Which is more invasive—mini versus standard incisions in total hip arthroplasty?

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Abstract In this study, interleukin-6 (IL-6), C-reactive protein (CRP), and haemoglobin levels were evaluated to compare the degree of surgical invasion between mini and standard incisions in total hip arthroplasty (THA). Sixty-two patients admitted for primary cementless THA were enrolled in this randomised study. The patients were allocated to have surgery through either a mini incision of <10 cm or a standard incision of 15 cm. In each group, inflammatory responses were evaluated by IL-6, CRP, and haemoglobin levels before operation and one day after operation. Significant differences were not found in IL-6, CRP, and haemoglobin levels between both groups. At six months after surgery, there were no significant differences in postoperative Harris hip scores or radiographic evaluations between both groups. In conclusion, a 5.0 cm difference in the skin incision to the hip joint seemed to have no influence on the degree of surgical invasion during THA.

Résumé Afin de mesurer l'importance de l'agression chirurgicale tissulaire dans les prothèses totales de hanche, incision standard, versus mini-invasifs, les niveaux d'Interleukin 6 (IL-6) de protéine C-réactive (CRP) et d'hémoglobine doivent être appréciés. 62 patients devant bénéficier d'une prothèse totale de hanche primaire sans ciment ont été enrôlés dans cette étude randomisée. Ces patients devaient bénéficier soit d'une mini-incision inférieure à 10 cm, soit d'une incision standard supérieure à 15 cm. Chaque groupe a été évalué avec ces différents facteurs biologiques avant

l'intervention et un jour après intervention. Il n'a été trouvé aucune différence significative dans les deux groupes avec ces différents marqueurs Interleukin, CRP et hémoglobine. Six mois après la chirurgie pas de différence significative non plus au niveau des scores de Harris ou au niveau de l'évaluation radiographique. En conclusion, la différence d'incision cutanée de 5 cm ne semble pas avoir d'influence sur l'importance des lésions des parties molles au cours d'une prothèse totale de hanche.

Introduction

Recently, several new surgical techniques for total hip arthroplasty (THA) have been developed and termed 'minimally invasive' by their proponents [6, 9, 11, 15, 18, 19, 23]. The so-called 'mini-incision' techniques involve limiting the length of the skin incision to <10 cm in any approach. The advantages claimed by the proponents of mini-incision techniques include reduced blood loss and less soft tissue damage, resulting in a faster recovery, shorter hospital stay, and less postoperative pain than standard techniques.

Cytokines that include C-reactive protein are the main mediators of inflammation and response to trauma. The acute-phase response, which is an important component of systemic biological responses to tissue damage, is initiated locally in the surgical wound where activation of leukocytes, fibroblasts, and endothelial cells stimulate the release of cytokines [8, 10]. Interleukin-6 is formed from monocytes, macrophages, fibroblasts, and T2-lymphocytes when tissue is traumatised. The subsequent inflammatory action induced by interleukin-6 produces C-reactive protein and serum amyloid A-protein in the liver, T and B cellular activation in the peripheral blood and bone marrow, and

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pyrexia via pituitary hormones [12]. Interleukin-6, the most widely studied cytokine, is responsible for hepatic responses, mainly stimulating the synthesis of other acute-phase proteins of which the most important is the C-reactive protein [14]. Serum levels of interleukin-6 and C-reactive protein have been shown to increase as part of the inflammatory response to surgical trauma following total hip arthroplasty [2, 20, 21]. A correlation has been demonstrated between the increase in interleukin-6 and C-reactive protein, the volume of the surgical wound, amount of blood loss, and duration of the surgical procedure [1, 14]. In this study, interleukin-6, C-reactive protein, and haemoglobin levels were evaluated to compare the degree of surgical invasion between mini and standard incisions in total hip arthroplasty.

Patients and methods

Sixty-two patients (62 hips) admitted for primary unilateral cementless total hip arthroplasty were enrolled in this randomised, blinded study between December 2003 and May 2005. The subjects included all patients for primary cementless total hip arthroplasty. The patients were randomly allocated to have surgery through either a minimally invasive incision of <10 cm or a standard incision of 15 cm. Informed consent was obtained from all patients. The exclusion criteria were a history of previous surgery on the affected hip and inflammatory polyarthritis including rheumatoid arthritis.

Table 1 shows the preoperative patient data. In the mini-incision group there were five males and 29 females with mean age and standard deviation of 59.8 ± 11.2 years. In the standard-incision group there were four males and 24 females with mean age and standard deviation of 59.1 ± 11.8 years. These two groups of patients were similar in age, sex, and body-mass index.

Baseline preoperative haemoglobin levels were recorded. Postoperatively, haemoglobin levels were measured after 24 hours. Baseline interleukin-6 and C-reactive levels were

measured preoperatively and were remeasured at 24-hours postoperatively to determine whether there was any difference in the magnitude of the inflammatory response between the two patient groups.

Interleukin-6 and C-reactive protein measurements were performed on routine venous blood samples stored directly after they were taken at $+4^{\circ}\text{C}$ for twelve hours, then centrifuged at 3,000 rpm for ten minutes and deep-frozen at -20°C until determination. We performed the analysis of C-reactive protein by using an immunoturbidometric technique on a Hitachi 7600-020S automatic analyser. The recommended cut-off level for this turbidimetric test is 0.5 mg/dl. The interleukin-6 concentration was determined using a chemiluminescent enzyme immunoassay (CLEIA; Lumipulse 1200, Fujirebio, Tokyo, Japan). The recommended cut-off level is 4 pg/ml.

In all patients, the same surgeon (M.N.) performed the surgery, employing either the translateral [7] or posterolateral approach with a capsular repair [24]. He had already performed more than 100 mini-incision hip replacements before starting this study.

All patients had epidural anaesthetics of 0.75% ropivacaine with intravenous propofol for intraoperative sedation. The patients were randomly allocated to have surgery either with a translateral or a posterolateral approach. Washed red blood cells autotransfusion (Cellsaver; Haemonetics, Massachusetts) was used in all patients. The patients in both groups were allowed out of bed on the second postoperative day. Weight-bearing using a walker or crutches was begun as tolerated on the third postoperative day.

Clinical assessment was based on Harris hip scores before surgery and at six months postsurgery, comparing the two patient groups. The intraoperative and postoperative complications at six months were also recorded.

Statistical analysis

Either Chi-square or Mann-Whitney U test was used to compare both the mini-incision and standard-incision groups. The level of significance was set at $p < 0.05$.

Table 1 Demographic data on the patients

Demographic/diagnosis	Mini-incision group (N)	Standard-incision group (N)	<i>p</i> value
Number of patients	34	28	
Age ^a (y)	59.8 ± 11.2	59.1 ± 11.8	0.76
Gender (male/female)	5/29	4/24	0.96
Body mass index ^{a,b}	23.2 ± 3.6	23.0 ± 3.7	0.76
Preoperative diagnosis			
Developmental dysplasia	30	24	
Avascular necrosis	4	4	

^a Values are given as mean $\pm$ standard deviation

^b Body mass index = weight (kg) / height (m^2)

Correlations were assessed using Pearson's correlation coefficients and the relationship between interleukin-6 or C-reactive protein or haemoglobin levels and operative time was analysed.

Results

Table 2 shows the operative data and Harris hip scores. The mean incision length and standard deviation measured 9.0 ± 0 cm in surgery in the mini-incision group. For the standard-incision group, the mean incision length was 14.4 ± 2.5 cm. As for surgical approach used, there was no significant difference between the two groups (Table 2; $p=0.21$). The only difference in surgical technique between the two groups was the length of skin incision and the shorter incision of the fascia lata in the mini-incision group. The mean operative time was 11.4 minutes longer for the mini-incision group (94.6 ± 23.5 minutes) than for the standard-incision group (83.2 ± 18.4 minutes), which is a significant difference of $p=0.03$. The mean postoperative blood autotransfusion was 467.6 ± 171.8 ml for the mini-incision group and 442.8 ± 147.7 ml for the standard-incision group. The difference was not significant ($p=0.55$).

As for intraoperative complications, a fissure fracture of the proximal femur (Vancouver classification: type A fracture [3]) occurred in one hip in the mini-incision group (3%) and a cerclage wire was used. None of the patients had postoperative pulmonary embolism, deep infection, or dislocation. Postoperative rehabilitation was similar in both groups. All patients in both groups began to walk with a

single cane within the first three postoperative weeks. The mean postoperative Harris hip score at six months was 93.5 ± 6.1 points for the mini-incision group and 94.7 ± 5.2 points for the standard-incision group. The difference was not significant ($p=0.43$).

Table 3 shows the laboratory data. The mean postoperative serum levels of interleukin-6 at 24-hours were 107.4 ± 76.2 pg/ml for the mini-incision group and 97.0 ± 47.8 pg/ml for the standard-incision group ($p=0.53$). The mean postoperative serum levels of C-reactive protein at 24-hours were 6.1 ± 2.3 mg/dl for the mini-incision group and 5.7 ± 1.9 mg/dl for the standard-incision group ($p=0.54$). The mean postoperative haemoglobin levels at 24-hours were 11.0 ± 1.4 g/dl for the mini-incision group and 10.8 ± 1.3 g/dl for the standard-incision group ($p=0.43$). Operative time did not correlate with postoperative serum level of interleukin-6 ($r=-0.07$, $p=0.60$), C-reactive protein ($r=0.03$, $p=0.80$), or haemoglobin levels ($r=0.14$, $p=0.30$).

Discussion

Enthusiasts of minimally invasive total hip arthroplasty have advocated potential benefits including reduced blood loss, less soft tissue damage, faster recovery, shorter hospital stay, and less postoperative pain compared to using standard techniques. It has also been stated that patients who undergo a mini incision are more likely to go directly home rather than to a skilled nursing or rehabilitation facility. However, these benefits have yet to be proven in well-designed trials.

Table 2 Operative data and Harris hip scores

Operative data	Mini-incision group		Standard-incision group		<i>p</i> value
	Translateral approach	Posterolateral approach	Translateral approach	Posterolateral approach	
Number of patients	15	19	8	20	0.21
Age ^a (y)	61.7 ± 11.5	58.3 ± 3.0	53.4 ± 13.3	61.3 ± 10.7	0.76
Operative time ^{a,b} (min)	104.3 ± 23.5	86.8 ± 14.6	90.0 ± 21.0	80.5 ± 17.0	0.03
Incision length ^a (cm)	9.0 ± 0	9.0 ± 0	13.1 ± 1.1	14.7 ± 2.8	<.0001
Autotransfusion ^a (ml)	500.0 ± 173.2	442.0 ± 171.0	475.0 ± 148.8	430.0 ± 149.0	0.55
Intraoperative complications (%)					
Fissure fracture of the proximal femur	0(0)	1(3)	0(0)	0(0)	
Post-operative complications (%)					
Pulmonary embolism	0(0)	0(0)	0(0)	0(0)	
Deep infection	0(0)	0(0)	0(0)	0(0)	
Dislocation	0(0)	0(0)	0(0)	0(0)	
Preoperative Harris hip score (points)	50.3 ± 12.5	58.1 ± 10.2	56.3 ± 6.3	55.7 ± 7.3	0.61
Postoperative Harris hip score (points)	93.9 ± 5.4	93.2 ± 6.7	92.7 ± 6.8	95.4 ± 4.4	0.43

^a Values are given as mean $\pm$ standard deviation

^b The mean operative time was 11.4 minutes longer for the mini-incision group (94.6 ± 23.5 minutes) than for the standard-incision group (83.2 ± 18.4 minutes) ($p=0.03$)

Table 3 Laboratory data (inflammatory response and haemoglobin level)

Laboratory data	Mini-incision group		Standard-incision group		<i>p</i> value
	Translateral approach	Posterolateral approach	Translateral approach	Posterolateral approach	
Number of patients	15	19	8	20	0.21
Serum interleukin-6 (pg/ml)					
Preoperative ^a	1.1±0.5	1.6±1.1	1.2±0.4	1.2±0.7	0.36
24-hr postoperative ^a	99.1±43.9	114.0±95.1	97.5±43.7	96.7±50.4	0.53
C-reactive protein (mg/dl)					
Pre-operative ^a	0.1±0.1	0.2±0.2	0.1±0.1	0.1±0.1	0.65
24-hr postop ^a	6.2±2.0	6.0±2.6	5.9±1.7	5.7±2.0	0.54
Haemoglobin (g/dl)					
Pre-operative ^a	11.6±0.9	11.6±1.0	12.0±1.0	11.8±0.8	0.29
24-hr postoperative ^a	11.1±1.1	11.0±1.6	11.3±1.7	10.6±1.2	0.43

^a Values are given as mean ± standard deviation

The mean serum levels of interleukin-6, C-reactive protein, and haemoglobin levels at 24 hours after operation were not significantly different between the mini-incision and the standard-incision groups

Sculco et al. [15] found no difference in either blood loss or length of stay for 42 patients who had undergone minimally invasive total hip arthroplasty compared with a cohort of 42 patients who had undergone total hip arthroplasty through a traditional incision. The Harris hip score was slightly higher in the mini-incision group at five years. Wenz et al. [19] reported that patients managed with a minimal-incision technique were able to walk sooner and with less assistance than those managed with a standard technique, but no difference was found in the length of hospital stay. Ogonda et al. [13] reported similar results that minimally invasive total hip arthroplasty performed through a single-incision posterior approach by a high-volume hip surgeon with extensive experience is a safe and reproducible procedure, but it offers no significant benefit in early postoperative period compared with a standard incision of 16 cm. In our study, there was no significant difference in the postoperative ambulation between both groups.

The potential disadvantages of minimally invasive approaches include reduced visualisation, a possible increased risk of neurovascular injury, and component malpositioning, thereby compromising the long-term results of an already successful procedure. The orthopaedic literature lacks well-designed studies to support the clinical superiority of minimally invasive total hip arthroplasty in the early postoperative period. Woolson et al. [22], in a retrospective study, reported the results of 135 hip replacements by three different surgeons. The mini-incision group was found to include thinner and healthier patients than the standard-incision group. No difference was detected with respect to operative time, blood loss, transfusion rates, or length of stay. The mini-incision group had a significantly higher risk of wound complications, acetabular component malposition, and poor fit and fill of the cementless femoral components. In this study, the mean operative time was

11.4 minutes longer for the mini-incision group (94.6±23.5 minutes) than for the standard-incision group (83.2±18.4 minutes) ($p=0.03$). At six months after surgery, there were no significant differences in postoperative Harris hip scores or radiographic evaluations between the mini-incision groups and the standard incision groups.

IL-6 levels peak in the first 6–24 hours after surgery and fall back to their base line by 48–72 hours postoperatively [5, 14, 21]. C-reactive protein is an acute-phase reactant that is produced by the liver in response to inflammation, infection, and neoplasm; its serum levels are elevated to their peak values two to three days after surgery and return to normal values approximately three weeks after surgery [2, 20]. Studies in general surgery have shown a reduced acute phase cytokine response in laparoscopic compared with open colectomy [4, 17]. This has been attributed to the reduced amount of soft tissue trauma. In this study, serum interleukin-6, C-reactive protein, and haemoglobin levels were evaluated to compare surgical invasion between a mini-incision and a standard-incision in total hip arthroplasty. The mean serum levels of interleukin-6, C-reactive protein, and haemoglobin levels at 24 hours after operation were not significantly different between the mini-incision and standard-incision groups. This may imply that the mini-incision is no less traumatic than a 14-cm standard incision.

The values of C-reactive protein obtained in this study were higher than that in the past report [16]. The reasons are thought to be that surgical time in both of our groups was slightly longer and the time for measurement of C-reactive protein was different. These differences may affect a value of postoperative C-reactive protein.

We note several limitations to our study. First, it involved only a small number of hips (62 hips) and only 62 total surgical hips divided into two groups. Second, this

is a study for comparison of the surgical invasion between mini and standard incisions in THA. Therefore, we did not compare detailed radiographic evaluation in both groups. Finally, the value of creatine phosphokinase (CPK) as the index of soft tissue damage was not investigated in this study because we could not measure this marker in all of the patients. In this study, we emphasised the total surgical invasion not limited to soft tissue damage, and therefore used IL-6 for total evaluation of surgical invasion. However, in future studies, evaluation for surgical invasion with CPK combined with IL-6 will be required.

In conclusion, a 5.0 cm difference in the skin incision to the hip joint seemed to have no influence on the degree of surgical invasion during total hip arthroplasty.

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