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Original Article

Early clinical and radiological results of minimally invasive total hip replacement

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ABSTRACT

Introduction: It is critical to achieve both proper component positioning and intact muscle balance if satisfactory results are to be attained after total hip replacement (THR). There have been fewer studies on minimally invasive (MI) THR than standard approaches. The objective of this paper is to present the early clinical and radiological results of posterolateral MI THR.
Materials and methods: The retrospective analysis of the records of patients undergoing posterolateral MI THR surgery between 2011 and 2014 was the basis of this study. 73 hips of 68 patients were included in the study. The acetabular component and femoral stem positions were measured on plane X-rays. Data on preoperative and postoperative hemoglobin and hematocrit values, as well as transfusion amounts, were also studied. The clinical evaluations were carried out with Harris Hip Scores.
Results: The mean HHS at the 3rd postoperative month was 87.60 (±7.70). Of the 73 cases, 61 were within the Lewinnek safe zone. The mean PMFA was 88.12 (±7.63°), which is within the normal ranges.

The mean postoperative hemoglobin value was 9.7 g/dl (±1.3) and the mean postoperative hematocrit value was 29.8% (±3.8). A nondisplaced proximal femoral fracture line was evident on the early postoperative X-ray of one patient. One patient experienced early dislocation caused by acetabular component malpositioning and an early acetabular cup revision was necessary.
Conclusion: MI posterior approach for THR is a method in which the prosthetic components can be properly placed. Posterolateral MI approaches are safe when THR is performed, and afford satisfactory results.

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1. Introduction

Total hip replacement (THR) is the most common treatment for hip osteoarthritis. The principal purposes of THR are pain relief and provision of a mobile and stable hip, and it is critical to achieve proper component positioning as well as an intact muscle balance. Anterolateral, direct lateral, transtrochanteric, and posterolateral approaches to THR surgery have been described. Recently, anterolateral and posterolateral minimally invasive (MI) approaches have been developed to decrease muscle disruption and blood loss, as well as shorten recovery time. The most important aim of MI surgery is to protect muscular structures and their innervation and vascularization, rather than the use of a small skin incision per se.[1] To decrease the likelihood of component malpositioning, perioperative fractures, and excessive blood loss, new tools and implant designs have been developed.

There have been fewer studies on MI THR than standard approaches. We retrospectively analyzed our MI THR cases and report the early clinical and radiological results in terms of perioperative and early postoperative success, complication rates, and the early postoperative positions of the femoral and acetabular components.

2. Materials and methods

We retrospectively analyzed the records of patients undergoing posterolateral MI THR surgery between 2011 and 2014; 73 hips of 68 patients who were operated by one senior orthopedist with 10 years experience on hip arthroplasty were included in the study. The mean body mass index of the patients was 28.6 kg/cm^2 kg ($\pm$3.07). The chief complaint of all patients was hip pain, which was resistant to analgesics. Of these, 44 hips were treated with the Anthology® hip system (Smith and Nephew) and 29 hips were treated with Profemur® Z stems (Wright).

The etiologies were hip dysplasia in 28 patients, femoral head avascular necrosis in 6 patients, and post-traumatic arthritis in 3 patients. The other 31 patients had primary hip joint arthrosis. The mean age of patients was 60.86 ($\pm$10.36 years). Of the dysplastic hips, 11 were of Crowe type 1 and 12 were of Crowe type 2; there were no Crowe type 3 or 4 hips in this series.

Data on preoperative and postoperative hemoglobin and hematocrit values, perioperative blood loss amounts, postoperative hemorrhagic drainage amounts, transfusion amounts, and preoperative and postoperative 3-month follow-up Harris Hip Scores (HHS) were obtained from patient records. The anteversion and inclination angles of acetabular components were measured on early postoperative radiograms. The anteversion angles of acetabular cups were calculated using the 'planar anteversion of the acetabular cup' method described by Pradhan.[4] Medial proximal femoral angles (MPFAs) were measured to evaluate femoral stem positions (Fig. 1). In unilateral cases, the distances between the acetabular teardrops and the lesser trochanter evident on standard plain radiograms were used to determine length discrepancies. In addition, early postoperative radiograms were evaluated in terms of fractures or dislocations.

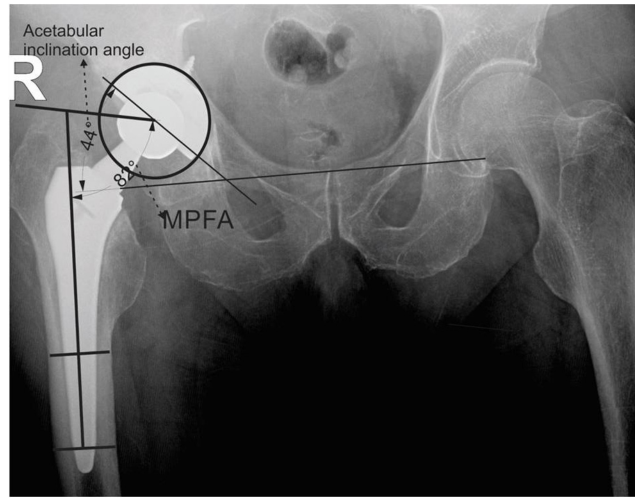

Fig. 1 – Measurement of acetabular inclination and MPFA on plain X-ray.

2.1. Surgical technique

The patient was placed in the lateral decubitus position under anesthesia. A 7–9 cm oblique linear skin incision, running from the posterolateral to the anterolateral side, at an angle of 30° to the coronal plane, was made with the midpoint of the cut lying on the tip of the greater trochanter (Fig. 2). Before cutting the fascia, the skin and subcutaneous fat tissue were widely separated from the fascia to form a mobile skin window. The special instruments designed for the MISTHR are necessary during the operations because the standard retractors are not suitable for this technique. The short external hip rotator muscles were retracted posteriorly, without any tenotomy, to access the proximal part of the posterior joint capsule, which was opened with a J-shaped cut before the hip was dislocated posteriorly. Two over-curved S-shaped Hohmann retractors, which are designed for MITHR, were placed to the femoral neck throughout the interval between short external rotator muscles without any tenotomy before the femoral neck was cut with an

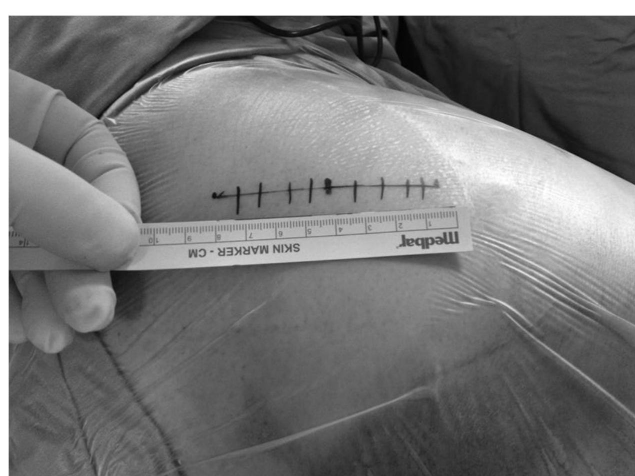

Fig. 2 – The skin incision for MI THR.

Fig. 3 – Acetabular exposure during MI THR.

oscillating saw. After the removal of the femoral head, the proximal femur was moved anteriorly and an over-curved S-shaped Hohmann retractor was placed on the transverse acetabular ligament, with two additional Hohmann retractors placed posterior and anterior to the acetabulum (Fig. 3). After standard reaming, the acetabular cup and insert were placed in their proper positions with the help of the three-dimensional guide, which takes the ipsilateral shoulder as landmark. For preparation of the femur, the proximal femur was placed in the 90° internal rotation position. A Hohmann retractor was placed on the tip of the greater trochanter and another one was placed just distal to the insertion site of the piriformis muscle. The lateral remnant of the femoral neck was removed with a square chisel. After standard reaming and broaching, the femoral component was placed in the proper position. The femoral component placement was checked with the transepicondylar line of the distal femur. Finally, the femoral head was adapted to the stem and the hip was reduced before wound closure (Fig. 4).

2.2. *Postoperative period*

Muscle strengthening exercises were started on the operating day. There was no restriction of any hip movements. All patients were allowed to bear full weight on to the operated extremity with the help of a walker on the postoperative day one except one patient with a proximal femoral nondisplaced fracture and one patient with early instability. The patients were trained for the home exercises before discharge. Thromboembolism prophylaxis was prescribed for all patients for 35 days. The patients were invited to attend 6-weekly clinical and radiological follow-ups (Fig. 5). Depending on performance, mobilization with either one or two crutches was allowed.

SPSS version 17.0 (SPSS Inc., Chicago, IL) was used for analysis of data. The paired samples *t* test was used to compare preoperative and postoperative data.

3. Results

The mean preoperative HHS was 34.09 (±7.45). The mean HHS at the 3rd postoperative month was 87.60 (±7.70). Significant improvements in postoperative compared to preoperative HHS scores were evident. Also, there was a significant decrease in the need for analgesic use. The mean acetabular inclination angle of the cases was 45.11° (±7.73°) and the mean acetabular anteversion angle was 7.48° (±9.58°). Of the 73 cases, 61 were within the Lewinnek safe zone. The mean PMFA was 88.12 (±7.63°), which is within the normal ranges. The mean postoperative leg length discrepancy was 2.56 (±5.28 mm). None of these radiological values were clinically significant. The mean operative time was 75.1 min (±12.3). The mean postoperative stay time of the patients was 2.6 days (±1.02).

The mean preoperative hemoglobin value was 12.3 g/dl (±1.7) and the mean preoperative hematocrit value was 38.0% (±5.5). The mean postoperative hemoglobin value was 9.7 g/dl (±1.3) and the mean postoperative hematocrit value was 29.8% (±3.8). According to our records, the mean intraoperative blood loss was 174.5 cm^3 (±18.2). The mean postoperative hemorrhagic drainage amount was 95.6 cm^3 (±24.7). The mean total blood loss was 266.5 cm^3, which is significantly lower than the expected blood loss amount after hip replacement surgeries. We suggest that the inconsistency of the blood loss amounts and hemoglobin and hematocrit decrease were due to hemodilusion, which could be caused by overhydration applied after regional anesthesia.

A nondisplaced proximal femoral fracture line was evident on the early postoperative X-ray of one patient. The case was followed up without weight bearing for 6 weeks and there was no need for a revision surgery. One patient experienced early dislocation caused by acetabular component malpositioning and an early acetabular cup revision was necessary. None of

Fig. 4 – Incision site after wound closure.

Fig. 5 – Clinical and radiological outcomes on 12-month follow-up of a bilateral MI THR case. (a) Standard anteroposterior pelvic radiogram; (b) the operative site; (c) clinical view of the patient in a neutral standing position; (d) active hyperflexion of both hips in the standing position and (e) active hyperflexion of both hips in the supine position.

the patients experienced infection or deep venous thrombosis. Complication-free cases were mobilized early without any restriction.

4. Discussion

Various surgical approaches for THR surgery have been described. Although the direct anterior approach seems to afford better outcomes, this was not significantly superior upon long-term follow-up compared to the posterolateral approach. In addition, various MI exposures have been tested in efforts to decrease complications and hasten recovery time. In a meta-analysis, Xu et al. found no differences in the functional outcomes of standard and MI approaches.[2] The advantages of the MI approach include shorter surgery time and less blood loss; the risk of component malpositioning was not enhanced by MI surgery.

Penenberg et al. reported that the mean blood loss during MI THR was 200 mL (100–500 mL) and 10% of 250 patients required transfusions.[5] Landgraeber et al. compared the conventional lateral approach and posterior MI THA in terms of hemoglobin and hematocrit decreases. The mean preoperative hemoglobin and hematocrit values were 13.93 g/dl ($\pm$1.34 g/dl) and 13.85% ($\pm$1.16%), respectively, and the values at 24 h postoperatively were 11.33 g/dl ($\pm$1.46 g/dl) and 11.38% ($\pm$1.48%), respectively; these differences were not significant.[3] In our study, decreases in hemoglobin and hematocrit values were similar to other studies. Nevertheless, when the perioperative records were considered, the mean blood loss amount was 266.5 cm^3, which was lower than expected. There was no requirement for a transfusion in any of our cases.

Barrett et al. reported a mean inclination of 42.4° ($\pm$7.6°) and a mean anteversion of 25.8° ($\pm$8.1°) for acetabular cups in a study including data on THR using the standard posterolateral approach. A total of 24 cases (57%) were within Lewinnek's safe zone.[6] Landgraeber et al. studied anterior MI THR cases and reported mean acetabular cup inclination and anteversion angles of 42.18° ($\pm$5.04°) and 19.71° ($\pm$6.15°), respectively.[3] Roger and Hill reported mean acetabular cup inclination and anteversion angles of 41° ($\pm$21.49°) and 21° ($\pm$15.27°), respectively, in 135 cases treated via the posterior MI technique.[7] In our study, the mean acetabular cup inclination was 45.11° ($\pm$7.73°) and the mean acetabular anteversion angle was 7.48° ($\pm$9.58°); 61 of our cases were within the Lewinnek safe zone. Only one of the remaining 12 cases (outside of the Lewinnek safe zone) had an instability that required revision. Postoperative hip stability after THR is known to be improved when the short external rotators are intact.[8,9] Although the Lewinnek safe zone has some objectivity on the evaluation of the component positions in the THR, our results were suggestive that sparing of the hip external rotators has a positive effect on the stability after THR.

A commonly used early means of postoperative femoral component evaluation is the sagittal plane position of the femoral stem. Roger and Hill studied 135 MI posterior THR cases and found five instances of femoral stem varus positioning of more than 2°, and three cases of such femoral stem valgus positioning.[7] Poehling-Monaghan et al. compared 96 cases of MI posterior THR with standard anterolateral THR, and found femoral stem varus positioning in one patient and femoral stem valgus positioning in 15. In the same paper, they also reported that of the 126 instances of the standard anterolateral approach, 34 had femoral stem varus positioning and three had femoral stem valgus positioning.[10] A high-standing greater trochanter is associated with insufficiency of hip abductors, together with a positive Trendelenburg sign and limping.[11] The level of the greater trochanter can be objectively determined by measuring the MPFA, i.e. the angle between the trochanter head line and the anatomical axis of the femur, which is normally 84° (80°–89°).[12] Femoral stem height, or varus or valgus, changes the angle (Fig. 2). Therefore, we evaluated the femoral stem position using the MPFA. The mean MPFA was 88.12 ($\pm$7.63°), which was within the normal limits. Although the long-term effects of MPFA variations remain unclear, our results suggest that a THR with a normal MPFA is associated with a stable hip joint and a more physiological gait.

The HHS of patients with coxarthrosis increased significantly after THR. Many reports have shown that scores after MI THR are as good as those obtained using standard approaches.[3,7,10] Similarly, we observed significant ameliorations in 3-month HHS scores after THR compared to preoperative scores.

We observed 1 proximal femoral fracture, which was diagnosed postoperatively. Poor visualization of the proximal femur can be a disadvantage for perioperative diagnosis of nondisplaced proximal femoral fractures occurring during posterolateral MI THR.

This study has some limitations. Although our case numbers were adequate to draw robustness, it is always possible to derive more accurate results with larger series. Our follow-up period was less than 2 years, and therefore the long-term results of posterolateral MI THR remain unknown. All surgeries were performed by a single surgeon and it is therefore unclear whether other surgeons would obtain similar results. We performed the MITHR without any tenotomy to the short external rotator muscles. At the end of the component placement, the gross appearances of these muscles were intact. The limitation here is we could not objectively detect the damage on the short external rotators due to retraction.

MI posterior approach for THR is a method in which the prosthetic components can be properly placed. The early postoperative instability rate is low and the functional outcomes are favorable. Although this study gives the short-term results, the high rate of the proper component positioning gives an idea on the long-term survival rates of the THR. Posterolateral MI approaches are safe when THR is performed, and afford satisfactory results.

Conflicts of interest

The authors have none to declare.

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