CLINICAL ORTHOPAEDICS AND RELATED RESEARCH
Number 453, pp. 160–167

THA Performed using Conventional and Navigated Tissue-preserving Techniques

Stephen B. Murphy, MD; Timo M. Ecker, MD; and Moritz Tannast, MD

Less invasive methods of performing total hip arthroplasty have been considered controversial after increased complication rates and component malpositioning were reported. A new method of performing total hip arthroplasty through an incision in the superior capsule, posterior to the abductors and anterior to the posterior capsule, was developed with the aim of producing a technique that maintained the joint stability of the transgluteal exposure and the rapid abductor recovery of the posterior exposure. We assessed the recovery and complications of this technique performed with surgical navigation. The study group was compared with similar subjects who had conventional total hip arthroplasty, without surgical navigation, using the transgluteal exposure. There were 185 consecutive total hip arthroplasties in the study group and 189 nonconsecutive historical total hip arthroplasties in the control group. The two groups were controlled for complexity and had no differences in body mass index, gender, diagnosis, operative side, bilateral operations, and previous surgeries. Patients were evaluated for clinical recovery and perioperative complications at 9 and 24 weeks. The study group recovered faster at both followup examinations. The study group had fewer perioperative and postoperative complications compared with the control group. Accuracy of component positioning was not compromised compared to the control group. Less invasive surgery with the philosophy of maximally preserving the abductors, posterior capsule, and short rotators may result in a safer operation with faster recovery than traditional techniques.

Level of Evidence: Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

From the Center for Computer Assisted and Reconstructive Surgery, New England Baptist Hospital, Tufts University School of Medicine, Boston, MA.
One or more of the authors has received funding from of the Swiss National Science Foundation (MT), and the Research Funding Awards Program of the New England Baptist Hospital (TME).
Each author certifies that his institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent was obtained.
Correspondence to: Stephen B. Murphy, MD, Center for Computer Assisted and Reconstructive Surgery, Tufts University School of Medicine, Harvard Medical School, 125 Parker Hill Avenue, Suite 545, Boston, MA 02120. Phone: 617-232-3040; Fax: 617-754-6436; E-mail: tecker@caregroup.harvard.edu.
DOI: 10.1097/01.blo.0000246539.57198.29

Conventional total hip arthroplasty (THA) in its many forms has been well established as a reliable procedure with predictable recovery. Less invasive surgical techniques have become more become popular, but without a strong scientific foundation. Most early reports document increased perioperative complications compared with established techniques.[2,5,21,23,24] Reported complications have included increased incidence of femur fracture, cup malpositioning, dislocation, infection, abductor morbidity, and nerve palsy.[17] Less invasive techniques vary widely with regard to the tissue intervals chosen, and these choices largely determine the most common complications. Methods that provide insufficient exposure of the proximal femur and abductors can produce abductor injury, femur fracture, or femoral component malpositioning.[1,10,18] Methods that involve traction during surgery apply stress to the lower leg and make trial reduction more difficult. These approaches may cause ankle fracture or in some cases hip instability due to inadequate assessment of tissue tension, stability, and impingement during surgery.[11] Additionally, anterior exposures may limit access along the axis of the femur, preventing the use of axial reaming and necessitating the use of curved rather than canal-filling stems. These techniques may also risk injury to the anterior gluteus medius, the gluteus minimus, and the lateral femoral cutaneous nerve.[5,8,9] Lastly, the use of the posterior exposure through a smaller incision may still result in hip instability, with the added risk of cup malposition or sciatic nerve injury.[23]

We describe a new method of performing total hip arthroplasty intended to maximally preserve the soft tissues surrounding the hip. The technique was developed with very specific criteria. These criteria include: the exposure can be easily transitioned into a conventional exposure; the implants can be inserted without touching the skin; the abductor muscles can be visualized and protected; the posterior capsule is not released and the capsule can be repaired; a trial reduction can be performed; osteophytes can be visualized and removed as necessary; and the femur can be reamed axially. The technique involves inserting the femoral and acetabular components anterior to the posterior capsule and short rotators and posterior to the gluteus medius and minimus through an incision in the superior capsule.[15,16]

Compared to a traditional approach, we asked whether this new approach would result in faster functional recovery, lower complication rates, and similar component positioning.

MATERIALS AND METHODS

We prospectively evaluated 185 hips in 157 patients treated using a tissue-preserving technique through a superior capsulotomy exposure (study group) compared to a nonconsecutive historical prospectively followed control group of 189 hips in 150 patients who were treated with a modified transgluteal exposure (Table 1). The 189 conventional THAs were performed between January 1996 and January 2003. From January 2003 until August 2003 the senior author (SBM) performed THA through a conventional approach with the assistance of surgical navigation. All the procedures performed during this interval were excluded because they did not meet the definition of conventional THA due to the use of navigation. The superior capsulotomy technique was introduced in August 2003, and the 185 hips in the study group started with the first procedure. To have study groups of equal complexity, 19 of the 208 earlier consecutive control patients were excluded because their procedures were considered inappropriate for the superior capsulotomy technique. Of those nineteen hips, 12 had previous pelvic or femoral osteotomies with or without residing hardware, four had deformities too severe to use the superior capsulotomy technique, one had a previous vascularized fibula and hardware, and two had previous open reduction and internal fixation (ORIF) with hardware. This left a total of 189 hips in the control group of similar complexity to the 185 hips in the study group. Institutional review board approval for the study was obtained. Patients were informed and agreed to participate in the study.

We documented demographic data including age, gender, height, weight, body mass index (BMI), preoperative diagnosis, preoperative Merle d'Aubigné hip score, and previous surgeries (Table 1). There were no differences between the study and control groups with regard to patient gender, BMI, operative side, number of patients with bilateral procedures, diagnosis, height, number of previous operations, and preoperative Merle

TABLE 1. Demographic Data

Parameter	Study Group (n = 185)	Control Group (n = 189)	p Value
Total number of hips	185	189	
Age (years)	56.1 ± 12.2 (range, 19–85)	50.4 ± 11.9 (range, 21–78)	< 0.05
Gender (male/female/percent male)	98/87/52.97	94/95/49.7	0.3
Side (left/right/percent right)	84/101/54.6	94/99/50.3	0.231
Bilateral hips (number/percent bilateral)	28/15.1	39/20.6	0.11
Preoperative diagnosis			
Osteoarthritis	146 (78.92%)	121 (64.02%)	0.115
Dysplasia	25 (13.51%)	49 (25.93%)	
Osteonecrosis	7 (3.78%)	7 (3.7%)	
LCPD	1 (0.54%)	1 (0.53%)	
Posttraumatic OA	2 (1.08%)	5 (3.17%)	
Rheumatoid arthritis	3 (1.62%)	1 (0.53%)	
SCFE	1 (0.54%)	4 (2.12%)	
Height (cm)	172 ± 10.3 (range, 145–193)	171 ± 10.8 (range, 142–198)	0.567
Weight (kg)	80.8 ± 17.9 (range, 36.4–129.5)	83.7 ± 20.3 (range, 45.5–136.4)	0.179
Body mass index (kg/m^2)	27.4 ± 5.1 (range, 17.3–42.7)	28.4 ± 5.7 (range, 18.3–49.9)	0.077
Number of hips with previous surgery	9 (4.9%)	12 (6.3%)	0.345
Pelvic osteotomy	1	1	
Trochanteric osteotomy	1	2	
ORIF	3	3	
Core decompression	2	—	
Shelf procedure	1	1	
Surgical dislocation	—	2	
SCFE pinning	1	—	
Other	—	3	
Preoperative Merle d'Aubigné score	10.9 ± 1.7 (range, 5–15)	11.1 ± 1.6 (range, 6–15)	0.120

LCPD = Legg-Calvé-Perthes Disease; OA = osteoarthritis; ORIF = open reduction internal fixation; SCFE = slipped capital femoral epiphysis d'Aubigné scores (Table 1). Patients in the study group were older ($p < 0.05$) (Table 1).

The operative technique for the study group was a tissue-preserving THA using a superior capsulotomy exposure.[15,16] All procedures in both groups were performed by the same surgeon (SBM). The patient was placed in a lateral position (Fig 1A). Most of the surgery was performed with the hip flexed 45°, fully adducted, and internally rotated 15° with the foot on a Mayo stand. The incision was made proximal to the greater trochanter, typically 6 to 8 cm long, in line with the long axis of the femur (Fig 1B). After spreading the gluteus maximus fibers, the posterior border of the gluteus medius was identified and reflected anteriorly (Fig 1C). The piriformis was identified and incised at its insertion. The posterior border of the minimus then was mobilized anteriorly enough to expose the superior hip joint capsule (Fig 1D). The posterior capsule and short external rotators were left intact. An incision was made in the superior capsule from the trochanteric fossa to the acetabular rim. The anterior capsule was tagged and incised along the acetabular rim for a distance of approximately 15 mm (Fig 1E). Blunt Hohmann retractors were placed inside the capsule around the anterior and posterior femoral neck (Fig 1F). The femur was reamed through the superior neck and the superior portion of the neck was excised to allow broaches to fully prepare the femur (Fig 1G). With the femoral broach in place, reference frames for surgical navigation using optical tracking were percutaneously affixed. The neck was then transected with the broach in place using the broach as an intraosseous neck-resection guide (Fig 1H), and the femoral head was excised using a Schanz screw (Fig 1I) and a slap-hammer (Fig 1J). Data were input to accurately register the pelvis relative to a three-dimensional computed tomography (CT) dataset. The socket was then reamed (Fig 1K), and the acetabular component was implanted using angled instruments with the assistance of CT-based surgical navigation (Fig 1L). At least one trial reduction was performed and any osteophytes were excised as necessary. The superior capsule was closed after implanting the components.

The operative technique for the control group was a transgluteal exposure in the lateral position and was performed without surgical navigation. The anterior ⅓ of the medius, entire minimus, and anterior ½ of the hip joint capsule were reflected anteriorly with a thin bony wafer of the anterior part of the greater trochanter. The procedure was then performed in a conventional manner by dislocating the hip, excising the femoral head, preparing and inserting the acetabular component with straight instruments, and then preparing and inserting the femoral component with straight instruments. After implantation, the superior capsule was closed and the abductors were repaired with simple and horizontal mattress transosseous sutures. We used a variety of bearing surface materials and implant sizes for both groups (Table 2).

No changes in anesthesia or postoperative pain control were instituted during the study, but the rehabilitation between the two groups differed. Both groups were allowed to progress their hip motion as tolerated without restriction. Patients treated with the transgluteal exposure used two crutches with 50% weightbearing for 6 weeks and were cautioned against abduction against gravity or progression to full weightbearing until at least 6 weeks post-

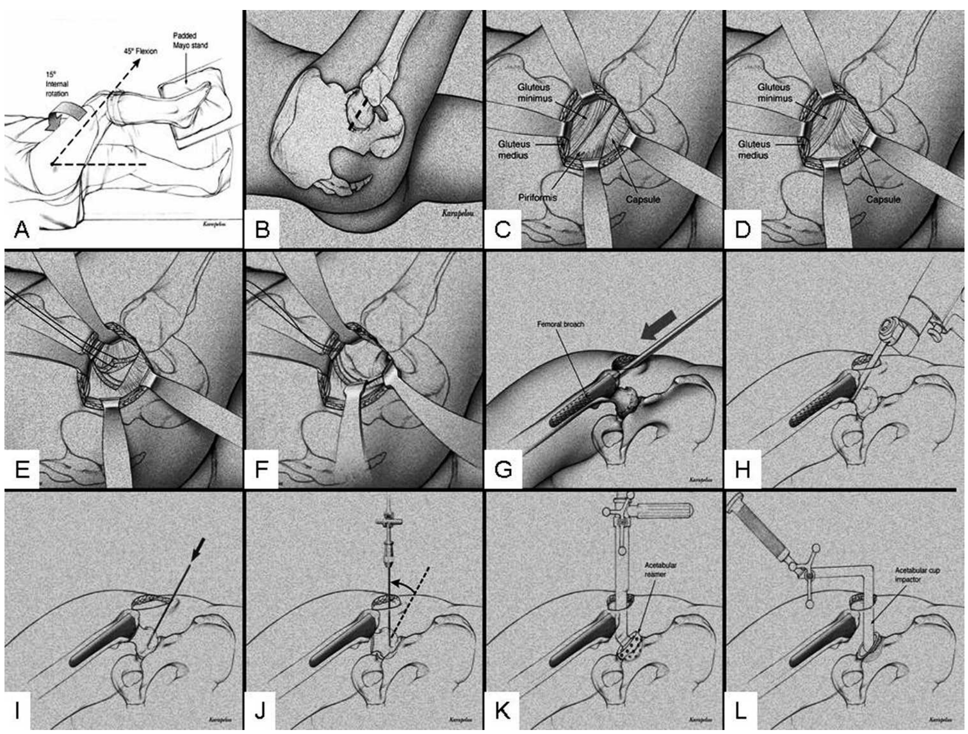

Fig 1A–L. A comprehensive demonstration of the surgical steps of the superior capsulotomy technique is shown.

TABLE 2. Implant Types and Sizes

Implant Properties	Study Group (n = 185)	Control Group (n = 189)
Head/liner combination		
Al-Ceramic-Ceramic	168 (90.81%)	107 (56.16%)
Ceramic (Zirconia)	—	55 (29.1%)
CoCr-Polyethylene	16 (8.65%)	22 (11.64%)
CoCr-CoCr	1 (0.54%)	5 (2.65%)
Head sizes (mm)		
22	—	10 (5.29%)
26	—	36 (19.1%)
28	39 (21.08%)	63 (33.3%)
32	146 (78.92%)	80 (42.3%)
Cup sizes (mm)		
46	9 (4.86%)	20 (10.58%)
48	25 (13.51%)	24 (12.7%)
50	2 (1.08%)	11 (5.82%)
52	67 (36.22%)	53 (28.04%)
54	38 (20.54%)	39 (20.63%)
56	21 (11.35%)	30 (15.87%)
58	19 (10.27%)	10 (5.29%)
60	2 (1.08%)	2 (1.06%)
62	2 (1.08%)	—
Femoral component		
EON®*	2 (1.1%)	4 (2.1%)
Perfecta®†	94 (50.8%)	110 (58.2%)
S-ROM®‡	—	1 (0.5%)
Profemur® Renaissance†	89 (48.1%)	—
Stability‡	—	74 (39.2%)

*Stryker Orthopaedics, Mahwah, NJ
†Wright Medical Technology, Arlington, TN
‡Depuy, Warsaw, IN

operatively to protect the abductor repair. Patients treated with the superior capsulotomy exposure were allowed to progress to full weightbearing as tolerated.

Both groups were evaluated with identical standardized hip function questionnaires, examination parameters, and radiographic views preoperatively and postoperatively. All patients completed the hip questionnaires at each visit that included information about pain and functional status and were evaluated clinically by the operating surgeon (SBM). Postoperative visits 1.4 to 9 weeks after surgery were included in the first followup analysis, and visits from 9 to 24 weeks were included in the second followup analysis. As a measure of functional recovery we calculated Merle d'Aubigné hip scores[12] at each visit. We also documented the duration of hospital stay and the disposition after discharge to home or rehabilitation facilities. Projected acetabular cup abduction was measured on a postoperative anteroposterior (AP) pelvic radiograph with the interteardrop line as a horizontal reference by one examiner (MT) blinded to the study group. We defined outliers as having projected abduction angles under 30° and over 50°. Patients were screened for the occurrence of complications as part of our secondary aim.

We used Fisher's exact test to analyze nominal data between the study and control groups. Continuous data between the groups were analyzed with nonparametric Mann-Whitney U tests. The standard deviation (SD) of the cup abduction angles between the two groups were calculated with the F test. Significance was set at the $p < 0.05$ level.

RESULTS

Patients in the study group showed faster recovery and return to good hip function than patients in the control group. This was reflected in better ($p < 0.0001$) postoperative Merle d'Aubigné hip scores at the first followup at similar mean times up to nine weeks for the study group compared with the control group (Fig 2). The Merle d'Aubigné hip score improvement was also greater ($p = 0.0047$) at the second followup (Fig 2).

The mean duration of surgery for unilateral THA for the two groups was similar (Table 4) when patients undergoing bilateral THR in one session were excluded. When comparing the last 50 procedures in both groups, the mean duration in the study group was shorter ($p = 0.003$) than the control group (138.8 ± 18.5, range 90 to 202 minutes versus 161.9 ± 44.4, range, 97–250, respectively). Patients in the study group had higher ($p = 0.0009$) amounts of autologous whole blood transfused than patients in the control group. There was no difference in the volume of packed red blood cells transfused (Table 4). When comparing the last 50 procedures in both groups, there was no longer a difference in whole blood or cells transfused (Table 4). There were no differences in length of hospital stay and the percentage of patients discharged home after hospitalization (Table 3).

Patients in the both groups had accurate acetabular component positioning. The mean cup adduction was

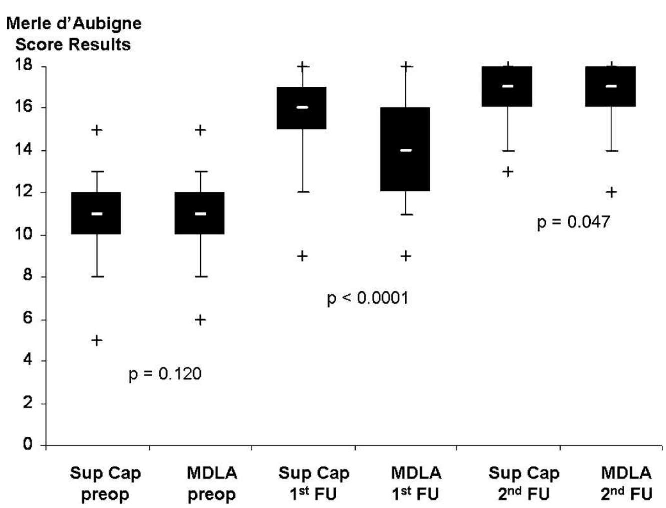

Fig 2. A box and whisker plot shows accelerated recovery at the first and second followup examinations for the study group versus the control group.

TABLE 3. Radiographical, Clinical, and Recovery Data

Parameter	Study Group (n = 185)	Control Group (n = 189)	p Value
Incision length (cm)	7.88 ± 1.56 (range, 5.5–16)	Not measured	
Cup abduction (degrees)	43.3 ± 3.4 (35–52)	41.6 ± 5 (26–59)	0.001
Abduction outliers (number/percent)	4/2.16	10/5.3	0.08
Standard deviation cup abduction	3.4	5	0.001
Length of stay (days)	4.0 ± 1.2 (range, 2–11)	4.1 ± 1.5 (range, 2–11)	0.550
Disposition (percent home)	81.8	82.5	0.495
Merle d'Aubigné score (preoperative)	10.9 ± 1.7 (range, 5–15)	11.1 ± 1.6 (range, 6–15)	0.120
Time of first followup (weeks)	6.1 ± 1.3 (range, 2.3–8.9)	6.3 ± 1 (range, 1.4–8.9)	0.09
Merle d'Aubigné score (first followup)	15.5 ± 1.7 (range, 9–18)	14.2 ± 2.3 (range, 9–18)	< 0.0001
Time of second follow up (weeks)	15.1 ± 2.6 (range, 9.4–24)	14.8 ± 2.8 (range, 10.7–24)	0.05
Merle d'Aubigné score (second followup)	16.9 ± 1.2 (range, 13–18)	16.5 ± 1.5 (range, 12–18)	0.0047
Complications	3 (1.6%)	10 (5.29%)	0.045
Intraoperative cup dislocation	1	—	
Intraoperative greater trochanteric fracture	1	1	
Postoperative greater trochanteric fracture	—	2	
Trochanteric wafer non-reunion	—	4	
Incision and drainage for acute infection	—	1	
Incision and drainage for suspected infection w/o infection in situ	—	1	
Acute Dislocation	1	1	

43.3° in the study group and 41.6° in the control group (41.6°) (Table 3). The SD in cup abduction angle was smaller (p = 0.001) in the study group (3.4°) compared with the control group (5°). There were similar numbers of abduction outliers in the study group (2.2%) and in the control group (5.3%).

The overall complication rate was lower (p = 0.045) in the study group when compared to the control group. Three patients (1.6%) in the study group and 10 in the control group (5.29%) had complications develop. Fewer (p = 0.09) patients in the study group underwent revision surgery as compared to the control group (two patients

TABLE 4. Surgical Time and Blood Replacement Therapy

Parameter	Study Group (n = 185)	Control Group (n = 189)	p Value
Blood Replacement (mL)			
Autologous whole blood	379 ± 382 (range 0–1350)	279 ± 434 (range, 0–2250)	0.0009
Red blood cells	166 ± 286 (range 0–1500)	173 ± 325 (range, 0–1500)	0.286
Blood replacement in last 50 hips (mL)			
Autologous whole blood	306 ± 369 (range, 0–900)	252 ± 354 (range, 0–900)	0.432
Red blood cells	155 ± 271 (range, 0–1000)	82.5 ± 195 (range, 0–50)	0.112
Surgery time (minutes)	176.8 ± 47.2 (range, 74–348)	177.7 ± 52.4 (range, 90–335)	0.91
Surgery time last 50 hips (minutes)	138.8 ± 18.5 (range, 90–202)	161.9 ± 44.4 (range, 97–250)	0.003

[1.08%] patients versus seven patients [3.7%]). There were three complications in the study group. One patient had an intraoperative greater trochanteric fracture treated at the time of surgery. One patient had displacement of the acetabular component recognized immediately postoperatively; the malpositioning was immediately corrected with another surgery. One patient had an acute dislocation immediately after surgery because the femoral implant was impacted more deeply than the trial. This patient was treated by immediate arthrotomy with exchange of the modular prosthetic femoral neck to a longer one. Subsequently, repeat trial reduction was always performed after insertion of the femoral prosthesis. Of the 10 complications in the control group, four patients had trochanteric wafer nonunions of which two underwent surgical repair, one patient had an intraoperative greater trochanteric fracture fixed during surgery, two patients sustained postoperative greater trochanteric fractures treated by internal fixation, one patient underwent incision and drainage for acute deep infection, and one patient underwent incision and drainage for suspected infection but with negative cultures. One patient was revised for acute dislocation.

DISCUSSION

Total hip arthroplasty in its many conventional forms is extremely reliable with low complication rates. Still, conventional THA has disadvantages, leaving potential opportunity for improvement in THA technique. Efforts to develop less invasive approaches are numerous. Performing THA through smaller incisions or through more tissue-preserving intervals may not always be an advantage. Perioperative and postoperative complications associated with minimally invasive THA have been reported.[1,10] Even if most patients treated by less invasive techniques recover faster, the benefits may be outweighed if there is even a small increase in complications. The method of performing total hip arthroplasty through a superior capsulotomy was developed with the desired goals of accelerating recovery while simultaneously maintaining or improving component positioning and complication rates. The results of this study demonstrate THA performed through a superior capsulotomy and with surgical navigation results in accelerated recovery and more consistent acetabular component positioning than conventional THR performed using a transgluteal exposure. Further, the incidence of complication was substantially reduced as compared to the conventional technique.

We note several limitations to our study design. The study group was only compared to a control group treated by a transgluteal exposure and not other approaches. This exposure requires mobilization and repair of the abductors.[3,20] These procedures have the consequence that early full weightbearing cannot be allowed without risking abductor injury, trochanteric non-reunion, and its associated consequences. Comparison of the study group to patients treated with other techniques, especially to a group of patients treated with a posterior exposure, might have resulted in smaller differences in recovery because it is likely patients treated by a posterior exposure would recover more quickly than those treated by a transgluteal exposure. However, none of the patients in the study or the control groups had incision of the posterior capsule. This allowed for unrestricted progression of motion in all patients. Generally, most surgeons who perform the posterior exposure, whether through a smaller or larger incision, and with or without posterior repair, recommend against unrestricted progression of motion immediately after surgery.[14,22,25] Thus, the comparison to a posterior exposure control group would be of great interest, but likely would have differed from the study group regarding the postoperative rehabilitation regimen. The study and control groups differed in their postoperative rehabilitation regimen since protection of the abductors was recommended for six weeks following the transgluteal exposure. Even with this protection, abductor complications were the most common complications in the control group. Therefore, it is unlikely removal of abductor restrictions in the control group would have led to improved results. Another limitation of our study is the control group was not a consecutive series: some patients treated by the transgluteal exposure were excluded from the control group because they were considered too complex to have been treated using the superior capsulotomy. This was done to ensure, as well as possible, that the two groups included hips of equal complexity. The study is also limited by the fact that the preoperative and postoperative physical examinations were performed by the operating surgeon (SBM), which introduces the potential for evaluation bias. However, most parameters were answered by patients or measured by one or more independent observers (TME, MT), which served to minimize the bias. The two parameters most open to interpretation would be ROM and postoperative limp. However, we did not find a difference in ROM in the two groups. Because the use of walking aids was defined by the patient, introduction of bias regarding limp would likely have little effect on our findings. Lastly, the study is limited because only one observer performed analysis of the radiographs. Such analysis does not allow for the inherent interobserver variations in measuring data on radiographs.

Protecting the abductors, posterior capsule, and short rotators as much as possible is a reasonable goal of tissue-preserving surgery. Performing THA while minimizing the adverse affects on these structures undoubtedly results in a more technically challenging procedure. However, we found THA performed through a superior capsulotomy with surgical navigation accelerated recovery while reducing the incidence of complications compared with a conventional transgluteal exposure without surgical navigation.

Our results are reflected in the current literature about minimal invasive surgery. Jerosch et al[7] reported promising results using an anterolateral mini-incision and Mont et al,[13] although investigating resurfacing procedures, showed better 3-month Harris Hip scores in patients with less invasive methods. The analysis of operative time data showed the mean operative times for computer-assisted THA using a superior capsulotomy were similar to those of the control group, even though the operative times for the study group include patients treated while the technique was being developed and before technique-specific instruments were designed. It is also encouraging the more recent procedures in the study group, performed with procedure-specific instruments, were performed in less time than those in the control group. This finding is of particular importance because the procedures in the study group included the additional time required for fixation of reference frames and establishment of coordinate systems. This finding also reflects the transgluteal exposure requires time to properly establish and repair the abductor interval.

Patients in the study group were transfused higher volumes of autologous whole blood than patients in the control group (Table 4). As noted with operative time, blood replacement was not greater in the more recently treated patients in the study group as compared to the control group, again possibly related to increasing experience and that procedure-specific instruments were used.

That the length of stay and disposition of patients is not altered suggests many perioperative factors contribute to length of stay. We did not attempt to change perioperative variables other than surgical technique. Our finding that a change in surgical technique alone did not alter length of stay or disposition supports Hou and Parvizi's[6] conclusion that these parameters are not a function of incision size but rather primarily a function of nonsurgical variables.

Both of our groups had acceptable acetabular component abduction angles with low standard deviations. This suggests THA can be performed with a tissue-preserving technique without compromising accuracy of component positioning. However, it is likely the use of surgical navigation contributed to the cup position accuracy in the study group. We do not have data to show similarly good results of cup position would result using the superior capsulotomy without navigation. Thus we cannot confirm the findings of Hart et al[4] and Rittmeister and Peters[19] who reported the risk for component malpositioning was not greater when using a less invasive approach in the absence of navigation.

That the overall complication rate in the study group was lower than in the control group is encouraging, especially considering the data included patients from the start of the learning and development curves. However, this finding may have as much to do with the high abductor complication rate of the transgluteal exposure as with the low complication rate of the superior capsulotomy.

The study group had the surgery performed with the femoral component instrumented before femoral neck osteotomy and femoral head removal. This technique has several advantages compared with traditional THA. First, the femur remained steady during the femoral instrumentation. Second, leverage retractors around the neck were easy to hold to maintain exposure. Third, the femur may be stronger with the head and neck intact as opposed to broaching against a freshly cut femoral neck, where crack initiation and propagation may be more likely. Additional possible advantages include that the hip is never disarticulated during the surgery and that the leg is never placed outside of the range of motion envelope of the normal hip. Both of these factors may reduce unnecessary tissue trauma associated with more mobilization of the surrounding tissues. Whether these aspects of the procedure have any beneficial affects is not known.

Despite the promising results, the superior capsulotomy technique is not adequate for every patient. We performed this procedure in some, but not all hips that had prior pelvic and femoral surgery for severe developmental dysplasia. In addition, we did not perform this procedure on patients with retained hardware. We recommend against using the superior capsulotomy technique for more complex cases until substantial experience with the technique is developed. The exposure to the acetabulum is straight down from lateral to medial, which makes the insertion of screws more difficult than insertion of the cup, particularly in morbidly obese patients.

The goal of the surgical technique was to provide a method of performing total hip arthroplasty with the limited abductor morbidity of the posterior exposure and the stability of the transgluteal exposure. This preliminary study suggests this goal is being achieved. Our findings suggest that, compared to one method of performing conventional THA, total hip arthroplasty performed through the superior capsulotomy interval, with surgical navigation, can accelerate recovery while reducing the incidence of perioperative complications and maintaining accuracy of component positioning.

Acknowledgments

The authors acknowledge the Swiss National Foundation and the New England Baptist Research Funding Awards Program.

References

1. Bal BS, Haltom D, Aleto T, Barrett M. Early complications of primary total hip replacement performed with a two-incision minimally invasive technique. *J Bone Joint Surg Am*. 2005;87: 2432–2438.
2. Berry DJ, Berger RA, Callaghan JJ, Dorr LD, Duwelius PJ, Hartzband MA, Lieberman JR, Mears DC. Minimally invasive total hip arthroplasty. Development, early results, and a critical analysis: presented at the Annual Meeting of the American Orthopaedic Association, Charleston, South California, USA, June 14, 2003. *J Bone Joint Surg Am*. 2003;85:2235–2246.
3. Gore D, Murray P, Sepic S, Gardner G. Anterolateral compared to posterior approach in total hip arthroplasty: difference in component positioning, hip strength, and hip motion. *Clin Orthop Relat Res*. 1982;165:180–187.
4. Hart R, Stipcak V, Janecek M, Visna P. Component position following total hip arthroplasty through a miniinvasive posterolateral approach. *Acta Orthop Belg*. 2005;71:60–64.
5. Hartzband MA. MIS THA: the New Jersey experience & how to choose. *Proceedings MIS meets CAOS, April 16–17, Pittsburgh, PA*. 2004;159–174.
6. Huo MH, Parvizi J, Gilbert NF. What's new in hip arthroplasty. *J Bone Joint Surg Am*. 2006;88:2100–2113.
7. Jerosch J, Theising C, Fadel ME. Antero-lateral minimal invasive (ALMI) approach for total hip arthroplasty technique and early results. *Arch Orthop Trauma Surg*. 2006;126:164–173.
8. Kennon RE, Keggi JM, Wetmore RS, Zatorski LE, Huo MH, Keggi KJ. Total hip arthroplasty through a minmally invasive anterior surgical approach. *J Bone Joint Surg Am*. 2003;85(Suppl 4):39–48.
9. Light TR, Keggi KJ. Anterior approach to hip arthroplasty. *Clin Orthop Relat Res*. 1980;152:255–260.
10. Mardones R, Pagnano MW, Nemanich JP, Trousdale RT. The Frank Stinchfield Award: muscle damage after total hip arthroplasty done with the two-incision and mini-posterior techniques. *Clin Orthop Relat Res*. 2005;441:63–67.
11. Matta JM, Shahrdar C, Ferguson T. Single-incision anterior approach for total hip arthroplasty on an orthopaedic table. *Clin Orthop Relat Res*. 2005;441:115–124.
12. Merle d'Aubigné R, Postel M. Functional results of hip arthroplasty with acrylic prosthesis. *J Bone Joint Surg Am*. 1954;36:451–475.
13. Mont MA, Ragland PS, Marker D. Resurfacing hip arthroplasty: comparison of a minimally invasive versus standard approach. *Clin Orthop Relat Res*. 2005;441:125–131.
14. Morrey BF. Instability after total hip arthroplasty. *Orthop Clin North Am*. 1992;23:237–248.
15. Murphy SB. Technique of tissue-preserving minimally-invasive total hip arthroplasty using a superior capsulotomy. *Oper Techn Orthop.* 2004;12:94–101.
16. Murphy SB. Tissue-preserving, minimally invasive total hip arthroplasty using a superior capsulotomy. In: Hozak W, ed. *Minimally Invasive Total Hip and Knee Arthroplasty*. New York: Springer Verlag; 2004:102–107.
17. Nemanich JP, Mardones RM, Pagnano MW, Trousdale RT. Abductor muscle damage during minimally invasive total hip arthroplasty: one-incision versus two-incision surgical technique: a cadaveric study. *Presented at the summer meeting of the Hip Society, October 7–9, 2004, Santa Fe, NM*.
18. Pagnano MW, Leone J, Lewallen DG, Hanssen AD. Two-incision THA had modest outcomes and some substantial complications. *Clin Orthop Relat Res*. 2005;441:86–90.
19. Rittmeister M, Peters A. Comparison of total hip arthroplasty via a posterior mini-incision versus a classic anterolateral approach. *Orthopade*. 2006;35:716–722.
20. Roberts JM, Fu FH, McCain EJ, Ferguson AB. A comparison of posterolateral and anterolateral approaches to total hip arthroplasty. *Clin Orthop Relat Res*. 1984;187:205–210.
21. Waldman BJ. Minimally invasive total hip replacement and perioperative management. *J South Orthop Assoc*. 2002;11:213–217.
22. Weeden SH, Paprosky WG, Bowling JW. The early dislocation rate in primary total hip arthroplasty following the posterior approach with posterior soft-tissue repair. *J Arthroplasty*. 2003;18:709–713.
23. Wenz JF, Gurkan I, Jibodh SR. Mini-incision total hip arthroplasty: a comparative assessment of perioperative outcomes. *Orthopedics*. 2002;25:1031–1043.
24. Woolson ST, Mow CS, Syquia JF, Lannin JV, Schurman DJ. Comparison of primary total hip replacement with a standard incision or a mini-incision. *J Bone Joint Surg Am*. 2004;86:1353–1358.
25. Wright JM, Crockett HC, Delgado S, Lyman S, Madsen M, Sculco TP. Mini-incision for total hip arthroplasty: a prospective, controlled investigation with 5-year follow-up evaluation. *J Arthroplasty*. 2004;19:538–545.