

THE DIRECT ANTERIOR APPROACH CAN BE SAFELY ADOPTED FOR TOTAL HIP REPLACEMENT IN A DEVELOPING COUNTRY SETTING: PERSPECTIVES FROM A TERTIARY ACADEMIC HOSPITAL IN AFRICA

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ABSTRACT

Background: The Direct Anterior Approach (DAA) is a muscle sparing technique for Total Hip Arthroplasty (THA) with reports showing superior early outcomes. It is the fastest growing surgical approach to the hip in Western countries and adoption is growing throughout the world. The DAA has a steep learning curve and adoption is commonly associated with increased risk of complications.

Objective: The purpose of this study was to determine the safety of the DAA by focusing on complications associated with its introduction in a tertiary academic hospital in Africa.

Design: A retrospective review.

Methods: Two hundred and sixty four THA cases done through the DAA from 1st January 2016 up to 31st December 2019 were reviewed. Demographic data was sourced from a database of all joint replacements performed in the unit. Complications were reported from patients clinical records as well as clinical audits.

Results: A total of 24 complications were documented. Early complications (<4 weeks) included seven intra-operative femoral fractures (3%), three acetabular fractures (1%), six femoral nerve palsies (2%), two superficial surgical site infections (1%) and one dislocation (0.4%) that required component revision. There were five prosthetic joint infections (three acute and two late). The overall complication rate was 9%, 13% amongst consultants and 7% amongst fellows. The odds of having complications were 2% greater for consultants (CI: 0.86-4.65). There was a steady decline in complications with increasing experience for both consultants and fellows, 41.7% complication rate for the first ten DAAs, 33.1% for the next ten cases, 16.7% for the subsequent ten cases and 8.3% between cases 31 and 40.

Conclusion: The study highlights that the DAA can be safely introduced in a teaching hospital setting with a staff complement with varying levels of experience. The risk of complications decreases with DAA experience irrespective of the level of orthopaedic experience of the surgeon.

Key words: Direct anterior approach, Complications, Academic hospital

INTRODUCTION

The Total Hip Arthroplasty (THA) is one of the most successful surgical procedures and has been dubbed the procedure of the century (1). With a satisfaction rate between 85-93% , this has become one of the most commonly performed procedures in orthopaedic surgery (2). Multiple surgical approaches have been described for THA, including the lateral approach, posterior approach and their modifications (3). The anterior approach was initially described by Hueter in 1885 and is currently the fastest growing approach for total hip replacement

(4,5). The anterior approach we have adopted is a modification of the Hueter approach, the Anterior Minimally Invasive Surgery (AMIS) approach as described by Laude (6). The AMIS is a truly muscle sparing approach and utilizes the interval between the tensor fascia lata and the sartorius muscles to access the hip joint. Within the sartorial fascia lies the lateral femoral cutaneous nerve and by sweeping the medial side of the sartorius muscle laterally, the nerve is moved from harms way. Deep dissection is carried out into the interval between the tensor fascia lata and the rectus femoris. At this stage, branches of the anterior circumflex arteriovenous

bundle come into view and must be ligated. Beyond this point, the joint capsule is reached and incised to present the hip joint.

The Direct Anterior Approach (DAA) has been associated with better early pain scores and early functional outcomes compared to traditional approaches (7,8). However, adoption of this approach is associated with an increased risk of complications and a steep learning curve (4). The most common early complications of DAA are fracture, loosening of implants and dislocation (5). Most complications have been reported within the first 20 DAA cases (9). Kong *et al.* (11) noted a 44% rate in complications in the first 50 DAA cases and a decrease to 16% in the second 50 cases. Van Den Eeden *et al.* (12) reported a complication rate of 12% in the first 100 cases which dropped to 6% in the subsequent 100 cases in a single surgeon series. It has been suggested that the learning curve for the DAA is >100 cases based on registry data (10).

There are a number of published articles emanating from single surgeon as well as group practices, showing similar patterns of complications in transitioning to using the DAA for THA (9,11-13). However, there is a paucity of literature documenting the learning experience from academic centres where surgeons with differing orthopaedic experience and at various levels of arthroplasty training all participate in DAA surgery. Furthermore, in spite of increasing numbers of THAs in developing countries, published reports on DAA in this setting are rare (14). We believe that this is contributing to the low levels of adoption of the DAA in resource constrained settings. The purpose of this study was to document the complications associated with the introduction of the DAA for THA and to compare the complications between surgeons of different experience level in an academic teaching hospital.

MATERIALS AND METHODS

The study was conducted at a University teaching hospital where fellows, registrars and medical officers are trained in THA. The DAA program was introduced in January 2016. Two consultants and a fellow attended a certified DAA training course and subsequently started DAA THA under the supervision of a local expert for their first three cases. Consultants and fellows that joined the unit thereafter all attended a similar DAA training course and

again benefitted from the supervision of the same local expert for their first three cases. Subsequent surgeries were then supervised by one of the two consultants (LM) that were originally trained until the new consultants and fellows were comfortable to operate independently. All surgeries were carried out through the Anterior Minimally Invasive Surgery (AMIS®) approach using a proprietary leg holder (Medacta®) using the Medacta versafit acetabular cup and qaudra stem in all primaries THAs. Initially patient selection was restricted to osteoarthritis, inflammatory arthritis, osteonecrosis, BMI of less than 40 and uncomplicated hip pathology. However, as surgeons confidence grew, hip fractures and more complicated pathology such as hip dysplasia were included. We undertook a retrospective analysis of all DAA THA done from inception in January 2016 to December 2019. The study was approved by the institutional ethics committee (HREC number: M190431). We reviewed patient charts, theatre registries and mortality and morbidity data. Demographic data, indication for surgery and complications were documented. We assessed the number of cases done per surgeon and complications in batches of 10. We further compared complications between consultants and fellows. The statistical analysis was performed using the IBM® Statistical Package for the Social Science system version, SPSS 23.0. For the purpose of this study dichotomous variables were compared using odds ratios (ORs) with 95% Confidence Intervals (CI). The OR was defined as the probability of an event occurring in the fellows group compared to the consultants group. Heterogeneity was assessed using the chi-squared (X^2) test, with $p < 0.050$ being regarded as significant.

RESULTS

A total of 100 males and 132 females were operated, mean age of 37.83 years in males (27-77) and 48.25 years in females (30-75) (Table 1). The primary pathology in 131 patients (56%) was osteoarthritis, 20 (9%) inflammatory arthritis, 30 (13%) avascular necrosis of the femoral head while 51(22%) sustained a femoral neck fracture. Thirty (13%) patients were known HIV positive on Highly Active Anti-Retroviral Treatment (HAART). The mean CD4 count for HIV positive patients was 371 (300-610) and all 30 patients were virally suppressed.

Table 1
Patient demographics

	Females	Males
Sex	132	100
Age	48.25 (30-75)	37.83 (27-77)

Table 2
Hip pathology

	No. (%)
Osteoarthritis	131 (56)
Inflammatory arthritis	20 (9)
Avascular necrosis	30 (13)
Neck of femur fracture	30 (13)

A total of 264 Direct Anterior Approach (DAA) THA procedures were performed (232 patients), of which 99 (34.85%) were performed by consultants. Fifteen cases (15.2%) were performed by consultants under the supervision of an experienced local proctor surgeon, while 84 cases were performed without supervision. One hundred and sixty five (65.2%) THA procedures were performed by fellows with 28/165 (16%) having been done under supervision of a proctor or consultant. A total of 24 complications were documented (Table 3) with an overall

complication rate of 9%. Consultants had a complication rate of 13% and fellows had a complication rate of 7%. When assessing the overall complications per case interval, both consultants and fellows had 41.7% (10/24) of the complications at 10 or less cases, while 33.3% (8/24) occurred in the 11-20 case interval. The number of complications decreased significantly to 16.7% (4 /24) during the 21-30 case interval and to 8.3% (2/24) when 31-40 cases were performed (Table 4).

Table 3
Complications

Complication	No. (%)
Femoral fractures	7 (2.7)
Acetabular fractures	3 (1.1)
Femoral nerve palsies	6 (2.2)
Superficial surgical site infections	2 (0.8)
Periprosthetic joint infections	5 (1.9)
Dislocations	1 (0.4)

Table 4
Interval of complications for fellows- versus consultants

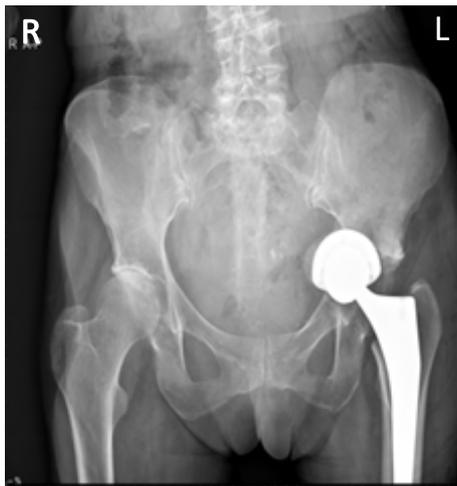
Surgeon	<10 cases	10-20 cases	20-30 cases	>30 cases	Total
Consultants	5 (41.7%)	4 (33.3%)	2 (16.7%)	1 (8.3%)	12
Fellows	5 (41.7%)	4 (33.3%)	2 (16.7%)	1 (8.3%)	12
Total	10 (41.7%)	8 (33.3%)	4 (16.7%)	2 (8.3%)	24

The odds of having complications were 2% greater for consultants (CI: 0.86-4.65) compared to fellows. A total of seven intra-operative femoral fractures were documented, three fractures involved the greater trochanter while the remaining four cases were unstable calcar fractures that were stabilized

using cables. A total of three acetabular fractures were reported, one stable fracture was treated non-operatively with non-weightbearing for six weeks and went on to union while two patients had pelvic discontinuity requiring revision surgery using a cup and cage construct (Figure 1).

Figure 1

*Right: Pelvic X-Ray showing left pelvic discontinuity.
Left: Pelvic X-Ray showing left hip acetabular revision with a cup-cage construct*



A femoral nerve palsy was reported in six patients, five of the six patients had a neuropraxia and went on to complete recovery while one patient had not recovered at 12 months follow up. We attributed the five neuropraxias to errant retractor placement while the one neurotmesis was likely a surgical transection.

Two patients developed a superficial surgical site infection, while five patients developed deep prosthetic joint infections with two requiring 2-stage revision arthroplasty while the remaining three patients underwent successful Debridement Antibiotics and Implant Retention (DAIR) procedures. Of the total seven patients with septic complications, three patients were HIV positive with two of the three patients having HIV and rheumatoid arthritis as comorbidities.

DISCUSSION

Transitioning to the DAA can be a challenge as the surgical anatomy and exposure are unfamiliar to the inexperienced orthopaedic surgeon and component placement cues are significantly different to standard approaches. However, the early clinical and functional advantage offered by the DAA compared

to other approaches is an attractive proposition for the African patient provided complications can be minimized (14). The controlled environment of an academic teaching hospital provided us with the ideal setting to initiate the DAA and monitor early complications. We chose to focus on early complications as these are technique related in the main (5,9-13,14-17,19-22,24-29). Our study showed an overall complication rate of 9%. Consultants had a complication rate of 13% compared to fellows with a complication rate of 7%. The odds of having complications were 2% greater for consultants (CI: 0.86-4.65) compared to fellows. A significant number of cases (165/264) were carried out by fellows. Consultants had a higher overall rate of complications compared to fellows, likely owing to the benefits of a longer period of continued supervision for the fellows as they were going through the learning curve. We also believe that fellows were more likely to accept the approach as they were unencumbered by an established history of a familiar approach with set reference cues.

This case series reported several femoral fractures with an incidence of 3%. Femoral preparation with the aid of a modified fracture table can potentially

lead to greater trochanteric as well as shaft fractures. We attributed the three fractures involving the greater trochanter to inadequate soft tissue release and poor exposure. Two of the fractures occurred during the 11-20 case interval and one occurred during the 21-30 interval. De Geest *et al.* (15) reported 9(3%) femoral fractures from their series of 300 DAA hips using a modified table. Berend *et al.* (16) reported 24(0.9%) femoral fractures (23 of the 24 fractures required revision) in their series of 2869 hips. Matta *et al.* (18) in a series of 437 patients who underwent THA on a modified fracture table, reported three ankle fractures and two femoral fractures. Jewett and Collins (17) in their review of complications with the DAA found the greatest risk of fracture to be in the first 200 cases. The contribution of the use of the fracture table to increased risk of femoral fractures remains controversial with Cohen *et al.* (19) reporting no significant difference in fracture risk in a retrospective study (n=487) comparing a surgeon who used a fracture table to another who did not.

This study reported 3(1%) acetabular fractures. One stable fracture occurred at > 30 cases (surgery performed by a fellow) and two cases of pelvic discontinuity occurred during the 21-30 case interval in surgery performed by consultants. The use of intraoperative fluoroscopy has been recommended to improve acetabular cup placement and reduce the risk of fractures (20). We are considering routine use of fluoroscopy in our DAA hips. Nerve injuries are uncommon complications. Fleischman *et al.* (21) reported an overall incidence of Femoral Nerve Palsy (FNP) of 0.21% after THA with the incidence 14.8-fold higher in patients undergoing anterior hip surgery. This study had 2% (6/264) incidence of femoral nerve palsies with three occurring at <10 cases and three at 11-20 cases. Hoschino *et al.* (22) in contrast reported a 1.1% incidence (3/273) of FNP in a retrospective review of 273 THAs performed by a single surgeon. This study attributes the relatively high number of FNPs to incorrect anterior acetabulum retractor placement. In addition, to placement of the Charnley retractor to facilitate acetabular exposure we often used a Hohmann retractor sited on the anterior lip of the acetabulum to improve exposure. We have since stopped this practice.

The incidence of injury to the lateral femoral cutaneous nerve with the DAA is reported to be between 0.1% and 81% (5). Our study did not specifically investigate lateral femoral cutaneous nerve injuries as this complication was infrequently reported in our patient population. Judet *et al.* (23)

described an incision more lateral to the lateral border of Sartorius and inferior to the anterior superior iliac spine which reduced nerve injury to less than a third of cases.

The study showed a 1% incidence of SSI (2/264) and 2% (5/264) incidence of prosthetic joint infections. Purcell *et al.* (24) compared the effect of the posterior approach and DAA on the incidence of superficial and deep infections in obese and non-obese patients. The impact of DAA and posterior approach on deep infections in non-obese patients was equivocal, however, an increased rate of deep infections in obese patients after DAA was reported. The DAA had a greater incidence of superficial wound complications in both obese and non-obese patients (24). Christensen *et al.* (25) reported a 1.4% (7/505) rate of wound complications in the DAA compared to 0.2% (3/1288) in the posterior approach. Watts *et al.* (26) in a retrospective review of 716 patients reported a similar complication rate of 1.7% (12/716) for DAA compared to 1.9% with the posterior approach, they further reported more complications in obese patients with a BMI \geq 40kg/m². Obesity and the proximity of the anterior incision to the inguinal skin crease with the overlying abdominal pannus in obese individuals is an established risk factor for wound complications and infection (5).

The case series showed a dislocation rate of 0.4% (1/264). The dislocation was an anterior dislocation due to an excessively anteverted acetabular cup that was subsequently revised. De Geest *et al.* (15) in their series of 300 cases reported a dislocation rate of 0.66% which is similar to our findings and relatively low compared to the conventional posterior and lateral approaches. Tamaki *et al.* (28) reviewed 871 consecutive DAA THAs and reported that 75% of dislocation in DAA is within the first 3 weeks and that the risk actually decreases substantially with time. Sariali *et al.* (29) reported a dislocation rate of 1.5% in 1764 cases of DAA, however, only 0.11% actually required revision THA.

The study is limited by its retrospective nature with a small patient cohort from our early experience with the DAA but highlights lessons learned with this new technique. The exposure of the DAA to both consultants and fellows presents a teaching hospital experience in the transition to a new approach. Our early experience with the DAA was marred by an initial high number of complications which decreased significantly beyond 30 cases irrespective of the grade of surgeon. A similar experience was reported by Foissey *et al.* (30) who reported a 20% complication rate for both trainees and a senior

surgeon in the first 20 cases and a decline in complications to 5% and 10% respectively with the last 20 cases, however it is worthwhile noting that the DAA was performed without the use of a proprietary leg holder. We believe that having experienced senior consultants and access to proctor surgeons enabled a more rapid journey through the learning curve. DAA has been associated with superior early outcomes in published literature from developed countries and we have successfully introduced the approach in the setting of a developing country. DAA can be safely adopted for elective THA for the African patient in a resource constrained environment, however the use of modifications such as the figure of four anterior approach may be utilised in resource poor centres where a proprietary leg holder is not available.

We recommend initial formal didactic training in the introduction of the DAA followed by cadaveric workshops. The first DAA cases should be done under the guidance of an experienced consultant or proctor. Patient selection is critical in avoiding early complications, our study showed higher wound complications in patients with HIV and rheumatoid arthritis. We further recommend the use of intraoperative fluoroscopy early during the learning curve to aid in familiarizing the training surgeon with acetabular preparation, cup placement and femoral broaching.

CONCLUSIONS

The purpose of this study was to determine the safety of the DAA by focusing on complications associated with its introduction in a tertiary academic. Our study demonstrates that the DAA can be safely introduced in a teaching hospital setting with a staff complement with varying levels of experience. The risk of complications decreases with DAA experience irrespective of the level of orthopaedic experience of the surgeon. There is a steep learning however, indications for this approach can be extended to complex hip pathology as the surgeon's experience progresses. Formal training in the technique is strongly advised.

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