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Direct superior approach with standard instrumentation for total hip arthroplasty: safety and efficacy in a prospective 200-case series

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Abstract

Introduction: Direct Superior Approach (DSA) is a muscle sparing approach for total hip arthroplasty (THA) implemented using special instrumentation. There is a lack of information in the literature concerning DSA with standard instrumentation.

Materials and methods: 238 patients were recruited for primary THA by a single surgeon from January 2016 until May 2017. 209 patients underwent THA through DSA approach with non-offset acetabular reamers and femoral broaches. We evaluated accuracy of implantation, complications and early functional results. Independent orthopaedic surgeons performed the clinical and radiographic assessments.

Results: 200 patients were followed for a year. 3 different implants were used. No sciatic nerve palsies, hip dislocations or fractures were recorded. There was one acute deep and superficial wound infection. The mean functional score was significantly improved at all follow-ups ($p < 0.001$). 97% of stems were inserted into the neutral coronal and 96% in neutral sagittal alignment. All cups fell within a safe zone of inclination and 91% of anteversion. 2 hips demonstrated heterotopic ossification, Brooker class I. Obese patients had no increased risk of complications.

Conclusions: DSA with standard instrumentation is safe and efficacious for THA. It offers fast recovery and facilitates correct implantation of different implants, can be useful even for hip dysplasia and obese patients with minimal complication rates.

Keywords

Direct superior approach, hip approach, hip arthroplasty, iliotibial-band preserving, minimally invasive, standard instrumentation

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Introduction

The ideal surgical approach for primary total hip arthroplasty (THA) should be simple, safe, muscle sparing and provide excellent exposure to ensure correct implantation; it must also offer fast and painless recovery and good cosmetic results.[1] While multiple studies have evaluated minimally-invasive (MIS) hip approaches, there is no consensus on a single preferred approach for THA.[1,2] The direct superior approach (DSA) is a muscle sparing hip approach that was developed to preserve the iliotibial band (IB) and minimise damage to short external rotators (SER). It is usually performed using special instrumentation and positioning of the patient's leg.[1–3]

We present a DSA-IB preserving approach with standard instrumentation. We aimed to assess the technical feasibility concerning: (1) implant placement accuracy; (2)

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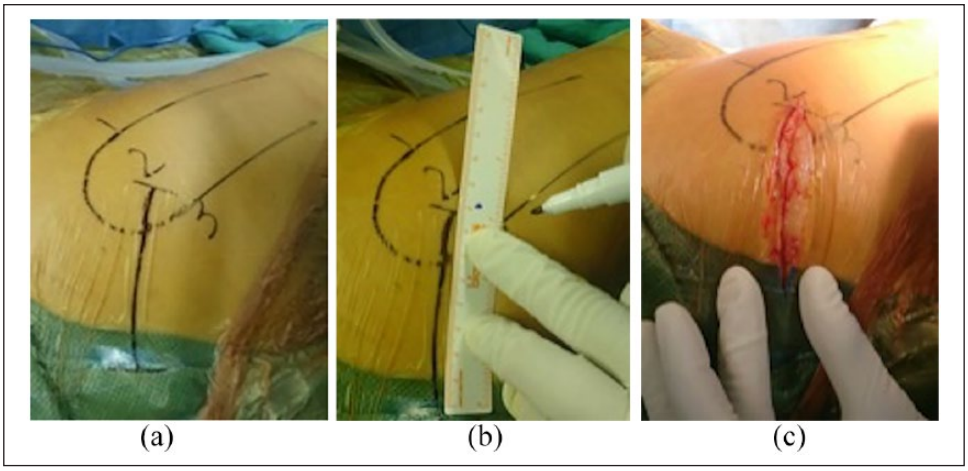

Figure 1. (a) Skin incision is made 45° backwards and upwards from the tip of the greater trochanter (b) and (c). The tip area is divided into thirds and the incision is made between the 2nd and 3rd thirds.

complications; and (3) up to 12 months functional outcome scores in 200 cases performed by a single surgeon as a continuous series.

Materials and methods

Our study was a prospective, single-blinded trial performed in our Academic Department with 12-month follow-up, with approval from the Institution's Scientific Research Board. All patients were informed about their participation in the study and gave signed consent. All data were recorded in the regional Arthroplasty Registry of Thessaloniki.

Between January 2016 until May 2017 consecutive patients $>$ 18 years, suffering from end-stage hip arthritis undergoing primary unilateral THA in our unit were enrolled in the study. Severe non-manageable pain and walking disability were the primary indications for THA. Arthroplasties were performed through a DSA-IB preserving approach with standard instrumentation (non-offset acetabular reamers and femoral broaches).

The exclusion criteria included revision THA, trauma, Hartofylakidis type III developmental hip dysplasia,[4] prior hip procedures with retained hardware and an American Society of Anesthesiologists score $\geqslant$ 4. The senior surgeon (ET) was not blinded to the study; although he performed the procedures, he did not participate in the clinical and radiological evaluation. The attending orthopaedic surgeons who performed clinical follow-up, radiographic assessment and analysis were blinded to the purpose of the study.

Operative technique

The patient was positioned in the lateral decubitus position supported with positioners placed on the pubic symphysis and sacrum. The initial incision was made between the middle and posterior thirds of the greater trochanter, 45° backwards and upwards from the posterosuperior corner of the greater trochanter (Figure 1(a)–(c)). The gluteus maximus fascia was incised sharply, and muscle fibres were bluntly divided. The pericapsular fat was swabbed to expose the SER and the sciatic nerve.

A Langenbeck retractor was placed underneath the gluteus medius (GMed) to identify the plane between the gluteus minimus (GMin) and piriformis (PF) muscles. Once the hip was flexed and internally rotated, the SER were exposed (Figure 2(a)). The PF and obturator internus (OI) tendon were tenotomised close to their femoral insertion and stripped off the posterior capsule. The PF and OI were separately tagged with Ethibond suture and were taken down to protect the sciatic nerve (Figure 2(b)). The capsule was incised from the anterior distal to posterior proximal, and the capsular flap was tagged with a running Ethibond suture and retracted posteriorly.

The hip was then dislocated (Figure 2(c)). Once the femoral head was removed, the leg was flexed, internally rotated and adducted to expose the anterior capsule and remove the anterior neck osteophytes. The proximal femur was then retracted anteriorly with a curved retractor placed over the anterior acetabular rim while the leg remained flat on the table. A Hohmann retractor was placed at the inferior acetabular margin and a smaller retractor anteroposteriorly to keep the posterior capsular flap away during reaming (Figure 3(a)). We used a straight reamer and impactor for sequential reaming (Figure 3(b)) and cup implantation, respectively (Figure 3 (c) and (d)).

Attention was then turned to the femur, placing the hip in flexion, internal rotation and adduction, with the knee flexed to 90° and the tibia vertical (Figure 3 (e)). The assisting surgeon exerted longitudinal force on the leg to adequately expose the femur. A curved blunt Hohmann

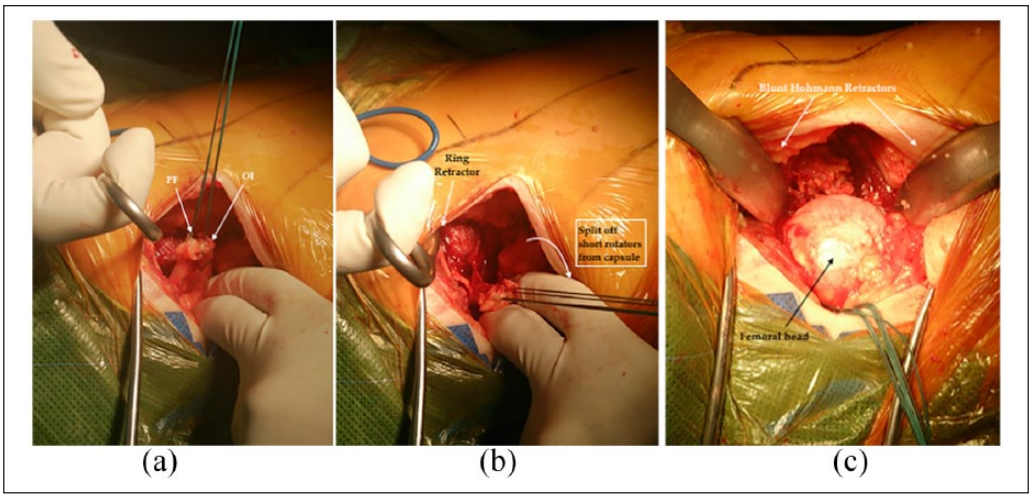

Figure 2. (a) and (b) Short rotators (PF: piriformis, OI: obturator internus) are tagged with Ethibond suture size 5 and detached from their base for reattachment after the end of surgery. The gluteus medius and minimus are protected using the ring retractor. (c) Two blunt Hohmann retractors were placed around the neck to expose the femoral head and neck. Compare the size of the femoral head to the size of the incision (the head occupies nearly 2/3 of the incision).

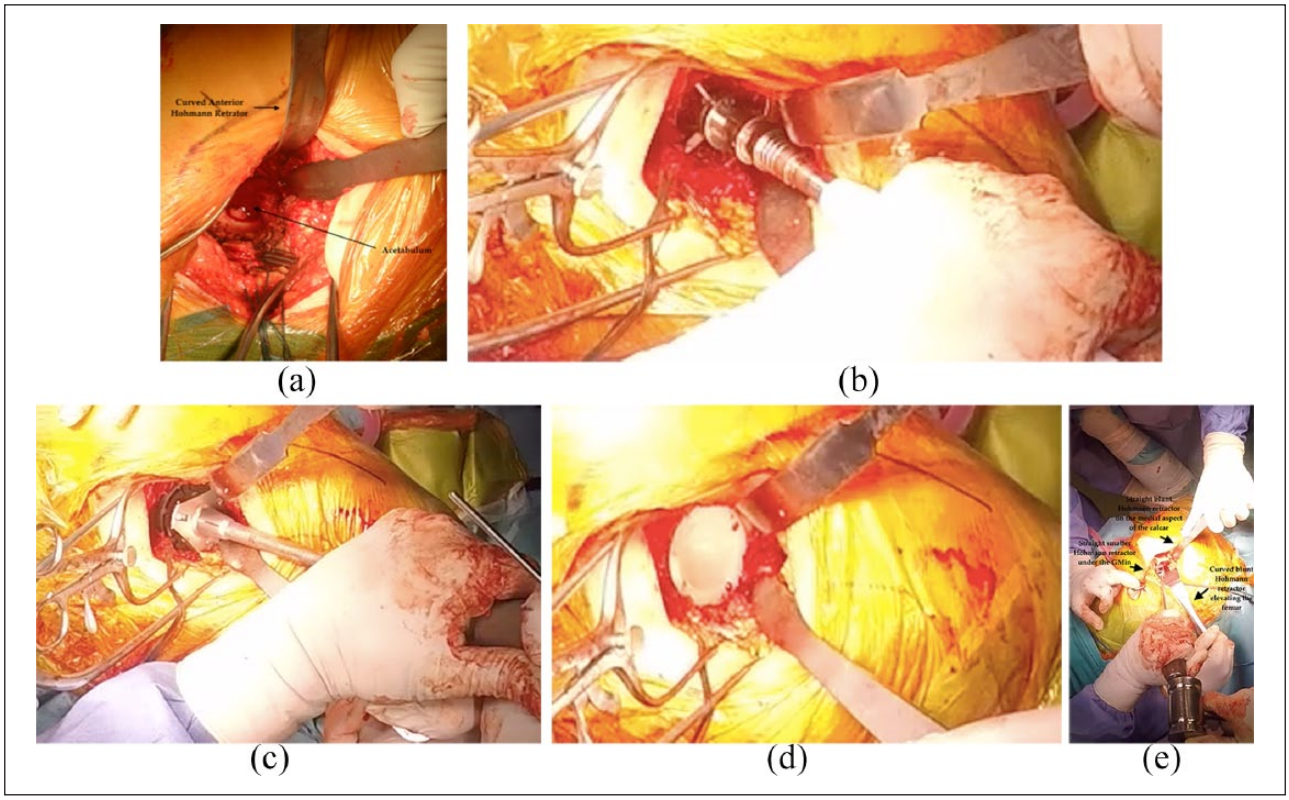

Figure 3. (a) An ideal view of the acetabulum (b) Use of a straight reamer for sequential reaming (c) Implantation of the acetabular component with a straight impactor (d): Implanted monoblock Socket (Matthys, European Orthopaedics) (e): Leg position with the knee flexed to 90° and the tibia vertical, serving as the reference for stem orientation during femoral preparation.

was placed under the anterior femoral neck to elevate the femur and a blunt Hohmann on the calcar to retract muscles away. The femur was prepared conventionally according to the surgical technique.

Once the definite components were implanted, the tendinous-capsular flap was repaired. The capsular flap was repositioned first and the musculotendinous second, using tagging sutures passing through a transosseous channel

made in the greater trochanter and lower part of the GMed. The gluteus maximus fascia, fat and skin were closed with running absorbable suture. No deep drain was used.

Perioperative management

Patients received general anaesthesia. Intravenous cefuroxime 750 mg 3 times and vancomycin 500mg twice a day were begun preoperatively and continued for 24 hours postoperatively. Patients received intravenously 1 gr of tranexamic acid preoperatively and oral rivaroxaban 6 hours postoperatively which continued daily for a month. Postoperative pain was initially controlled with intravenous paracetamol three times, lornoxicam twice a day and tramadol for 48 hours. Patients were mobilised during the first 12 hours postoperatively and encouraged to ambulate with partial weight bearing for 15 days.

Clinical and radiographic assessment

Preoperatively, a standard detailed history was collected. We also recorded the operating time, length of incision, type of anaesthesia, estimated blood loss, type of implant, intraoperative complications, blood transfusion rate, length of hospital stay and discharge to home or to a rehabilitation unit. Follow-up was carried out during the first postoperative year; complications, re-administration and revision rates were recorded. Two independent hip arthroplasty specialists assessed hip function using the Harris Hip Score (HHS) and the Hip disability and Osteoarthritis Outcome Score (HOOS) preoperatively and at 1, 3 and 12 months postoperatively.[5] They also performed radiographic analysis using supine anteroposterior (AP) pelvic x-rays centred over the pubis and cross-table lateral radiographs of the femur in a standardised position preoperatively, immediate postoperatively, and on the year.[6]

Cup inclination was measured by the angle formed by the transverse axis and plane of the acetabular opening and stem alignment as the angle between the longitudinal axis of the femoral intramedullary canal and the long axis of the stem in AP radiographs.[6,7] Cup anteversion was determined as the angle formed by the bottom of the radiographic plate and the opening plane of the cup in lateral femoral x-rays.[6] We used the Danoff criteria to assess a safe acetabular zone for implantation and the Brooker classification for heterotopic ossification.[8] The difference in distance between the tip of the lesser trochanter and the inter-teardrop line was used to measure leg-length discrepancy (LLD).[8,9]

Statistical analysis

Standard statistical methods were used for descriptive statistics. The Kolmogorov-Smirnov and Shapiro-Wilk tests tested the normality of data distribution. Statistical tests were 2-tailed. Alpha level was set at 0.05. A 2-sided independent sample t-test or Mann-Whitney U-test was used to compare continuous variables normally and not normally distributed, respectively. Interrater agreement between raters was measured with the Cohen kappa coefficient (κ). Statistical analyses were performed using SPSS software (IBM, version 25.0).

Results

238 patients were recruited by the senior surgeon for primary THAs from January 2016 until May 2017. 209 patients met the inclusion criteria and underwent THA through DSA. Five patients declined to participate in this study. Four patients were lost to follow-up, primarily due to residing in other countries. Thus, complete data were available for 200 (95.7 %) patients at 1-year follow-up.

Patient demographics and preoperative baseline characteristics are depicted in Table 1. The IB and quadratus femoris were preserved in all cases. Table 2 demonstrates intraoperative data, implant characteristics and postoperative radiological data. 92 patients received hybrid THA with cementless Trident cup and cemented Exeter stem (Stryker, Mahwah, USA), 55 uncemented THA with Pinnacle cup and Corail stem (Depuy Synthes) and 53 uncemented THA with RM Monoblock cup and twinSys stem (Matthys European Orthopaedics). No lipped liners were used. All hips fell within the safe zone of inclination and 182 hips (91%) within the safe zone of anteversion; 18 hips were implanted only 7^0 outside the safe zone. See Supplementary material 1, data list.

No sciatic nerve palsies, hip dislocations, intraoperative fractures or thromboembolic events were recorded. There was an acute deep infection in an otherwise stable and well-aligned prosthesis which was treated with thorough debridement, lavage and exchange of modular parts of the implants; a superficial infection was managed with debridement and oral antibiotics. Bruising or hematoma due to increased pressure on wound edges from retractors was recorded in five patients. Patients with body mass index (BMI) $>$ or $< 30\,kg/m^2$ had a similar risk of infection.

The mean postoperative functional scores were significantly improved at 1, 3 and 12 months compared to the preoperative scores ($p < 0.001$) (Table 3). The mean LLD was corrected from 1.6 cm (range 0–2.6 cm) preoperatively to 0.4 cm (range 0–1 cm) postoperatively ($p < 0.001$). There was a strong agreement between surgeons, $\kappa > 0.8$, $p < 0.001$ for all parameters screened. Two hips demonstrated heterotopic ossification Brooker class I at the 1-year follow-up.

Discussion

Our series reports 200 unilateral THAs performed by a senior surgeon using DSA with standard instrumentation. Our initial experience suggests that DSA is easy to perform and doesn't necessarily need specialised instruments. It offers an ideal view of the acetabulum and femur, results in minimal blood loss and can be performed quickly using

Table 1. The demographics, preoperative baseline characteristics, and clinical data of the patients.

Parameters		Values
Number**		200
Age (years)*		66.53 ± 8.87 (49–87)
Sex***	Male	71 (35.5)
	Female	129 (64.5)
BMI (kg/m^2) *		27.59 ± 2.98 (22–39.7)
BMI < 30kg/m^2 ***		154 (77)
BMI > 30kg/m^2 ***		46 (23)
ASA grade ***	I	62 (31)
	II	114 (57)
	III	24 (12)
Operated side ***	Right	119 (59.5)
	Left	81 (40.5)
Preoperative diagnosis ***		
Primary osteoarthritis		142 (71)
Hip dysplasia Hartofylakidis type I		20 (10)
Hip dysplasia Hartofylakidis type II		20 (10)
Avascular necrosis		14 (7)
Rheumatoid arthritis		3 (1.5)
Psoriatic arthritis		1 (0.5)
Comorbidities ***		
Hypertension		142 (71)
Diabetes mellitus		64 (33)
History of malignancy		7 (3.5)

BMI, body mass index; ASA, American Society of Anesthesiologists score.
*The values are given as the mean with the standard deviation (±) and the range in parentheses.
**The values are given as raw numbers.
***The values are given as raw numbers with the percentages in parentheses.

Table 2. Operative and postoperative radiological data of the patients.

Operative and radiological data		Values
Incision length (cm) *		9.15 ± 1.32 (8–14)
Operation time (min) *		59.35 ± 13.37 (45–95)
Estimated intraoperative blood loss (ml)*		191.2 ± 80.16 (50–450)
Blood transfusion**	Yes	38 (19)
	No	162 (81)
Hospital stay (days) *		2.53 ± 0.64 (2–4)
Discharge **	Home	184 (92)
	Rehabilitation	16 (8)
Acetabular cup diameter*		50.53 ± 3.14 (46–58)
Screws for cup fixation *		1.54 ± 0.81(0-3)
Bearing type**	MoP	36 (18)
	CoP	164 (82)
Head diameter (mm) **	32	85 (42.5)
	36	115 (57.5)
Cup orientation*	Inclination	44.15 ± 3.35 (31–49)
	Anteversion	20.76 ± 3.59 (11–27)
Stem coronal alignment**	Neutral	194 (97)
	Varus	6 (3)
	Valgus	0 (0)
Stem sagittal alignment**	Neutral	192 (96)
	Flexion	8 (4)
	Extension	0 (0)

MoP, metal-on-polyethylene; CoP, ceramic-on-polyethylene.
*The values are given as the mean with the standard deviation (±) and range in parentheses.
**The values are given as raw numbers with the percentages in parentheses.

different implants. It is useful even for hip dysplasia and obese patients with minimal complications.

1. Easy to perform

The DSA facilitated exposure and passage of non-offset reamers. Specific instrumentation remained minimal. An intraoperative adjustment of limb position was only necessary for the femoral approach; however, this was standard and reproducible. Our view of the lesser trochanter was unhampered even though surgeons have expressed doubts using MIS-PA.[2] We did not follow the proposed femoral position of 40° of flexion, adduction and internal rotation for DSA as this needs special instruments and may be misleading in stem orientation.[3]

2. Implant placement accuracy

In our series, there were no revisions for component malposition; the orientation of implants was excellent and reproducible. Our results are similar to studies evaluating component positioning using an MIS-PA or standard PA.[1,10,11] Cup placement has also been reported to be safe and effective using various MIS approaches.[12] However, the unobstructed view to the femur is not guaranteed in all approaches. The access to the femur using anterolateral or DAA is hampered due to the difficulty of elevating the proximal femur, resulting in more frequent stem malposition or restriction of stem choices.[13,14]

3. Complications

We had limited major complications. No sciatic nerve palsies were recorded. Our standard DSA involved the identification and protection of the sciatic nerve throughout the procedure. The risk of sciatic nerve damage was similar to standard PA in contrast to typical types of nerve damage after DAA.[11,15]

The wound complication rate of DSA was narrow and similar to other hip approaches.[16] Obesity and diabetes did not increase the risk of infection. The higher risk of superficial infection using DAA than PA in obese patients could be attributed to anatomical differences[17]; the part of gluteal muscles involved in MIS-PA is relatively clean and well draped away from the perianal region compared to the

Table 3. Preoperative and postoperative outcomes data given as mean ± standard deviation.

Variable	Preoperative	Postoperative		
		1 month	3 months	12 months
HHS	44.79 ± 5.0	79.99 ± 4.64	87.94 ± 5.0	91.45 ± 5.38
HOOS				
Symptoms	44.89 ± 5.72	74.93 ± 5.57	87.9 ± 5.44	91.89 ± 5.63
Pain	41.38 ± 5.02	78.85 ± 5.48	88.23 ± 5.63	92.01 ± 5.79
ADL	37.9 ± 5.15	79.7 ± 6.02	87.47 ± 5.86	92.16 ± 6.34
S&R	37.26 ± 11.42	43.96 ± 14.38	55.50 ± 17.31	72.35 ± 21.29
QQL	39.69 ± 11.79	53.06 ± 13.33	66.87 ± 12.76	82.99 ± 12.31

HHS, Harris Hip Score; HOOS, Hip disability and Arthritis Outcomes Score; ADL, Activities of Daily Living; S&R, Sport and Recreation; QOL: Quality of Life.

inguinal fold of abdominal fat that macerates the skin in obese patients.

DSA is a tissue-friendly PA with minimal blood loss similar to other MIS-PA and standard PA.[1,2,11] A recent cadaveric study from the Mayo clinic demonstrated that DSA causes less soft tissue damage than DAA, which may help minimise blood loss.[18] Haemorrhage control may also be beneficial using PA, as branches of the medial femoral circumflex artery, the primary blood supply to the hip, arises posteriorly.[19]

Ideal access to the femur and acetabulum, excellent implant position and meticulous capsular release before dislocation probably resulted in the low risk of intraoperative fractures similar to standard and MIS-PA.[11] PA is reported to have similar or less fracture risk than DAA due to the easier approach to the femoral canal and stem position.[14,16,20] No dislocation was recorded in our series; this is mainly attributed to the accuracy of implantation, the use of large heads and the repair of the posterior capsule and SER.[2,21] This repair is essential for proprioception and stability, remains intact for the majority of patients and provides a biological scaffold to form a posterior pseudocapsule.[21]

4. Feasibility

DSA was used successfully for mild or moderate dysplasia, obese patients and different implants. Access to a dysplastic acetabular roof for reconstruction can occur *via* DSA purely for anatomical reasons. Dysplastic femoral canals are narrow with antetorsion, and anteversion and access to the proximal femur is critical for the proper stem version. DSA was successful even for obese patients; however, the level of difficulty was higher in obese patients where we may need a longer incision. The beneficial access to the proximal femur using DSA allowed us to use anatomical and non-anatomical stems with or without cement.

5. Quality of life

Our patients demonstrated continuous improvement of hip function and quality of life. DSA facilitated recovery and shortened length of hospital stay. Our results are equivalent to, or even better than other MIS-Pas.[10,11] The current evidence does not demonstrate clear superiority of the PA or DAA approach on functional recovery.[22] In a recent study from the Mayo Clinic, both approaches were found to provide excellent early recovery with minimal complications.[22]

There are some limitations to this study. 1st, it is not a controlled prospective study. Second, the follow-up is relatively short. However, we aimed to illustrate our first experience with DSA. All procedures were performed by the senior surgeon which reduces bias due to having multiple surgeons with different experiences of DSA. Bias was also reduced due to the fact that the attending surgeons who performed the analysis were also blinded to the study.

Conclusion

DSA with standard instrumentation is a safe and efficacious approach for THA. It offers an excellent view of the acetabulum and the proximal femur which facilitates correct implantation. It is an iliotibial band sparing approach that protects the gluteus medius and minimus without difficulty. It is a painless approach with relatively low blood loss offering very fast recovery and good cosmetic results. It can be extended to a posterior approach if needed with relative ease, can be performed quickly using different implant designs or techniques (cemented or uncemented) and it can be useful even for hip dysplasia and obese patients with a minimal complication rate.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: ET is Secretary General of the European Hip Society.

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Supplemental material

Supplemental material for this article is available online.

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