Alexandria Journal of Medicine

ISSN: 2090-5068 (Print) 2090-5076 (Online) Journal homepage: https://www.tandfonline.com/loi/tajm20

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To cite this article: Helmy Fekry Refai & Mohamed Samir Kassem (2014) The minimally invasive total hip replacement via the direct anterior approach: A short term clinical and radiological results, Alexandria Journal of Medicine, 50:1, 31-36, DOI: 10.1016/j.ajme.2013.09.004

To link to this article: https://doi.org/10.1016/j.ajme.2013.09.004

Alexandria Journal of Medicine (2014) **50**, 31–36

Alexandria University Faculty of Medicine

Alexandria Journal of Medicine

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The minimally invasive total hip replacement via the direct anterior approach: A short term clinical and radiological results

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Received 8 November 2012; accepted 25 September 2013
Available online 1 November 2013

KEYWORDS

Minimally invasive;
Hip replacement;
Direct anterior approach

Abstract *Introduction:* There has been a recent interest in the minimally invasive approaches for hip replacements. The direct anterior approach is characterised by being a muscle preserving approach which should make it an ideal minimally invasive approach.
Aim: The purpose of this study was to assess the short term results and the complications of primary total hip replacements done through this approach.
Methods: This study included twenty uncemented primary hip replacements done in eighteen patients. The average age at the time of surgery was 71.5 years and the average body mass index was 22.5. The period of follow up ranged from 26 to 43 months.
Results: The length of hospital stay ranged from 3 days up to 19 days with a median of 5 days. Trendelenberg test was negative in 18 cases (90%). The Oxford hip score improved from a median of 16.5 preoperatively to a median of 40.5 postoperatively which was statistically significant ($p < 0.001$). Radiographically, seventeen hips (85%) had no malalignment of the stem with neutral

Abbreviation: BMI, body mass index.

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Peer review under responsibility of Alexandria University Faculty of Medicine.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.ajme.2013.09.004

position, and the cup version ranged from 14° to 45° of anteversion with a median of 26° whilst the cup abduction angle ranged from 35° to 63° with a median of 46.5. The complications included hyposthesia at the lateral cutaneous nerve of the thigh distribution in four cases (20%), partial femoral nerve palsy in one case, one early postoperative dislocation and one femoral shaft penetration. *Conclusion:* Total hip replacement through the direct anterior approach can offer an early good functional recovery with a short hospital stay. It may be associated with specific complications related to the approach which the surgeon should be aware of; especially in the start of his learning curve of the approach.

1. Introduction

There has been a recent interest in the minimally invasive approaches for total hip replacements.

The ideal goal of any minimally invasive approach is to reduce soft tissue damage during the surgery. This will allow an early recovery with subsequent decrease in the hospital length of stay and early return to normal activities. This ideal goal should be achieved without any increase in the risk of complications.[1]

The types of minimally invasive approaches of the hip used include the mini posterior approach, the mini anterolateral approach, the double incisions (anterior or posterior), and the direct anterior approach.[2]

The concept of minimally invasive approach has evolved from the small skin incision concept without much concern about the deep structures to the more logical concept of minimal damage to the deep structures especially the muscles and the tendons. The direct anterior approach has started to be popular since 2004 when Siguier et al.[3] published their results of 1073 hip replacements done through the direct anterior approach. This approach is characterised by being a muscle preserving approach and does not involve any tendon or muscle cutting, which should make it the ideal minimally invasive approach.[4]

2. Aim of the study

The purpose of this study was to assess the short term results and the complications of primary total hip replacements done through the direct anterior approach.

3. Materials and methods

This study included twenty uncemented primary hip replacements done in eighteen patients. The inclusion criteria included significant arthritis of the hip joint with associated pain, which interferes with their daily activities. The exclusion criteria included infection, the need for femoral shortening osteotomy or bone graft for bone defects.

There were six females and fourteen males. The average age at the time of surgery was 71.5 years and the average body mass index was 22.5 as shown in Table 1.

The pathological diagnosis was primary osteoarthritis in all patients.

All these patients were operated by the senior surgeon (HR) using the same implant (Accolade stem, Trident cup, Stryker UK) during the period from August 2008 till January 2010.

Table 1 Demographic data of the studied group.

Sex	Number	Percentage
Male	6	30
Female	14	70
Age		
Range	54.0–82.0	
Mean ± SD	68.85 ± 8.95	
Median	71.5	
BMI		
Range	21.0–38.0	
Mean ± SD	25.90 ± 3.54	
Median	25.5	

3.1. Approach

The patient was positioned supine with both legs draped freely. The operating table used had a side extension which allows abduction of the other hip to allow adduction of the operated side during femoral preparation.

The caudal side of the operating table was lowered at the hip level to allow hip extension whilst exposing the femur. The hip was approached through the intermuscular plane between the tensor fascia lata and the sartorius muscles. The anterior capsule was exposed and a small capsulotomy was done followed by double cut of the femoral neck to remove a part of the neck to allow extraction of the femoral head with the corkscrew. The acetabulum was prepared first followed by the femur. The proximal femur was exposed whilst hyperextension and adduction of the hip. The exposure was done with the help of the minimally invasive equipment provided by the implant manufacturing company, which includes multiple curved retractors as well as curved acetabular and femoral reamers and introducers.

Postoperatively, the patients underwent the routine postoperative physiotherapy regimen and they were discharged when they were safely mobilising on crutches.

3.2. Data collection

The data were collected and analysed by the second author and included the need for blood transfusion, the length of hospital stay, the early clinical assessment at 6 weeks, patient satisfaction as regards the scar, the preoperative and the postoperative Oxford hip scores, and the complications.

Radiological assessment of the hip replacement included the position of the stem, the cup abduction angle, the cup version, and the leg length discrepancy.

Data were fed to the computer using the Predictive Analytics Software (PASW Statistics 18).

Qualitative data were described using number and percent. Association between categorical variables was tested using Chi-square test. When more than 20% of the cells have expected count less than 5, correction for chi-square was conducted using Fisher's Exact test or Monte Carlo correction.

For normally distributed data, comparison between two independent populations was done using independent *t*-test. For abnormally distributed data, Mann–Whitney test (for data distribution that was significantly deviated from normal) was used to analyse two independent populations.

Significance test results are quoted as two-tailed probabilities. Significance of the obtained results was judged at the 5% level.

4. Results

4.1. Period of follow up

The period of follow up ranged from 26 to 43 months with a mean of 35.3 months and a median of 35 months.

4.2. Blood transfusion requirement

Seventeen cases (85%) did not need any allogenic blood transfusion. These seventeen cases included ten cases that did not have any transfusion at all and seven cases that had autogenous transfusion through the Cell saver (Table 2).

4.3. The length of hospital stay

The length of hospital stay ranged from 3 days up to 19 days with a median of 5 days. 12 patients (60%) were mobilising safely with crutches and were discharged before or at the fifth postoperative day.

4.4. Early clinical assessment at 6 weeks

Trendelenberg test was negative in 18 cases (90%) which indicates good hip abductor muscle power. Twelve cases (60%) were mobilising comfortably without any walking aids before the 6 weeks follow up appointment.

4.5. Oxford hip score

All patients were assessed with the Oxford hip score preoperatively and postoperatively at the last follow up appointment. Oxford hip score is formed of twelve questions which include assessment of the pain and the daily activities with a minimum score of 0 and a maximum of 48.

The preoperative Oxford hip score of our studied group ranged from 5 to 44 with a median of 16.5 which improved significantly postoperatively to a score range from 19 to 48 with a median of 40.5 ($p < 0.001$)

Better results (Oxford hip score) were related to longer follow up, lower BMI, and older patients, ($p = 0.359$, $p = 0.075$, and $p = 0.806$, respectively). There was no statistically significant difference between the male and the female patients as regards the postoperative Oxford score ($p = 0.836$) (Table 3).

Table 2 Blood transfusion requirements.

Blood transfusion	No.	Percentage
No	10	50
Auto	7	35
Auto, 1 unit	1	5
Auto, 2 units	1	5
2 units	1	5

Table 3 Correlation between the postoperative Oxford hip score and age, sex, BMI, and length of follow up.

	Oxford post	
	r	*P*
Age	$r = 0.079$	0.806
Sex	–	0.836
BMI	$r = -0.406$	0.075
Follow up	$r_s = 0.217$	0.359

r: Pearson coefficient.
r_s: Spearman coefficient.

4.6. Patient satisfaction

The satisfaction of the patients with the exposure was evaluated using a questionnaire assessing if they are satisfied or not with the look of their scar and if they are happy to have the other side operated through the same approach.

Table 4 Radiographic stem position and leg length and cup position.

	Number	%
Stem position		
Neutral	17	85.0
1* varus	1	5.0
2* varus	1	5.0
Femoral penetration	1	5.0
Leg length		
−0.5	2	10.0
0	10	50.0
0.5	6	30.0
0.5	2	10.0
Range	−0.50 to 1.0	
Mean ± SD	0.20 ± 041	
Median	0.0	
Cup version		
Range	14.0–45.0	
Mean ± SD	26.55 ± 4.78	
Median	26.0	
Cup inclination		
Range	35.0–63.0	
Mean ± SD	47.10 ± 7.66	
Median	46.50	

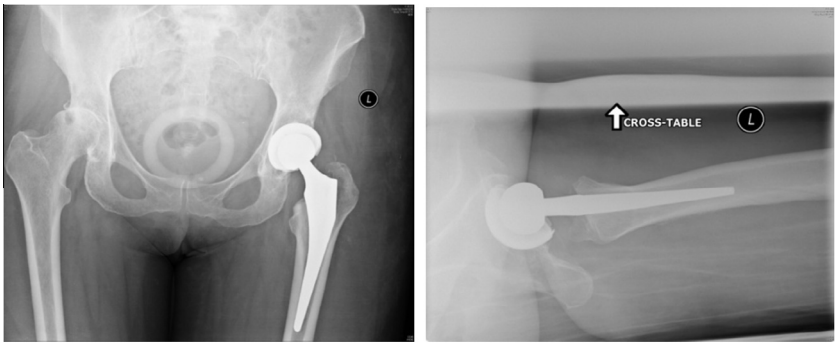

Figure 1 (a and b): Postoperative radiograph of the case who had early dislocation showing total hip replacement with neutral stem, 44° of cup abduction and 45° of cup anteversion.

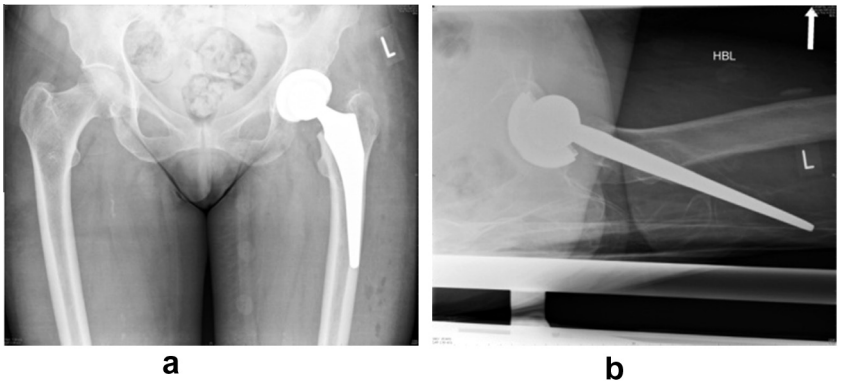

Figure 2 (a and b): Immediate postoperative radiograph showing posterior penetration of the femur by the stem.

All patients (100%) were satisfied with the look of their scar and accepted to have the other side operated through the same approach.

4.7. Analysis of postoperative radiographs

As regards the stem position on the sagital plane, seventeen hips (85%) had no malalignment of the stem with neutral position. Two patients (10%) had slight varus alignment whilst the third patient had femoral penetration (Table 4).

Looking at the cup, the cup version ranged from 14° to 45° of anteversion with a median of 26° whilst the cup abduction angle ranged from 35° to 63° with a median of 46.5 (Table 4). There was no cup retroversion in the studied group.

As regards the leg length, ten cases had equal bilateral leg lengths postoperatively whilst the other ten cases had small non clinically significant leg length discrepancies (Fig. 1 and Table 4).

4.8. Complications

Thirteen hips (65%) did not have any complications whilst the rest of cases had complications in the form of some hyposthesia at the lateral cutaneous nerve distribution in four cases (20%), partial femoral nerve palsy in one case, one early postoperative dislocation (Fig. 1) and one femoral penetration (Figs. 2 and 3).

5. Discussion

Postoperative rehabilitation following hip replacements is one of the important factors, which affects the long term results of the replacement surgery. This rehabilitation is usually affected by the amount of postoperative pain that is in turn related to the damage of the soft tissue structures during the surgery including the skin, the muscles and the tendons. The interest in the minimally invasive approaches to the hip originated from the need to decrease the surgical soft tissue damage in order to minimise postoperative pain and to facilitate rehabilitation. The direct anterior approach is an ideal minimally invasive approach for hip replacement. It is an intermuscular approach, which does not include any surgical incision into the muscles or their tendons.[5,6]

This approach needs a special operating table with a side extension to allow for abduction of the non operated side and adduction of the operated side as well as an articulation in the table to allow for the hyperextension of the operated hip to help for the exposure of the proximal femur. Special instruments are also needed for this approach including special curved retractors, special handles for the acetabular and the femoral reamers and special acetabular and femoral introducers.[4]

The period of follow up in this study ranged from 26 to 43 months with a median of 35 months. We consider this period enough for assessment of the results of the direct anterior

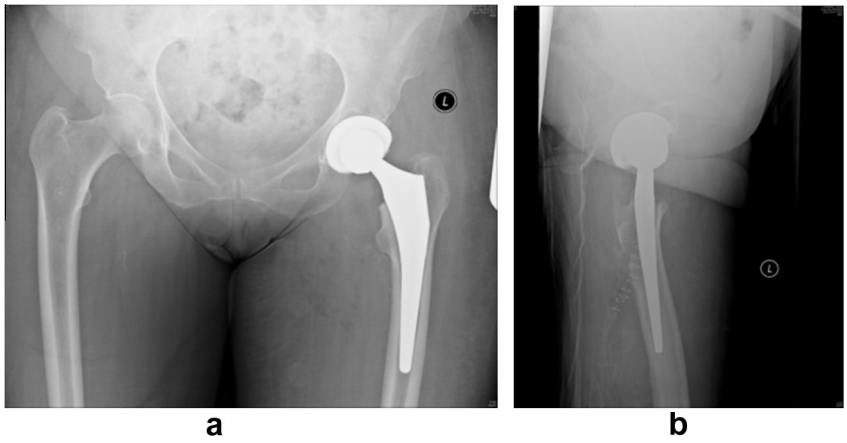

Figure 3 (a and b): Postoperative radiograph following revision of the stem.

approach clinically and radiographically, which is the goal of this study.

As regards the postoperative rehabilitation, the patients were mobilised out of bed as soon as it is safe according to our routine physiotherapy protocol used for conventional hip replacements. They were discharged as soon as they are safe mobilising with crutches. With this routine protocol some of our patients were discharged as early as the third postoperative day. Some studies have reported similar good results and early patient discharge with the use of accelerated rehabilitation programme associated with good pain control and managed to have their patients discharged as early as the first day postoperative.[5,6] We think that an accelerated physiotherapy regimen which is motivating for the patient and the physiotherapist may have increased the number of early discharges as well as may have achieved discharges earlier than the third day.

The early clinical assessment at six weeks has showed good functional recovery of the hip muscle power as expected with this muscle sparing approach. Many other studies have showed that the direct anterior approach can lead to early postoperative functional recovery of the hip.[7–9]

A study done by Meneghini et al.[10] has showed that although there is no direct injury by surgical cutting to any of the hip muscles with the direct anterior approach, there is a potential for indirect injury through retraction and manipulation especially to the tensor fascia lata and the direct head of the rectus femoris. This indirect injury to these muscles should be avoided during surgery to make sure that the hip replacement done through the direct anterior approach remains as minimally invasive as possible.

There has been a high statistically significant improvement of the Oxford hip score postoperatively, which correlates with the high patient satisfaction following the surgery. All patients accepted to have their other side operated through the same approach. Two patients had the other side replaced through the direct anterior approach including the patient who had an early dislocation of her first replaced hip that did not prevent her from having the other hip replaced through the same approach.

There were two cases with slight varus malalignment of the stem whilst a third case had intraoperative femoral penetration with the stem. This indicates that femoral exposure and preparation is more difficult through the direct anterior approach than the acetabular exposure and preparation. We are considering the use of the short femoral stem to avoid such a complication in the future. Some studies have reported the use of intraoperative fluoroscopy that should be well considered throughout the start of the learning curve.

Looking at the cup position, there was no significant malalignment as regards the cup version and the cup abduction angle with a median of 26° and 46.5° respectively. The direct anterior approach allows a good exposure to the acetabulum with the help of the curved retractors. Therefore the assistants can retract the soft tissues without compromising the surgeon's view and access to the acetabulum. It is worth mentioning that we found that two assistants are mandatory for this minimal invasive surgery.

As regards the leg length, there was no significant leg length discrepancy in all cases. It is obvious that having the patient operated in the supine position will allow the surgeon to adjust the leg length more accurately than being on their side.

Hyposthesia at the distribution of the lateral cutaneous nerve of the thigh has been reported to occur following this approach in many studies.[11–15] Several studies of the surgical anatomy of the lateral cutaneous nerve of the thigh have showed that there is a normal anatomical variation of the nerve position in relation to the anterior superior iliac spine as well as the anatomical crossing of its two branches (the gluteal and the femoral) in front of the tensor fascia lata muscle.[16,17] Thus, this variation makes the nerve vulnerable for injury either directly or through traction. Ropars et al.[17] recommended the incision to be as lateral and as distal to the anterior superior iliac spine as possible to avoid this injury.

Femoral nerve injury has also been reported as a possible complication of this approach.[18] The case reported in this study had partial injury which recovered within eighteen months postoperatively.

We had one early postoperative dislocation which occurred three weeks postoperatively. The patient was not compliant with the postoperative instructions and dislocated her hip whilst bending to pick up an object from the floor. Her radiograph also showed an anteversion of the cup of 45°. She had closed reduction of her dislocation under sedation and her

hip has been stable since. She had the other side replaced through the same approach 4 months after the first hip replacement.

The intraoperative femoral penetration was recognised immediately postoperatively when the patient complained of pain related to the back of her thigh and the postoperative radiograph was done. The good impaction of the stem after penetration and the limited access to the proximal femur offered by this approach has led to lack of identification of the femoral penetration intraoperatively. The patient had a revision of her stem through the anterolateral approach with the use of the same type of stem as the cortical defect was less than one third of the circumference. Other studies have reported similar complications related to the femur.[19,20] Looking at the complications and the stem alignment on the femoral side, this study has showed that the direct anterior approach offers better exposure to the acetabulum than the femur. We recommend the use of fluoroscopy in cases of difficult exposures.

6. Conclusion

Total hip replacement through the direct anterior approach is a minimally invasive surgery, which can offer the patient an early good functional recovery with a short hospital stay. It is cosmetically very well accepted by the patient. It should be considered a technically demanding procedure needing good training and previous mastering of the conventional method of replacement. It may be associated with specific complications related to the approach that the surgeon should be aware of especially in the start of the learning curve of the approach.

Conflict of interest

None declared.

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