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Minimal Invasive Technique for Total Hip Arthroplasty: Different Approaches

Umair Masood, Liming Wang*, Qiangrong Gu, Mujtaba Ansari, Xiang Zhang, Shuai Liu, Uzair Masood, Senthur Rajendren

Department of Orthopedics, Nanjing First Hospital, Nanjing Medical University, Nanjing, Jiangsu, China

***Corresponding Author**

Liming Wang

E-mail

limingwang99@yahoo.com

Phone

+86 18951670968

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Abstract

For about half a century now, hip-joint prosthesis implantation was successfully implemented by orthopedists. Because of such procedures and the evolution of surgical techniques, the postoperative recovery period has been reduced. Still, the success of treatment is only assessable by a quick recovery of limb function, management and minimizing the post-operative pain and also the reproducibility of the procedure including its safety. Total hip arthroplasty (THA) is performed by making the shortest possible skin incision as compared to the so-called original technique which is conducted by a standard length of 15 cm incision. However, the recent techniques are being discussed in depth and their effectiveness over the conventional methods is the current field of study amongst the researchers. The objective of this review was to understand different approaches of minimal invasive techniques of THA and to study the advantages and disadvantages of each technique as per the available literature, and to summarize the effectiveness of minimal invasive technique as an emerging approach for THA procedures. The anterior approach seems to be the most promising out of the available techniques given that intramuscular incision is avoided which reduces the rehabilitation time considerably. However, surgical skills and expertise are needed to perform the same as avoiding injury to the lateral femoral cutaneous nerve is critical.



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Introduction

In early 1970's, a Japanese surgeon named Watanabe introduced the concept of Minimal Invasive Surgery (MIS) to the orthopedics. With Watanabe's idea, a surprisingly increased cellular and the systemic response was provoked if the tissue damage was marginally reduced. This, in turn, was discovered to quicken the regaining of limb function which was significantly slower in the traditional techniques [1]. The concept of MIS refers to minimizing the damage to specific muscles, their respective insertions and also to the soft tissues by minimizing the size of the incision because a larger incision would make these structures prone to injury which would, in turn, lead to sensory and motor damage [2]. Protecting the muscle via the shorter incision would result in a speedy recovery, early discharge from the ward and subsequent initiation of the rehab plan. This rehab plan can be initiated as early as the third postoperative day [3, 4]. The above-mentioned plan would be of clinical significance only if it resulted in decreased perioperative mortality and subsequent post-operative trauma. The primary goal of MIS is to potentially decrease the perioperative risk even though it increases the risk of neurovascular insult and makes the surgery technically demanding as it becomes difficult to assess the placement of the implant [5].

The choice of using imaging techniques perioperatively during an MIS surgery is still controversial. Some studies conclude that the use of imaging would reduce the probability of an improperly placed implant and leg length discrepancy [6, 7]. On the other hand, some studies conclude that using imaging would increase the operating time and consequently increase the operative complications [8, 9]. In this review, we review the research that has been done in regards to the MIS technique and to delineate the most clinically suitable surgical approach to perform the hip replacements with minimal invasion [10-14].

Minimally invasive surgical approaches for THA

Anterior approach

Intact muscle and muscular insertions after hip joint prosthesis implantations are achieved best by the anterior approach which is well according to the MIS principles. Robert Judet first introduced this approach as a varied form of the Smith-Peterson

approach in 1947. In his technique, Judet applied bilateral traction indirectly on an orthopedic table [8]. Traction on the lower limbs together with the instantaneous external rotation and hyperextension caused on the hip joint of the limb being treated assists in the dislocation of the hip joint [15]. In this technique, the advantage is that the joint is closest to the skin where also the fat tissue is conveniently thin. Unlike the posterior and lateral approaches where muscle needs to be detached or dissected the anterior approach does not include either of these maneuvers [16, 17]. The prevention of injury to the pelvic muscles and femoral muscles and their attachment respectively is an advantage noted in the anterior approach in the lateral or supine position as this approach does not necessitate the separation of muscles and/or the incision or cut over tendons, this relaxes the increased tension soon after the surgery [18,19]. Stability of the muscles in the hip joint can be notably recovered as a result of intact muscles and their attachments [18, 19]. In case of complications, this incision can be further extended distally over the proximal femur similar to as in the non-minimally invasive anterior approach to the hip [Smith-Peterson technique]. Because this approach is incised via the inter-nervous plane of the femoral nerve and the superior gluteal nerve, one of the major precautions that are to be considered while performing the surgery via an anterior approach is the injury to the lateral femoral cutaneous nerve [20, 21].

Posterior approach

Although the plane/location of dissection in the MIS-THA is the same as the conventional approach (posterior), the MIS approach has been known to marginally reduce soft tissue dissection. The posterior approach, however, necessitates incising the posterior capsule and the external rotators for appropriate exposure of the joint cavity [22]. This is one of the noted disadvantages of this approach because it may easily result in the posterior subluxation/dislocation of the hip joint. In contrast to the conventional approach, in the MIS technique, the preparation of the femur is imperiled, which is the result of the lack of visibility of the lesser trochanter adding to the fact that the quadratus femoris is intact. Also, while dissecting from the superficial surface of the joint cavity during operation, this approach places the inferior gluteal nerve at risk of damage. The ensuing neuropathy would result in a diminished range of motion (ROM), especially the abduction and a classical limping gait as a result of muscle weakness [23].

Table 1 Brief summary of advantages and disadvantages of minimal invasive surgery techniques for total hip arthroplasty.

Approach	Advantages	Disadvantages
Anterior approach	No muscle detachment Needed from its insertions to expose the joint	Injury to the lateral femoral cutaneous nerve
Posterior approach	Surgeon friendly	Needs incision of the posterior capsule and the rotators for the exposure of the surgical area
Lateral approach	-	Excision of the gluteus muscle elongating the post-op rehabilitation
Dual incision technique	Addresses the disadvantages of both anterior and posterior approaches	Higher risk of proximal femoral fractures

Lateral approach

The preferred site of incision in this approach is generally 2 cm proximal to the greater trochanter down to a point 6-8 cm parallel, alongside the long axis of the femur. The only unavoidable disadvantage while performing the lateral approach is that the gluteus medius and minimus need to be incised from their insertions over the proximal femur, which can cause a prolonged functional recovery and also affect the recovery of the abductor muscles to the greater trochanter. The superior gluteal nerve that innervates these abductors is prone to be cut. The limited abduction and the consequent limp gait are signs of superior gluteal neuropathy [24].

Dual incision technique

The pros and cons of both the anterior and posterior approach are addressed in the double incision approach which enables early discharge [25, 26]. A direct anterior approach is preferred in this technique, which facilitates better osteotomy of the femur neck, thus the acetabulum can be orderly prepared for the insertion of the acetabular component. A 5 cm incision is made internally, which runs diagonally from the intertrochanteric line to the midpoint of the femoral head. However, the imaging (fluoroscopy) should always be in use for this technique [26]. To facilitate the placement of the femoral component, a second incision is required posteriorly, which is 3-4 cm long and made parallel to the femoral body. This approach, however, increases the prevalence of proximal femoral fractures marginally than the conventional approach (s).

Concerns regarding said approaches

Recent alterations of the anterior approach technique do not require the traction on the lower limb or the orthopedic table, as now a flat top table is considered sufficient and equally convenient. The gluteus maximus and medium muscles along with their insertion site, which is the greater trochanter

cover the proximal femoral shaft, both laterally and posteriorly. Namely, double-incision and posterior or lateral procedures that are commonly referred as minimal invasive techniques more frequently involve the injury of the muscles and tendons. These techniques, hence, can be better referred to as Less Invasive Surgery (LIS) [27, 28].

To better facilitate the implantations of the prosthesis and more importantly marginally decrease the complication hazards, the use of apposite instruments is also important [28]. Recent literature considers it to be clinically significant and with improved functional outcomes. But unfortunately, there are very few reports that present liable and comprehensive data which ensures the safety of the procedure and statistically acceptable results. Although the learning and mastering of this technique (MIS) is a very progressive subject [29], the risks associated with it must not be understated [30]. The standard protocol for any surgery requires adequate exposure along with preservation of the surrounding neurovascular and other important structures. To reduce the danger of dislocation and also to make easy the implantation of the prosthesis, therefore, improving the durability of the implant requires a broad exposure of the surgical field. This in turn also conveniently reduces the chances of thrombophlebitis or other infections. Appropriate handling of the surgical field was comparatively more necessary than the preservation of short skin incisions and/or the muscular insertions [31].

Quick recovery, reduced rehab time and time spent in the ward, the requirement of considerably small doses of analgesics due to less pain and minimal blood loss as the result of a smaller scar, are the obvious advantages of the MIS techniques when compared to the more traditional procedures of the THA [32-34]. Commonly, intense mental trauma is associated with the postoperative pain, and relieving these postoperative pain leads to decrease in the severity of such associated traumas. Minimal blood loss and the claimed decrease in pain via the MIS techniques is under questioning [35, 36]. Patients with osteoporosis, more commonly women

over the age line of 65 years and exceeding 32 points of the body mass index (BMI), are more prone to the complications with the MIS technique during the THA procedure. Adding to that, the chances of complications are far more if the surgeons are inexperienced or are only performing 40 to 50 procedures of THA in a year. Increased frequency of late and/or early dislocations, placement of the prosthesis stem in a varus angle and non-centric drilling of the acetabulum which causes it to obtain a rather vertical position are the more common/frequent mistakes of inexperienced surgeons or surgeons who haven't the appropriate exposure of the MIS technique. If there is a use of unnecessary and excessive force for these procedures, more commonly associated complications are femoral shaft along with its condyles suffering torsion fractures and also the femoral fractures more chiefly in the areas of the greater trochanter and Adam's arch. Injuries to the femoral and sciatic nerves are also associated with such errors. Weakened post-operative wound healing and damage to the skin (rupture) are more of the less major complications which are caused due to the extreme tension of the hooks [37]. Higher chances of both deep and superficial infections and also hematomas are also the risk factors. However, early or late dislocation of the prosthesis in the THA procedures based on MIS technique is still under questioning.

Another complication with the MIS technique is the fact that there is only a limited field for assistance as only the main surgeon/one surgeon of the lot has more clear access to the surgical plane, this increases the probability of relative complications. This may also further result in hindering the sharing of experience among the group of surgeons. It is critical that the decision of making the cutaneous incision should mean its appropriate compatibility with the muscle septa [38]. This procedure has been known to be a good example, as it brings about a considerable effect of the acclaimed learning curve [38]. Fractures of the greater trochanter and also in the region of Adam's arch are specifically associated with the progression in the experience which directly reflects upon the reducing incidence of complications, also the incidence of early revisions is reduced [39]. However, the MIS technique is not suitable for all the patients that have been approved for or have opted for the surgical treatment and it is crucial that the team of surgeons performing the procedure should be experienced with an adequate exposure to

such implantations. As these implantations, based on the MIS technique have been rightfully so compared to building a ship in a bottle [40]. The danger of postoperative complications related to MIS techniques necessitates care.

Conclusions

Although the effectiveness of MIS based techniques is now well-known, the implementation of the procedure is mainly by the operating surgeon's own comfort and convenience, maximum possible protection of the tissues and also the avoidance of muscular detachments is the primary precautions of the THA procedures based on MIS techniques. Issues such as the scar length postoperatively are of not much significance. As of now, the criterion of the debate is that minimal incision technique is not the only principle of MIS procedures; rather, the techniques which do not involve incising through the muscles or the detachment of muscles are more suitable principles of the approach for MIS, because if not so, then the procedures are more appropriately referred as less invasive techniques. So far having discussed the various approaches for MIS based procedures, the anterior approach proposed by Judet is seemingly more in tune with the criterion of the minimal invasive surgical technique for performing total hip arthroplasty.

Conflict of Interest

The authors have no conflict of interest.

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