Functional recovery, complications and CT positioning of total hip replacement performed through a Röttinger anterolateral mini-incision. Review of a continuous series of 103 cases

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Summary

Introduction: Minimally invasive approaches entail an increased risk of malpositioning and perioperative complications. Most studies analyzed these data only on plain X-ray rather than computed tomodensitometry (CT) in assessing implant positioning.

Hypothesis: A Röttinger minimally invasive anterolateral (MIS-AL) approach provides rapid complication-free functional recovery with reliable implant positioning on CT-scan.

Patients and method: One hundred and three primary cemented total hip replacements (THR) performed by a single surgeon using a MIS-AL approach underwent clinical assessment at six weeks and three, six and 12 months on X-ray, including CT and postoperative myoglobinemia and creatine phosphokinase (CPK).

Results: Pain, on a visual analog scale, was graded less than 1 at 36 hours; canes ceased to be used at a mean three weeks; and mean Postel-Merle-D’Aubigné score at six months was 17.36 (range, 13–18). There were ten approach-related complications (9.7%: one femoral perforation, two dislocations, two femoral neck fissures, two cases of meralgia paresthetica and three of tensor tendinitis). Mean CPK level was 390.9 ± 252 µg/L (range, 88–1095 µg/L) at 24 hr post-operatively and 319 ± 256 µg/L (95–1028 µg/L) at 48 hr. Mean postoperative myoglobinemia was 299 ± 152.6 µg/L (75–914 µg/L). Mean acetabular inclination and anteversion on CT were respectively 44.7° ± 4.6° (34°–56°) and 9.2° ± 9.2° (−17°–35°) and mean femoral anteversion 23.5° ± 9.4° (2°–53°).

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ORIGINAL ARTICLE

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Introduction

Minimally invasive (MI) approaches in total hip replacement (THR) are not universally recommended. Initially defined by a skin incision of less than 10 cm [1–4], their particular advantage lies in respecting the stabilizer muscles. The few comparative studies reported no specific major clinical benefit apart from reduced operative bleeding, analgesia, functional recovery time and hospital stay [5–8]. Some reports [4,9] worried about the risk of implant malpositioning and immediate complications related to reduced visibility. Implant positioning, however, was, in most reports of MI approaches, assessed on plain X-ray, limiting the validity of the results [1–8].

The minimally invasive anterolateral (MIS-AL) approach described by Bertin and Röttinger in 2004 [10] is a modification of the standard Watson-Jones approach described in 1936 [11]. It uses the space between the medial gluteal and tensor fasciae latae (TFL), without muscle sectioning, unlike posterior or two-incision minimally invasive approaches [12,13]. We have been using this approach since June 2007. The present study sought to assess whether it provided rapid functional recovery without an increased rate of complications, and whether the reliability of implant positioning could be confirmed on computerized tomography (CT) as well as on plain X-ray. The hypotheses were tested in a single-operator prospective study.

Patients and methods

Patients

The present prospective continuous series included 103 patients (Table 1) receiving primary THR on a Röttinger MIS-AL [10]. At the outset, the senior surgeon (JM) had an experience of 30 Röttinger approaches.

Only patients requiring acetabular reconstruction or with history of femoral osteotomy were excluded, as well as those with morbid obesity (body-mass index (BMI) >35 kg/m²).

Surgery was performed under general anaesthesia, with curarization, in lateral decubitus on a standard table. The operated limb was dislocated in maximum adduction and lateral rotation. The only dedicated ancillaries were angled acetabular reamers and a curved femoral rasp. Implants were cemented, with polyethylene cup and solid or modular femoral stem as required, and a 22.2 mm head (Kerboull™ MKIII, Benoist-Girard, Stryker-Howmedica). Cement fixation was performed by hand with a second generation technique for the femur. The surgeon’s positioning objectives were 45° inclination and 10° acetabular anteversion with respect to the cup-bearer and 15° femoral anteversion with respect to the knee.

Surgical precautions comprised antibioprophylaxis, an analgesic regime (Table 2) and preventive thromboprophylaxis following SFAR (French society of anesthesia and intensive care) recommendations [14,15]. Ossification

Discussion: Functional recovery was quick, but with an 8.7% complications rate (excluding four cases of spontaneously resolved tendon pain). CT showed reliable cup positioning, but a wide scatter in femoral anteversion. Elevated muscle enzyme levels possibly testified to approach-related tissue attrition. The MIS-AL approach involves a learning curve to avoid femoral perforation. It provided rapid functional recovery with reliable positioning, at least for the cup, and a low rate of associated complications.

Level of evidence: III, prospective continuous study.

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prevention consisted solely in abundant iterative lavage. A drain was installed for 48 hours to measure blood loss. Walking was resumed at 48 hours under physiotherapist supervision.

Assessment

Functional recovery was assessed on Iowa score [16] before discharge. Patients were given a self-assessment questionnaire at discharge, to be handed back at the 6-weeks' postoperative check-up (Appendix 1). Serum samples were taken preoperatively (hemoglobinemia) and postoperatively (myoglobinemia at 10 hrs, total CPK at 24 and 48 hrs, and hemoglobinemia at 24 hrs). Perioperative bleeding was measured as aspiration volume minus lavage volume.

X-ray assessment comprised weight-bearing AP pelvic view and AP and lateral view of the operated hip. Analysis focused on limb length discrepancy (distance between lesser trochanter and inter-teardrop line) [17], acetabular inclination [18] and ectopic ossification on Brooker’s classification [19]. Implant mobilization, defined by more than 5 mm subsidence, was assessed as the distance between the center of the femoral head and the tangent of the lesser trochanter. Pelvic CT was performed before discharge to determine the orientations of the components on multiplanar reconstructions using predefined anatomic landmarks (Fig. 1).

Preoperative status was assessed on ASA [20], Charnley [21] and Devane et al. [22] scores. Radioclinical follow-up at six weeks and three, six and 12 months postoperatively was performed by an independent investigator; functional recovery was assessed on Postel Merle d’Aubigné (PMA) [23], Harris (HHS) [24], WOMAC [25] and SF12v2 [26] scores. Scar size was measured at three months. If a different approach

![Figure 1](image1.png)

**Figure 1** Landmarks used for CT-scan measures of implant positioning.

**Table 2** Analgesics and surveillance on request.

<table>
<thead>
<tr>
<th></th>
<th>Medical prescriptions</th>
<th>Nursing program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medical prescriptions</strong></td>
<td>Self-administered iv morphine 1 mg on demand for the first 24 hrs After 24 hrs, replaced by oral: 100 mg tramadol (Topalgic®) x 4 + 500 mg paracetamol codeine (Efferalgan Codeine®) x 6</td>
<td>VAS every 4 hrs for 24 hrs post-op VAS at 36 hrs post-op Quantity of morphine per 24 hrs</td>
</tr>
</tbody>
</table>

VAS: visual analog scale.
Recovery assessment after hip replacement on a Röttinger approach

Figure 2 Malposition of femoral stem (left) and after revision (right).

had been used on the contralateral hip, the patient was asked which he or she preferred overall in terms of postoperative course.

Statistics

The series comprised 103 patients operated on during 2008 with the above-mentioned inclusion criteria. Statistical analysis used GraphPad inStat v3.06 software (La Jolla, CA, USA). CT implant position data were analyzed on Z-score test assessing scatter of observed means with respect to planning objectives (acetabular inclination/anteversion, 45°/10°; femoral antversion, 15°). The other quantitative data (clinical and VAS scores) were also analyzed on Z-score test (comparison of means). The significance threshold was set at 0.05.

Results

Preoperative data

Mean age was 67 ± 11 years (range, 35–96 yrs), with female predominance (68/103); mean BMI was 27.3 ± 3.7 kg/m² (range, 20–35) (Table 1). Seventy-five percent of patients had ASA scores of 2; mean preoperative PMA and Harris scores were respectively 13 (5–15) and 47.8 (16–81). There were 85 cases (82%) of primary osteoarthritis of the hip. Seventy-seven patients (74.7%) were retired, with no sports activity.

Operative data

Mean surgery time was 92 ± 13.8 minutes (60–140 mins), but shorter by a mean 10 minutes in the last 52 cases, thanks to the learning curve. Mean peroperative bleeding was 372 ± 182.6 cc (100–1,000 cc). Antero-inferior medial gluteus contusion was almost systematic, due to retractor tension during the femoral preparation.

Postoperative data

Mean morphine consumption was 2 ± 7.5 mg (0–53 mg) over the first 24 hours. Immediate postoperative visual analog scale (VAS) pain assessment showed significant improvement between 8 and 12 hours postoperatively (Z = 2.66), plateauing between 24 and 36 hours (Table 3). Mean total CPK was 390.9 ± 252 μg/L (88–1,095 μg/L) at 24 hours and 319 ± 256 μg/L (95–1,028 μg/L) at 48 hours postoperatively. Mean postoperative myoglobinemia was 299 ± 152.6 μg/L (75–914 μg/L). Postoperative hematocrit fell by eight points (32 ± 4% vs. 40 ± 4%) and six patients (6%) underwent transfusion (2–4 PRBCs).

In-hospital functional recovery was rapid, with mean Iowa score of 6.5 ± 3.6 at day 3 after full weight-bearing and a mean hospital stay of 7.3 ± 1.7 days (4–15 days). Sixty-five patients (73%) were discharged directly home.

Mean findings on the postoperative self-assessment questionnaire (Table 4) were: unassisted gait at three weeks, cessation of analgesics at one month, recovery of independence at 7–10 days, and mild pain during the first week (VAS 2.6 at day 1 and only 1.4 by day 7). Twenty-three (82%) of the 28 patients with a different previous contralateral THR approach (26 anterior hemimyotomies and two posterior approaches: Table 1) preferred the MIS-AL approach and 5 preferred anterior hemimyotomy. Medium-term functional recovery showed significantly improved objective PMA (Z = 20.4) and HHS (Z = 27) scores at 1-year follow-up compared to preoperatively, and likewise for the subjective WOMAC (Z = 5.57) and SF12v2 (Z = 4.3) scores, with optimal results at 3 months (Table 5). Twenty-one cases of associated
Immediate postoperative pain assessment.

<table>
<thead>
<tr>
<th>Time</th>
<th>VAS</th>
<th>Quantity of morphine per 24 hrs (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hrs</td>
<td>2.7 ± 2.2</td>
<td>0 (0—8) a</td>
</tr>
<tr>
<td>8 hrs</td>
<td>2.8 ± 2.3</td>
<td>0 (0—10) a</td>
</tr>
<tr>
<td>12 hrs</td>
<td>2 ± 1.9</td>
<td>0 (0—8) a</td>
</tr>
<tr>
<td>20 hrs</td>
<td>1.6 ± 1.6</td>
<td>0 (0—8) a</td>
</tr>
<tr>
<td>24 hrs</td>
<td>1.2 ± 1.4</td>
<td>0 (0—6) a</td>
</tr>
<tr>
<td>36 hrs</td>
<td>0.7 ± 1.1</td>
<td>0 (0—5) a</td>
</tr>
</tbody>
</table>

a Only 15 patients took morphine.

Differences on VAS: (significant) and Z value.

<table>
<thead>
<tr>
<th>Time</th>
<th>VAS</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hrs</td>
<td>2 ± 1.5</td>
<td>5 (Z = 2.6)</td>
</tr>
<tr>
<td>8 hrs</td>
<td>2 ± 1.5</td>
<td>5 (Z = 2.6)</td>
</tr>
<tr>
<td>12 hrs</td>
<td>2 ± 1.5</td>
<td>5 (Z = 2.6)</td>
</tr>
<tr>
<td>20 hrs</td>
<td>1 ± 1.2</td>
<td>2 (Z = 1.6)</td>
</tr>
<tr>
<td>24 hrs</td>
<td>0.7 ± 1.1</td>
<td>0 (Z = 0.5)</td>
</tr>
</tbody>
</table>

Locomotor pathology limited functional assessment. Mean scar size at three months was $8 \pm 2.1$ cm.

Follow-up data and complications

Perioperative complications related to the MIS-AL approach included four perioperative complications (3.9%): one perforation, detected on X-ray in the recovery room and immediately treated by distal extension of the approach, without muscle sectioning, using a cemented stem (Fig. 2); one anterior dislocation in the recovery room (counted as a perioperative complication due to excessive curarization); and two small fissures, limited to the femoral neck, caused by femoral component impaction, not requiring surgical revision. Evolution was simple in all four cases, with resumption of weight-bearing at 48 hours.

There were six approach-related postoperative complications (5.8%): three cases of TFL tendinitis, resolved by rehabilitation; one recurrent dislocation (days 8 and 30), without abnormal implant positioning, managed by short-leg cast without further recurrence; two cases of meralgia paresthetica in the territory of the lateral cutaneous nerve of the thigh, including one with late onset inducing suspended hyposthesia. There were also three complications (2.9%) not specifically related to the approach: one hematoma requiring drainage (error in anti-coagulant prescription); one contralateral thrombophlebitis at six weeks, complicated by pulmonary embolism; and one psoas irritation resolved by radio-guided corticosteroid infiltration.

At 1 year, there were two deaths and three patients lost to follow-up. The operated hip was no longer bothersome by three months in 70% of cases (69/98), by six months in 74% (73/98) and by one year in 90% (88/98).

Imaging data

Radiological analysis concerned 98 cases (after two deaths and three patients lost to follow-up). Mean acetabular inclination was $45° \pm 5°$ ($34°–58°$). There was limb-length discrepancy of at least 5 mm in 25 cases (out of 103: 24%) and at least 10 mm in 10 (9.7%). No implants showed mobilization. In seven out of 98 cases (7%), there were ectopic ossifications: six grade 1 and one grade 2, all without associated pain.
Tableau 5. Évaluation fonctionnelle par FU. Significativité : S (significatif) ou NS (non significatif) et Z valeur.


CT scan findings: Mean cup inclination of 44.7° ± 4.6° (Table 6, Fig. 3). Femoral anteversion showed significant cumulative anteversion amounting to 23.5° ± 9.4° (Z = 2.5), mean cup anteversion of 32.7° ± 12.5° (Z = 2.2). Femoral anteversion showed significant scatter with respect to planning (Z = 3.77), which was not apparent for cup inclination.

Figure 3. Results of CT scan for implant positioning.
the case for cups (cup anteversion, \( Z = 0.87 \); cup inclination, \( Z = 0.71 \)) despite 50 cups (48.5%) showing \( \pm 5^\circ \), 86 (83%) \( \pm 10^\circ \) and 93 (90%) \( \pm 15^\circ \) anteversion and 76 (74%) showing \( \pm 5^\circ \) inclination. On Lewinnek's criteria [27] (cup inclination/anteversion: \( 40^\circ \pm 10^\circ / 15^\circ \pm 10^\circ \)), 69 cups (67%) were satisfactory in terms of anteversion and 92 (89.3%) in terms of inclination.

**Discussion**

MIS-AL is an interstitial approach, theoretically respecting all muscular elements relevant to postoperative course. Acetabular access is good, allowing femoral head autograft, although insufficient in case of severe acetabular dysplasia (Crowe types III or IV [28]). Femoral exposure is more difficult, but femoral extension is possible, unlike on an anterior approach [29] which is limited by the TFL. There is little risk of serious lesion, except to the terminal branch of the superior gluteal nerve innervating the TFL with a risk of denervation at the proximal part of the incision [30,31], with undetermined clinical impact. Unlike on an anterior approach, the lateral cutaneous nerve of the thigh is at a safe distance, but is probably liable to compression or stretching during the femoral phase, as seen in two cases in the present series. The present results showed rapid functional recovery, particularly during the first three postoperative months, with little pain and with independence recovered as of postoperative day 7. Hospital stay was comparable to that associated with classical approaches [32–35]. The approach-related complications rate was 9.7%, which was in line with the literature [36]. The CT study demonstrated statistically reliable positioning on the acetabular side.

The study involved certain limitations, mainly due to the lack of randomization and of a control group operated on with a classical approach. Interpretation should also take account of difficulties in data collection (questionnaire comprehension, associated locomotor pathology and specificities of the study population (relatively inactive, elderly, with low functional demand). Finally, precise CT landmarking was difficult, despite the millimetric scale of the images, which may have induced a margin of error.

Some comparative studies reported a slight clinical benefit in favor of MI approaches [5–8], tending to level off over time (between six months and one year, depending on the series) [32,34,37]. Vavken et al. [38], in a meta-analysis, found functional benefit to be of borderline significance. Dorr et al. [39] attributed clinical benefit partly to the psychological effect of MI surgery, entailing less body-image disturbance than classical approaches. Few studies have compared different MI approaches: Meneghini et al. [40] found no significant differences in functional recovery between a posterior, anterolateral or anterior mini-approach.

Muscular contusion of the anterior head of the medial gluteal was systematic, although observed in only 28.5% of cases by Martin et al. [34], while according to Oldenrijk et al. [41] anterior and anterolateral MI approaches are alone in respecting the medial gluteal muscle. The increased myoglobin and CPK rates reflect this muscular aggression secondary to contusion caused by the retractors, without being conclusive. A multicenter study [42] comparing MIS-AL and a classical Hardinge approach found a significant difference only in postoperative CPK rates. Cohen et al. [43], comparing muscular biomarker levels on three MI approaches (anterolateral, posterolateral and double), found no significant differences, but their sample size was small. Muller et al. [30] reported fatty degeneration in the anterior part of the medial gluteus on MRI to be significantly greater on a transgluteal than on a MIS-AL approach (with no difference in the TFL).

The approach-related complications rate may seem high, but depends on the criteria applied. Thus, following Kim [36] (who compared posterior MI and classical posterolateral approaches) in assessing only infection, dislocation and neurologic disorder, the present series showed a rate of 3.9% (two dislocations, two cases of meralgia paresthetica), comparable to Kim's respective rates of 3% and 4%. Lafosse et al. [32], on the other hand, in a continuous prospective comparative series of posterior MI versus a classical posterolateral approach, reported a 10% 6-month complications rate with the former. Swanson [44] reported an 11.8% complications rate on a posterior MI approach. Some series have reported high rates on MI approaches, but mainly with the Berger two-incision technique [45]. Finally, the present ectopic ossification rate was 7%, compared to 5% to 15% in other reports [44,46], and was mainly grade I, without clinical impact; this may be attributed to the operator taking care to remove any bone debris following rasping and limiting muscular contusion by releasing the retractors whenever possible.

CT assessment of acetabular and femoral anteversion [47] is a matter of debate. Measurement does not take account of pelvic tilt, as examination is performed without weight-bearing, in dorsal decubitus; pelvic anteversion in fact ranges from 18° to 30° during the passage to orthostatism [48], which affects functional acetabular anteversion. Acetabular anteversion has been shown to depend on the spatial position of the pelvis, while acetabular inclination is unaffected [49]. Most authors, however, used a range of positions, rather than any ideal value, which makes comparison difficult [27,36,50,51]. Thus, according to Kim [36] (on a posterior MI approach), 90% of cups showed satisfactory anteversion (normal range: 20° to 30°), while Mouihade et al. [52] (on a MIS-AL approach) reported 80.5% satisfactory cup anteversion, for a normal range of 10° to 25°.

Analysis of scatter with respect to planning objectives assesses implant positioning reproducibility. However, the range of measured values reported in several studies [53,54] using a classical anterolateral approach was already wide: on the Lewinnek criteria [27], only 25.7% or 20% of cups were well positioned according to Saxler et al. [53] and Hohmann et al. [54] respectively. Finally, we consider that variations in cup positioning are more a matter of patient positioning in dorsal decubitus, with varying pelvic tilt, than of the MIS-AL approach. Femoral anteversion scatter, on the other hand, was considerable, and Wines et al. [55] demonstrated that peroperative and CT assessments of femoral component version differed, witnessing to imperfect reproducibility. This may be due to individual differences in femoral torsion and the difficulty of assessing it on this approach.
Conclusion

The MIS-AL approach entails a learning curve and avoidance of perforation in the femoral stage. It provides rapid functional recovery without an increased rate of complications. Implant positioning appears reliable and reproducible on the acetabular side, whereas the femoral side shows greatly variable anteverision.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Acknowledgments

The authors thank Pr Dujardin for his help and Dr Adrian for training on the Röttinger approach.

Appendix A. Appendix 1. Self-assessment.

Surname:................ First name:............
During the 7 days since discharge, how do you rate your pain?
0 (no pain) to 10 (worst imaginable pain)
0........ D1........ D2........ D3........
D4........ D5........ D6........
D7........
How many days after the operation could you:
give up all walking aids (cane, crutch):.........
stop all pain-killers:........
drive:........
recover independent everyday activity:........
move from bed to chair:........
climbing up and down stairs:........
walking:........
washing:........
dressing, apart from socks and shoes:........
socks and shoes:........

References


