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Original Article

Good long-term outcomes for Direct Anterior Approach Total Hip Arthroplasty in South Africa

Jurek Rafal Tomasz Pietrzak [a,**], Zia Maharaj [a,*], Josip Nenad Cakic [a,b]

[a] Arthroplasty Unit, Orthopaedic Department, Division of Surgery, Charlotte Maxeke Johannesburg Academic Hospital, University of the Witwatersrand, Johannesburg, South Africa
[b] Life Fourways Hospital, Fourways, Johannesburg, South Africa

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ABSTRACT

This study aims to assess long-term outcomes of Total Hip Arthroplasty (THA) through Direct Anterior Approach (DAA) in a developing country using traditional and novel Patient-Reported Outcomes. There were 522 patients (mean age, 56.5 years; 66.3% female) after mean follow-up 7.35 years. There were 13 revisions. Overall 5-year implant survival rate was 97.5%. Patient Joint Perception scores of 65.5% perceived a completely natural joint. Mean Hip Disability and Osteoarthritis Score was 89.1. Median Forgotten Joint Score-12 was 90 and modified Harris Hip Score was 88. Primary DAA THA in sub-Saharan Africa allows good clinical outcomes at minimum 5 years follow-up.

1. Introduction

Total Hip Arthroplasty (THA) remains one of the most reliable and cost-effective surgical procedures worldwide.[1] Globally, approximately 1 million THA procedures are performed each year[1] In the United States of America (USA) the annual volume of primary THA procedures has increased 132% between 2000 and 2014 to total an estimated 370,770 operations.[2] Demand for THA continues to rise and is projected to increase a further 145% by 2030 to total approximately 909,900 annual THA procedures, in the USA alone.[2] Despite the high demand for this procedure, there remains significant controversy regarding the most effective surgical approach.[3–7]

The most commonly performed approach to THA remains the posterior and lateral approaches, while less than 5% of surgeons in the United Kingdom, Sweden and New Zealand routinely use the Direct Anterior Approach (DAA).[5,7] The DAA THA is becoming increasingly popular, as it is the only surgical approach to THA that completely respects an internervous and intermuscular plane.[6] Traditionally, the DAA has been associated with decreased surgical trauma, less muscle damage, shorter operative times, accelerated recovery rates and decreased post-operative complications.[8–11] Literature has indicated improved short-term benefits for DAA THA but these superior clinical outcomes have been shown to even out and be matched by alternative, more traditional surgical techniques after six weeks.[3–5,9–12] A survey of members of the British Hip Society (BHS) found that despite only 16.9% of surgeons being trained in anterior approach THA during residency, a subsequent 49.3% of surgeons had used the DAA in their clinical practice. However, only 22.5% of BHS respondents believed the DAA had significant benefits over other surgical approaches and 42.9% of the respondents had abandoned the technique by the time the survey was conducted.[13] There is a documented steep learning curve for surgeons resulting in increased revisions and overall complication rates for the first 20 to 50 DAA cases performed which may indicate the need for more detailed training in this technique during residency.[13–18] Some studies have associated the DAA with increased risks for early complications including aseptic loosening, periprosthetic fractures and periprosthetic joint infections (PJI).[19–23] There, however, exists a debate concerning the long-term clinical benefit, safety and longevity of implants when using the DAA.[18]

In the developing world, the number of THAs performed is expected to increase and subsequently double the volume of annual operations globally to 2 million by 2030.[1,24] There remains a high rate of overall patient satisfaction after THA globally, however there is limited data available regarding Patient-reported outcome Measures (PROMs) in less

* Corresponding author.
** Corresponding author. Institutional address Charlotte Maxeke Johannesburg Academic Hospital Jubilee street, Parktown, Johannesburg, Gauteng, 2193, South Africa.
E-mail addresses: jrtpietrzak@yahoo.com (J.R.T. Pietrzak), maharajzia@gmail.com (Z. Maharaj).

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developed countries.[1] PROMs are becoming of increasing importance as performance indicators for hospitals and surgeons.[25] In the USA, policymakers have started using PROMs to evaluate the quality of healthcare service provided for value-based reimbursement.[25] Traditional PROMs after THA include Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and modified Harris Hip Score (mHHS), however these methods were developed earlier than the 1980s.[27] Importantly, these traditional PROM scores have become limited by ceiling effects due to the advances in surgery and improvement in clinical outcomes.[27] Subsequently, more novel tools have been developed, including the Forgotten Joint Score-12 (FJS-12) and Patient Joint Perception (PJP) scores, to aid discrimination between patient outcomes by describing more accurate results.[27]

The purpose of this study was to assess the long-term outcomes of DAA THA in a developing country. Secondarily we sought to compare overall clinical outcomes across a variety of more traditional and novel PROMs.

2. Methods and materials

2.1. Study design

A retrospective analysis was conducted on patients who underwent THA by a single high-volume surgeon in Gauteng, South Africa. Medical clearance was obtained from the South African Medical Association Research Ethics Committee registered with the National Health Research Ethics Council (NHREC) of the national Department of Health (Hip Registry Rev: II 25-08-10).

2.2. Patients

All patients over 18 years of age who underwent primary elective Anterior Minimally Invasive Surgery (AMIS®) THA between January 1, 2010, and December 31, 2014, were included in the study. Subsequently, a minimum patient follow-up of 5 years was required. Exclusion criteria included patients receiving THA using an alternative surgical approach or implant design, THA for femoral neck fractures, patients who did not wish to participate in the study and those presenting for revision surgery.

An electronic survey was distributed via e-mail in January and February 2019, to those patients that qualified for inclusion into the study. All patients who voluntarily participated in the questionnaire provided consent. A copy of the full survey has been provided in the Appendix. Patients were re-invited to participate in the survey via three reminder emails that were sent after 2-week intervals. Those who did not respond to email communication were further sent two reminder text messages after 2-week intervals respectively.

2.3. Surgical procedure

All patients underwent a general anaesthetic by a single anaesthetist supplemented by a lumbar plexus regional anaesthetic block. Pre-operatively, antibiotic prophylaxis was given intravenously to all patients and was continued for the first 24 h post-operatively. The AMIS® DAA THA was performed by a single surgeon for all patients. The AMIS® Mobile Leg Positioner was used and operated by a single, trained non-sterile table operator. This leg positioner allows controlled hip flexion, extension, abduction, adduction and rotation. No additional hip rotation is possible if the leg is in traction due to a protective locking mechanism that is shields against any potentially adverse forces through the femur. The patient was operated on in the supine position with padded perineal support (Fig. 1). The patient is pre-operatively prepared and draped with end of AMIS® Mobile Leg Positioner left open allowing the non-sterile table operator to rotate and manipulate leg enabling adequate intra-operative exposure of both acetabulum and proximal femur (Fig. 2). A 6–10 cm long incision was made 2–3 cm lateral to a line connecting the

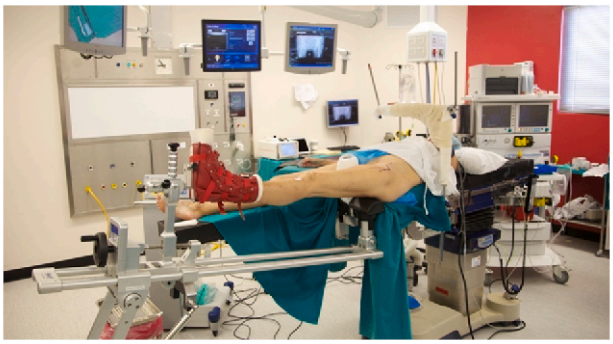


Fig. 1. Flowchart of the study cohort.

anterior superior spine to the Gerdy's tubercle. The tensor fascia lata (TFL) was exposed and the perimysium divided (Fig. 3). The surgical plane between the TFL and Sartorius muscle was used to reduce the potential of lateral femoral cutaneous nerve (LFCN) injury. The lateral head of reflected portion of rectus femoris was retracted medially. An anterior capsulotomy was made and preserved for closure upon surgical completion. Femoral neck osteotomy was made in slight leg traction with care not to damage the posterior capsule. Modified instruments for the exposure of acetabulum and the femur were used during the AMIS® approach. The superior, medial and inferior acetabular labrum were retained as far as possible. Subsequent acetabular preparation was accomplished in standard fashion. Selected soft tissue releases on the posterior aspect of the femoral neck allowed full exposure of the femoral canal while preserving the abductor mechanism and short external rotators. Standard femoral preparation with specialized AMIS® broaches was performed as per convention.

Uncemented implants with a ceramic femoral head and highly cross-linked polyethylenes acetabular shell were preferentially used. Cemented femoral implants were only used in selected patients based on the surgeon's discretion at peri-operative evaluation. This decision was based on the patients' age, Dorr classification and presence of pathological bone either on pre-operative assessment or intra-operative findings. The use of metal femoral heads was based on the patients' age (>70 years) and health funder status. A suction drain was routinely placed intra-articularly and removed within 36 h post-operatively. Pneumatic calf compression pumps were applied immediately post-operatively and were only discontinued upon discharge.

A physiotherapist routinely treated all patients the day after surgery. Physical therapy occurred twice per day until discharge. All patients were discharged home only once they were fully ambulatory with 2 crutches. The surgical incision was covered by single occlusive dressing and a wound check was done by a clinical assistant 10 days post-operatively. Standard oral thromboprophylaxis was given to each

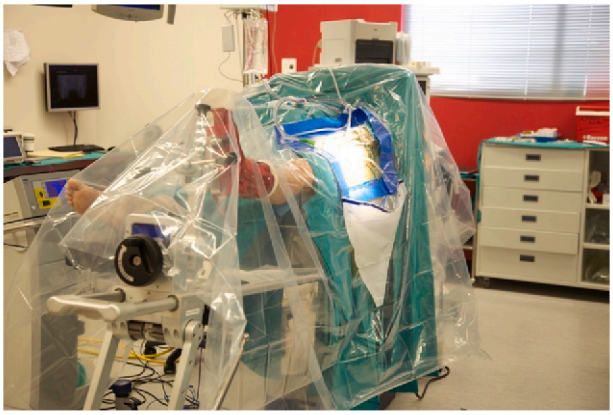


Fig. 2. Forgotten Joint Score and modified Harris Hip Score Histograms.

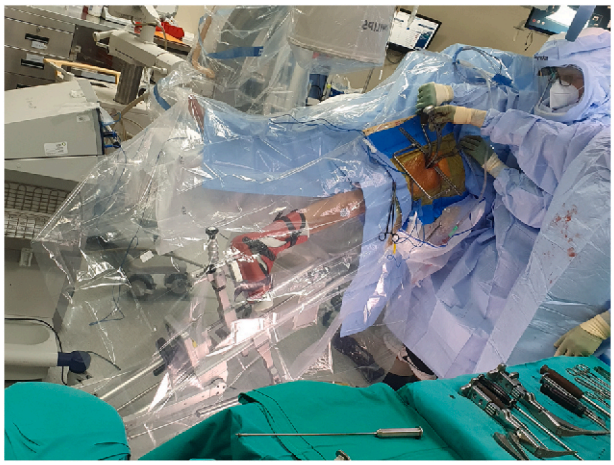


Fig. 3. Pre-operative positioning of Left leg in AMIS® Mobile Leg Positioner

patient to take for 3 weeks. Three weeks after surgery, a routine duplex Doppler was done to ascertain asymptomatic deep vein thrombosis. The surgeon did routine post-operative follow-up assessments at 6 weeks, 6 months, 1 year and 5 years post-operatively.

2.4. Main variables and Outcome Measures

Baseline demographic data was recorded for all study participants, including age, gender, body mass index (BMI) and medical co-morbidities. Surgical variables included etiological radiographic diagnosis, bearing surface coupling, femoral head size, intra-operative blood loss and operative time. Early- (<4 weeks) and late- (>4 weeks) post-operative medical and surgical complications and revision rate was noted for the study cohort.

The online questionnaire assessed the long-term functional outcomes across a variety of PROMs. The following PROMs were included: overall satisfaction rate, PJP, Joint Functionality, Visual Analog Scale (VAS) pain score, FJS-12, mHHS, post-operative participation sports-participation and Hip Disability and Osteoarthritis Score (HOOS). Revision THA after index primary THA was classified upon exchange of any implant component.

2.5. Statistical analysis

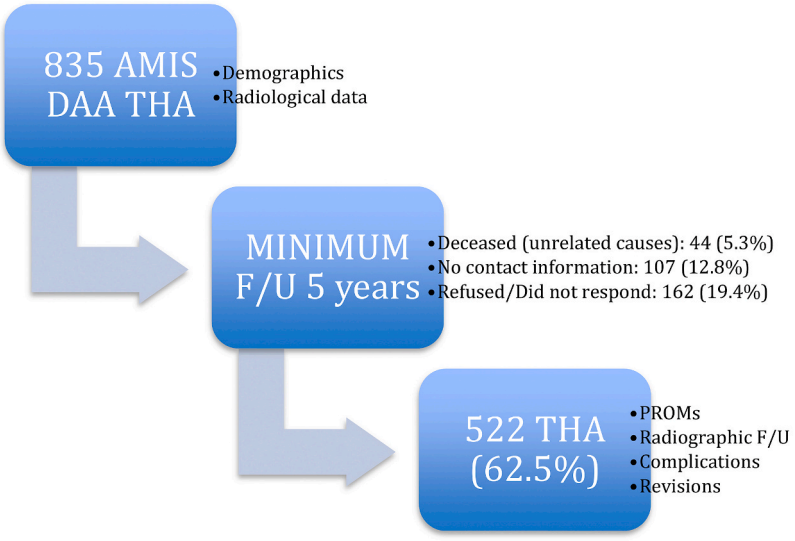
Calculation of mean and standard deviation with univariate analysis was conducted to assess quantitative variables. Absolute and relative frequencies were determined for qualitative variables. Comparative analysis of PROMs was conducted using Spearman's rank correlation coefficient. Implant survival was calculated using the Kaplan-Meier Method. The level of statistical significance was set at $p \leq 0.05$ with a confidence interval (CI) of 95%. All statistical analyses were performed using STATA (version14) statistical package.

3. Results

There were 835 eligible patients identified with 522 included in the study cohort (Fig. 4). Demographic data was obtained for all patients (mean age, 56.5 years; 66.3% female) and is shown in Table 1. Intra-operatively there were 2 peri-prosthetic femoral (calcar) fractures (0.4%). The mean operative time was 72 ± 24.7 min and the mean blood loss was approximately 270 ml ± 23, per patient respectively.

The mean follow-up of all patients was 7.35 years. Post-operatively, there were 42 (8%) surgical complications and no medical complications observed (Table 2). The surgical complications included 2 (0.4%) deep PJI, 9 (1.7%) cases of aseptic loosening, 3 (0.6%) dislocations and 6 (1.1%) periprosthetic fractures respectively. There were 22 (4.2%) early- and 20 late- (3.8%) complications with 21 (4%) readmissions respectively. There were 13 patients (2.5%) that underwent revision THA. The indications for revision THA included 9 cases of aseptic femoral loosening (1.7%), 2 periprosthetic fractures (0.4%%), 1 chronic deep PJI (0.2%) and 1 dislocation (0.2%). There were no cases of acetabular component loosening. Total implant survival with respect to revision for any reason was 97.5% at 5 years (standard error (SE), 1.01; 95% CI, 96.2–98.9). Total stem survival was 97.7 (SE, 0.968; 95% CI, 96.4–98.9) and total cup survival was 99.6% (SE, 0.406; 95% CI, 99.1–100) respectively, for any reason at 5 years.

Post-operatively there were 490 (93.9%) patients satisfied overall and 436 (83.5%) patients reporting negligible to no pain with a VAS pain score of 2 or less (Table 3). Joint Functionality was limited in 36 (6.9%) patients whilst PJP scores indicated that 342 (65.5%) patients perceived a completely natural joint. There were 385 (73.7%) patients who continued to participate in sports post-operatively. The activity level was equal to or better than their premorbid function in 339 (88.1%) of these patients. The study cohort reported a mean HOOS of



AMIS, Anterior Minimially Invasive Surgery; DAA, Direct Anterior Approach; THA, Total Hip Arthroplasty; F/U, Follow-up
PROMs, Patient-reported Outcome Measures

Fig. 4. Pre-operative preparation and draping of Left leg and hip in AMIS® Mobile Leg Positioner.

Table 1
Baseline Demographic Data and Peri-operative Surgical Characteristics (n = 522 patients).

Age (mean years ± SD)	56.54 ± 7.9
Gender, n (%)	346 (66.3)
Female	176 (33.7)
Male	
Side of operative site, n (%)	245 (46.9)
Left	277 (53.1)
Right	
BMI (mean kg/m^2 ± SD)	28.54 ± 23.7
BMI category, n (%)	283 (54.2)
Non-obese (<30 kg/m^2)	239 (45.8)
Obese (>30 kg/m^2)	
ASA, n (%)	126 (24.1)
1	150 (28.7)
2	246 (47.1)
3	
Number of Comorbidities, n (%)	126 (24.1)
0	233 (44.6)
1	121 (23.2)
2	42 (8.1)
≥3	
Type of Comorbidities, n (%)	238 (45.6)
Hypertension	155 (29.7)
Diabetes	13 (2.5)
Epilepsy	39 (7.5)
Asthma	13 (2.5)
COPD	14 (2.7)
SLE	78 (14.9)
Rheumatoid Arthritis	43 (8.2)
Cardiac problems	7 (1.3)
Thyroid	3 (0.6)
Previous Tuberculosis	8 (1.5)
Kidney problems	
Etiology, n (%)	195 (37.3)
1° OA	19 (9.7)
1° OA sub-classification, n (%)	40 (20.5)
Tonnis 1	136 (69.7)
Tonnis 2	151 (28.9)
Tonnis 3	63 (41.7)
2° OA	22 (14.6)
2° OA sub-classification, n (%)	66 (43.7)
Inflammatory OA	109 (20.9)
Previous trauma	67 (12.8)
FAI	21 (31)
ADH	46 (69)
AVN	
AVN sub-classification, n (%)	
Ficat and Arlet 3	
Ficat and Arlet 4	
Operative time (mean min ±SD)	72.45 ± 24.7
Intra-operative blood loss (mean ml ± SD)	273 ± 23
Acetabular component, n (%)	522 (100)
Non-cemented	457 (87.5)
No screw augmentation	65 (12.5)
Screw augmentation	
Bearing surface coupling, n (%)	187 (35.8)
MoP	335 (64.2)
CoP	
Femoral head size (mm), n (%)	31 (5.9)
28	294 (56.3)
32	197 (37.7)
36	
Femoral stem, n (%)	33 (6.3)
Non-cemented	489 (93.7)
Cemented	

SD, Standard Deviation; BMI, Body Mass Index; ASA, American Society of Anaesthesiologists classification; COPD, Chronic Obstructive Pulmonary Disease; SLE, Systemic Lupus Erythematosus; 1°, primary; OA, osteoarthritis; 2°, secondary; FAI, Femoroacetabular impingement; ADH, Adult Dysplasia of the Hip; AVN, Avascular Necrosis; MoP, Metal-on-Polyethylene; CoP, Ceramic-on-Polethylene

Table 2
Post-operative Complications and Readmission Rates (n = 522 patients).

Surgical Complication	n (%)
Total	42 (8)
Early (<4 weeks)	22 (4.2)
Late (>4 weeks)	20 (3.8)
Wound problems	22 (4.2)
Wound dehiscence	19 (3.6)
SSI	3 (0.6)
Deep PJI	2 (0.4)
Aseptic loosening	9 (1.7)
Acetabular loosening	0 (0)
Femoral component loosening	9 (1.7)
Dislocations	3 (0.6)
Periprosthetic Fractures	6 (1.1)
Intra-operative Fractures	2 (0.4)
Post-operative Fractures	4 (0.8)
Vancouver B1	1 (0.2)
Vancouver B2	2 (0.4)
Vancouver C	1 (0.2)
Readmission Rate	21 (4)
<30 days	4 (0.8)
30–90 days	1 (0.2)
90 days–1 year	4 (0.8)
1–3 years	8 (1.5)
>3 years	4 (0.8)
Revision THA[a]	13 (2.5)

PJI, Periprosthetic Joint Infection; SSI, Surgical Site Infection; THA, Total Hip Arthroplasty.
[a] Mean follow-up 7.35 years.

89.1 (range 86.8–93) across all categories respectively. There was a mean and median FJS-12 of 82.5 and 90, respectively (range 25–100) and 211 patients (40,4%) had a maximum FJS-12 score. The respective mean and median mHHS were 86.6 and 88 (range 22–100). The cumulative FJS-12 and mHHS scores are depicted in Fig. 5.

4. Discussion

Worldwide, DAA THA is increasing in popularity although there is a lack of reported trends for developing countries.[5,11,23] Furthermore, literature has proven the short-term benefits of the DAA technique, but there is limited data on the long-term outcomes of these patients.[6,8–10,12,28–30] In our South African cohort, there was an overall complication rate of 8% after AMIS DAA elective primary THA after a mean follow-up of 7.35 years. There were 2 intra-operative femoral (calcar) fractures (0.4%) with a mean surgical time of 72 min and blood loss approximately 270 ml per procedure, respectively. In the systematic review and meta-analysis including 2302 participants, Higgins et al. (2014) reported similar surgical findings for DAA THA procedures with an intra-operative fracture rate of 1.3%, an estimated mean blood loss of 378 ml and mean operative times ranging between 78 and 129.1 min respectively.[4]

The DAA has been associated with an increased risk of early revision and aseptic loosening.[21] There was a revision rate of 2.5% (n = 13) in our study and all of these patients were re-admitted after 6 months or more from index procedure. Aseptic loosening was the indication in 1.7% of cases (n = 9) for revision THA. In a study by Eto et al. (2016), the mean duration from primary to revision THA was shorter for DAA (3 ± 2.7 years) in comparison to non-DAA cohorts (12 ± 8.8 years) ($p < 0.01$).[21] There was a greater incidence of aseptic loosening in the DAA cohort (9/30, 30%) compared to the non-DAA cohort (8/100, 8%) ($p = 0.007$).[21] A retrospective review of primary THA patients found comparable functional outcomes for 205 DAA hips satisfactorily matched to 205 posterior approach hips.[29] After a minimum follow-up of 2 years, there were no significant differences in the complications ($p = 0.2240$) between the cohorts.[29] Similar to results in our study, Maldonado et al. (2019) reported the complication rate for the DAA cohort was 7.8% (n =

Table 3
Summary of Patient-reported Outcome Measures (n = 522 patients).

Assessment	Mean, n (%)	95% CI (%)
Satisfaction Rate		
Very Satisfied	417 (79.9)	74.3–84.1
Satisfied	73 (14)	8.8–16.8
Neutral	11 (2.1)	1.5–5.7
Dissatisfied	11 (2.1)	1.5–5.1
Very Dissatisfied	10 (1.9)	0.7–4.2
Joint Functionality		
Can do Anything	214 (41)	35.1–47
Can do Most Things	272 (52.1)	46–58.2
Limited	20 (3.8)	2–6.7
Severely Limited	16 (3.1)	1.5–5.2
VAS Pain Score		
0 (No Pain)	296 (56.7)	50.7–57.2
1	68 (13)	9.4–17.6
2 (Mild Pain)	72 (13.8)	9.8–18.1
3	36 (6.9)	4.3–10.5
4 (Moderate Pain)	2 (0.4)	0–1.8
5	16 (3.1)	1.5–5.7
6 (Severe Pain)	2 (0.4)	0.1–1.6
7	10 (1.9)	0.7–4.2
8 (Very Severe Pain)	12 (2.3)	1–4.7
9	2 (0.4)	0.3–1
10 (Unbearable Pain)	6 (1.2)	0.3–3.1
Patient Joint Perception		
Natural Joint	342 (65.5)	59.7–71.2
Artificial Joint, No Restriction	82 (15.7)	11.4–20.2
Artificial Joint, Minimal Restriction	82 (15.7)	11.8–20.6
Artificial Joint, Major Restriction	10 (1.9)	0.7–4.2
Nonfunctional Joint	6 (1.2)	0.3–3.1
Participation in Sports		
Yes	385 (73.7)	68.1–78.8
No	137 (26.3)	21.2–31.9
Level of Activity* (Total n = 385 patients)		
Better	135 (35.1)	28.6–42
Same	204 (52.9)	45.8–59.9
Worse	46 (12)	8–17.2

Hip Disability and Osteoarthritis Outcomes Scores

Dimension	Median	Mean (SD)	Mean Rank**
Pain	97.5	91.7 (13.2)	3.18
Symptoms	85	91.1 (13.7)	3.23
Activities of Daily Living	98.5	93 (12.7)	3.53
Sports and Recreation Function	93.8	84.7 (20.5)	2.52
Quality of Life	93.9	84.8 (21.9)	2.54

CI, Confidence Interval; VAS, Visual Analog Scale.
*Compared to Premorbid Function.
**Friedman test (chi-square 116.260, df 4, $p < 0.05$).
AMIS, Anterior Minimially Invasive Surgery; DAA, Direct Anterior Approach; THA, Total Hip Arthroplasty; F/U, Follow-up PROMs, Patient-reported Outcome Measures.

16) with a revision rate of 1.5% (n = 3) including 2 (1%) cases of loosening and 1 (0.5%) periprosthetic fracture.[29] A recent study of 51 patients undergoing DAA THA by Assaker et al. (2020) reported a revision rate of 3.9% (n = 1) including one case of peri-prosthetic fracture and one case of cup aseptic loosening.[30]

There was a good satisfaction rate in our study of 93.9% (n = 490) through a minimum follow-up of 5 years. Maldonado et al. (2019) reported a satisfaction rate of 89% for a DAA cohort at a minimum 2-year follow-up.[28] Similarly, Assaker et al. (2020) found a mean Harris Hip Score (HHS) of 91 with a satisfaction rate of 98.0% after mean follow-up of 16 months.[30] In a study assessing the long-term changes in patient satisfaction after THA, by Galea et al. (2020) found equivalent rates at medium- and long-term follow-up.[32] There was no significant change in pain or HHS after 919 THA procedures between 1- and 3 year follow-up assessments respectively ($p = 0.499$).[32]

All cases in our study underwent AMIS® DAA THA with the assistance of a specialized traction table operated by a single, trained non-sterile table operator. In a systematic review of 44 studies, Sarraj et al.

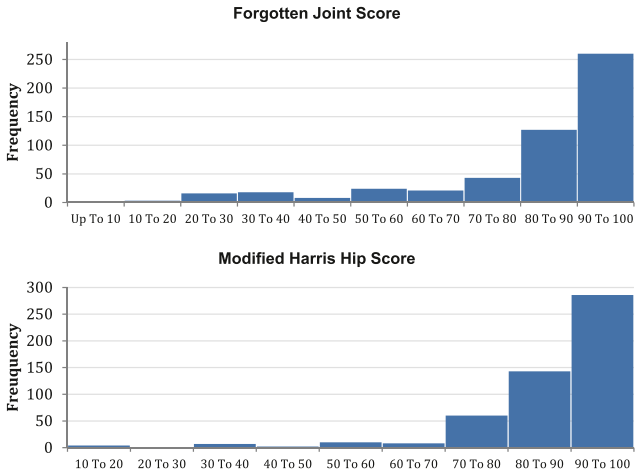


Fig. 5. Surgical exposure of the left proximal femur, achieved with gradual external rotation followed by controlled leg extension using AMIS® Mobile Leg Positioner

(2020) reported that standard- and traction-table DAA allow comparable short term functional improvements with a similar complication profile.[33] Similarly subgroup analysis of the DAA instrumentation by Kucukdurmaz et al. (2019) noted no significant difference in functional outcomes at 6 weeks follow-up ($p < 0.001$).[29] However both reviews indicated that the standard table DAA technique had intra-operative benefits. The standard table DAA demonstrated less estimated mean blood loss (382.3 vs. 531.7 ml), quicker operative times (70.9 vs. 100.1 min), smaller length of incision ($p < 0.001$) and decreased incidence of intra-operative fractures (1.3% vs 1.7%) in comparison to the traction table, respectively.[28,33] Despite these findings, our study of a single high-volume surgeon using DAA technique with a traction table had less mean blood loss (270 ml ± 23) and equivalent mean operative time (72 ± 24.7 min). This could imply that surgeon experience and preference may have a more significant role than instrumentation alone.

The PROMs for the study population reported PJP scores indicating that 65.5% (n = 342) of patients perceived their hip as a natural joint with a median FJS-12 of 90. Current literature indicates that the PJP is a simple and reliable tool to identifying forgotten joint perception.[27] Puliero et al. (2019) found that FJS-12 and WOMAC are less reliable than PJP scores with a ceiling effect between 20 and 30%.[27] Although novel PROMs including FJS-12 and PJP are becoming more popular, there are limited studies with which to compare findings along these variables. [27–39] Although novel PROMs including FJS-12 and PJP are becoming more popular, there are limited studies with which to compare findings along these scales.[27–33] Our study has included a wide variety of PROMs to serve as a standard to compare existing data and as a baseline for the evolving trends. Very few studies in the literature have evaluated long-term outcomes using these novel PROMs.

Several studies have demonstrated similar long-term results along traditional PROMs in comparison to our study. In a study of 275 DAA THAs using a traction table, the HHS remained stable and did not differ significantly over time after a minimum follow-up period of 10 years.[36] Rahm et al. (2019) reported a median HHS at 5 and 10 years post-operatively of 99 (range, 58–100) and 99 (range, 29–100), respectively.[36] Müller et al. (2014) conducted a study including 150 AMIS DAA THA procedures with a minimum follow-up of 5 years.[18] The median subjective HHS was 99 (range 11–100) and median clinical outcome HHS was 99 (range 61–100) respectively at 5 year follow-up ($p < 0.001$).[18]

There were several major weaknesses identified in the evaluation of the study. Firstly the retrospective nature of the study is an important limitation. Additionally, there was a high attrition rate of 37.5% of the eligible study cohort that was lost to follow-up. Although there was an

unavoidable loss of 44 patients (5.3%) that were deceased, there were 107 patients (12.8%) for whom contact information was not available and were subsequently not sent questionnaires. There was also a lack of a control cohort with which to compare results. Variability of the population was further compromised as a single high volume surgeon conducted all procedures from a single institution.

5. Conclusion

To the authors' knowledge, this is the first paper from a developing country showing good long-term clinical and functional outcomes for DAA THA. Furthermore this study assesses both traditional and novel PROMs to serve as a baseline with which to compare prospective reports in the future.

Declarations of interest

None.

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CRediT authorship contribution statement

Jurek Rafal Tomasz Pietrzak: Conceptualization, Writing - original draft. **Zia Maharaj:** Writing - original draft, Writing - review & editing. **Josip Nenad Cakic:** Writing - review & editing, Supervision.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jor.2020.08.014.

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