



Learning curve for a modified Watson-Jones minimally invasive approach in primary total hip replacement : Analysis of complications and early results versus the standard-incision posterior approach

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We analysed the learning curve of an anterolateral minimally invasive (ALMI) approach for primary total hip replacement (THR). The first 42 THR's with large-diameter heads implanted through this approach (group 1) were compared to a cohort of 58 THR's with a 28-mm head performed through a standard-incision posterior approach (group 2). No selection was made and the groups were comparable. Implant positioning as well as early clinical results were satisfactory and were comparable in the two groups. In group 1, the rate of intraoperative complications was significantly higher (greater trochanter fracture in 4 cases, cortical perforation in 3 cases, calcar fracture in one case, nerve palsy in one case, secondary tilting of the metal back in 2 cases) than in group 2 (one nerve palsy and one calcar crack). At 6 months, one revision of the acetabular cup was performed in group 1 for persistent pain, whereas in group 2, we noted 3 dislocations (2 were revised) and 2 periprosthetic femoral fractures. Our study showed a high rate of intra- and perioperative complications during the learning curve for an ALMI approach. These are more likely to occur in obese or osteoporotic patients, and in those with bulky muscles or very stiff hips. Postoperative complications were rare. The early clinical results are excellent and we may expect to achieve better results with a more standardised procedure. During the initial period of the learning curve, it would be preferable to select patients with an appropriate morphology.

Keywords : total hip replacement ; minimally invasive surgery ; learning curve ; anterolateral approach.

INTRODUCTION

The increasing amount of data being published on minimally invasive approaches for total hip replacement (THR) shows that the trend of has not waned in any way (20). Several different approaches have been described (5, 6, 15, 18, 19, 30), and the number of studies analysing their results keeps increasing (3, 5, 6, 10, 13-15, 24-26, 30, 32). Some of them (3, 13, 14, 26, 32) insist on the potential complications.

Among minimally invasive approaches, the anterolateral mini-incision, the so-called modified Watson-Jones approach, described by Bertin and Röttinger (7), is one of the most innovative and one

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of the least studied. It uses the interval between the tensor fascia latae and the gluteus medius. We chose to combine the theoretical advantages of this anatomical approach with those of large heads and metal-on-metal articulating surfaces. This approach does not require the use of an orthopaedic table. It leaves the abductor muscles intact and minimises postoperative limp (23). It also leaves periarticular elements (tendon and capsular elements) intact, which reduces the risk of dislocation (27). Large heads in THR are used to restore a range of motion as close as possible to normal (12). The range of motion is optimised due to an increased head-neck ratio, which decreases the risk of impingement between neck and cup (1, 12). Angular and axial stability of the implants is improved (1, 12, 31). The choice of a metal-on-metal articulation is associated with reduced wear of implants (21) and avoids the risk of fracture or disassembly of the polyethylene (PE) liner when large heads are used in a metal-on-PE configuration (1). These advantages should in theory ease the postoperative course, due to rapid recovery of function and less restrained rehabilitation as well as the durability of the hip replacement.

A large number of surgeons use the posterior approach for THR. Moving to the minimally invasive anterolateral approach means a major change in technique. All new techniques require a learning curve of variable duration (6, 15, 16). This period can be even longer and more difficult if the change in surgical approach is combined with a change in ancillary equipment and/or implant used in these minimally invasive procedures. Studies which specifically analyse the learning curve for total hip replacement are rare (2, 8).

We hypothesised that : 1) the minimally invasive anterolateral approach associated with large heads could offer excellent early results, but 2) the learning curve for a new approach associated with a change in implant could lead to an increase in perioperative complications.

MATERIALS AND METHODS

The aim of this prospective study was to analyse the learning curve for THR with large-diameter heads

implanted by a single skilled senior surgeon using the minimally invasive anterolateral approach in a continuous group of patients. The early clinical results of this cohort were also analysed and compared with a group of consecutive THR's performed using a standard-incision posterior approach.

MATERIAL AND METHODS

One hundred primary total hip replacements (THR) divided into 2 distinct and comparable groups were enrolled in our study. The first 42 THR's with large heads implanted using the minimally invasive anterolateral approach in our department were included and constituted our first group. All these patients were operated on by the same senior surgeon using the anterolateral minimally invasive approach described by Bertin and Röttinger (7). The second group comprised of 58 consecutive THR's performed using the standard-incision posterior approach (11) that was used in our department before the Bertin and Röttinger approach. All cases were primary THR's. No selection in terms of weight, Body Mass Index (BMI) or type of morphology was made. The preoperative data (sex, age, BMI, ASA score, diagnosis, Charnley class, preoperative functional scores) are summarised in table I.

Surgical technique : The antero-lateral minimally invasive approach

The patient was placed in a strict lateral position and the posterior half of the table distal to the pelvis was removed. An incision eight centimetres in length was made from the anterior tubercle of the greater trochanter on a line running from the trochanteric crest to the anterior superior iliac spine (ASIS). The interval between the gluteus medius and the tensor fascia lata was identified and an extra-articular exposure of the capsule was carried out using two Hohmann retractors. After H-shaped capsulotomy, the neck was transected *in situ* while protecting the posterior and lateral aspect of the neck so as to not damage the greater trochanter. The head of the femur was removed using a cork screw. The acetabulum was exposed using two retractors placed at 5 o'clock and 7 o'clock. The acetabulum was prepared using normal or curved acetabular reamers, followed by insertion of the implants. The femur was exposed, the lower limb was kept in extension, adduction and external rotation by the assistant. The patient's leg was protected by a sterile cover. The difficulty in this preparation is to find the axis of the femoral shaft. Exposure

Table I. — Pre-operative data

	Anterolateral mini-incision approach	Standard-incision posterior approach	p
Number of hips	42	58	
Gender : M/F	24/18	33/25	0.99
Age (years)	57.4 ± 13.2 (32 – 83)	59.7 ± 15.3 (21 – 86)	0.27
Body Mass Index (kg/m ²)	26.1 ± 3.7 (18.9 – 34.9)	26.2 ± 4.5 (17.2 – 36.7)	0.87
ASA score : 1/2/3	23/16/3	20/35/3	0.09
Diagnosis	Primary OA : 20 AVN : 13 Secondary OA : 6 RDHOA : 2 RP : 1	Primary OA : 32 AVN : 14 Secondary OA : 7 RDHOA : 2 RP : 2 RS : 1	
Charnley Class : A/B/C	18/18/6	28/27/3	0.29
Functional scores :			
– PMA	11.4 ± 2.5 (6 – 15)	11.7 ± 3.1 (5 – 17)	0.43
– Modified HHS	42.3 ± 11.2 (17 – 63)	44.2 ± 16 (11 – 83)	0.86
– Womac osteoarthritis Index	54.0 ± 18.1 (26 – 87)	49.4 ± 16.1 (17 – 84)	0.55

Abbreviations : M = Male, F = Female, ASA = American Society of Anaesthesiology, OA = OsteoArthrosis, AVN = Avascular Necrosis, RDHOA = Rapidly Destructive Hip Osteoarthritis, RP = Rheumatoid Polyarthritits, RS = Rheumatoid Spondylitis, PMA = Postel-Merle d'Aubigné, HHS = Harris Hip Score.

* The values are given as the mean and the standard deviation with minimum and maximum.

of the anterolateral side of the neck with careful dissection of the capsule, removal of cancellous bone at the lateral part of the metaphysis and use of a curette to locate the medullary canal of the femoral shaft were used to ensure a correct positioning of the rasp and limit the risk of perforation of the posterior femoral cortex. The vertical direction of the leg was used to adjust the anteversion of the rasps. The femoral stem was implanted. The capsule could then be closed. After reduction, a drain was inserted before closure. All patients had a postoperative AP radiograph of the pelvis taken before leaving the operating room.

In the first group, all patients but two received the same type of implant. The acetabular components were cementless impacted Durom™ (Zimmer, Centerpulse) cups combined with a large-diameter Metasul™ head with the exception of one case where, due to previous pelvic radiation therapy, we used a Schuster™ (Zimmer, Centerpulse) type acetabulum which was impacted and fixed with two screws. In the second group, a Schuster™ (Zimmer, Centerpulse) or Atlas™ (Fournitures Hospitalières, Heimsbrunn, France) uncemented acetabular component was implanted. The femoral components were hydroxyapatite-coated cementless Omnicase™

(Zimmer, Centerpulse) stems in all cases, except one in which a cemented stem of the same type was used.

Outcome assessment

All patients in the two cohorts were assessed by the same investigator independently from the operating surgeon. The duration of the surgical procedure and number of intraoperative complications were noted. Blood loss was assessed with a standardised method for calculation (9) taking into account the preoperative and postoperative haematocrit on day five and the number of red blood cells units transfused in the postoperative period. Length of hospital stay and type of discharge were noted.

Early clinical evaluation was carried out using questionnaires sent by post 3 and 6 months after operation, which enabled a Womac osteoarthritis Index (4) and a modified Harris Hip Score (22) to be determined. Late postoperative complications were also registered.

Radiographic evaluation

The pre and postoperative radiographs included a supine AP view of the pelvis, and AP and lateral views

Table II. — Operative data

	Anterolateral mini-incision approach	Standard-incision posterior approach	p
Duration of surgery average (<i>minutes</i>)	82.4 ± 19 (55 – 150)	72.6 ± 19 (45 – 125)	0.01
Peri-operative complications (number of complications / patient)	11 complications (0.26/patient)	2 complications (0.03)	0.02
Transfusion data :			
– Preoperative haematocrit (%)	42.9 ± 3.2 (37.2 – 51.3)	41.6 ± 3.1 (35.8 – 47.9)	0.09
– Postoperative haematocrit on 5 th day (%)	31.3 ± 3.1 (24.7 – 37.8)	30.1 ± 4.3 (20.1 – 39.3)	0.12
– Calculated global RBC loss (<i>millilitres</i>)	556 ± 187 (107 – 920)	572 ± 294 (214 – 1665)	0.51
– Number of blood units transfused (<i>units</i>)	0.15 ± 0.5 (0 – 2)	0.69 ± 1.4 (0 – 8)	0.02
– Number of patients transfused	3/42	15/58	0.04
Radiographic data :			
– Coronal stem alignment (<i>degrees</i>)	- 0,3 ± 2,3 (-8 – 5)	- 0,7 ± 1,8 (-6 – 3)	0.41
– Abduction cup angle (<i>degrees</i>)	50,7 ± 7,6 (38 – 72)	47,4 ± 6,8 (30 – 60)	0.11
– Metal-back centering : good/fair/poor	28/13/1	43/14/1	0.72

* The values are given as the mean and the standard deviation (SD) with minimum and maximum.

of the hip. The positioning of the stem was studied in AP and lateral views. The abduction angle of the cup was measured. Centering of the cup was evaluated using the Pierchon *et al* (28) method. It was considered to be good when the difference between the planned position and the effective position was less than 5 mm, fair between 5 and 10 mm and poor beyond 10 mm. The acetabular version could not be measured because of the presence of the metal back.

In order to assess the early results of the THRs implanted using the anterolateral minimally invasive approach, we used the standard-incision posterior group as the reference.

Statistical analysis was performed using Statview®. The continuous variables between the two groups were compared using a non-parametric Mann-Whitney U test. For categorical variables, we used an exact Fisher-Yates test. A p value < 0.05 was considered significant.

RESULTS

Operative data

Mean operative time was significantly higher in the first group with 82.4 minutes (range, 55 – 150) versus 72.6 minutes (range, 45 – 125) (p = 0.01). The mean calculated blood loss was comparable. Only three patients in the first group were transfused whereas 15 in the second group required a

blood transfusion. Positioning of the implants in the femur was satisfactory and was comparable in both groups. The mean abduction angle of the cup was higher in the first group than in the second group but the difference was not significant (respectively 50.7° ± 7.6 versus 47.4° ± 6.8, p = 0.11). In 7 cases in the MIAL group, the angle was greater than 45 ± 10°, with the implant too vertical. Centering of the cup was good or fair in all cases. The operative data of the two groups are summarised in table II.

Comparison with the standard-incision posterior group

We noted a significantly shorter hospital stay and more patients discharged to home in the first group. The early functional results were excellent and comparable. The Womac Osteoarthritis Index and modified Harris Hip Score at 3 months were significantly better in group 1 but were similar at 6 months. Early clinical data are summarised in table III.

Complications

In the MIAL group, we noted 11 intraoperative complications in 10 patients. Four fractures of the

Table III. — Post-operative data

	Anterolateral mini-incision approach	Standard-incision posterior approach	p
Length of hospitalisation (<i>days</i>)	9.2 ± 3 (5 – 24)	11.5 ± 3.1 (7 – 22)	< 0.0001
Discharge (<i>Home/Rehabilitation unit</i>)	19/23	10/48	0.005
Modified Harris hip score :			
– Preoperative :	42.3 ± 11.2 (17 – 63)	44.2 ± 16 (11 – 83)	0.86
– 3 months postoperative :	89.1 ± 9.3 (63 – 100)	79.8 ± 18.4 (30 – 100)	0.047
– 6 months postoperative :	90.3 ± 11.1 (54 – 100)	83.2 ± 16.8 (45 – 100)	0.08
WOMAC Osteoarthritis Index :			
– Preoperative :	54.0 ± 18.1 (26 – 87)	49.4 ± 16.1 (17 – 84)	0.55
– 3 months postoperative :	87.6 ± 9.3 (60 – 100)	79.2 ± 16.6 (34 – 100)	0.04
– 6 months postoperative :	89.7 ± 9.7 (65 – 100)	82.1 ± 18 (26 – 100)	0.16

* The values are given as the mean and standard deviation (SD) with minimum and maximum.

greater trochanter (fig 1) were diagnosed intraoperatively. All had healed at the last follow-up. Three cases of cortical perforation during rasping were diagnosed and were corrected intraoperatively. In all these cases patients were overweight with a BMI around 30. One calcar fracture occurred during reduction of the definitive implant and the stem was exchanged for a cemented one. Lastly, we had two cases of tilting of the acetabular implant : one was diagnosed on the postoperative radiograph (fig 2) and was corrected and the other occurred secondarily and was corrected on the 5th day after the primary surgery. This latter case was a female patient operated on for osteoarthrosis secondary to hip dysplasia with a defect of lateral acetabular coverage (fig 3a, b and c). In both cases, we found the labrum incarcerated behind the metal back. One case of peroneal nerve palsy was diagnosed postoperatively but had recovered at 6 months. Three months after the operation, we had one patient requiring repeat surgery for persistent mechanical pain. We discovered a non-integrated acetabular implant with fibrosis behind the metal back. The cup was exchanged for a similar type of implant, which cleared the problem of pain.

In the standard-incision posterior group, we noted in one case a calcar crack, which was treated with wiring. One peroneal nerve palsy was diagnosed in the recovery room. No other intraoperative complications were noted. Postoperatively,

during the first 6 months, we noted three dislocations, two femoral periprosthetic fractures due to falls (one during hospitalisation and the second at 3 months) and a distal deep vein thrombosis. The dislocations were all due to falls. In one case, the dislocation was reduced by manipulation and did not recur. It did recur in the other two cases and necessitated repeat surgery with a constrained acetabular liner. Repeat surgery was also performed for the periprosthetic fractures : the first case was treated with a cemented stem with wiring, the second one was operated elsewhere.

DISCUSSION

The aim of our study was to evaluate the learning curve for a senior surgeon using a minimally invasive surgical technique. Studies in the literature specifically analysing the learning curve for a new approach for total hip replacement (2) or for a technique using new equipment (8) are rare. However, new surgical techniques always require a learning curve before they are fully mastered, especially if a significant change to usual practice is required. This is particularly the case when moving from a posterior approach to an anterolateral approach or when learning the two-incision technique (2). On the other hand, the posterior approach is used by the majority of orthopaedic surgeons in our area. The learning curve would likely be shorter using a posterior min-



Fig. 1. — Immediate postoperative pelvic radiograph : AP view showing displaced fracture of the greater trochanter.



Fig. 2. — Immediate postoperative radiograph (AP view) showing tilting of the metal back Repeat surgery was performed immediately before departure from the operating room. There was also a fracture of the greater trochanter.

imally invasive procedure (11) because it is easier to progressively reduce the length of the incision while using the usual approach. This decreases the risk of complications, even though they still exist (32). Some authors have demonstrated (8) that early functional results are not affected by the learning curve in their experience. Our study confirms this. However, the experience of a surgeon in relation to a given technique is a significant variable for the quality of the surgical intervention (2, 8, 17). This is even more true when learning the minimally invasive approaches (2). There are new anatomical landmarks, a reduced operating field, and differences in terms of dissection and exposure which require

specific manoeuvres. This can increase the duration of the procedure (16) and the rate of intraoperative complications (2). The use of new techniques raises the problem of patient recruitment. Initially minimally invasive approaches were often applied in selected cases (32), to patients without significant comorbidity and not obese (10) and to those without any major architectural malformation. The results were therefore skewed. Our study involved a consecutive series of unselected patients. However, although the absence of prior selection of patients is necessary to obtain a strong level of evidence, it is safe, at the beginning of the learning curve, to select patients with the most favourable anatomy (16).

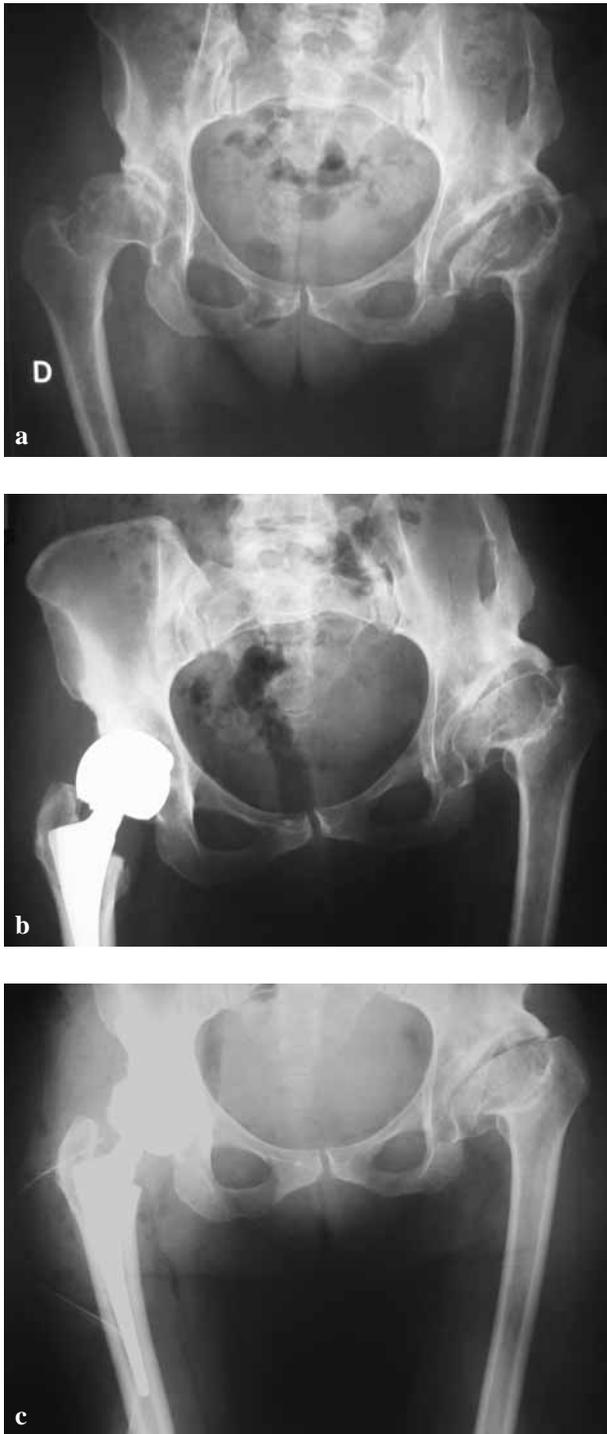


Fig. 3. — a) Osteoarthrosis secondary to dysplasia of the hip with deficient lateral coverage, b) Tilting of the metal back after weight-bearing, c) Immediate postoperative radiograph after repeat surgery.

Currently, no series in the literature has analysed short-term or long term results of the minimally invasive anterolateral technique described by Bertin and Röttinger (7); unlike other minimally invasive routes (2, 26), no study has reported complications related to this approach. Exposure of the femur is difficult and our results showed a relatively high rate of perioperative complications. Jerosh *et al* (18) used a minimally invasive anterolateral approach with the patient in the supine position and dislocated the hip by traction, adduction and external rotation. Anterior dislocation of the hip is difficult with this approach. Even though we had no such complication, there is a risk of fracture of the shaft of the femur, particularly in patients with osteoporosis, with very stiff joints or bulky muscles. For this reason, some surgeons have recommended to cut the neck *in situ* (7). Exposure of the proximal femur, achieved by hyperextension, adduction and rotation also imposes significant forces and requires precise placing of the retractors. Fractures of the greater trochanter can be initiated during cutting of the neck if the saw cut extends too far laterally and posteriorly. Intraoperative fractures also occur more easily in patients with osteopenia. The surgeon, who cannot view the lesser trochanter, must make a detailed preoperative template by using the tip of the greater trochanter and the trochanteric fossa as cutting landmarks. Exposure of the acetabulum presents little difficulty since it is directly in line with the incision. However, in our study, repeat surgery was necessary in some cases because of early mobilisation of the metal back. There were two cases (out of 42 implants) in which the cup mobilised and which needed repeat surgery. This rate is close to that of other authors (1) using large diameter hip implants inserted using the standard posterior approach. In both cases, we found labrum remnants incarcerated behind the metal back. In these cases the approach used was to blame because of the narrow field of vision, but also the limited training with this type of implant. Another cause for poor fixation of the acetabular implant is inadequate rasps due to poor marking or to wear. We now measure the size of the final rasp with a caliper. In our series, we noted 7 cups for which the angle was



Fig. 4. — An over aggressive Hohmann-type retractor can cause neurovascular injury.

more than 55° (55 – 72). This translated into an increased risk of dislocation (1) which means that the benefit of using large heads was lost (12). In addition, a cup which is excessively vertical will encourage conflict between the neck and the lower edge of the cup in adduction of the hip, with a risk of metallosis in the short term. This excessive cup abduction angle is facilitated by a defect in acetabular coverage (1) in dysplastic hips, but also by the approach used because of the distal part of the scar and of the proximal femur levering on the cup holder. Moreover, they encourage elliptical drilling by a leverage effect on the instrument handles, which compromises the primary stability of the implants. Traction along the axis of the leg together with the use of curved instruments will facilitate acetabular preparation and insertion of the acetabular implant.

During femoral preparation, the posterior and lateral part of the trochanter needs to be scooped out before localising the centre of the shaft with a right angled curette. There is a weak zone in the posterior cortical bone at the level of the lesser trochanter, which is at risk for perforation, all the more so as the proximal part of the incision acts as a lever on the handle of the rasp, giving it a posterior direction. The perforations we encountered always occurred in very bulky patients. As described by Archibeck and White (2), these complications occur in patients whose BMI is greater than 30.

We noted one case of peroneal nerve palsy in each group. This is a classic complication during THR using the posterior approach (29) but highly unusual when using the anterior or anterolateral approaches. We believe it was caused by the use of an over aggressive Hohmann-type retractor (fig 4) used to protect the gluteus medius during preparation of the femoral canal.

All but one of the complications in the anterolateral group were noted intraoperatively or immediately postoperatively and were due to the learning curve for this approach or to the use of the large heads. In the postoperative period no dislocation occurred. The subjective impression of the stability of the hip replacement using this technique was excellent, despite curarisation of the patient. It is highly advisable during the learning curve to carry out these procedures under general anaesthesia which will enable curarisation to be adjusted according to the stages of the procedure. This will avoid the possible sudden removal of motor spinal block during spinal or epidural anaesthesia, which would make the procedure more difficult and thereby increase the risk of complications. On the other hand within the standard posterior approach group, there are fewer perioperative complications (no cortical perforations and no fractures of the greater trochanter) but a higher rate of dislocation.

CONCLUSION

Our study confirmed our two hypotheses. It demonstrated the difficulties in the learning period with a higher incidence of complications. The possibility to prevent these should reassure new operators. It also confirms the excellent early functional results of this technique. Nevertheless, only a prospective and comparative study with a more standardised procedure combined with longer follow-up after the learning period, will make it possible to define the real advantages of this approach. However, it should be remembered that although this procedure is exacting for the surgeon it will assist him in integrating the appropriate manoeuvres. It also requires definite caution in patients with significant osteoporosis, with bulky muscles and in those with very stiff hips.

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