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Original research

Direct anterior versus mini-anterolateral approach for primary total hip arthroplasty: early postoperative outcomes and complications

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ABSTRACT

Background: Anterior-based approaches to primary total hip arthroplasty (THA) are being used more frequently, and several variations have been described. The supine direct anterior (DA) approach has been widely studied, but few studies have compared it with the mini-anterolateral (mini-AL) approach (abductor-sparing, Watson-Jones approach) in the lateral decubitus position. This study aims to compare early perioperative complications and outcomes between these 2 approaches.

Methods: This study retrospectively reviewed 340 consecutive THAs (n = 170 DA, n = 170 mini-AL) performed by 3 arthroplasty surgeons at a single institution between January 2017 and May 2018. The primary outcome was reoperation for any reason within 1 year. Secondary outcomes included wound-healing complications and several perioperative factors. A Student's *t*-test was used for continuous variables, and a chi-squared test was used for categorical variables.

Results: In this cohort, 6 patients (4%) from the mini-AL group required reoperation within 1 year, compared with 2 patients (1%) from the DA group ($P = .024$). However, the DA group had 13 patients (8%) with wound-healing complications compared with 6 patients (4%) in the mini-AL group 4% ($P = .036$). Perioperative outcomes were similar for operative time, distance walked with physical therapy, morphine milligram equivalent consumed, length of stay, and discharge disposition. Pain scores during index hospitalization were also similar.

Conclusions: Patients who underwent THA using the supine DA approach had fewer reoperations within 1 year, but more wound-healing complications compared with the mini-AL approach in the lateral decubitus position. For surgeons performing primary THA using an anterior-based approach, relative risks and benefits of these approaches must be understood.

Level of Evidence: Level III.

Introduction

Total hip arthroplasty (THA) is a common orthopaedic procedure with projections for increasing demand in the future [1]. Despite generally excellent results, there is room for improvement in outcomes after THA. One area of frequent debate in the literature is the optimal surgical approach for THA, with an increasing emphasis placed on minimally invasive approaches to help decrease recovery time.

Approaches to the hip can be divided between those that approach the joint from the anterior or posterior side of the greater trochanter. Surgical approaches posterior to the trochanter, such as the posterolateral, Moore, or Southern approach have the advantage of sparing the abductor attachment, but also have a higher dislocation rate [2]. Approaching the hip from the anterior side of the trochanter more traditionally involved taking down some part of the abductor attachment, as seen in the direct lateral (Hardinge) and anterolateral (Watson-Jones) approaches. More recently, surgical approaches anterior to the trochanter have been developed which spare the abductor musculature and utilize intermuscular planes. The most popular of these approaches in the United States is the direct anterior (DA) approach, popularized by Matta which utilizes the Heuter interval to approach the hip capsule through the internervous plane between the sartorius and tensor fascia lata [3]. An alternative anterior approach which utilizes the Watson-Jones interval without taking down any abductor attachment was initially

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described by Rottinger [4], and has gone by several different names—Rottinger, modified or mini Watson-Jones, anterolateral minimally invasive, and anterior-based muscle sparing [4-6]. Patient positioning for this approach may be either in the supine position or the lateral decubitus position, Rottinger's original description was in the lateral decubitus position [4]. For the sake of simplicity, we will refer to this as the mini-anterolateral (mini-AL) approach for the remainder of this text.

There have been multiple publications detailing the benefits and complications of THA performed through the DA approach and several small studies detailing the results of those performed through the mini-AL approach. One theoretical advantage of the mini-AL approach over the DA approach is that its more lateral location may avoid meralgia paresthetica related to lateral femoral cutaneous nerve injury; a downside is that it is not an internervous plane, and therefore has limited extension, particularly proximally. However, to date, there have been no studies comparing the postoperative outcomes of these 2 increasingly popular total hip approaches. The purpose of this study is to directly compare early outcomes and incidence of complications in a comparative cohort of patients after THA performed through the DA and mini-AL approaches.

Material and methods

We retrospectively reviewed 340 matched patients who underwent primary, elective THA at a single urban arthroplasty center between January 2017 and May 2018. A study flow diagram is displayed in Table 1. The cases were divided based on approach into 2 groups, 170 patients who underwent THA with a DA approach and 170 patients with a mini-AL approach. Inclusion criteria were any primary THA performed via the DA or AL approach. Revision arthroplasties and those performed by any other approach were excluded. Baseline demographics were recorded, including age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, and preoperative diagnosis (Table 2). All the cases were performed by one of 3 senior fellowship-trained arthroplasty surgeons who were all past their learning curves for their respective approaches. The choice of approach was selected by each surgeon for each individual patient based on patient factors such as BMI, age, and sex. This study was approved by the local institutional review board.

All patients received the same course of treatment including preoperative patient education and discharge planning, spinal anesthesia, inpatient physical therapy, and appropriate disposition based on progress postoperatively. Pain control measures preoperatively and postoperatively were standardized except in cases where patient factors led to contraindications, such as patients unable to tolerate nonsteroidal anti-inflammatories. Overall, the only difference in care between the 2 cohorts was the surgical approach to THA. A single surgeon utilized the DA approach, performed in a supine position on a standard operating room table with the use of fluoroscopy. Two surgeons utilized the mini-AL approach, performed in the lateral decubitus position without fluoroscopy. Each surgeon used their implants of choice for each case.

The primary outcome was reoperation for any reason within 1 year. Secondary outcomes were wound-healing complications, as well as perioperative factors including operative time, distance walked with physical therapy (PT) on each postoperative day (POD), patient-reported visual analog scale (VAS) pain scores, opioid consumption as measured in morphine milligram equivalents, hospital length of stay, and discharge disposition. A preliminary data set showed a difference in reoperation rate of 6.2%. A power analysis for the primary outcome of reoperation within 1 year revealed that to have 80% power with $\alpha = 0.05$, 160 patients in each cohort (320 total) would be needed, to assure adequate power and allow for the possibility of incomplete records, 170 patients from each cohort (340 total) were included in the analysis.

A paired Student's *t*-test was used for continuous variables and chi-square test or Fisher's exact test was used for categorical variables. All statistical analyses were performed using SPSS version 24.0 (SPSS, Chicago, IL). Statistical significance was set a priori to $P < .05$.

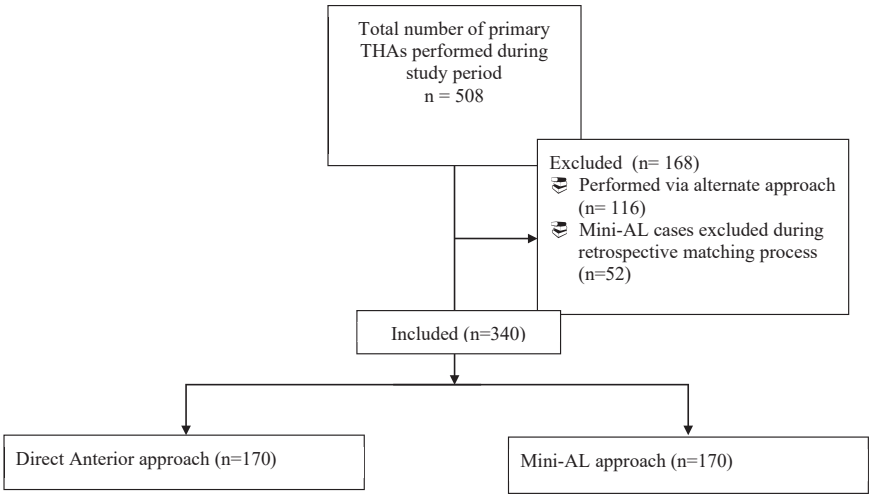
Source of funding

No additional funding was sought or received to conduct this project.

Results

We identified 340 patients who underwent THA over the study period through one of the 2 approaches. The DA cohort consisted of 170 patients, 94 (55.2%) were female with mean age 60.4 ± 14.6

Table 1
Study flow diagram.



years, mean ASA score of 2.2 ± 0.5. The mini-AL cohort consisted of 170 matched patients, 90 (52.9%) were female with mean age 61.6 ± 12.1 years, and mean ASA score of 2.2 ± 0.5. Osteoarthritis was the most common diagnosis in both groups representing 79.4% and 84.1% in the DA and mini-AL approach, respectively. There was a small, but statistically significant difference between BMI between groups, with the DA group having a slightly higher BMI (28.1 ± 5.2 kg/m^2) vs the mini-AL group (26.9 ± 5.3 kg/m^2) ($P = .036$). There were no other significant differences in baseline demographics between the 2 groups (Table 2).

In total, 8 (2.4%) patients required reoperation within 1 year of index surgery, comprising 2 (1.1%) patients from the DA group and 6 (3.5%) patients from the mini-AL group ($P = .02$). The reoperations in the DA group were 1 patient with a superficial suture reaction and continued drainage 4 weeks postoperatively. He was treated with a superficial irrigation and debridement and closed with an incisional vac and went on to heal uneventfully. The second was a patient with an acute deep periprosthetic joint infection due to staphylococcal species requiring a 1-stage revision of components on POD 41 (6 weeks). The reoperations in the mini-AL group consisted of 3 revisions for aseptic femoral loosening on POD 63 (2 months), 196 (6.5 months), and 324 (11 months); 1 complex revision after a fall resulting in a medial wall acetabular fracture on POD 35 (1 month); 1 revision due to periprosthetic femur fracture on POD 18 (2 weeks); and 1 revised on POD 126 (4 months) due to instability. Thirteen (7.6%) patients in the DA and 6 (3.5%) patients in the mini-AL group had minor incisional complications within the postoperative period ($P = .04$). One of those wound complications from the DA group had to return to the operating room for a superficial incision and debridement as mentioned previously, but none of the wound complications in the mini-AL group required reoperation (Table 3). There were no documented cases of meralgia paresthetica or implant-related intraoperative complications in either cohort.

Perioperative outcomes were similar between the DA group and the mini-AL groups in terms of operative time (108.8 ± 29.3 vs 104.4 ± 25.4 minutes, $P = .15$), hospital length of stay (2.0 ± 1.0 vs 2.1 ± 1.3 days, $P = .34$), and discharge disposition, with 149 (87.6%) patients in the DA group being discharged to home, compared with 155 (91.2%) patients in the mini-AL group ($P = .34$) (Table 4).

There were no differences in distance ambulated with PT on any POD comparing the DA group to the mini-AL group. In addition, there was no difference in opioid consumption in morphine milligram equivalents on each POD or during the index hospitalization between the DA and mini-AL group. There was a statistically significant difference in patient-reported VAS pain scores on POD 0 and POD 2, showing higher scores in the DA group compared with the mini-AL group (POD 0: 3.3 ± 2.9 vs 2.6 ± 2.7, $P = .04$; POD 2: 3.3 ± 2.6 vs 2.4 ± 2.3, $P = .03$). There was no difference in VAS pain scores on POD 1 (3.2 ± 2.7 vs 2.8 ± 2.4, $P = .17$) and on POD 3 (3.4 ± 3.2 vs 2.4 ± 2.1, $P = .15$) (Table 4).

Table 2
Patient demographics.

Patient factors	DA group N = 170, mean ± SD	Mini-AL group N = 170, mean ± SD	*P* value
Age (y)	60.4 ± 14.6	61.6 ± 12.1	.43
Sex			
Male (%)	76 (45%)	80 (47%)	
Female (%)	94 (55%)	90 (53%)	.33
BMI (kg/m^2)	28.1 ± 5.2	26.9 ± 5.3	.036[a]
ASA score	2.2 ± 0.5	2.2 ± 0.5	.60
Preoperative diagnosis			
OA	135 (79%)	143 (84%)	
Other	35 (21%)	27 (16%)	.39

[a] Statistical significance ($P < .05$).

Table 3
Postoperative complications.

Complication	DA group, n (%)	Mini-AL group, n (%)	*P* value
Wound healing complications			
Yes	13 (7.6%)	6 (3.5%)	
No	157 (92.4%)	164 (96.5%)	.036[a]
Reoperation			
Yes	2 (1.1%)	6 (3.5%)	.024[a]
No	168 (98.9%)	164 (96.5%)	
Reason for reoperation			
Superficial wound infection	1 (0.6%)		
Deep periprosthetic joint infection	1 (0.6%)		
Instability		1 (0.6%)	
Periprosthetic femur fracture		1 (0.6%)	
Periprosthetic acetabular fracture		1 (0.6%)	
Femoral stem loosening/subsidence		3 (1.8%)	

[a] Statistical significance ($P < .05$).

Discussion

Minimally invasive approaches to THA have become increasingly important to patients and surgeons alike. In 2007, 52% of patients seeking a joint replacement reported having heard some type of advertisement about an implant or approach to be used [7]. Over 70% of patients who have heard of the direct anterior approach believe it is the best approach for THA because they perceive that it causes less pain and less muscle damage [8]. Surgeons also promote anterior approach THA, as a review of American Association of Hip and Knee Surgeons members found that 22.8% have websites touting the benefits of anterior approach hip replacements [9].

Most of this increased popularity has centered on the DA approach, and there continues to be evidence to show it has advantages compared with direct lateral and posterior approaches to the hip. The DA approach has been shown to both minimize muscle damage and lead to faster return to function [10-12]. However, the direct anterior approach is not without disadvantages, as problems with femoral preparation, meralgia paresthetica, and wound complications have been reported [13-16].

Table 4
Perioperative outcomes.

Perioperative outcome	DA group, mean ± SD	Mini-AL group, mean ± SD	*P* value
Operative time (min)	108.8 ± 29.3	104.4 ± 25.4	.15
Length of stay (d)	2.0 ± 1.0	2.1 ± 1.3	.34
Discharge disposition			
Home (%)	149 (88%)	155 (91%)	
Rehabilitation institution (%)	21 (12%)	15 (9%)	.34
VAS pain scores			
POD 0	3.3 ± 2.9	2.6 ± 2.7	.043[a]
POD 1	3.2 ± 2.7	2.8 ± 2.4	.17
POD 2	3.3 ± 2.6	2.4 ± 2.3	.029[a]
POD 3	3.4 ± 3.2	2.4 ± 2.1	.15
Distance ambulated with PT (ft)			
POD 0	117.9 ± 125.6	113.6 ± 101.2	.77
POD 1	416.7 ± 312.2	424.2 ± 279.2	.82
POD 2	386.3 ± 305.0	355.5 ± 324.7	.52
POD 3	111.1 ± 90.9	129.0 ± 216.4	.690
Morphine milligram equivalents (mg)			
POD 0	35.5 ± 24.1	35.4 ± 50.8	.97
POD 1	41.3 ± 35.8	38.1 ± 55.0	.53
POD 2	17.9 ± 32.3	14.4 ± 55.6	.48
POD 3	7.4 ± 24.7	7.2 ± 50.9	.95
Total	105.4 ± 103.8	99.9 ± 250.0	.79

[a] Statistical significance ($P < .05$).

It has been suggested that because the mini-AL approach also utilizes an intermuscular interval anterior to the greater trochanter and does not violate the abductor tendon attachment, it provides the same benefits of the DA approach [17]. However, there has been little functional data published on the mini-AL approach to date. Past research has focused primarily on comparisons to more invasive traditional approaches and has found mixed results. Martin et al. [18] compared the mini-AL approach to the Hardinge approach and found no difference in patient outcomes at 1 year. Mandereau et al. [19] examined a series of 103 hip replacements performed through the mini-AL approach and found reliably placed acetabular components but an 8.7% complication rate with most complications involving femoral preparation. Delanois et al. [20] compared patients who had hip replacements from the mini-AL and Hardinge approach and found no difference in outcomes.

There is one study to date which directly compares the mini-AL to the DA approach for THA but only reports on postural control and balance. Van Driessche et al. examined the postural control of 15 patients from a DA group, 15 patients from a mini-AL group, and 15 patients from a posterolateral group, and found that the posterolateral approach patients had better postural control at 2 months postoperatively, but reported no data on functional outcomes or complications [21].

In the present study, the mini-AL approach appears to be as effective as the DA approach in promoting early return to function, allowing patients to ambulate with PT immediately postoperatively, expediting discharge from the hospital, and discharging patients home rather than to rehabilitation institutions. Furthermore, with the current opioid crisis, avoidance of narcotics is important, and the mini-AL approach was similar to the DA approach in terms of opioid consumption during inpatient hospitalization. Both cohorts were managed with neuraxial anesthesia and also had a multimodal non-narcotic analgesic protocol used as well, allowing for low narcotic consumption. There were few advantages of the mini-AL approach compared with the DA approach in terms of pain on POD 0 and POD 2, but these findings likely do not reflect a clinically important difference.

We did, however, observe a higher rate of reoperation in the mini-AL group compared with the DA group at 1 year. There were 6 reoperations in the first year in the mini-AL group, all requiring revision of components compared with 2 reoperations in the DA group, one of which was a superficial irrigation and debridement only. Of the revisions in the mini-AL group, there were 3 for femoral subsidence or aseptic loosening, one for periprosthetic acetabular fracture and dislocation, one for instability, and one for periprosthetic femur fracture, summing to an overall revision rate of 3.5%. Although this rate of revision is lower than the rate of revision with the mini-AL approach as reported by Mandereau et al. [19], both demonstrate that there is increased risk of complication on the femoral side with the mini-AL approach. The difference in revision for femoral sided complications between these 2 approaches may be attributable to the use of fluoroscopy with the DA approach as the mini-AL surgeons did not use fluoroscopy in this study.

By using intraoperative fluoroscopy, the surgeon can ensure appropriate sizing and positioning of components [22,23]. By not utilizing this side because of having patients in the lateral decubitus position, the mini-AL cohort may have suffered from very slight malpositioning of the acetabular and femoral components, which may explain the higher rate of revision in that cohort, especially the 3 cases of femoral subsidence and 1 case of instability that were avoided in the DA cohort because of the fact that fluoroscopy was used in those cases.

Difficulty preparing the femur from the DA approach has been well established in the literature. Perforation, fracture, and femoral stem subsidence have all been shown to be more common from a DA approach [13,15]. Interestingly, we did not see any femoral complications in our DA cohort. These findings could be related to the difference in learning curves with the 2 approaches. Although all 3 surgeons in this present study were beyond their initial learning curve, before the start of our study, the DA approach surgeon had performed over 500 THAs via the DA approach, whereas the 2 mini-AL surgeons had performed approximately 100 cases each. Although all were experienced in their respective approaches, the DA surgeon's additional experience may have played a factor in avoiding femoral-sided complications in that cohort. This data may corroborate the suggestion by Mandereau et al. [19] that femoral-sided complications are more common and a learning curve may exist with the mini-AL approach. In addition, technical differences such as operative time, soft tissue handling, femoral exposure and preparation, and other facets of the case may predispose one group to complications compared with the other. More research in larger patient groups with longer follow-up is necessary to further explore this possibility.

Wound healing issues have similarly been a well-reported complication with the DA approach, and this study supports that. Cooper et al. found that obesity and diabetes are associated with an increased risk of developing a wound complication with the DA approach [16]. There has been no data specifically looking at the wound complications from the mini-AL approach. In this study, there were 6 patients in the mini-AL group who had wound healing problems (3.5%) which were all managed nonoperatively with eventual healing of the wound. In the DA group, there were 13 patients (7.6%) with wound healing problems, one of which required a repeat operation. Despite these superficial wound healing complications, only 1 patient in the entire study (0.3%) was found to have a deep periprosthetic joint infection. The difference in wound healing complications between these 2 approaches may be attributable to the location of the incision, as the cohorts were similar in terms of wound-healing risk factors such as DM and the average BMI of each cohort was below 30. In the experience of the senior authors, the incision for the mini-AL approach is typically 2-4 cm more lateral, and therefore further away from the abdominal pannus and groin crease, than the incision routinely used for the DA approach.

There are several weaknesses in the present study. First, this being a retrospective study, there are inherent weaknesses in its design that a randomized, prospective study may have avoided. However, baseline patient characteristics were similar between groups and all surgeries were performed at the same center with the same perioperative protocols, education, and follow-up. Given its retrospective nature, the data are also limited to what is documented in the patient charts. Although no instances of meralgia paresthetica were documented, we suspect this is due to underdocumentation, and find it plausible that there could be examples of injury to the lateral femoral cutaneous nerve in either or both cohorts that were not captured here. The next weakness is the length of follow-up—we have shown outcomes of the DA and mini-AL approaches only over the course of the inpatient stay, and complications only for the first year postoperatively. Following up these patients over time would be helpful and is a planned extension of this study. However, many of the wound healing issues occur during the first weeks after surgery and would be captured with this follow-up. Finally, although this study represents the largest number of mini-AL approach patients studied to date, its strength is still limited by the number of subjects. Larger, multicenter studies comparing these 2 approaches will have to be performed to further elucidate the risks and benefits of each. As a result of this investigation, the AL surgeons at our institution have now altered their techniques to position the patient supine on the operating room table and use fluoroscopic assistance to improve on visualization, implant sizing, and positioning. A follow-up study is planned to re-evaluate reoperation rate using this protocol.

Conclusions

This study demonstrates that primary THA performed using either the DA or mini-AL approach is safe and effective with low complication and reoperation rates within 1 year. When compared with the DA approach, the mini-AL approach exhibited a higher reoperation rate, but lower rate of wound healing complications. There were no clinically significant differences in perioperative outcomes or discharge disposition during index hospitalization. Based on these findings, arthroplasty surgeons may consider the mini-AL approach as a viable anteriorly-based approach for THA, offering the similar benefits of decreased pain and early return of function that are commonly cited as benefits of the DA approach. However, caution must be taken, especially if performing the mini-AL approach without the use of fluoroscopy, as revision rate was higher in the mini-AL group compared with the DA group. For surgeons seeking to perform primary THA via an anterior-based approach, relative risks and benefits of these approaches must be understood.

Conflict of interest

H. John Cooper, MD Speakers bureau/paid presentations for KCI; Paid consultant for Depuy – Johnson & Johnson Company, KCI Medical Canada, KCI USA, OnPoint Knee, Zimmer – Biomet; Research support from KCI, Smith & Nephew; Medical/Orthopaedic publications editorial/governing board for JOA, JBJS; Board member/committee appointments for AAOS. Roshan P. Shah, MD, Paid consultant for Link Orthopaedics. Jeffrey Geller, MD, reports royalties from Smith & Nephew Speakers bureau/paid presentations for Smith & Nephew Paid consultant for Smith & Nephew Research support from Orthopaedic Scientific Research Foundation, Orthosensor, Smith & Nephew; Medical/Orthopaedic publications editorial/governing board for CORR, JOA, JBJS.

All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2020.02.009

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