梨花醫大誌：第 28 卷 第 1 號 2005
Ewha Med J Vol. 28, No. 1, 2005

Results of Primary Total Hip Arthroplasties Performed with a Mini-Incision or a Standard Incision

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최소절개술 또는 표준절개술을 이용한 일차 고관절 전치환술의 결과

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목 적: 고관절 전치환 수술 시 소위 '최소절개술'을 이용한 수술법이 여러가지 장점을 가지고 있다고 알려져 왔다. 연부 조직의 외상을 줄이고, 수술 시 출혈양을 줄일 수 있으며, 수술 후 통증, 입원기간을 줄일 수 있다. 수술 후 회복을 빠르게 하고 미용상 수술 창상을 줄일 수 있다. 이 논문에서는 최소절개술과 표준절개술을 이용한 고관절 전치환술에서 수술적 측정요소와 삽입물 위치와 안전성의 차이를 전향적으로 비교연구 하였다.

방 법: 60명의 환자 79예에서 표준절개술(절개길이 12~15cm)로, 58명의 환자 78예에서 최소절개술(10cm 이하)로 일차 고관절 전치환술을 시행하였다. 두 군에서 모두 후외측 도달법으로 시행하였다. 임상적 결과, 수술 및 병실자료, 수술 후 합병증 그리고 방사선학적 결과 등을 두 군에서 비교하였다.

결 과: 수술 중 출혈양, 헤모백 배출량, 입원기간, 주합병증의 비율, 방사선학적 측정요소 등 두 군간의 의미있는 차이가 없었다($p>0.05$). 이에 비해 평균 수술시간, 헤모백 유지기간은 최소절개군에서 의미있게 짧았다($p<0.05$). 또한 입원기간 중 평균 수혈량도 최소절개 군에서 의미있게 적었다($p<0.05$). 피부절개의 연장은 최소절개군에서 의미있게 높았다($p<0.001$).

결 론: 두 군사이에 대부분의 측정요소에서 차이가 없었지만, 환자의 대부분은 작은 수술창상을 선호하였다. 따라서 인공관절 삽입물의 위치, 피부와 연부조직의 치유에 문제가 없다면 최소절개술을 시행하는 것이 좋을 것으로 제의한다.

중심 단어: 고관절 전치환술 · 최소절개술.

Introduction

Minimally invasive total hip arthroplasty has created much controversy among orthopaedic surgeons and a great deal of publicity in the popular press. So-called "mini-incision techniques" involve limiting the length of the skin incision to ≤10cm with use of either an anterior or posterior approach. Advocates emphasizes the potential for these methods to reduce soft tissue trauma and thereby reduce operative blood loss, postoperative pain, and hospitalization time ; speed the postoperative recovery ; and improve the cosmetic appearance of the surgical scar[1-6]. Opponents of mini-incision total hip replacement point out that conventional hip replacement already provides excellent pain relief, functional improvement, and durability with low complication rate. Skeptics are concerned that mini-incision procedures introduce new potential problems related to reduced visualization at the time of the operation, such as implant malposition, neurovascular injury, poor implant fixation, or component long-term results[7-9].

All but three of the published reports on mini-incision total hip arthroplasties were either retrospective single-cohort studies or comparisons of patients who had a mini-incision and control groups of patients managed with a standard incision[2-8)10)]. None of these studies have provided convincing evidence of the advantages of mini-incision total hip arthroplasty.

We designed this prospective, randomized study to determine whether there was a difference in surgical parameters, component positioning, and safety of the mini-incision technique compared with the standard-incision technique for total hip replacement.

Materials and Methods

Between March 2001 and February 2002, the senior author performed consecutive primary unilateral or bilateral simultaneous total hip arthroplastics in sixty patients (seventy-nine hips) using a standard-incision technique. Between March 2002 and February 2003, the senior author again performed consecutive primary unilateral or bilateral total hip arthroplasties in fifty-eight patients (seventy-eight hips) using a mini-incision technique. All 118 patients were enrolled in the present study The bilateral total hip arthroplasties were performed during the same anesthetic session, with one side treated immediately after the other. The study was approved by our institutional review board, and all patients provided informed consent.

Patient demographic characteristics and procedure data are summarized in Table 1 and these parameters were not significantly different ($p>0.05$) between the standard- and mini-incision groups. No patient had previous hip

Table 1. Patient demographic characteristic and procedure data

	Standard-Incision Group	Mini-Incision Group	P value
No. of hips	79	78	0.1718
No. of patients	60	58	0.1715
Unilateral hip	41	38	0.1735
Bilateral hip	19	20	0.1719
Gender (M/F) (%male)	44/16 (73%)	35/23 (60%)	0.1712
Age (Yrs)	67.4 (58−84)	68.7 (57−86)	0.0750
Average height (cm)	165.7 (143−178)	163.0 (142−183)	0.1029
Average weight (kg)	64.6 (45−82)	64.3 (40−90)	0.8758
Average body-mass index	23.5 (17.6−39.0)	24.1 (17.6−38.5)	0.2289
No. (%) of patients with body-mass index of ≥30*	15 (25%)	14 (24%)	0.5654
Preoperative diagnosis (no. [%] of patients)			
Osteonecrosis	47 (78%)	31 (53%)	
Osteoarthritis	11 (18%)	25 (43%)	
Traumatic arthritis	2 (4%)	−	0.076
Rheumatoid arthritis	−	1 (2%)	
Ankylosing spondylitis	−	1 (2%)	
No. of procedure without cement (%)	79 (100%)	78 (100%)	−
Average preoperative ASA score †	1.65 (1−3)	1.70 (1−3)	0.6774
No. of procedure done with regional anesthesia/no. with general anesthesia (% with regional anesthesia)	47/13 (78%)	53/5 (91%)	0.0718

* : Body-mass index=weight (in kilograms) /height (in meters) 2, † : ASA=American Society of Anesthesiologists[14]

operation.

In the standard-incision group, all procedures were performed through a posterolateral approach (the length of the incision was 15 to 20cm). In the mini-incision group, all procedures were performed through a posterolateral approach (the length of the incision was ≤ 10 cm). The senior surgeon routinely performed a posterior capsular and short external rotators repair.

A cementless Optional acetabular component (Depuy, Leeds, United Kingdom) was used in all hips. In all hips, the acetabular component was press-fit after underreaming of the acetabulum by 2 mm. A 28-mm (inner diameter) alumina ceramic liner (DePuy, Leeds, United Kingdom) was used in all hips.

A cementlessl Immediate Postoperative Stability (IPS) femoral component (DePuy, Leeds, United Kingdom), which is an anatomic metaphyseal filling titanium-alloy implant with a short, narrow, polished distal stem, was used in all hips[11]. The proximal, metaphyseal portion of the stem (about one-third of the stem) is porous-coated with sintered beads. The pore size is between 200 and 300 μm, and the hydroxyapatite coating is 30 μm in depth. A 28-mm alumina ceramic head was used in all hips.

The patients were allowed to stand on the second postoperative day. They progressed to full weight-bearing with crutches as tolerated. The average time for these patients to full weight bearing was fifteen days.

We performed a clinical and radiological follow-up at three and six months and at one year after the operation and yearly thereafter. The clinical ratings[12] were determined before the operation and at each follow-up examination.

The data collected for analysis were surgical time, intraoperative estimated blood loss, blood replacement during the hospitalization, amount of hemovac suction drainage, average duration of hemovac suction drainage, and length of hospital stay. A research associate, who did not contribute patients to the study, reviewed all of the documentations to determine whether a complication had occurred.

One of us, who was blinded to the length of the incision, analyzed a postoperative anteroposterior and lateral radiographs of the both hips for each patient. The parameters that were included the cup abduction and anteversion angles, stem alignment, and the fit and fill of the cementless femoral components, femoral displacement, and limb-length discrepancy. Limb-length discrepancy was measured from the inter-teardrop line to the lesser trochanter[9]. Stem alignment was classified as varus, neutral, or valgus. The quality of the fit and fill of the cementless femoral component was classified as satisfactory and undersized according to previously defined criteria[13].

Statistical analysis was done with use of a two-tailed t test for continuous variables and a chi-square contingency table for dichotomous values. A P value of <0.05 was considered to be significant.

To determine whether there was a significant difference ($p=0.8$ and $p<0.05$) in the hip score, surgical and hospital data, postoperative complications and radiographic parameters between the standard-incision and mini-incision groups, at least fifty-five patients were required.

Results

1. Clinical results

The preoperative hip scores for the two groups (48 and 49 points) were not significantly different ($p=0.3788$). In the standard-incision group, the mean postoperative hip score was 93 points (range, 85 to 100 points) and 92 points (range, 70−100 points) in the mini-incision group. The postoperative hip scores for the two groups were not significantly different ($p=0.3429$).

Intraoperative estimated blood loss, amount of hemovac suction drainage, and length of hospital stay, major complication rates, and radiographic parameters for the standard-incision and mini-incision groups were not significantly different ($p>0.05$). On the contrary, average surgical time, and duration of hemovac suction drains were significantly shorter in the mini-incision group ($p<0.05$). Also, average blood replacement during hospitalization was significantly less in the mini-incision group ($p<0.05$) (Table 2).

Five standard-incision (6%) and forty-four mini-incision (56%) procedures were associated with postoperative complications ($p<0.001$) (Table 3). All five compli-

Table 2. Surgical and hospital data

	Standard-Incision Group	Mini-Incision Group	P value
Average surgical time (min)	65 (58–80)	52 (48–90)	<0.001
Average intraoperative extimated blood loss (ml)	575.6	455.4	0.1578
Average amount of hemovac suction drain	1338.9	1192.4	0.1415
Average total blood replacement during hospitalization (ml)	878	759	0.0287
Average duration of hemovac suction drainage (days)	6.4	5.2	0.0016
Average length of hospital stay (days)	10.1	9.9	0.7678

Table 3. Postoperative complications

	Standard-incision group	Mini-incision group	P value
No. (%) of hips with surgical compllications			
Inadvertent extension of skin incision	0 (0)	37 (47%)	<0.001
No. (%) of hips with wound compllications	0 (0)	0 (0)	–
No. (%) of hips with major compllications			
Infection	0 (0)	2 (3%)	
Dislocation	4 (5%)	2 (3%)	
Fracture of proximal femur	0 (0)	1 (1%)	0.5253
Trochanteric crack	0 (0)	1 (1%)	
Peroneal nerve palsy	1 (1%)	1 (1%)	
Total no (%) of hips with complications	5 (6%)	44 (56%)	<0.0001

cations in the standard-incision group were classified as major ; one was a peroneal nerve palsy that completely resolved in six months, and other four were posterior dislocations that required closed reduction and abduction brace for three months. We considered six complications that occurred in the mini-incision group as major ; these included one femoral fractures (that required open reduction, stem revision and internally fixed with four cerlage cables), one peroneal nerve palsy that completely resolved in three months, two deep wound infections with Staphylococcus that were diagnosed five and eight days postoperatively and required the administration of intravenous antibiotics for six weeks, and two posterior dislocations that required in closed reduction and abduction brace for three months. Thrity-seven minor complications (47%) in the mini-incision group were inadvertent extension of skin incision.

2. Radiographic results

The radiographic results are summarized in Table 4. There were no significant differences between the groups with regard to the abduction and anterversion angles of the acetabular component, stem alignment, and the fit and fill of the femoral components, and limb length discrepancy. The average abduction angle (and standard deviation) was 43° ±6° and the average anterversion was 27° ±6° in the standard-incision group. In the mini-incision group, the average abduction angle (and standard deviation) was 44° ±6.2° and the average anteversion was 31° ±8.1°. The goal at the operation in both groups was an abduction angle of 35° to 45° and antervision of 20° to 30°. Five hips (6%) were outliers (those outside the desired range) with regard to abduction angle and six hips (8%) were outliers for anteversion in the standard-incision group. Six hips (8%) were outliers with regard to abduction angle and eight hips (10%) were outliers with for anteversion in the mini-incision group. The prevalence of outliers in both groups was not significantly different ($p>0.05$).

The femoral component alignment was within 3° of neutral in the coronal plane in seventy-five hips (95%) in the standard-incision group and seventy-three hips (94%) in the mini-incision group (Fig. 1). Four hips (5%) were outliers with regard to stem alignment in the

Table 4. Radiographic data

	Standard-Incision group				Mini-Incision group				P value
	Anteroposterior view		Lateral view (anterversion)		Anteroposterior view		Lateral view (anterversion)		
	Stem (Varus+/ valgus-)	Cup (Inclination)	Stem	Cup	Stem (Varus+/ valgus-)	Cup (Inclination)	Stem	Cup	
Mean	1.2°	42.8°	12.4°	26.5°	1.7°	44.2°	14.8°	27.7°	
Minimum	−3°	26°	−1°	16°	−1°	31°	2°	8°	
Maximum	4°	54°	24°	34°	6°	59°	25°	35°	
Standard deviation	1.2°	6°	5°	6°	1.4°	6.2°	5.1°	8.1°	
Inliers (Desired alignment)	75 (95%)	74 (94%)	71 (90%)	73 (92%)	73 (94%)	72 (92%)	69 (88%)	70 (90%)	
Outliers	4 (5%)	5 (6%)	8 (10%)	6 (8%)	5 (6%)	6 (8%)	9 (12%)	8 (10%)	
Leg length discrepancy (cm)	0.9cm (0−1.5cm)				0.8cm (0−1.7cm)				

Stem alignment in anteroposterior view in both groups	P=0.347
Stem alignment in lateral view in both groups p	P=0.287
Cup inclination in both groups	P=0.356
Cup anteversion in both groups	P=0.374
Outliers of stem alignment in anteroposterior view in both groups 75	P=0.175
Outliers of stem alignment in lateral view in both groups	P=0.357
Outliers of cup in clinination both groups	P=0.368
Outliers of cup anteversion in both groups	P=0.352
Leg length discrepancy in both groups	P=0.589

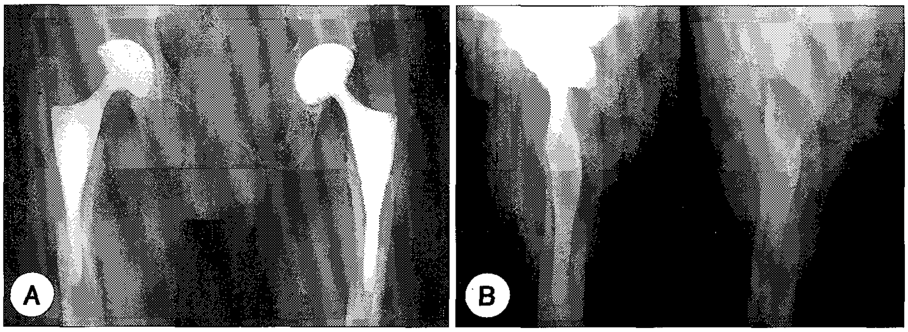

Fig. 1. A and B : Radiographs of both hips of a thirty-six-year-old male patient with osteonecrosis of femoral heads. A : Anteroposterior radiographs of both hips, made two years after surgery, showing the IPS prosthesis with alumina-on-alumina ceramic bearing implanted by a standard-incision (right side of image) and the IPS prosthesis implanted by a mini-incision (left side of image) to be solidly fixed in a slightly varus position. B : Lateral radiographs of both hips, made after two years after surgery, showing the IPS prosthesis with alumina-on-alumina ceramic bearing implanted by a standard-incision (right side of image) and IPS prosthesis implanted by a mini-incision (left side of image) to be solidly fixed in a satisfactory position.

coronal plane and eight hips (10%) were outliers with regard to stem alignment in sagittal plane in the standard-incision group. Five hips (6%) were outliers with regard to stem alignment in the coronal plane and nine hips (12%) were outliers with regard to stem alignment in the sagittal plane in the mini-incision group. The difference in stem alignment in both planes in both groups was not significant ($p>0.05$). All hips had a satisfactory stem-canal fill in both groups.

The average limb length was increased 0.9±0.79cm compared with the preoperative length in the standard-incision group and was increased 0.8±0.59 cm in the mini-incision group. The average femoral displacement was increased 1.6±0.81cm in the standard-incision group and 1.9±.79cm in the mini-incision group. The differences of limb length and femoral displacement in both groups were not significant ($p>0.05$). At the final follow-up, all acetabular and all but one femoral components were radiographically stable. One femoral component was loose resulted from a fracture of the proximal femur and it was revised after fracture was fixed.

Discussion

The major complications following total hip replacement that require revision are failure of fixation, instability, and infection. To minimize failure of fixation, implant-bone interfaces must be optimally prepared. To minimize dislocation, components needs to be positioned optimally, osseous impingement (including osteophytes) should be eliminated, and stability needs to be assessed. To minimize infection, tissue trauma needs to be minimized, as does the duration of the operation. A so-called "mini-incision techniques" do not address these problems, and they could potentially increase each of them, especially in the hands of a surgeon who is less skilled or who is doing few procedures. These are reasons for skepticism as well as for concern about the mini-incision total hip arthroplasty.

The current study documented gratifying results of total hip arthroplasty included excellent fixation and stability of implants, and good skin and soft tissue healing in both standard-incision and mini-incision groups. We believe that several factors were responsible for good results in both groups : (1) The instruments with curvatures and an increased handle length, and a curved acetabular reamer were used in the mini-incision group to minimize skin trauma and to provide optimal exposure for reproducible component placement ; (2) the proximal canal-filling design of of the stem and a surgical technique that optimizes stem-canal fill ; (3) the strong trabecular bone in these young patients ; (4) the fact that the patients were small and light ; (5) the utilization of alumina-on-alumina ceramic bearing to avoid wear of polyethylene liner ; and (6) the follow-up was not long enough.

Three previous controlled studies of total hip arthroplasties reported that most of the in hospital results for the patients managed with a mini-incision were worse or no better than those for the standard-incision groups[7-9]. First one of these published studies reported that the mini-incision group was found to have a significantly higher risk of a wound complication and a higher percentage of component malposition[9]. The second study found no differences with the exception of a decreased blood loss in the mini-incision group but with no increased transfusion requirement in the standard-incision group[7]. Third study found no difference in the early results except for the size of the scar[8]. The results of our study agree with latter two previous controlled studies[7][8]. We found no differences in most parameters in both groups with the exception of increased inadvertent extension of skin incision in the mini-incision groups and increased surgical time, transfusion requirement, and average duration of hemovac suction drainage in the standard-incision group.

Although we did not select patients for the mini-incision technique according to body-mass index, and a score of the system of the American Society of Anesthesiologists[14], no improvements were seen any of these in-hospital parameters in the mini-incision group. Thus, the contention by proponents that mini-incision procedures cause less bleeding and less soft tissue trauma (that is, they are less invasive) and results in shorter hospital stays than do standard-incision procedures were not bone out by the present study. In this study, there was no demonstrable benefits associated with the mini-incision procedure except less transfusion , shorter surgical time, shorter duration of hemovac drain and a smaller scar.

The wound complication and infection rate can be higher for the mini-incision group. Working through a small incision may results in both more pressure on the skin and soft tissues from stronger retraction and more abrasion of the skin edges from reamers and rasps. These factors may cause more wound complications and infection. In the current series, the infection was developed in two hips with the mini-incision. These two infections appeared to be related to soft tissue damage from stronger retraction and reamers.

Common sense dictates that a surgeon use the smallest incision possible for any procedure in order to limit soft-tissue trauma and improve the appearance of the scar ; however, the surgical exposure must be adequate to perform the procedure well to avoid soft tissue complications. Also, it is important that the well-known long-term benefit of total hip replacement not be compromised by a technique that offers only short-term benefits, which, in this study, was less transfusion, shorter surgical time, shorter duration of hemovac drains, and a shorter scar.

Although there were no differences in the most parameters in standard-and mini-incision groups in the current study, the majority of patients clearly favor a shorter scar. Therefore, we suggest that a mini-incision technique should be employed unless it compromises the satisfactory component positioning and skin and soft-tissue healing.

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