

Chapter 5

Anterior Minimally Invasive Surgery



Hiran Amarasekera and Dakshini Egodawatte

Abstract Total hip arthroplasty has been one of the most successful orthopaedic procedures over the past 30 years. Currently, several surgical approaches for hip arthroplasty have been defined; these include the anterior, the lateral and the posterolateral approaches. In literature the advantages and disadvantages of each surgical approach have been documented and which approach will be chosen depends on the experience of the surgeon. This chapter will focus on anterior minimally invasive surgery (AMIS). This surgical approach follows an inter-muscular and inter-nervous plane to reduce the risk of injury to muscles, tendons, vessels, and nerves. This review will discuss the history, technique, tricks and pitfalls of AMIS procedure that reduces anatomical invasiveness and blood loss and speeds up the functional recovery of the patient.

Keywords Hip replacement · AMIS · Anterior approach · Minimally invasive hip surgery · Hip preservation surgery

5.1 Introduction

5.1.1 Background

The hip joint a ball and socket joint covered by strong muscles is situated deeply in pelvis and can be approached almost in any direction (Figs. 5.1 and 5.2; Amarasekera 2013).

H. Amarasekera (✉)

University Hospitals of Coventry and Warwickshire, Coventry, UK
e-mail: huruwan@hotmail.com

Warwick Medical School, Coventry, UK

Neville Fernando Teaching Hospital, Malabe, Sri Lanka

D. Egodawatte

Trauma and Orthopaedics, Neville Fernando Teaching Hospital, Malabe, Sri Lanka

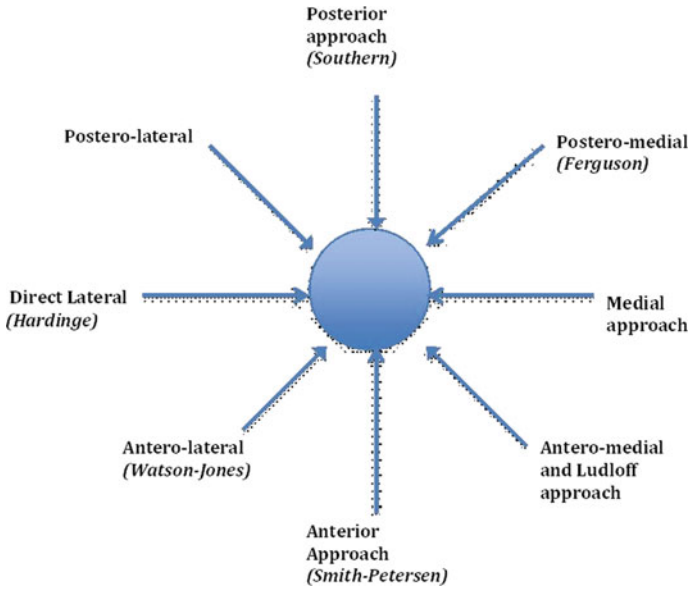


Fig. 5.1 Different approaches to the hip (Hunter 1986)

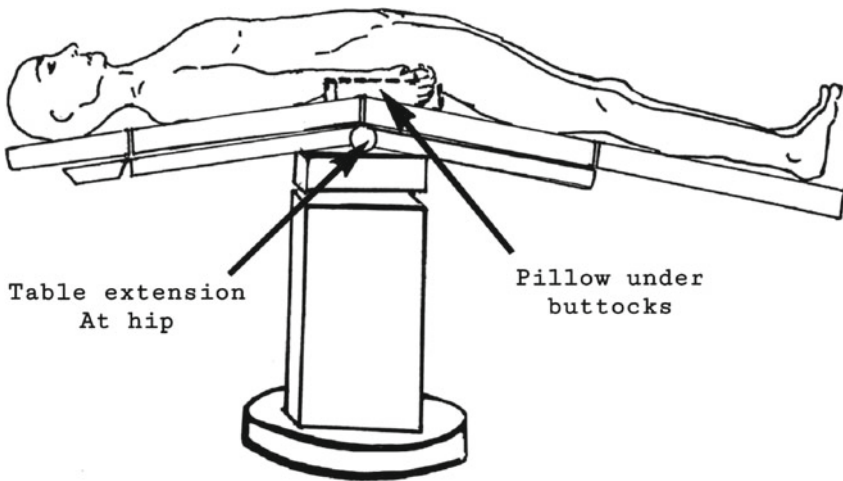


Fig. 5.2 Table and supine position with sand bag under operating side buttock

However out of the many approached described commonest used approaches for arthroplasty has been posterior (Hunter 1986), antero-lateral (Watson-Jones 1936) and anterior approaches (Smith-Petersen 1949). Different approaches have been popular during different times in history of orthopaedics depending on instrumentations, implants, surgeon's preference and training and patients active life styles,

early return to working and need to achieve high range of motion with minimal risk of dislocation.

5.1.2 History

Hueter initially described the direct anterior approach in 1881 (Rachbauer et al. 2009) describing the Hueter as a key landmark in the approach. It was later popularized by Smith-Petersen in 1917 (Smith-Petersen 1917) in early 50s direct anterior approach (DAA) was a popular mode for hip arthroplasty. In 1950 two French surgeons Judet and Judet reported this as a successful approach for hip replacement (Judet and Judet 1950) and later O'Brien published case series of total hip arthroplasty done via the anterior approach (O'Brien 1955). However with the introduction of Charnley's low friction arthroplasty in late 50 the this approach fell out of favour among the orthopaedic surgeons giving way for the posterior approach to come in to vogue (Charnley 1970; Charnley 1970; Charnley and Cupic 1973).

Through out this approach has been popular for other surgeries mainly for paediatric hip surgery such as developmental dysplasia, hip biopsy, and drainage of septic arthritis.

5.1.3 Resurgence of the Approach

With increasing life expectancy, ageing population, increase demand for physical activity and early return to work more and more surgeons have planned minimally invasive approaches to the hip. With a clear inter nervous plane without any requirement for muscle detachment stability being maintained with minimal dislocation rates (Tsukada and Wakui 2015; Sariali et al. 2008) and new instrumentation and devices being developed minimally invasive direct anterior approach has gained popularity among the arthroplasty surgeon since the last few decades. Interests appear to be rapidly growing and gaining increasing popularity among arthroplasty surgeons with modern concepts of hip preservation, minimally invasive hip surgery, hip resurfacing, in a population with a high active life style, demanding early return to work or sports activities.

5.1.4 Key Advantages and Disadvantages of the Approach

The key advantages of the approach include the ability to directly access the hip through the true internervous planes with minimal on no muscle dissection leading to early recovery and higher functional rates. The approach also preserves the blood flow to the hip joint as the posterior structures are not damaged thus making this a

popular approach in hip preservation surgery and surface replacement of hip joint (Amarasekera 2012) However the steep learning curve, poor cosmetic scar, lack of specialised instrumentation made the approach less preferred by orthopaedic surgeons in last few decades. At present these issues have been addressed with specific training courses, cadaveric run in cadaveric skills labs and development of specific instruments (Paillard 2007; Oinuma et al. 2007).

5.2 The Approach

5.2.1 Indications and Contraindications

Given the proper training and after gaining experience with the use of the correct instrumentation and selecting the ideal patient most hip surgeries can be performed through most approaches. In modern day practice indications key indications for the approach in modern day practice still remain to be most paediatric surgeries, hip preservation surgery, surgical dislocation of the hip, open osteo-chondroplasty, arthrotomy for drainage or biopsy, total hip replacement and in experiences centres revision hip arthroplasty (Nogler et al. 2012).

However contraindications and caution when selecting the patients and surgeries remain. Obesity a BMI > 40 are a contra indication as it increases wound infection, rates.

5.2.2 Anatomy

The approach uses the Hueter interval (Figs. 5.3 and 5.4).

The skin incision is between Tensor fascia latae and sartorius. Key anatomical landmark is the anterior superior iliac spine (ASIS) felt as a bony prominence at the anterior most point of iliac crest. The sartorius and the inguinal ligament originate from here. Tensor fascia latae (TFL) originates just below and lateral to ASIS along with the gluteus medius. The femoral vessels and nerve are medial to sartorius a key point to remember that too medial dissection will put these structures at risk. Lateral cutaneous nerve of the thigh (LCNT) begins from the lower end of lumbar plexus emerging laterally to the psoas major and crossing the iliacus. Then it runs near the ASIS running laterally through the muscular lacuna under the inguinal ligament crossing over the sartorius and enters the thigh. The nerve divides to anterior and posterior branches and supplies the skin over the antero lateral part of the thigh and the skin over the gluteal region.

The rectus femoris muscle originates from two heads, the straight head from the anterior inferior iliac spine and the reflected head from the anterior lip of acetabular and the hip joint capsule.

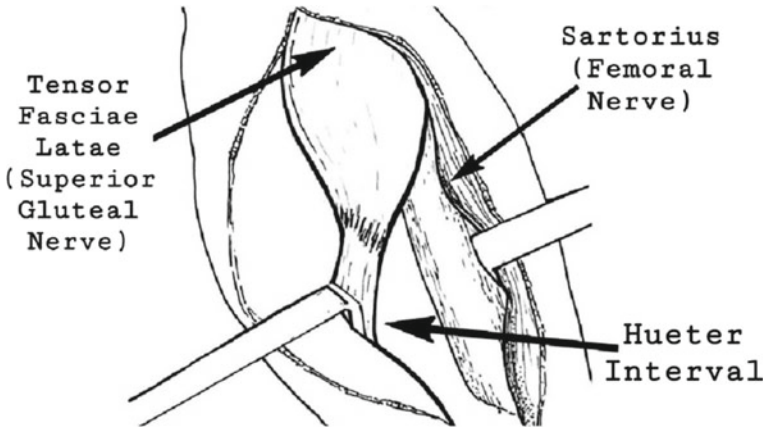
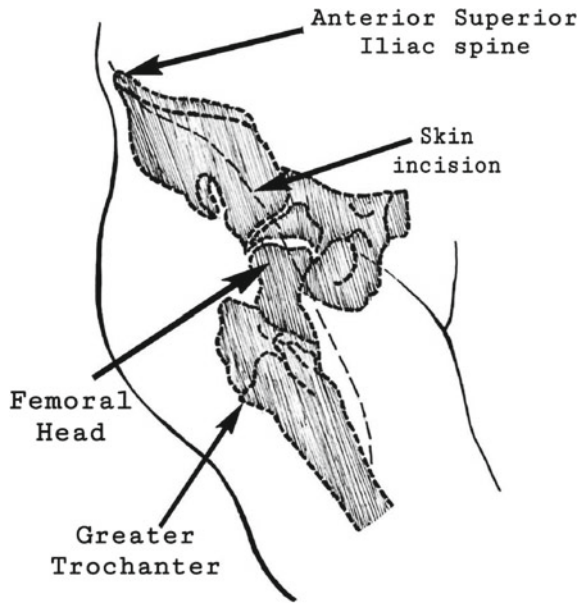


Fig. 5.3 Superficial dissection showing the Hueter interval

Fig. 5.4 Skin incision: note the traditional incision runs from 2-cm inferior and posterior to ASIS



Gluteus medius originates from the gluteal surface of ilium runs antero medially and inserts to the oblique ridge on the lateral surface of greater trochanter. This along with gluteus minimus forms the abductor complex. The approach uses internervous muscle plane between superior gluteal nerve and the femoral nerve. (Figs. 5.5 and 5.6).

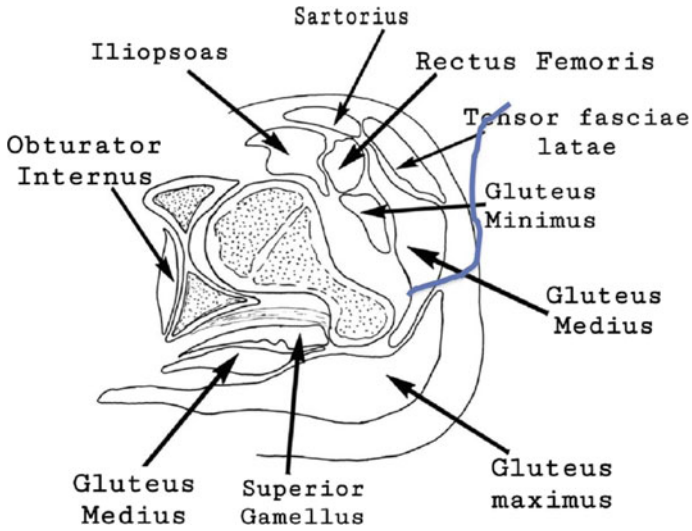


Fig. 5.5 Deep dissection showing clear inter nervous plane

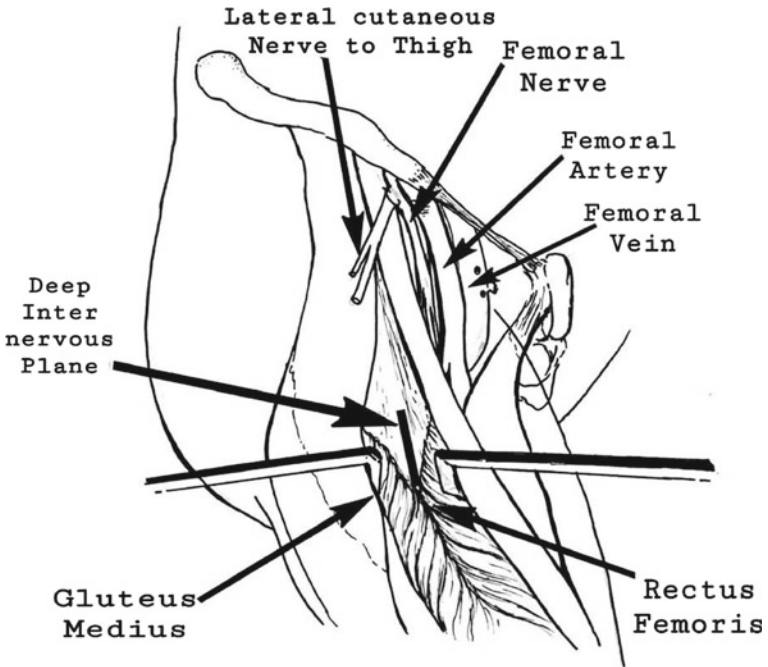
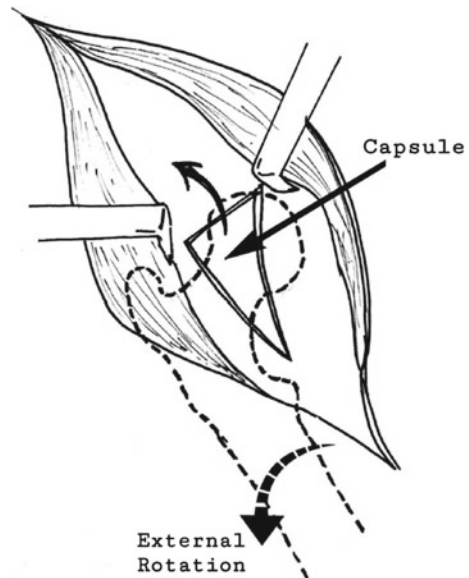


Fig. 5.6 Transverse section of the thigh (dissection and tissue planes marked in blue)

5.2.3 The Traditional Approach

1. **Position:** The patient is placed in the supine position with a sand bag placed under the buttock of the operating side as it helps to identify the muscle planes easily.
2. **Incision:** The incision lies along a line drawn along the anterior half of the iliac crest towards ASIS and curving downwards in a slight lateral direction heading towards the outer border of the patella.
3. **Approach:** Initially the gap between the tensor fascia late and sartorius is identified facilitated by external rotation of the limb, which tenses the muscles. Care should be given to protect the LCNT that passes across sartorius. Once retractors are placed deep dissection is done medially to TFL identifying the rectus femoris in the deep layer. Lateral margin of the rectus femoris identified and an interval between it and the gluteus medius is developed. Rectus femoris can be detached from the origin if needed. The retractors are gently placed between the muscles taking care not to damage the femoral neurovascular bundle. The joint capsule is seen through this interval.
4. **Muscle planes Inter nervous plane:** Both in superficial and deep layers the inter-nervous plane lies between the femoral and the superior gluteal nerves. Superficially medially bound by the sartorius (femoral nerve) and laterally bound by TFL (superior gluteal nerve) and deep layer medially bound by rectus femoris (femoral nerve) and laterally gluteus medius (Superior gluteal nerve), this is considered a true inter nervous plane.
5. **Capsule Arthrotomy:** Depending on the surgery the capsular arthrotomy can be done as a straight line, vertical, triangular or any preferred way (Fig. 5.7).

Fig. 5.7 Capsulotomy and dislocation of head



6. Dislocation: The head is dislocated by gentle traction, external rotation and adduction and external rotation.
7. Surgical procedures: Once the hip is approached many surgical procedures can be carried out, arthrotomy, drainage, surgical dislocation, and preservation surgeries such as osteo-chondroplasty, biopsy, Paediatric surgery such as DDH, osteotomies, combine pelvic and acetabular procedures, Total, partial or surface hip replacements few of the common and popular procedures done through this approach.
8. Closure: The tissue planes are closed in layers as there are no tendons or muscles re attachment needed.

5.2.4 Modifications, New Instrumentations and Minimally Access Approach (Rachbauer 2006)

1. Incision: Modern operating tables can be extended at the mid trunk level to enhance the position created by a sand bag placed under the buttocks. Some surgeons prefer to use both as it gives better presentation of the capsule anteriorly.
2. Approach: The mini incision anterior approach or the minimally invasive approach utilizes small 6–7 cm incision starts 2 cm posterior and 2 cm inferior to ASIS running around 2 cm below the greater trochanter (Rachbauer and Krismer 2008).
3. Muscle planes Internervous plane: These are respected as per the traditional approach.
4. Capsule Arthrotomy: This remains a surgeon's preference decided based on the procedure itself.
5. Closure: Stepwise layers of closure are advocated with function and cosmesis kept in mind.

5.2.5 Rehabilitation Protocol

As in all approaches rehabilitation plays a key role in early recovery early return to work and early return to sport. Functional recovery is believed to be faster than in any Approach (Rodriguez et al. 2014; Zhang et al. 2018) and development of a standard protocol for rehab is s mandatory. Even though these may change from institution to institution or surgeon to-surgeon, and the surgical procedure, by and large the principles remain the same. Basic principle in rehabilitation following THR through anterior approach is outlined below.

Once the general recovery following surgery is passed the patients are put on full weight bearing mobilization ideally from day 1.

ROM (range of motion exercises) gait training, day to day activities such as walking, climbing stairs, are achieved within first three days and the patient is

discharged. Within the 0–2 weeks gait training, quadriceps and muscle strengthening and core strengthening exercises are started.

3–6 weeks further ROM muscle strengthening including abductors adductors and core body workouts are developed. Patients can return to work within 2–4 weeks depending on the work.

From 7 to 12 weeks further gait training is continued within specific concentration of muscle groups.

Sport activities are started during this period and full return to sports can be achieved as early as 12 weeks.

5.3 Complications

Apart from the general complications that are common to all surgical approaches around the hip such as damages to neurovascular structures, bleeding, deep vein thrombosis pulmonary embolism certain specific set of complications that are unique to this approach.

Higher rate of wound complications (Jahng et al. 2016; Watts et al. 2015) and superficial wound infection is been reported. One main reason is anterior thigh area being covered by skin folds in obese patients. Poor scar is another complications as the approach cuts across the Langer's lines. Dislocation rates are believed to be low capered to traditional approaches such as the posterior (Tsukada and Wakui 2015).

Damage to lateral cutaneous nerve of the thigh (LCNT) that can lead to loss of sensation around anterior thigh some times leading to meralgia paresthetica (Barton and Kim 2009).

Going too medially medial to sartorius run the risk of damaging femoral vessels and nerve, this can be avoided by staying lateral to sartorius and keeping to the correct tissue plane (Fig. 5.4) some times the retractors it self can damage these structures rather than the dissection it self. Carefully placing retractors is key to avoid this, especially if a retractor comes out re placing it should be done by the surgeon him self. These are high usually within the learning curve and with experience these can be avoided.

In hip preservation surgeries and resurfacing femoral neck fracture is a keep complication that leads to failure of the procedure (Kreuzer et al. 2011). Cautiously dislocating the hip mastering the technique, and using customized implants (Khemka et al. 2018) will help to reduce this complication.

5.4 Pearls and Pitfalls

Steep learning curve is probably the single most reason many orthopaedics surgeons have been hesitant to perform this approach over the years. However with present day demand this may be an essential approach where all hip surgeons are expected

master. To avoid steep learning curves at present there are many cadaveric courses other training materials and many training programs available throughout the world. Special instruments including retractors, guide wires broach handles (Zachary et al. 2014) reamers along with operating tables have been developed (Wayne and Stoewe 2009).

It is essential to avoid too medial dissection and to stick to the correct tissue planes to avoid damaging the femoral vessels and nerve. Careful handling of instruments, training or minimally invasive techniques, using special tables will help to avoid all these complications.

Even though the mini incision is shorter both traditional and mini incisions do not respect Langer's lines and achieving a cosmetically acceptable scar has been a challenge. Some surgeons have developed a more cosmetically accepted bikini incision to overcome this (Faldini et al. 2017).

5.5 Conclusions

Direct anterior approach seems to have evolved over the years and has return to modern orthopaedic practice gaining rapid popularity among orthopaedic surgeons in this decade. Many reasons such as modern patients demands, active life styles development of modern instruments, demand for minimally invasive techniques, and more hip preservation work carried out in young adult hips have all contributed for this resurgence. However it is worth noting that to achieve successful results, training in specific procedures reduces steep learning curve, familiarizing with modern instrumentation, are key to success. In modern day all hip surgeons, should know this approach or need to learn the basic concepts as more and more open hip procedures are done through this approach.

References

- Amarasekera HW. Surface replacement of the hip joint. In: Fokter S, editor. Recent advances in hip and knee arthroplasty. 1st ed. Croatia: Intech; 2012. pp. 181–90.
- Amarasekera H (2013). Surgical approaches to the hip joint and its clinical implications in adult hip arthroplasty. In: Kinov P, editor. Arthroplasty. 1 ed. 2013.
- Barton C, Kim PR. Complications of the direct anterior approach for total hip arthroplasty. *Orthop Clin North Am.* 2009;40:371–5.
- Charnley J. Total hip replacement by low-friction arthroplasty. *Clin Orthop Relat Res.* 1970;72:7–21.
- Charnley J. Arthroplasty of the hip. A new operation. *Lancet* 1961;1:1129–32.
- Charnley J, Cupic Z. The nine and ten year results of the low-friction arthroplasty of the hip. *Clin Orthop Relat Res.* 1973:9–25.
- Faldini C, Mazzotti A, Perna F, et al. Modified minimally invasive direct anterior approach through a bikini incision for total hip arthroplasty: technique and results in young female patients. *J Biol Regul Homeost Agents* 2017;31:83–9.

- Hunter SC. Southern hip exposure. *Orthopedics* 1986;9:1425–8.
- Jahng KH, Bas MA, Rodriguez JA, Cooper HJ. Risk factors for wound complications after direct anterior approach hip arthroplasty. *J Arthroplasty* 2016;31:2583–7.
- Judet J, Judet R. The use of an artificial femoral head for arthroplasty of the hip joint. *J Bone Joint Surg Br.* 1950;32-B:166–73.
- Khemka A, Mograby O, Lord SJ, Doyle Z, Al Muderis M. Total hip arthroplasty by the direct anterior approach using a neck--preserving stem: safety, efficacy and learning curve. *Indian J Orthop.* 2018;52:124–32.
- Kreuzer S, Leffers K, Kumar S. Direct anterior approach for hip resurfacing: surgical technique and complications. *Clin Orthop Relat Res* 2011;469:1574–81.
- Nogler M, Mayr E, Krismer M. The direct anterior approach to the hip revision. *Oper Orthop Traumatol.* 2012;24:153–64.
- O'Brien RM. The technic for insertion of femoral head prosthesis by the straight anterior or Hueter approach. *Clin Orthop.* 1955;6:22–6.
- Oinuma K, Eingartner C, Saito Y, Shiratsuchi H. Total hip arthroplasty by a minimally invasive, direct anterior approach. *Oper Orthop Traumatol* 2007;19:310–26.
- Paillard P. Hip replacement by a minimal anterior approach. *Int Orthop.* 2007;31(Suppl 1):S13–5.
- Rachbauer F. Minimally invasive total hip arthroplasty. Anterior approach. *Der Orthopade* 2006;35:723–4, 6–9.
- Rachbauer F, Kain MS, Leunig M. The history of the anterior approach to the hip. *Orthop Clin North Am.* 2009;2009(40):311–20.
- Rachbauer F, Krismer M. Minimally invasive total hip arthroplasty via direct anterior approach. *Oper Orthop Traumatol.* 2008;20:239–51.
- Rodriguez JA, Deshmukh AJ, Rathod PA, et al. Does the direct anterior approach in THA offer faster rehabilitation and comparable safety to the posterior approach? *Clin Orthop Relat Res.* 2014;472:455–63.
- Sariali E, Leonard P, Mamoudy P. Dislocation after total hip arthroplasty using Hueter anterior approach. *J Arthroplasty* 2008;23:266–72.
- Smith-Petersen MN. A new supra-articular subperiosteal approach to the hip joint. *J Orthop Surg (Phila Pa).* 1917;Am:593.
- Smith-Petersen MN. Approach to and exposure of the hip joint for mold arthroplasty. *J Bone Joint Surg Am.* 1949;31A:40–6.
- Tsukada S, Wakui M. Lower Dislocation rate following total hip arthroplasty via direct anterior approach than via posterior approach: five-year-average follow-up results. *Open Orthop J.* 2015;9:157–62.
- Watson-Jones R. Fractures of the neck of femur. *Br J Surg.* 1936;23:787–808.
- Watts CD, Houdek MT, Wagner ER, Sculco PK, Chalmers BP, Taunton MJ. High risk of wound complications following direct anterior total hip arthroplasty in obese patients. *J Arthroplasty* 2015;30:2296–8.
- Wayne N, Stoewe R. Primary total hip arthroplasty: a comparison of the lateral Hardinge approach to an anterior mini-invasive approach. *Orthop Rev (pavia).* 2009;2009(1): e27.
- Zachary D, Post M, Fabio Orozco M, Claudio Diaz-Ledezma M, William J, Hozack M, Alvin Ong M. Direct anterior approach for total hip arthroplasty: indications, technique, and results. *J Am Acad Orthop Surg JAAOS* 2014;22:595–603.
- Zhang Z, Wang C, Yang P, Dang X, Wang K. Comparison of early rehabilitation effects of total hip arthroplasty with direct anterior approach versus posterior approach. *Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi* 2018;32:329–33.