The outcomes of total hip arthroplasty (THA) have improved in recent decades with advances in surgical techniques and prosthetic designs. At present, traditional THA provides excellent clinical effects in terms of pain relief, functional improvement and long-term survival, with a low complication rate [1–3]. As orthopedic surgeons have become more experienced with THA, the desire for a more rapid recovery with cosmetic appearance has surfaced. Less invasive techniques, termed minimally invasive or mini-incision surgery, for THA have become popular over the past several years [4–20].

Theoretically, surgeons presume that a smaller incision is more likely to reduce soft tissue damage and thereby improve cosmetic appearance, speed functional recovery, and reduce blood loss, operative time, postoperative pain and complication rate [4,11,14–16,18,21–26]. Potential disadvantages may be related to decreased visualization during the operation, and include a higher probability of neurovascular injury, fracture, dislocation, and component malposition or poor fixation [5,7,9,13,14,20]. In addition, more retraction force is needed for proper visualization with a smaller incision, resulting in increased injury to the surrounding soft tissue [27].

Minimally invasive total hip arthroplasty (THA) has become popular over the past few years. The advantages of this technique include reduced soft tissue damage. On the other hand, there are new risks related to reduced visualization. The widespread introduction of minimally invasive THA is still controversial. Here, we present our experiences and early results with a posterolateral approach to minimally invasive THA. Between August 2005 and July 2006, 85 hips from 79 consecutive patients were operated on using posterolateral minimally invasive THA. The outcomes were assessed on the basis of clinical and radiographic parameters. The mean operative time was 55 minutes. The mean length of hospital stay was 5.3 days. Average postoperative Harris hip score was 92.0 at 3 months postoperatively. Complications included only one (1.18%) intraoperative nondisplaced calcar split. There were no cases of dislocation, neurovascular injury or postoperative infection. Our study indicates an early result of low complication rate and good functional recovery following minimally invasive THA using a posterolateral approach. This minimally invasive THA technique provides short-term safety and efficacy.
There are always advantages and disadvantages when introducing a new surgical technique. Supporting the use of minimally invasive THA is the fact that minimally invasive surgery provides benefits and is the way of the future; against it is the lack of scientific data, the potential risks, and the new learning curve involved. Minimally invasive THA has created much controversy [28]; the purpose of this study was to present our experience and early results with a posterolateral approach to minimally invasive THA.

**Materials and Methods**

*Patient selection and preoperative data collection*

Seventy-nine consecutive patients were operated on between August 2005 and July 2006 at Chung-Ho Memorial Hospital, Kaohsiung Medical University in Kaohsiung, Taiwan. We performed 85 primary THAs in these 79 patients using a posterolateral minimally invasive technique. The only exclusion criterion was a history of previous surgery on the affected hip. Demographic and baseline characteristics for the study population are presented in Table 1.

*Surgical technique and perioperative data collection*

All patients underwent a cementless THA with use of a proximally coated titanium stem (Versys; Zimmer, Warsaw, IN, USA) and a modular porous coated cup (Trilogy; Zimmer). All prosthetic heads were 28 mm in diameter with cobalt chrome on polyethylene bearings. No specialized minimal access instruments were used.

The minimally invasive posterolateral approach was modified from Moore’s posterior approach. A skin incision of about 8–10 cm in length was made over the posterior third of the greater trochanter. The following procedures were almost the same as traditional THA with a posterolateral approach except for two modifications. First, the piriformis tendon was preserved. Second, the short external rotator with the underlying posterior capsule was detached as a single flap as close to the insertion point as possible while performing capsulotomy. Enhanced posterior capsule and short external rotator repair were performed later with nonabsorbable sutures through drill holes in the greater trochanter to prevent posterior dislocation.

**Table 1. Demographic and baseline characteristics of the 79 patients who received minimally invasive total hip arthroplasty**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender, female/male</td>
<td>46/33 (58.23/41.77)</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>55.58 ± 15.84 (25–92)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.78 ± 12.08 (40–96)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>160.62 ± 9.93 (142–181.5)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>24.66 ± 3.71 (17.97–35.24)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>47 (59.5)</td>
</tr>
<tr>
<td>Osteonecrosis</td>
<td>26 (32.9)</td>
</tr>
<tr>
<td>Ankylosing spondylitis</td>
<td>4 (5.1)</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>2 (2.5)</td>
</tr>
<tr>
<td>Operative procedure, unilateral/bilateral</td>
<td>73/6 (92.4/7.6)</td>
</tr>
</tbody>
</table>

*Data are presented as n (%) or mean ± standard deviation (range).

Patient-controlled analgesia was used for postoperative pain management by 20 (25.3%) patients receiving minimally invasive THA, whereas the others were treated with intramuscular meperidine (30–50 mg) every 4 hours during the first 24 hours, followed by every 6 hours during the next 24 hours. The standard protocol for physical therapy began on the day after surgery, consisting of exercise, mobility transfer and gait training with partial weight-bearing. All patients achieved their goals before discharge.

We collected perioperative data from clinical and radiographic assessments. Clinical data included operative time, blood loss, blood transfusion status, hemoglobin deficit, hospital stay, follow-up period, Harris hip score and complications. Complications that arose, such as neurovascular injuries, fracture or dislocation, were immediately recorded. Total blood loss recorded was the sum of intraoperative and postoperative blood loss. Intraoperative blood loss was evaluated from the amount of blood in the suction bottles and the weights of gauzes. Postoperative blood loss was estimated by measuring the volume of blood in the negative-pressure drain container. Intraoperative and postoperative blood transfusion was performed if there was unstable hemodynamic status or symptomatic anemia. The postoperative hemoglobin level was measured on the first postoperative day.

All patients underwent postoperative X-ray assessment (anteroposterior view of the pelvis, and cross-table lateral view of the hip). Radiographic data included cup abduction angle, cup anteversion angle,
stem alignment and component loosening. Outliers were defined as cups positioned $\leq 30^\circ$ or $\geq 50^\circ$ of abduction angle, and $\leq 10^\circ$ or $\geq 30^\circ$ of anteversion angle. Stem alignment was only classified as valgus, neutral or varus. Neutral was defined as stems positioned within $\pm 5^\circ$. All analysis of clinical and radiographic data was performed by a single observer.

RESULTS

Clinical results
Clinical information for the 85 consecutive THAs is presented in Table 2. The mean operative time was 55 minutes. The mean length of hospital stay was 5.3 days. Average total blood loss was 602.7 mL. The mean hemoglobin deficit was 3.08 g/dL (23.2%). Only 12 (14.1%) patients receiving minimally invasive THA needed blood transfusion. Patients who did not require blood transfusion had stable hemodynamic status and tolerated the asymptomatic hemoglobin deficit. Complications only included one (1.18%), an intraoperative nondisplaced calcar split that was treated immediately with cerclage wire fixation. There were no cases of posterior dislocation, neurovascular injury, symptomatic deep vein thrombosis or pulmonary embolism, acute medical comorbidities, postoperative infection, or wound problems. All patients received regular follow-up. The mean follow-up period was 13.1 months. Average postoperative Harris hip score was 92.0 at 3 months postoperatively.

Radiographic results
Radiographic data for the 85 consecutive THAs is presented in Table 3. The mean cup abduction angle was $43.3^\circ$ and the mean anteversion angle was $16^\circ$. There were seven (8.2%) cup abduction outliers and two (2.4%) cup anteversion outliers. All femoral stems were in a neutral position. No evidence of component loosening was found during follow-up.

DISCUSSION

Minimally invasive THA has recently become more widespread due to its potential advantages, which are supposed to be the result of reduced soft tissue damage. However, most studies that claim improved outcomes are retrospective or uncontrolled. There is still no objective evidence demonstrating the efficacy of minimally invasive THA. On the other hand, some studies have described the potential disadvantages related to reduced visualization and greater retraction force [27]. This makes minimally invasive THA more unreliable. Thus, its efficacy and safety remain matters of debate.
Reduced soft tissue damage is the biggest advantage of minimally invasive THA. One of the potential benefits of reduced soft tissue damage may be a reduced hospital stay. According to the current literature, mean hospital stay following minimally invasive THA via a posterior approach ranges from 2.7 to 9.9 days [4–13]. In our study, the mean length of stay was 5.3 days. Rehabilitation protocol may affect the length of hospital stay. Peck et al reported that intensive physiotherapy significantly decreased the lengths of inpatient stays [29]. Koji et al reported a longer hospital stay of 23 days, which might be related to their specific rehabilitation protocol [14].

Decreased blood loss and transfusion rate are other potential benefits of the reduced soft tissue damage associated with minimally invasive THA. Average blood loss following minimally invasive THA via a posterior approach ranges from 127 mL to 603 mL [4,5,7,8,10,14,15]. In our study, the mean total blood loss was 602.7 mL. However, the usual methods of assessing intraoperative loss and postoperative drainage are thought to be inherently weak. Sehat et al reported that there might be substantial hidden blood loss of about 26% following THA due to extravasation into the soft tissues, residual blood in the joints and hemolysis [30].

Blood transfusion rates following minimally invasive THA via a posterior approach range from 12% to 65% [6,7,10,15]. In our study, the blood transfusion rate was 14.1%. DiGioia et al described the indication for blood transfusion as hematocrit < 28% [11]. However, no other studies mentioned the criteria for blood transfusion.

Good functional recovery is also supposed to be associated with reduced soft tissue damage. Wright et al presented a significant difference in mean postoperative Harris hip score between a minimally invasive surgery group (86.9) and a standard group (84.2) at 5-year follow-up [16]. On the other hand, some studies found no significant differences between minimally invasive surgery and standard groups with regard to Harris hip score [15,17]. In our study, mean postoperative Harris hip score was 92.0 (range, 82–100) at 3 months postoperatively.

Operative time is another advantage of minimally invasive THA. Average operative time following minimally invasive THA via a posterior approach ranges from 37.5 to 97 minutes [4–8,10,13–15,18]. In our study, the mean operative time was 55 minutes. Many factors affect operative time, one of which is the proficiency of the surgeon. Archibeck and White reported a significant decrease in the mean operative time through a gradual learning curve for minimally invasive THA [19]. Another factor is the difference in prostheses. Koji et al reported a mean operative time of 76 minutes in cementless minimally invasive THA and 85 minutes in hybrid minimally invasive THA, although this difference was not statistically significant [14].

Safety is important in minimally invasive THA. The potential risks may compromise the results of minimally invasive THA. Early complications, such as neurovascular injuries, fractures or dislocations, infections, wound problems and component malposition, have been reported [4,6–15,17,20]. The only complication in our study was a calcar split during broaching (1.18%).

The occurrence of postoperative dislocation is a serious problem, especially when using posterior approach THA. Dislocation following minimally invasive posterior approach THA ranges from 0% to 3% in the current literature [4,6–9,11–15,31]. In our study, we had no case with dislocation. This might be attributed to enhanced posterior soft tissue repair (EPSTR) and preservation of the piriformis tendon in our patients. Repair of the short external rotator of the hip after a posterior approach is controversial. Some favor the repair and believe it helps decrease the dislocation rate [31–34]. Yamaguchi et al reported that posterolateral reconstruction might promote the recovery of abduction and external rotator muscle strength, and improve joint stability without range of motion limitation [33]. Iorio et al reported that EPSTR decreased the dislocation rate to about 1.7% in patients who received minimally invasive THA with the posterior approach, compared to those who received a simple repair (5.6%) [31]. However, some researchers suggest that such a repair does not help, and demonstrate a high failure rate of the repair early in the postoperative period [35,36]. Stahelin et al reported a 75% failure rate of EPSTR [35]. They concluded that repair of the short external rotator added little to the prevention of dislocation, and was insufficient to withstand the forces that occurred as it was healing. Due to the probability of failure of repair, we decided to preserve the piriformis tendon. In addition, we also used the EPSTR technique to increase posterior stability. Clinical outcome studies and gait analysis are necessary to ascertain the efficacy of this modified method.
The accuracy of component placement may be impaired by the reduced visualization associated with minimally invasive THA. Rittmeister and Callitis reported that cup orientation was influenced by the use of a minimally invasive technique [37]. In the current literature on minimally invasive THA via a posterior approach, cup outliers range from 0% to 30%, and stem outliers range from 0% to 17% [4–8,15,20,38]. Malposition of the cup has been recognized as one of the factors related to postoperative dislocation, and is an important issue in minimally invasive THA.

The limitations of this early study include the short term, the small study population size, and lack of a control group. We will be performing a prospective, randomized controlled study with a larger population sample, for long-term results, in the near future.

In conclusion, our study indicates an early result of low complication rate and good functional recovery in patients who underwent minimally invasive THA with the use of a posterolateral approach. This minimally invasive THA technique provides short-term safety and efficacy.

REFERENCES


微創全人工髕關節置換手術：使用後外側置入方式的技巧和早期成果

林育全  陳崇桓  黃炫迪  蘇景源
傅尹志  張瑞根  王國照
高雄醫學大學附設醫院  骨科
高雄醫學大學  醫學院醫學系  骨科學

近幾年來，隨著微創手術的發展，微創全人工髕關節置換手術也漸漸成為一種趨勢。贊成者認為，這種微創技術可以減少軟組織的傷害，而這儼然是一種優勢。反對者則顧慮到因為手術視野的減少所產生的危險性。所以目前來說，微創全人工髕關節置換手術是否適用仍存在著許多爭議。本文目的在於報告我們使用後外側置入方式施行微創全人工髕關節置換手術的經驗和早期成果。從 2005 年 8 月至 2006 年 7 月期間，連續 79 位患者接受了此項手術 (共 85 例髕關節置換)。我們依據臨床及 X 光的各項結果來做評估。平均手術時間是 55 分，平均住院日是 5.3 日。術後三個月的髕關節功能量表平均是 92.0 分。唯一一例 (1.18%) 的併發症是術中非移位性骨折，其他則沒有脫臼、神經血管損傷及術後感染等問題發生。短期追蹤的結果顯示，我們的手術併發症機率低且術後恢復良好，我們認為這種技術方法是安全而有效的。

關鍵詞：迷你傷口，微創，後外側置入方式，全人工髕關節置換

(高雄醫誌 2007;23:611－7)