therapists to avoid the necessity for the use of a low chair for sitting purposes and avoid cross the legs in bed.

All HOD’s [Heads of Departments] in Orthopaedics should educate teaching on DAA to their students at all levels in training so that they are aware of the DAA.

The ‘word dislocation’ has been looked as a unacceptable/ inadequate/ banned as constituting a risk/ not acceptable to mention associated with mainly Posterior Approach in Surgical Approaches to the Hip Joint since over 5 decades which is extremely difficult to overcome in literature even till today. I had also described a Modified Approach to the Posterior Approach in 1981, which is well held in literature K Mohan Iyer [25] and textbooks (<https://kmohaniyer.com>) of repute even till today but I feel that we should encourage the younger generations of Orthopaedic Surgeons in the world to embrace the DAA even for the most commonly seen Fracture neck of femur initially instead to straight embarking on Primary or Revision Total Hip Arthroplasty.

I had done a few cases in Hemiarthroplasty only [without using a fracture table] in selective patients which is not ideal and enough to write this chapter which has a difficult learning curve and specialised surgical skills with special instruments including a special operation table for this type of Surgery [26]. Ideally this is best done by John O, et al. [27] with whom I had several interactions saying that he is extremely comfortable with the DAA for his Hip Replacements and that he cannot imagine changing himself for another Surgical Approach that I developed an interest in the DAA. He has also been instrumental in giving me a forward for a small book written by me and published in 2018 by Lambert academic publishing, Germany.

## References

1. Beddow FH, Tulloch C (1990) Rheumatoid Arthritis Surgical Society-Clinical Experience with the Iyer Modification of the Posterior Approach to the Hip. J Bone Joint Surg BR 73B(SII): 164-165.
2. Thomas S, Vienne P, Hershe O (2002) Failure of Reinserted Short External Rotator Muscles after Total Hip Arthroplasty. The Journal of Arthroplasty 17(5): 604-607.
3. Calandruccio R (1991) Surgery Exposure Hip. In: Laurin CA, Riley JLH, Roy-Camille R (Eds.), Atlas of Orthopaedic Surgery (Ed.), 3.
4. Ranawat CS, Rasquinha VJ, Ranawat AS, Miyasaka K (2004) An Extensile Posterior Exposure for Primary and Revision Hip Arthroplasty. Minimally Invasive Total Joint Arthroplasty: 39-46.
5. Steven AS, Jennifer SM (2011) Oblique Posterior Trochanteric Osteotomy in Revision Total Hip Arthroplasty. The Journal of Arthroplasty 26(3): 472-475.
6. Stanley H, Piet D, Richard B (2009) Surgical Exposures in Orthopaedics: The Anatomic Approach, 6<sup>th</sup> (Edn.), Wolters Kluwer Health, pp: 784.
7. Somashekar, Sathya VK, Sridhara MJN (2013) Treatment of Femoral Neck Fractures: Unipolar Versus Bipolar Hemiarthroplasty. Malays Orthop J 7(2): 06-11.
8. Mohan KI (1981) A New Posterior Approach to the Hip Joint. Injury 13(1): 76-80.
9. Mohan KI, Shatwell MA, Elloy MA (1982) Experience with Thompson's prosthesis using the New Posterior Approach. Injury 14(3): 243-244.
10. Jaoquin S, John G, Daniel B, Charles R, Robert C (2005) Primary Hip Arthroplasty Through a Limited Posterior Trochanteric Osteotomy. Acta Orthop Belg 71(5): 548-554.
11. Charnley J (1972) The Long-Term Results of Low-Friction Arthroplasty of the Hip Performed as a Primary Intervention. J Bone Joint Surg Br 54(1): 61-76.
12. Hueter C (1917) Injuries and Diseases of the Hip Joint. In: Hueter C (Ed.), Outline of surgery. 2<sup>nd</sup> (Edn.), J Bone Joint Surg, pp: 592-595.
13. James P, Malcolm B, Phil W, Roger S (2011) Piriformis and Obturator Internus Morphology: A Cadaveric Study. Clin Anat 24(1): 70-76.
14. Charbel DM, Fadi AH, Jean-Claude FL (2012) Incidence of Piriformis Tendon Preservation on the Dislocation Rate of Total Hip Replacement Following the Posterior Approach: A Series Of 226 Cases. J Med Liban 60(1): 19-23.
15. Mark BC (1982) The Year Book of Orthopaedics, 1<sup>st</sup> (Edn.), Year Book Medical Publishers, pp: 371-373.
16. Terry CS (1992) Campbell's Operative Orthopaedics, 9<sup>th</sup> (Edn.), 1: 466.
17. Callaghan JJ, Rosenberg AG, Rubash HE (1998) The Adult Hip (Lippincott-Raven). The Journal of Bone & Joint Surgery 1: 718.
18. Smith-Petersen MN (1917) A New Supra-Articular Subperiosteal Approach to the Hip Joint. J Bone Joint Surg Am 15(8): 592-595.
19. Judet J, Judet R (1950) The Use of an Artificial Femoral Head for Arthroplasty of the Hip Joint. J Bone Joint Surg Br 32(2): 166-173.
20. Judet J, Judet H (1985) Anterior Approach in Total Hip Arthroplasty. Presse Med 14(18): 1031-1033.
21. Matta JM, Shahrddar C, Ferguson T (2005) Single-Incision Anterior Approach for Total Hip Arthroplasty on an Orthopaedic Table. Clin Orthop Relat Res 441: 115-124.
22. Laude F (2006) Total Hip Arthroplasty through an Anterior Hueter Minimally Invasive Approach. Interact Surg 1: 5-11.
23. Moreau P (2018) Minimally Invasive Total Hip Arthroplasty using Hueter's Direct Anterior Approach. Eur J Orthop Surg Traumatol 28(5): 771-779.
24. Leunig M, Hutmacher JE, Ricciardi BF, Impellizzeri FM, Rudiger HA, Naal FD (2018) Skin Crease 'Bikini'

Incision for the Direct Anterior Approach in Total Hip Arthroplasty: A Two- to Four-Year Comparative Study in 964 Patients. *Bone Joint J* 100 (7): 853-861.

1<sup>st</sup> (Edn.), Jenny Stanford Publishing, Wiesbaden, Frankfurt, Germany, pp: 466.

25. Mohan IK Consultant Orthopedic Surgeon.

27. John O (2018) Direct Anterior Approach to the Hip Joint. In: Mohan IK (Ed.), *Hip Joint in Adults: Advances and Developments*. 1<sup>st</sup> (Edn.), Jenny Stanford Publishing, Melbourne, Australia, pp: 466.

26. Manfred K, Ilan E (2018) Total Hip in a Day: Setup and Early Experiences in Outpatient Hip Surgery. In: Mohan IK (Ed.), *Hip Joint in Adults: Advances and Developments*.