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Total Hip Arthroplasty Performed Using Conventional and Computer-Assisted, Tissue-Preserving Techniques[6]

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Introduction

Less invasive techniques in total hip arthroplasty have been associated with higher peri- and postoperative complication rates, including increased incidences of femur fracture, cup malposition, dislocation, infection, abductor morbidity, and nerve palsy[1,5]. With the goal of addressing these issues, a technique of tissue-preserving, computer-assisted THA was developed with the specific goals of maximally preserving the soft tissue surrounding the hip joint and protecting the abductor musculature during surgery. The technique involves inserting both the femoral and acetabular components anterior to the posterior capsule and short rotators and posterior to the gluteus medius and minimus[2,3]. The technique was designed to easily incorporate surgical navigation into the procedure.

The current study prospectively compares recovery and perioperative complications of a consecutive series of THA performed using a transgluteal exposure without surgical navigation to a consecutive series of THA performed using a superior capsulotomy with surgical navigation.

Materials and Methods

185 consecutive computer-assisted THA performed using a tissue-preserving technique through a superior capsulotomy (study group) were prospectively compared to 189 THA performed using a modified transgluteal exposure without computer-assistance (control group). Cases were carefully reviewed to exclude any cases that were too complex to have been performed using the superior capsulotomy technique.

Both groups were studied prospectively using the same standardized hip function questionnaires, the same examination parameters, and the same radiographic views, pre-operatively, and at each visit post-operatively. These evaluations were performed pre-operatively and at the first and second visits post-operatively. Post-operative visits that occurred at up to 9 weeks following surgery were included in the 1st follow-up visit analysis. Post-operative visits that occurred from 9 to 24 weeks were included in the 2nd follow-up visit analysis. The Merle d'Aubigné hip score[4] was calculated for each patient at each visit. The acetabular cup abduction was measured on a postoperative AP pelvic radiograph with the interteardrop line as a horizontal reference by one single examiner blinded to the study group. OR time and blood replacement therapy was compared.

Results

Demographic data

There was no statistically significant difference in the demographic parameters between the groups, except that patients in the study group were significantly older (table 1)

Clinical and radiographic results

Clinical and radiographic results are shown in Table 2. Mean first follow up was at 6.1 weeks for the study group and 6.3 weeks for the control group ($p = 0.09$). Mean second follow up was 15.1 weeks for the study group and 14.8 weeks for the control group ($p = 0.05$).

The mean cup abduction angle was 43.3° for the study group and 41.6° for the control group (Table 2). The difference was statistically different ($p = 0.001$). Further, the standard deviation in cup abduction was 3.4 for the study group and 5.0 for the control group. The smaller standard deviation in the study group was also statistically different ($p = 0.001$).

Assessment post-operatively demonstrated a statistically significant improvement in the Merle d'Aubigné hip score at the 1st follow up visit for the study group as compared to the control group. Moreover the Merle d'Aubigné hip score at the 2nd follow-up remained statistically significantly higher for the study group than the control group (figure 1).

The mean duration of surgery for unilateral THA for the two groups was not significantly different ($p = 0.91$), (Table 4). Patients undergoing bilateral THR in one session were excluded from the calculation. When comparing the last 50 procedures in both groups, the mean duration in the study group was even significantly 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 were transfused significantly higher amounts of autologous whole blood than patients in the control group. There was no significant difference in the volume of packed red blood cells transfused. When comparing the last 50 procedures in both groups, there was no longer a significant difference in whole blood or cells transfused (table 3).

Complications

There were 3 surgical complications (1.6 %) in the study group and 10 in the control group (5.29 %). This lower incidence of surgical complications for the tissue-preserving group was not statistically significant ($p = 0.045$). Two patients (1.08 %) had to be reoperated in the study group, 7 patients (3.7%) needed reoperation in the control group. This difference was not statistically significant ($p = 0.09$).

Discussion

The technique of total hip arthroplasty using a superior capsulotomy is designed to maximally preserve the soft-tissues around the hip, particularly the abductors, posterior capsule, and short external rotators. Thus the patients are allowed to progress motion after surgery without restriction. Since the technique does not involve splitting the abductors and allows for straight, canal-filling stems to be inserted, the patients are allowed to progress their weight bearing as tolerated. The patients treated by the superior capsulotomy technique experienced a faster recovery than the control group and this difference was remained at 3 months following surgery. The study also demonstrates that, contrary to prior reports on "minimally invasive" hip surgery, cup position was more reliable (statistically significantly smaller standard deviation) through the small incision using computer-assistance that it was using a larger incision without computer-assistance. While the complication and reoperation rate in the study group was lower than in the control group, these findings were not statistically significant. However, it is clear that, contrary to previous studies, the complication rate and reoperation rate following total hip arthroplasty using a superior capsulotomy and computer-assistance was not higher than with conventional total hip arthroplasty. The analysis of operative time data is interesting in that the mean operative times for computer-assisted THR using a superior capsulotomy are not statistically significantly different compared to the operative times 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 further encouraging that the more recent procedures in the study group, performed with procedure-specific instruments, were performed in significantly less time than those in the control group. This finding is of particular note since 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 fact that the transgluteal exposure requires time to properly establish and repair the abductor interval.

Patients in the study group were transfused significantly higher volumes of autologous whole blood than patients in the control group (table 3). As noted with operative time, blood replacement was not significantly more in the more recently operated patients in the study group as compared to the control group, again possibly related to increasing experience and particularly to the fact that procedure-specific instruments were being used.

While it has yet to be proven that this technique can be safely taught and produce the same results at other medical centers, the current study demonstrates the potential that less invasive, tissue-preserving techniques, combined with surgical navigation, can simultaneously accelerate recovery, while maintaining accuracy and reducing the incidence of perioperative complications.

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 %)	21 (64.02 %)	
Dysplasia	25 (13.51 %)	49 (25.93 %)	
Osteonecrosis	7 (3.78 %)	7 (3.7 %)	0.115
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	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

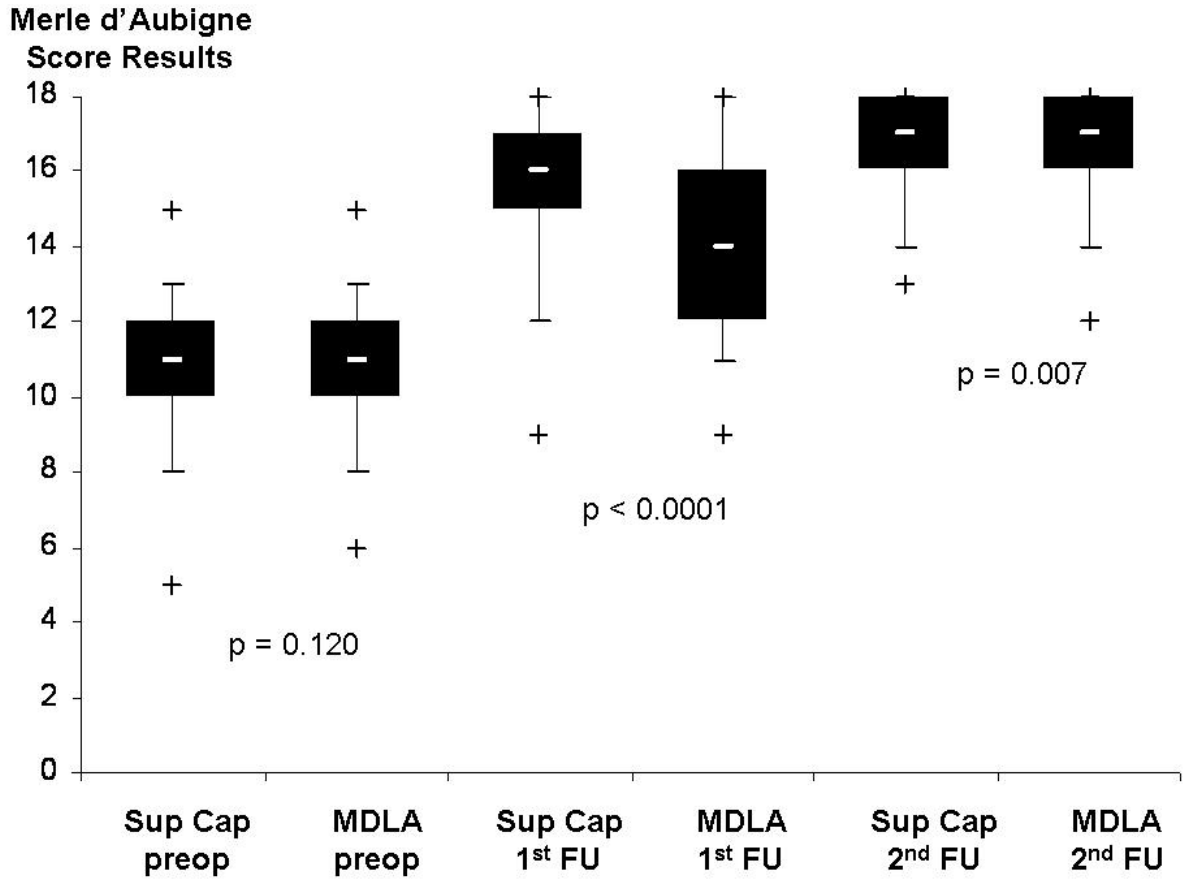
Table 2: Clinical and Radiographic Followup Data

Parameter	Study Group (n=185)	Control Group (n=189)	p Value
Incision length (cm)	7.88 ± 1.56 (range, 5.5-16.0)	Not measured	
Cup abduction (°)	43.3 ± 3.4 (35–52)	41.6 ± 5.0 (26–59)	**0.001**
Abduction outliers (number / percent)	4 / 2.16	10 / 5.3	0.08
Standard deviation cup abduction	3.4	5.0	**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	6.1 ± 1.3 (range, 2.3 – 8.9)	6.3 ± 1.0 (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	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)	**0.007**
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 nonreunion	-	4	
Incision and drainage for acute infection	-	1	
Incision and drainage for suspected infection w/o infection in situ	-	1	
Acute Dislocation	1	1	

Table 3: OR 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 – 750)	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**

Figure 1: Improvement of the Merle d' Aubigne Score



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