Original article

Mini-incision direct lateral approach versus anterior mini-invasive approach in total hip replacement: results 1 year after surgery

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Abstract. *Background and aim:* Minimally invasive total hip arthroplasty (THA) is a subject of much debate in the literature and is claimed to be superior to the standard technique due to the potential reduction of soft tissue damage via a smaller and tissue-sparing approach. The aim of the study was to compare the outcomes of THAs which were implanted through a modified "less-invasive/mini-incision" lateral approach performed and through an anterior mini-invasive (MI) approach and to eastablish their safety. *Materials and methods:* Seventy patients, who underwent THA between January 2011 and September 2011, were divided into two groups according to the surgical approach. Group 1 included 35 patients who were operated through a modified "less-invasive/mini-incision" lateral approach and group 2 included 35 patients operated through an anterior MI approach. Operation and hospitalisation time, blood loss and number of transfusions were analyzed as well as the peri-operative complications and prosthetic component placement. The Harris Hip Score (HHS) was recorded before and at 1 year follow-up evaluation. The Pain Visual Analogue Scale (pain VAS) was administered to the patients before, 1 week and 1 month after surgery as well as at the follow-up visit. *Results:* Similar satisfactory results and complication rates between the two approaches were observed. Group 2 patients experienced less pain in the early postoperative period. *Conclusions:* The satisfactory and similar results and the low rate of complications observed suggest that THA can be performed safety through these 2 approaches. (www.actabiomedica.it)

Key words: hip, prosthesis, minimally invasive, anterior, lateral, surgical approach

Introduction

From the time of the first hip prostheses in the late 1960's (1) the improvement of surgical techniques progressively resulted in better long-term outcomes (2,3) of these interventions. Recently, these advancements broadened the spectrum of patients that could undergo this type of surgery such as young and active persons which could then undergo early rehabilitation and return quickly to their activities of daily living (ADL's) and work. With this in mind, the concept of "mini-invasiveness" was introduced as an attempt to minimize damage to soft-tissues and peri-articular vascular-nervous structures. The term "mini-invasiveness" has yet to be universally accepted and still poses confusion about its true definition. A distinction must be made between approaches that use mini or less invasive incisions and the techniques that truly are mini-invasive. The first offers minimal trauma to soft tissues and minimizes muscle detachment, and requires a small learning curve on behalf of the surgeon in order to shorten the size of the incision. The latter approach

allows to access the joint with a small incision, without detaching any muscles and requires a completely or partially new learning period on behalf of the surgeon. Some studies have demonstrated substantial benefits of mini-invasive access over traditional ones, most likely related to the fact that muscular and vascular-nervous structure damage is less important (4-7). Other authors argued that these benefits in terms of less peri- and post-operative blood loss (8, 9), shorter hospitalisation time (10, 11) and faster functional recovery (12, 13) play a major role in the immediate postoperative recovery but have less influence in the mid- and long-term periods, and resembles to the recovery of traditional approaches (14, 15). In fact, others yet have described a higher number of complications (peri-prosthetic fractures and misalignment of the prosthetic components) (16, 17). Inevitably a real debate has risen in the orthopaedic community about the effective advantages of mini-invasive techniques and the same occurred in our hospital between defenders of the traditional approach and those of the mini-invasive one. The authors have thus decided to begin implanting hip prostheses through an anterior mini-invasive approach, which derives from the traditional anterior approach described by Smith-Petersen (18) and takes advantage of the muscle layers between the Fascia Lata Tensor (lateral femuro-cutaneous nerve) and the Rectus Femoris muscle (femoral nerve). Nonetheless, the authors continued using the standard lateral transgluteal approach (19), because of the long lasting experience accumulated through the years, which minimized the incision length and the musculo-tendinous detachment around the joint. The authors report and compare their clinical and radiographic outcomes at 1 year follow-up between two groups of patients operated with a modified "less-invasive/mini-incision" lateral approach and with an anterior mini-invasive approach in order to establish the safety of these procedures.

Materials and methods

Seventy patients who underwent primary THA between January 2011 and September 2011 were enrolled in this retrospective study. All prostheses were performed by a single experienced hip surgeon.

Exclusion criteria were patients requiring bilateral THA, obesity (body mass index (BMI) N30 kg/m2), leg length discrepancy of more than 2.5 cm, rheumatoid arthritis, history of previous surgery on the affected hip, femoral neck fractures, post-traumatic osteoarthritis after complex acetabular fractures previously synthesized and major acetabular and/or femoral deformities. The authors also excluded patients with any mental disability and the first 30 patients operated through an anterior MI approach between January and December 2010, which the authors considered as those of the learning curve period for this new approach.

Thirty-five patients (group 1) were operated through a modified "less-invasive/mini-incision" lateral approach and 35 patients (group 2) through an anterior MI approach. For both groups, a cementless cup and stem were implanted. In group 1, a M2a-Magnum acetabular component and a Taperloc Microplasty (Biomet®) stem were used in 15 cases whereas in 20 patients a Selexys or Expansys cup associated to a CBC stem (Mathys®) were implanted. In group 2, a M2a-Magnum acetabular component and a Taperloc Microplasty (Biomet®) stem were always positioned.

There were 18 males and 17 females patients in group 1 and 19 males and 16 females in group 2. The mean age at surgery was 64.54 years (range 48-80) in group 1 and 64.57 in group 2 (range 46-79) (table 1). The preoperative diagnosis was primary osteoarthritis in 31 patients of group 1 and 32 of group 2 and femoral head necrosis in 4 patients of group 1 (3 avascular and 1 subsequent to hip dislocation and femoral head fracture) and in 3 cases of group 2 (3 avascular) (table 1).

All patients were given antitromboembolic prophylaxis with low molecular weight heparin and antibiotic prophylaxis with second generation cephalosporins.

The modified "less-invasive/mini-incision" lateral approach, which derives from the standard lateral transgluteal approach of Bauer (19), requires the patient to lie supine and a 7 to 10 cm longitudinal incision is made centrally over the greater trochanter. The fascia is thus separated just beneath the skin incision. The fascia is spread apart until the large gluteus is un-

Table 1. Numbers of implants and characteristics of the patients. NS: no significance

	Group 1	Gruppo 2	p value
Ns. of implants	35	35	
Age (years)	64.54 (48-80)	64,57 (46-79)	p>0.05 (NS)
Gender (M/F)	18/17	19/16	
BMI	26.5 ± 1.93	26.6 ± 1.76	p>0.05 (NS)
Preoperative diagnosis			
Hip osteoarthritis	31	32	
Femoral head necrosis	4	3	

covered using a large Hohmann lever inserted delicately beneath the greater trochanter and a large dull retractor placed above it. The gluteus is incised between its medial third and anterior third portions, ending proximally 2 cm from the greater trochanter and distally at the epitrocanter tendon portion, preserving the anterior part of the gluteus medius and vastus lateralis. The proximal border of the muscular dissection lies perfectly within the so-called "safe area", in other words the zone in which the superior gluteal nerve branches cannot be severed. The detachment of the anterior portion of the epitrocanteric laminal tendon must be achieved with a subperiosteal dissection and without transverse incisions in order to facilitate its reinsertion. The sectioning of the reflected anterior rectus tendon from the anterior part of the capsule is followed by its removal. This leads to the dislocation and removal of the femoral head and implant, after preparing both articular surfaces of the prosthetic components.

In the anterior MI approach, that the authors always performed with the patient lying supine and with the limb in traction, a 6 to 9 cm incision was made through the intermuscular interval between the tensor fasciae latae and the sartorius muscle. This approach provided good exposure of the hip joint while preserving muscle integrity. The incision originates 2 cm distal and 2 cm posterior to the antero-superior iliac spine and runs distally towards the lateral margin of the patella. After protecting the lateral femoral cutaneous nerve and sectioning the superficial fascia along with the cutaneous incision, the tensor fasciae latae was retracted laterally and the sartorius muscle with the rectus femoris was retracted superiorly and medially. Particular care must be taken to detach the rectus femoris fibers on the anterior portion of the joint capsule and to tie the ascending branches of the lateral circumflex artery. At this point the joint capsule was sectioned and the surgery could proceed with the implant of the prosthetic components.

All patients received epidural analgesia for 36 hours after operation and oral administration of non-steroidal anti-inflammatory drugs for 5 to 7 days post-operatively.

All patients received the same standardized post-operative care with identical rehabilitation protocols. Physical therapy started on the first postoperative day and all patients were allowed to commence walking exercises using a walker from the second postoperative day. Patients were permitted to walk with a cane from the fourth day after operation.

Surgical and hospitalisation time, blood loss and number of transfusions, systemic and local complications as well as prosthetic component placement were analyzed. Surgical outcomes were evaluated by using the Harris hip score (HHS) (20) and the pain visual analog scale (pain VAS). HHS was obtained before surgery and at the follow-up visit 12 months after surgery and pain VAS was also recorded 1 week and 1 month after surgery.

For the acetabular component placement, the acetabular cup angles were measured on anteroposterior (AP) radiographs performed at the 1 year follow-up visit.

For the femoral component placement, stem alignment was measured on AP and axial radiographs as the angle between the long axis of the stem and the anatomical axis of the femur. Using the AP projections, normal positioning was considered when the stem was located between 3° of varus and 3° of valgus.

Using the lateral projections, normal positioning was considered when the axis of the stem had a tilt of less than 3º in relation to the axis of the femur. Signs of loosening and migration as well as heterotopic ossifications, classified according to Brooker (21), were detected on x-ray performed immediately after surgery and at 1 year follow-up. Measures on radiographs were calculated by an impartial radiologist (MD) using the Software EBIT Esaote. All clinical data were recorded by an impartial observer (AP).

The results of the two groups were compared and statistical analyses were elaborated using the SPSS software (11.0 version). ANOVA F-test was used to analyze differences between groups for continuous variables (age, BMI, blood loss, operating time and acetabular inclination). The Mann-Whitney test was used to analyze differences between groups for discrete variables (number of blood transfusions, hospitalisation, preoperative and 1 year follow-up of HHS and VAS of the group 1 vs. group 2). Wilcoxon test was used to compare preoperative vs.1 year follow-up HHS and VAS for each technique. The difference was considered significant when the P value was less than 0.05.

Results

There was no difference in age, sex, BMI, or preoperative disease between the 2 groups (Table 1). Overall blood loss was similar in Group 1, with a mean value of 629.43±132.58 ml (range: 480-1000), and in Group 2, with a mean value of 600.14±143.97 ml (range: 350-900) (p=0.38) (Table 2).

No significant group differences were found in number of transfusions, surgical and hospitalisation time. Mean number of post-operative blood transfusions was 0.74 (range: 0-2) in Group 1 and 0.71 (range: 0-2) in Group 2 (p=0.78) (Table 2). Mean operating time was 90.1±11.75 minutes (range: 70-105) in Group 1 and 91.9±13.41 (range: 75-110) in Group 2 (p=0.4) (Table 2). Mean hospitalisation time was 6.7 days (range: 6-9) in Group 1 and 6.5 days (range: 5-8) in Group 2 (p=0.7) (Table 2).

HHS and pain VAS score improved significantly after THA (p<0.0001) (Table 3) and there was no difference in these values between two approaches throughout the study period.

Average HHS preoperatively was 53.22 (range 46.7-65) in Group 1 (30 poor results) and 53.04 (range 42-60) in Group 2 (p=0.79) (30 poor results). Average HHS at 1 year follow-up was 91.51 (range 87-94) in Group 1 (28 excellent and 7 good results) and 91.39 (range 87-95) in Group 2 (p=0.87) (27 excellent and 8 good results) (Table 2).

Average pain VAS score in Group 1 and Group 2 was respectively 69.86 (range 60-85) and 69.71 (range 60-85) before surgery (p=0.99), 45.58 (range 40-60) and 43 (range 35-55) 1 week after surgery (p=0.15), 24.57 (range 15-35) and 23.14 (range 15-30) 1 month after surgery (p=0.37) and 9.27 (range 0-15) and 9.15 (range 0-15) at 1 year follow-up (p=1) (Table 2).

With regard to the x-ray data, in the "less-invasive/mini-incision" lateral and anterior MI approach, the mean cup acetabular inclination was 46.78°±3.02° and 46.11°±2.68°, respectively. There was no difference in this parameter between the 2 groups (p=0.34) (Table 2).

Radiographs made at follow-up visit did not show any signs of loosening nor lines of radiolucency in comparison to immediate postoperatively views.

A stem misalignment with a varus beyond 3º was observed in 2 cases (one in group 1 and one in group 2). A stem misalignment with a tilt beyond 3º was observed in 4 cases (2 in each group) (Table 2).

Overall rates of complications were similar between the 2 groups. One dislocation was observed in the MI anterior approach group during the postoperative rehabilitation period. This dislocation was treated successfully by closed manual reduction and there was no recurrent dislocation. There was 1 case of early and superficial infection in the mini-incision direct lateral approach group consequent to postoperative haematoma, which was treated successfully with a drain and wide spectrum antibiotics.

One case in group 2 suffered from a transitory neuropraxia of the ipsilateral lateral femoral cutaneous nerve, which resolved spontaneously at 8 months from surgery. Two patients in Group 1 presented type I asymptomatic heterotophic ossifications which did not require additional treatment.

Table 2. Clinical and radiographic outcomes of group 1 and 2. NS: no significance

	Group 1	Group 2	p value
Blood loss (ml)	629.4±132.58	600.1±143.97	>0.05 NS
Number of transfusions	0.74	0.71	>0.05 NS
Operating time (minutes)	90.1±11.75	91.9±13.41	>0.05 NS
Hospitalization (days)	6.7	6.5	>0.05 NS
HHS (preoperative)	53.22	53.04	>0.05 NS
HHS (1 year)	91.51	91.39	>0.05 NS
VAS (preoperative)	69.86 (60-85)	69.71 (60-85)	>0.05 NS
VAS (1 week)	45.58 (40-60)	43 (35-55)	>0.05 NS
VAS (1 month)	24.57 (15-35)	23.14 (15-30)	>0.05 NS
VAS (1 year)	9.27 (0-15)	9.15 (0-15)	>0.05 NS
Acetabular inclination	46.78°±3.02°	46.11°±2.68°	>0.05 NS
Stem varus/valgus >3°	1	1	
Stem tilt >3°	2	2	

Table 3. HHS and pain VAS scores in group 1 and 2 before and 1 year after surgery

	Before surgery 1	year follow-up	p value
HHS (Group 1)	53.22	91.51	<0.0001
HHS (Group 2)	53.04	91.39	<0.0001
VAS (Group 1)	69.86	9.27	<0.0001
VAS (Group 2)	69.71	9.15	<0.0001

Discussion

Despite conflicting evidence of the true benefits of mini-invasive approaches in hip prosthesis (9, 14, 15), minimally invasive THA has become a common and safe surgical procedure.

Safety can be defined as avoiding complications for the patient. These complications may be related to intra-operative, immediately post-operative, or short-mid- and long-term component malpositioning (20).

Considering that there have been few reports which compare clinical outcomes between the anterior MI and "less invasive/mini-incision" direct lateral approaches (22-24), the purpose of this retrospective study was to compare the clinical outcomes using these 2 approaches in primary THA and to establish the safety of these procedures.

Several minimally invasive or "less-invasive or mini-incision" approaches have been described with innovative techniques: posterior (25, 26), anterior (27), anterolateral (28), direct lateral (22, 30) and the two-incision approaches (31). Each of them presents advantages and disadvantages.

The anterior MI approach, that the authors used in group 2 of this case series, is performed through an intermuscular plane between the sartorius and the tensor fasciae latae muscles and has been associated with a lower risk of dislocation than the posterior approach since the posterior capsule and short external rotators are preserved (25-26).

Despite these advantages, the anterior MI approach has to be considered a high demanding procedure in which exposure and visualization is harder to obtain especially at the beginning of the learning curve (32, 33). Before this study the senior surgeon usually performed THA through a standard lateral approach. Moving from the standard lateral approach to the anterior MI approach required a new learning curve. The anterior MI approach requires significant adaptation by the surgeon who routinely uses a lateral approach. Different instrumentations and landmarks within a reduced operative space must be used and new maneuvers to obtain exposure are required (in particular when placing the retractors and prosthetic components). For this reason the authors excluded the first 30 patients operated between January and December 2010 through the anterior MI approach which were considered as those of the learning curve period for a surgeon using this new approach.

On the other hand, because of the familiarity and long experience in the use of the standard transgluteal approach, moving from the standard lateral approach

to the "less invasive/mini-incision" lateral approach was more simple. In any case, in order to match the groups and the results, the more complex cases which were traditionally operated through a standard transgluteal lateral approach were excluded.

The lateral approach provides better acetabular and femoral exposure even if residual abductor weakness and limp post-operatively are reported (27, 33). In the modified and less invasive lateral approach, the skin incision is minimized to approximately 6 to 9 cm, and laceration of the gluteus medius and minimus is limited to a maximum length of 3 cm to protect the inferior branch of the superior gluteal nerve, and the anterior portion of the gluteus medius is not detached from the greater trochanter (25).

However, it is certain that anterior MI approach does not require any sort of muscular detachment unlike the modified "less invasive/mini-incision" lateral approach. For this reason, even if the modified "less invasive/mini-incision" lateral approach is less invasive than the standard lateral approach, less peri-operative blood loss, fewer transfusion, less post-operative pain, hospitalisation time and faster recovery have been advocated for the MI anterior approach (8-13).

In the current study, no significant difference was found for these parameters. Group 2 patients experienced less pain in the early post-operative period (1 week after surgery) but this difference of pain VAS score was not considered statistically significant. The similarity for the HHS in group 1 and 2 indicates no clinical advantage of the anterior MI approach over the "less invasive/mini-incision" direct lateral approach.

Because of the higher demands of the anterior MI approach, a greater operative time could be expected in patients treated with this technique. In this study, the operating time was similar between groups.

Furthermore, the evaluation of the radiographic results showed a good post-operative positioning of the prosthetic components in both groups, which was maintained at 1 year follow-up, without any signs of early loosening and migration. The measure of the acetabular inclination angles, as well as the evaluation of the stem alignment was satisfactory and similar between groups. These findings confirms that in the present series, even if the operating field was smaller, the surgeon did not encounter particular difficulties in cup and stem positioning.

The authors believe that surgical experience of the physician in hip surgery could be the main reason of these similarities, even if, for the more demanding anterior MI approach, a greater learning curve is necessary. One must consider, as demonstrated in the literature, that the first 30 cases are sufficient and representative of the learning of this new MI approach (32, 34, 35). Moreover, the authors, even if one of the limitations of this study could be the short-follow-up, consider that the assessment done 1 year after surgery is long enough in order to obtain reliable results and that potential future prosthetic loosening and/or migration are not to be related to the technique utilized.

The sum of all surgical complications in the two groups was similar. In this study, typical complications related to the surgical approach were encountered (1 case of neuropraxia of the ipsilateral lateral femoral cutaneous nerve and 1 dislocation in group 2, and 1 case of superficial infection consequent to postoperative haematoma and 2 cases of type I asymptomatic heterotophic ossifications in group 1) but their rate was within the range described in the literature (14, 15).

The differences between the anterior MI and "less invasive/mini-incision" direct lateral approaches found in our study seems to be smaller than those reported by previous studies. The authors believe that the reasons for this finding is that, despite not being randomized, the two groups were similar at baseline, all patients were operated by the same experienced hip surgeon and group allocation was blinded to patients. Also, results of the current study differ from those reported by others because the damage to the gluteus muscles is relatively smaller because the anterior part of the gluteus medius is not detached from the greater trochanter in our lateral procedure (25). Furthermore, the authors always performed the anterior MI approach on an operating table with the patient's leg in traction, thus facilitating hip and leg movements and better visualisation of the operating field and component positioning. In this group of patients, in which leg length and implant stability are more difficult to assess, precise pre-operative planning, supine positioning, release of the traction after components

placement and the use of fluoroscopy during surgery may help to prevent these complications.

Conclusions

Our study did not demonstrate whether one approach is superior to the other. On the basis of the satisfactory and similar results obtained and the low rate of complications observed, the authors conclude that THA can be performed safety through these 2 mini or less invasive approaches by an experienced hip surgeon.

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