

Slower Recovery After Two-Incision Than Mini-Posterior-Incision Total Hip Arthroplasty

A Randomized Clinical Trial

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Background: It has been claimed that the two-incision total hip arthroplasty technique provides quicker recovery than other methods do. To date, however, there have been no studies that have directly compared the two-incision technique with another method in similar groups of patients managed with the same advanced anesthetic and rehabilitation protocol. We posed the hypothesis that patients managed with two-incision total hip arthroplasty would recover faster than those managed with mini-posterior-incision total hip arthroplasty and designed a randomized controlled trial specifically (1) to determine if patients recovered faster after two-incision total hip arthroplasty than after mini-posterior-incision total hip arthroplasty as measured on the basis of the attainment of functional milestones that reflect activities of daily living, (2) to determine if the general health outcome after two-incision total hip arthroplasty was better than that after mini-posterior-incision total hip arthroplasty as measured with Short Form-12 (SF-12) scores, and (3) to evaluate the surgical complexity of the two procedures on the basis of the operative time and the prevalence of early complications.

Methods: Between November 2004 and January 2006, seventy-two patients undergoing total hip arthroplasty were randomized to two treatment groups: one group was managed with the two-incision technique, and the other group was managed with the mini-posterior-incision technique. The two-incision group comprised thirty-six patients (twenty men and sixteen women) with a mean age of sixty-seven years and mean body mass index of 28.7. The mini-posterior-incision group comprised thirty-six patients (twenty men and sixteen women) with a mean age of sixty-six years and a mean body mass index of 30.2. All patients received the same design of uncemented acetabular and femoral components and were managed with the same comprehensive perioperative pain management and rapid rehabilitation protocol. Operative times and complications were recorded. At two months and one year, all patients were assessed with regard to functional outcome and general health outcome.

Results: The patients in the two-incision group recovered more slowly than did those in the mini-posterior-incision group as measured on the basis of the mean time to discontinue a walker or crutches, to discontinue all walking aids, and to return to normal daily activities. The clinical outcome as measured on the basis of the SF-12 scores was similar at both two months and one year postoperatively. The two-incision total hip arthroplasty was a more complex surgical procedure, with a mean operative time that was twenty-four minutes longer; however, the rate of complications (2.8%; one of thirty-six) was the same in the two groups.

Conclusions: Our hypothesis that the two-incision technique for total hip arthroplasty would substantially improve the short-term recovery after total hip arthroplasty compared with the mini-posterior incision technique was not proved; instead, the patients managed with the mini-posterior-incision technique had the quicker recovery.

Level of Evidence: Therapeutic Level I. See Instructions to Authors for a complete description of levels of evidence.

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Substantial interest in so-called minimally invasive total hip arthroplasty exists among patients and surgeons alike¹⁻⁷. The concept that less surgical dissection should result in less pain and quicker recovery makes sense intuitively and is thus inherently appealing. Proponents of the two-incision technique have claimed that recovery is dramatically quicker after that procedure than after other methods of total hip arthroplasty^{1,8}. One report on the two-incision technique demonstrated rapid rehabilitation, with a quick return to activities of daily living and with a low rate of complications⁸. That report included a select subgroup comprising 100 (15.8%) of 538 patients from that surgeon's practice; the selected patients were substantially younger and were much more likely to be male than female as compared with the typical population of total hip arthroplasty patients. To date, however, there are limited data that directly compare two-incision total hip arthroplasty with another method of total hip arthroplasty in similar groups of patients managed with the same advanced anesthetic and rapid rehabilitation protocol⁹.

We designed a prospective randomized trial of two-incision total hip arthroplasty and mini-posterior-incision total hip arthroplasty to test the hypothesis that patients managed with two-incision total hip arthroplasty recover faster than those managed with mini-posterior-incision total hip arthroplasty. Specifically, we sought (1) to determine if patients recovered faster after two-incision total hip arthroplasty than after mini-posterior-incision total hip arthroplasty as measured on the basis of the attainment of functional milestones that reflect activities of daily living, (2) to determine if the clinical outcome after two-incision total hip arthroplasty was better than that after mini-posterior-incision total hip arthroplasty as measured with Short Form-12 (SF-12) scores, and (3) to evaluate the surgical complexity of two-incision total hip arthroplasty as compared with mini-posterior-incision total hip arthroplasty on the basis of the operative time and the prevalence of early complications.

Materials and Methods

Design

This randomized clinical trial was conducted from November 2004 through January 2006. Seventy-five consecutive patients with primary degenerative arthritis of the hip were identified as meeting the criteria, and seventy-two of those patients agreed to enroll in this trial (Fig. 1). All patients gave written informed consent to participate in the study, and the study was approved by our institutional review board. There was no advertisement for patient recruitment into the study, and no remuneration was offered to the patients for participation. To minimize any potential patient bias during the postoperative rehabilitation, each patient was told that both techniques had proved to be successful clinically, care was taken not to discuss the study hypothesis, and at no time were study data reviewed with patients prior to completion of the entire study.

Inclusion Criteria

The inclusion criteria were an age of twenty to eighty-five years and management with total hip arthroplasty for the treatment

of primary degenerative arthritis of the hip. The exclusion criteria were an age of less than twenty or more than eighty-five years; an inability or unwillingness to comply with the postoperative rehabilitation or follow-up protocols; severe bone deformity about the hip (such as Crowe type-III or IV dysplasia); osteomyelitis or a previous intra-articular infection of the hip joint; substantial neurologic or musculoskeletal disorders or diseases that would adversely affect gait or early weight-bearing after surgery; metastatic cancer; congenital, developmental, or other bone disease that would, in the surgeon's judgment, interfere with the survival of the total hip replacement; the presence of retained hardware around the hip; and arthrodesis of the affected hip.

Randomization and Blinding

After patients were enrolled, the randomization was carried out with use of a secure, web-based computerized process that was developed and implemented by our Department of Biostatistics, which dynamically balanced the groups on the basis of age, gender, and body mass index. Randomization was done after the surgeon had completed the preoperative examination and discussion with the patient. Both the patient and the surgeon were blinded with regard to the group assignment prior to surgery but not during or after the procedure. The study coordinator who collected the clinical data remained blinded to the group assignment throughout the follow-up period.

Surgical Technique

For the two-incision technique, the surgical approach involved a 6-cm anterior incision and dissection through the Smith-Petersen interval to expose the hip, to cut the femoral neck, and to prepare the socket¹. A second incision of 3.8 to 5 cm was then made in the buttock, and the abductors and external rotators were identified and were protected with use of a cannula, through which the reamers were placed. The femur was then reamed, and the femoral component was placed through that posterior incision. Intraoperative fluoroscopy was used routinely at key intervals throughout the procedure to verify acetabular reaming depth, acetabular component positioning, femoral alignment for reaming, femoral sizing, and femoral component positioning. Before beginning this study, the surgeon (M.W.P.) had been trained at a company-sponsored cadaveric training course (Zimmer Institute; Zimmer, Warsaw, Indiana) and had performed >100 total hip arthroplasties with the two-incision technique. The technique used in the present study followed that outlined in the company-sponsored training course.

For the mini-posterior-incision technique, the surgical approach involved a 7 to 9.5-cm incision along the posterior aspect of the femur, starting at the tip of the greater trochanter and proceeding distally¹⁰. The fascia of the gluteus maximus was split, and blunt dissection revealed the underlying abductor and external rotator musculature. The external rotators and the hip capsule were incised and preserved as one layer, with an attempt being made to preserve the insertion of the quadratus femoris on the femur. The hip was dislocated pos-

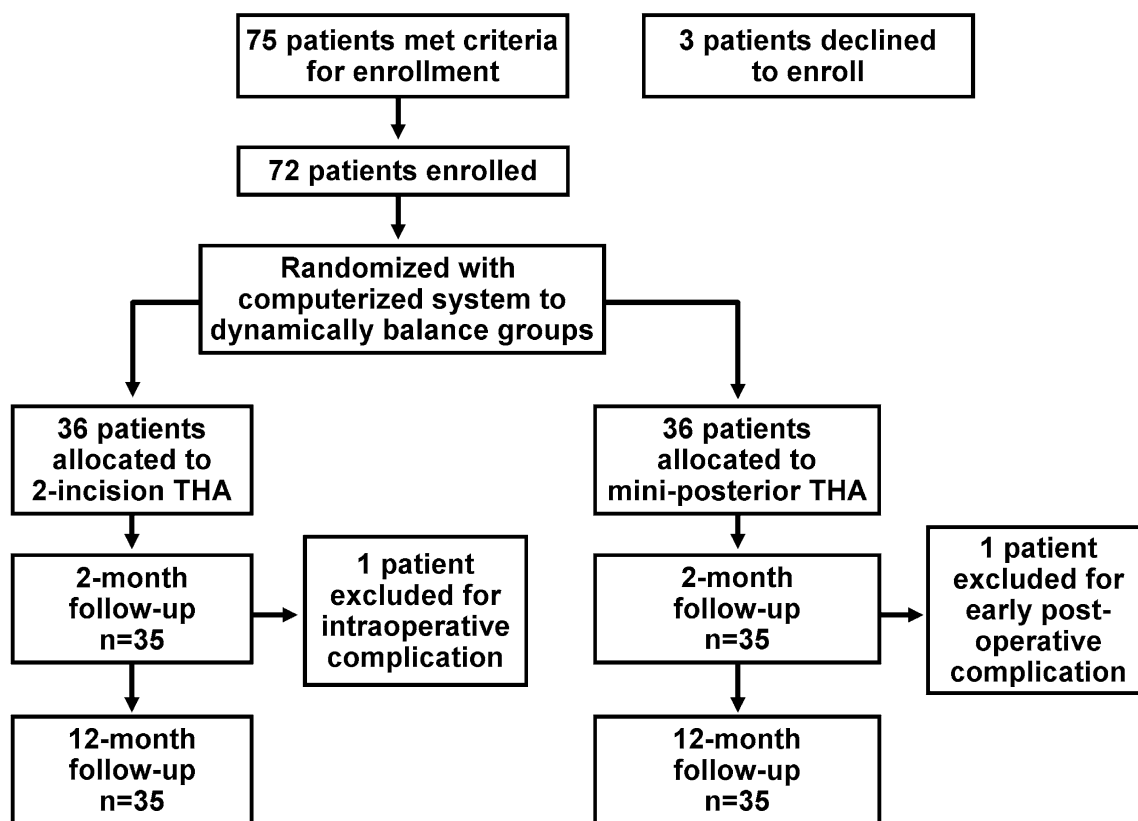


Fig. 1

Flowchart depicting the patient randomization procedure, treatment groups, and follow-up. THA = total hip arthroplasty.

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teriorly, and the femoral neck was cut in accordance with the preoperative plan. Acetabular retractors were positioned, the acetabulum was reamed, and the real acetabular component was placed. The hip was then flexed, and retractors were placed around the femoral neck to allow reaming, broaching, and trial insertion of the femoral component. The femoral component was then impacted into place, the femoral head was assembled, and the hip was reduced. The hip capsule and the external rotators were meticulously repaired back to the greater trochanter through three drill-holes with use of nonabsorbable sutures that were placed in a locking-looped fashion. Before the initiation of this study, the surgeon (M.W.P.) had performed >100 total hip arthroplasties with this mini-posterior technique.

Implant Selection

The same femoral component design (VerSys FullCoat; Zimmer, Warsaw, Indiana) and the same acetabular component design (Trilogy Modular Trabecular Metal; Zimmer) were used in every case. These fully porous-coated femoral components were prepared for a press-fit over a 4 to 5-cm segment of the femoral diaphysis and were prepared with 0.5 mm of underreaming relative to the stated size of the implant. These acetabular components with a porous-metal coating were reamed line-to-line with the stated size of the real implant and were

inserted without additional screws for fixation in all cases. The acetabular liners were all of a highly cross-linked polyethylene design (Longevity; Zimmer), and all had a flat liner without additional lips, buildup, or offset. The femoral head size was chosen on the basis of the size of the acetabular component according to a decision tree, with a 28-mm head being used for cup sizes of ≤ 48 mm; a 32-mm head being used for cup sizes of 50, 52, and 54 mm; and a 36-mm head being used for cup sizes of ≥ 56 mm.

Perioperative Management

All patients were managed with the same comprehensive multimodal anesthesia and analgesia protocol¹¹. Preoperatively, patients received 400 mg of a COX-II anti-inflammatory medication (Celebrex [celecoxib]; Pfizer, New York, NY) and 20 mg of a sustained-release oral opioid medication (OxyContin [oxycodone HCl sustained release]; Purdue Pharma, Stamford, Connecticut). An ipsilateral peripheral nerve block of the lumbar plexus was performed preoperatively, and an indwelling catheter was used to deliver local anesthetic for the first two nights after surgery (a 10-mL bolus of 0.2% bupivacaine at the time of entrance into the recovery room and then 0.2% bupivacaine at a rate of 10 mL/hr). The dosage was changed to a continuous infusion of 0.1% bupivacaine at a rate of 10 mL/hr at 6 A.M. on the day after surgery, and the in-

dwelling catheter was discontinued at 6 A.M. on the second postoperative day. A short-acting spinal anesthetic was administered intraoperatively, and supplemental intravenous sedation was used as needed for patient comfort. Postoperative analgesia was managed by a dedicated pain-management team with the goal of minimizing the use of parenteral opioid medications. Patients were given acetaminophen, a COX-II anti-inflammatory medication, and a sustained-release oral opioid on a schedule for the first forty-eight hours after surgery. For breakthrough pain, a short-acting oral opioid (oxycodone) was used on an as-needed basis. No patient-controlled-analgesia pumps or other parenteral opioid medications were used by any of the patients in the present study.

All patients were moved from bed to a chair on the day of surgery and began walking with weight-bearing as tolerated on the morning after surgery. Two sessions of supervised physical therapy were done on each day that the patient remained in the hospital. The patients were discharged from the hospital when they could move in and out of bed with minimal assistance, walk 100 ft (30.5 m) with a walker or crutches, walk up and down three stairs, and control their pain with oral medication. Traditional patient precautions to prevent total hip dislocations were not employed; the only warning was for the patients in the mini-posterior-incision group to avoid the combination of flexion of $>100^\circ$ combined with marked internal rotation of the hip. Otherwise, the patients were encouraged to proceed with activities as tolerated, allowing the hip symptoms to be their guide. Specifically, the patients were told that they did not need to feel as if the hip were fragile and that they were free to switch from the walker to a cane and then to get rid of the cane whenever they felt comfortable doing so. Return to driving was at the patient's discretion as long as the patient was not taking narcotic pain medication during the daytime. The safety of returning to driving at the patient's discretion has not been established.

Assessment of Early Functional Outcome

As has been done in other studies of minimally invasive total hip arthroplasty, early functional outcome was assessed by the attainment of functional milestones, including the time to discontinue a walker or crutches, the time to discontinue all walking aids, the time to carry out activities of daily living (defined as the time when the patient felt safe to be left at home all day with no additional help), the time to discontinue narcotic pain medication, the time to drive a car, the time to return to work, the time to ascend and descend stairs, and the time to walk one-half mile (0.8 km)^{8,9,12}. Care was taken to avoid setting specific expectations for when the patients might attain each functional milestone. Patients were simply and clearly instructed to proceed with activities as tolerated, letting the hip symptoms be their guide to activity. Patients were encouraged to discontinue the use of walking aids whenever they felt comfortable doing so. Each patient entered the data for the attainment of functional milestones in a diary that was subsequently collected at the two-month follow-up visit. Complete milestone functional follow-up data were obtained for each patient.

Assessment of General Health Outcome

General health outcome for each patient was assessed with the SF-12 score, a validated and widely used outcome measure with the ability to assess both physical and mental well-being¹³. Patient-completed SF-12 forms were collected preoperatively and at the time of follow-up visits two and twelve months after the total hip arthroplasty.

Assessment of Surgical Complexity

We sought to capture the surgical complexity associated with the two-incision technique by measuring the surgical time from incision to closure and by comparing the rates of early postoperative complications for the two techniques^{14,15}. Radiographs (including an anteroposterior radiograph of the pelvis, an anteroposterior radiograph of the hip, and a cross-table lateral radiograph of the hip) were made immediately postoperatively and at two months and one year postoperatively to look for complications such as an unrecognized femoral shaft or trochanteric fracture.

Statistical Methods

For statistical analysis, a *p* value of 0.05 was considered significant. The milestone functional outcomes and the SF-12 scores were assessed with use of the rank-sum test. A power analysis was performed on the basis of the milestone functional outcomes found in a previous study of the early results of two-incision total hip arthroplasty. In that study, the mean time to discontinue all walking aids (and standard deviation) was 14 ± 5.2 days, the mean time to climb stairs was 21 ± 7.1 days, and the mean time to walk one-half mile (0.8 km) was 40 ± 8.3 days. Assuming that similar variability would be observed in the current study, a sample size of twenty-six patients in each group would provide 80% power to detect a difference of 4.0 days in the time to discontinue all walking aids, a difference of 5.6 days in the time to climb stairs, and a difference of 6.6 days in the time to walk one-half mile (0.8 km). To account for the possibility of patients being lost to follow-up, we elected to enroll thirty-six patients in each group.

Results

Patient Characteristics

The two-incision group comprised thirty-six patients (twenty men and sixteen women) with a mean age of 67 ± 10.6 years, a mean body mass index of 28.7 ± 4.4 , and a mean preoperative hemoglobin level of 14.1 g/dL (141 g/L). The mini-posterior-incision group comprised thirty-six patients (twenty men and sixteen women) with a mean age of 66 ± 12 years, a mean body mass index of 30.2 ± 5.6 , and a mean preoperative hemoglobin level of 14.3 g/dL (143 g/L). There were no measurable differences in the demographic characteristics between the two groups. All patients who were enrolled in the study received the treatment as allocated, and no patient was lost to follow-up. One patient in each group had an early complication, and both of those patients were excluded from the analysis of early postoperative function.

TABLE I Time to Attain Postoperative Functional Milestones

Milestone	Time to Attain Milestone* (no. of days)		P Value
	Two-Incision Group	Mini-Posterior-Incision Group	
Discontinue walker/crutches	24 ± 21	14.5 ± 12	0.01†
Discontinue all walking aids	33 ± 20	24 ± 14	0.04†
Discontinue narcotic medication	15 ± 9	17 ± 16	0.75
Perform activities of daily living	15.5 ± 12	10 ± 11	0.02†
Climb stairs	9.5 ± 12	7.5 ± 7	0.60
Drive a car	31 ± 15	27 ± 13	0.38
Return to work	29.5 ± 18	31.5 ± 22	1.00
Walk one-half mile (0.8 km)	31 ± 19	28 ± 18	0.65

*The values are given as the mean and the standard deviation. †Significant.

Early Functional Outcome

Patients did not recover faster after two-incision total hip arthroplasty than after mini-posterior-incision total hip arthroplasty as measured by the attainment of functional milestones in the early postoperative period (Table I). The patients in the mini-posterior-incision group were more quickly able to return to daily activities ($p = 0.02$), to discontinue a walker or crutches ($p = 0.01$), and to discontinue all walking aids ($p = 0.04$) than were those in the two-incision group. The length of stay in the hospital was not different between the two groups, with a mean of 2.6 ± 1.1 days for the two-incision group and of 2.6 ± 1.2 days for the mini-posterior-incision group. The hemoglobin level at the time of hospital discharge was higher for the mini-posterior-incision group than for the two-incision group (11.36 ± 1.2 g/dL [114 ± 12 g/L] compared with 10.4 ± 1.1 g/dL [104 ± 11 g/L]; $p < 0.05$).

TABLE II SF-12 Scores

SF-12 Component	SF-12 Score* (points)		P Value
	Two-Incision Group	Mini-Posterior-Incision Group	
Preop.			
Physical score	30 ± 8.4	30 ± 7.2	0.99
Mental score	55 ± 11.8	55 ± 11	0.84
8 weeks			
Physical score	36.9 ± 10	39.8 ± 9	0.19
Mental score	56.4 ± 9.6	58.6 ± 7	0.39
1 year			
Physical score	41.3 ± 13.3	45.8 ± 10.9	0.24
Mental score	57.6 ± 5.7	56.7 ± 6.8	0.54

*The values are given as the mean and the standard deviation.

General Health Outcome

The clinical outcome as measured with the SF-12 scores was not better for the two-incision group than for the mini-posterior-incision group at either two months or one year postoperatively (Table II). The preoperative baseline scores were similar for both groups for both the physical component score ($p = 0.99$) and the mental component score ($p = 0.84$).

Surgical Complexity

The two-incision total hip arthroplasties were more complex surgical procedures than the mini-posterior incision total hip arthroplasties were as measured in terms of the mean operative time but not in terms of the rate of early complications. The mean total operative time from incision to closure was significantly greater for the two-incision group than for the mini-posterior-incision group (95.3 ± 29 minutes as compared with 71.6 ± 18 minutes; $p = 0.001$). The rate of substantial complications was the same in each group. One (2.8%) of the thirty-six patients in the two-incision group sustained an intra-operative femoral calcar fracture that was treated with a single cerclage wire. No change in postoperative management was made for that patient. One (2.8%) of the thirty-six patients in the mini-posterior-incision group fell and sustained a posterior dislocation at two weeks postoperatively. The dislocation was treated successfully with closed reduction.

Discussion

Over the past five years, minimally invasive total hip arthroplasty has generated substantial interest from patients and surgeons alike^{1-7,16}. While recent reports of modest outcomes and some substantial complications have tempered the initial enthusiasm for minimally invasive total hip arthroplasty, many such procedures continue to be performed^{9,14,15,17}. Driving much of that interest has been the early functional results reported after two-incision total hip arthroplasty in selected groups of patients^{2,8}. What has remained unclear, however, is what contribution the surgical technique makes to the

reported early improvements in pain and function and to what degree those observed differences are the result of patient selection, new anesthetic techniques, new postoperative pain-management methods, or new rapid rehabilitation protocols⁹. In the present prospective randomized study, we compared the two-incision technique with the mini-posterior-incision technique for minimally invasive total hip arthroplasty and used the same advanced anesthetic and pain-management protocols and the same rapid rehabilitation program in both groups. We found that patients who had a two-incision total hip arthroplasty recovered more slowly, had similar general health outcome scores, and had longer operative times in comparison with those who had a mini-posterior-incision total hip arthroplasty.

Our study had a few limitations. First, none of our patients had preoperative physical therapy to teach them how to walk with crutches or a walker, and this may have slowed their early progress as compared with patients in other series who were managed with a rapid rehabilitation protocol^{8,16}. Second, although we did not limit patient activities after surgery, we may not have urged the patients to return to activities as aggressively as has been done in other reports. Our patients were told to progress with activities as tolerated, to discontinue walking aids when they felt comfortable, and to wean themselves from oral pain medications as the pain subsided, but we did not suggest guidelines for when those events should occur. Other reports on the two-incision technique have noted that both physical therapists and patients were explicitly encouraged to advance activities as quickly as possible and that those patients were seen in the surgeon's office at one week, two weeks, six weeks, and twelve weeks after surgery^{1,8}. The close follow-up in those series may well have encouraged some otherwise reluctant patients to progress more quickly through some of the functional milestones. In the present study, a telephone call was made to all patients at two weeks postoperatively to check on their progress, but the first office visit was at eight weeks after surgery. Finally, all of the procedures in the present study were performed by a single, experienced total hip surgeon who had extensive training in the described techniques prior to the initiation of the study. Less experienced surgeons or those with limited access to additional training opportunities might achieve different results. Although these limitations may have affected the absolute time to attain the various functional milestones, it is unlikely that the limitations adversely impacted the relative difference in recovery times between the two techniques.

In the present study, patients who were managed with a two-incision arthroplasty had a slower recovery in comparison with those who were managed with a mini-posterior-incision total hip arthroplasty. That finding contrasts with the initial reports on the two-incision technique from the surgeon developers, who reported a substantially more rapid recovery^{1,2,8}. The early functional milestones in one study included a mean of six days to discontinue crutches and narcotics and to resume driving, eight days to return to work, nine days to discontinue all walking aids, ten days to resume activities of daily living, and sixteen days to walk one-half mile (0.8 km)⁸. Another

study included a retrospective matched-pair analysis of patients managed with two-incision or mini-posterior-incision total hip arthroplasty and demonstrated faster recovery after the two-incision procedure¹⁸. In that study, however, the authors noted that early differences in function may have been the results of hip precautions placed on the patients in the mini-posterior-incision group. Reports from other investigators have suggested less dramatic early functional outcomes after two-incision total hip arthroplasty, particularly when the technique was used in a broad group of typical total hip replacement patients^{9,12,15}. In one of those studies, the return of function was more modest, with discontinuation of the walker or crutches at fourteen days, discontinuation of the cane at twenty-eight days, discontinuation of narcotic pain medications at nine days, being independent with daily activities at fourteen days, driving at six weeks, and walking one-half mile (0.8 km) at eight weeks¹². Furthermore, in a retrospective review of twenty-six patients who underwent staged bilateral total hip arthroplasty with use of a two-incision technique on one side and a mini-posterior-incision technique on the other, more patients preferred the mini-posterior-incision side because the recovery after the mini-posterior-incision arthroplasty was easier or faster⁹. In the present study, the patients in the two-incision group had lower hemoglobin levels, by a mean of 1 g/dL [10 g/L], at the time of hospital discharge than did those in the mini-posterior-incision group. To what degree that small difference in hemoglobin levels accounted for differences in early postoperative function remains unclear.

The clinical outcome scores as measured with the SF-12 questionnaire were not different between the two groups preoperatively, at two months postoperatively, or at one year postoperatively. This finding is perhaps not surprising because the large improvement that is conferred by any type of total hip arthroplasty likely masks any subtle differences that could be attributed to changes in surgical technique. This represents the long-recognized problem of a so-called ceiling effect associated with many traditional measures of outcome after procedures that are very effective, such as total hip arthroplasty.

The two-incision technique was a more complex surgical procedure than the mini-posterior-incision technique as judged on the basis of the mean operative time (ninety-five compared with seventy-two minutes). These operative times are very similar to those that were reported in a recent retrospective matched-pair analysis in which the mean times for two-incision and mini-posterior-incision total hip arthroplasties were 93.7 and 61.7 minutes, respectively¹⁸. The technical demands of the two-incision technique have been well outlined in several previous reports^{12,14,15,17}. In the present series, the rate of substantial complications was relatively low and was the same in both groups (2.8%; one of thirty-six). This low rate of complications probably reflects the fact that the surgeon had already performed >100 two-incision total hip arthroplasties prior to initiating the trial.

In conclusion, this prospective randomized trial showed that patients who had had a two-incision total hip arthroplasty recovered more slowly than did patients who had had a mini-

posterior-incision total hip arthroplasty. The general health outcome measures, however, were similar at both two months and one year postoperatively. While both techniques were associated with a low rate of complications, the added surgical complexity of the two-incision technique, as reflected in substantially longer operative time, was not rewarded, and instead it was the patients in the mini-posterior-incision group who had the quicker recovery. ■

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