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Direct Anterior THA with Leg Positioning Traction System for Avascular Necrosis: Technique and Early Outcomes

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Learning Point of the Article:

Use of a leg-positioning traction system in direct anterior total hip arthroplasty facilitates femoral exposure and may improve component positioning and early recovery in young patients with avascular necrosis.

Abstract

Introduction: Avascular necrosis (AVN) of the femoral head commonly affects young adults, particularly in Asian populations, often requiring total hip arthroplasty (THA) at an early age. The direct anterior approach (DAA) is a muscle-sparing technique utilizing the internervous plane between the tensor fasciae latae and sartorius, preserving abductors and posterior structures, and enabling faster recovery with lower dislocation risk. However, DAA is technically demanding and often requires adjuncts, such as leg-positioning traction systems (LPTS) and intraoperative fluoroscopy.

Case Series: We report a consecutive series of five hips in young patients (mean age 34.6 years) with stage III/IV atraumatic AVN and femoral head collapse. All patients underwent cementless DAA-THA using a mobile LPTS and fluoroscopic guidance. The mean operative time was 85 min, and mean incision length was 11.6 cm. Components were implanted with target acetabular positioning of 40–43° abduction and ~15° anteversion. Full weight-bearing was initiated on postoperative day 1. At a mean follow-up of 14 months, significant functional improvement was observed: Harris Hip Score improved from 41.6 to 91.4, hip disability and osteoarthritis outcome score for joint replacement from 49.8 to 90.6, and Patient-Reported Outcomes Measurement Information System Physical Function T-score from 42.5 to 59.2. Radiographs showed well-aligned components without loosening or subsidence. No dislocations or fractures occurred; one transient lateral femoral cutaneous nerve neuropraxia resolved within 3 months.

Conclusion: Direct anterior approach THA with a leg-positioning traction system and fluoroscopic guidance demonstrated favorable short-term functional and radiological outcomes in this small series of young AVN patients. However, given the limited sample size, retrospective design, and absence of a comparison group, these findings should be interpreted with caution. Larger prospective comparative studies with longer follow-up are required to validate the wider applicability and long-term outcomes of this technique.

Keywords: Avascular necrosis, femoral head, total hip arthroplasty, direct anterior approach, leg-positioning traction system, fluoroscopy, cementless total hip arthroplasty, young adults.

Introduction

Osteonecrosis of the femoral head avascular necrosis (AVN) is a common indication for hip arthroplasty in young adults worldwide, particularly in Asian countries [1]. Progressive subchondral collapse leads to end-stage arthritis, at which point total hip arthroplasty (THA) is the only reliable treatment [2]. Conventional approaches often violate the abductors or external rotators, risking limp and instability. The supine direct

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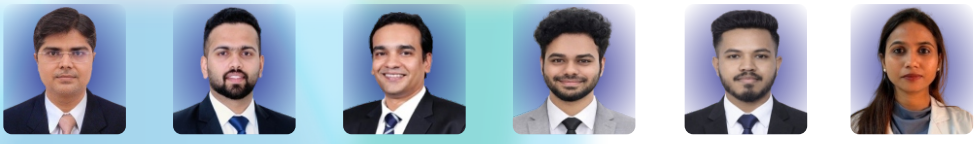

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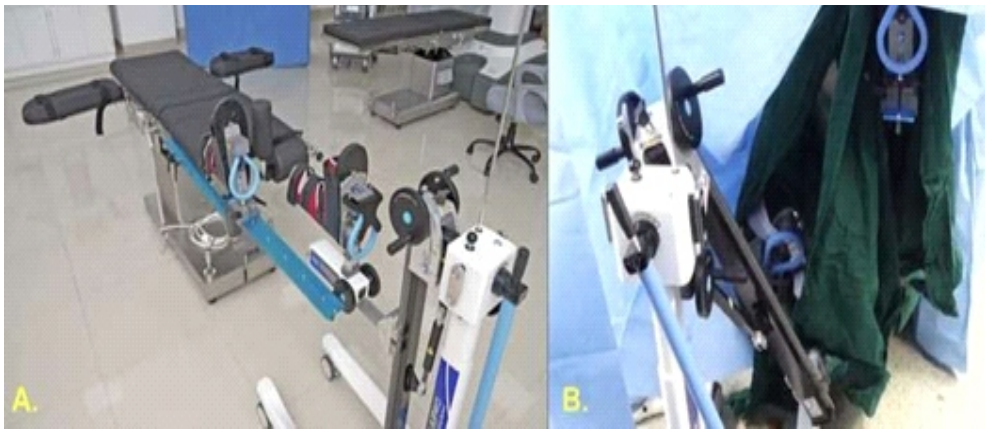

Figure 1: Operative room setup for direct anterior total hip arthroplasty. (a) The patient lies supine on a standard table. A padded perineal post and opposite-leg holder secure the contralateral limb. (b) The operative foot (not visible) is secured in the leg-positioning traction systems foot clamp. This orientation allows the C-arm to obtain anteroposterior pelvic views of the hip.

anterior approach (DAA) exploits the Smith–Petersen interval between sartorius and tensor fasciae latae (TFL), avoiding detachment of the gluteus medius/minimus and preserving the posterior capsule [3,4]. This muscle-sparing "internervous" plane theoretically allows earlier ambulation and lower dislocation rates [5]. Indeed, meta-analyses show DAA patients tend to mobilize faster and have modestly shorter hospital stays than posterior or lateral approaches [5,6], though longer-term outcomes and complication profiles are generally similar [7,8].

DAA THA is technically demanding, with reports of steep learning curves and specific risks (femoral fracture, anterior cortical perforation, and lateral femoral cutaneous nerve [LFCN] injury) [9,10]. Specialized tables or mobile leg positioners traction system (LPTS) have been introduced to improve femoral exposure without rotating the patient onto a dedicated traction table. In 2025, Aneja et al. described a LPTS adjunct to standard OR tables for DAA, which allows controlled traction, rotation and hyperextension of the operative leg [11]. They noted that DAA requires such equipment and that LPTS can make exposure more reproducible in diverse operating rooms [11,12,13]. Early descriptions of the anterior approach have been reported in

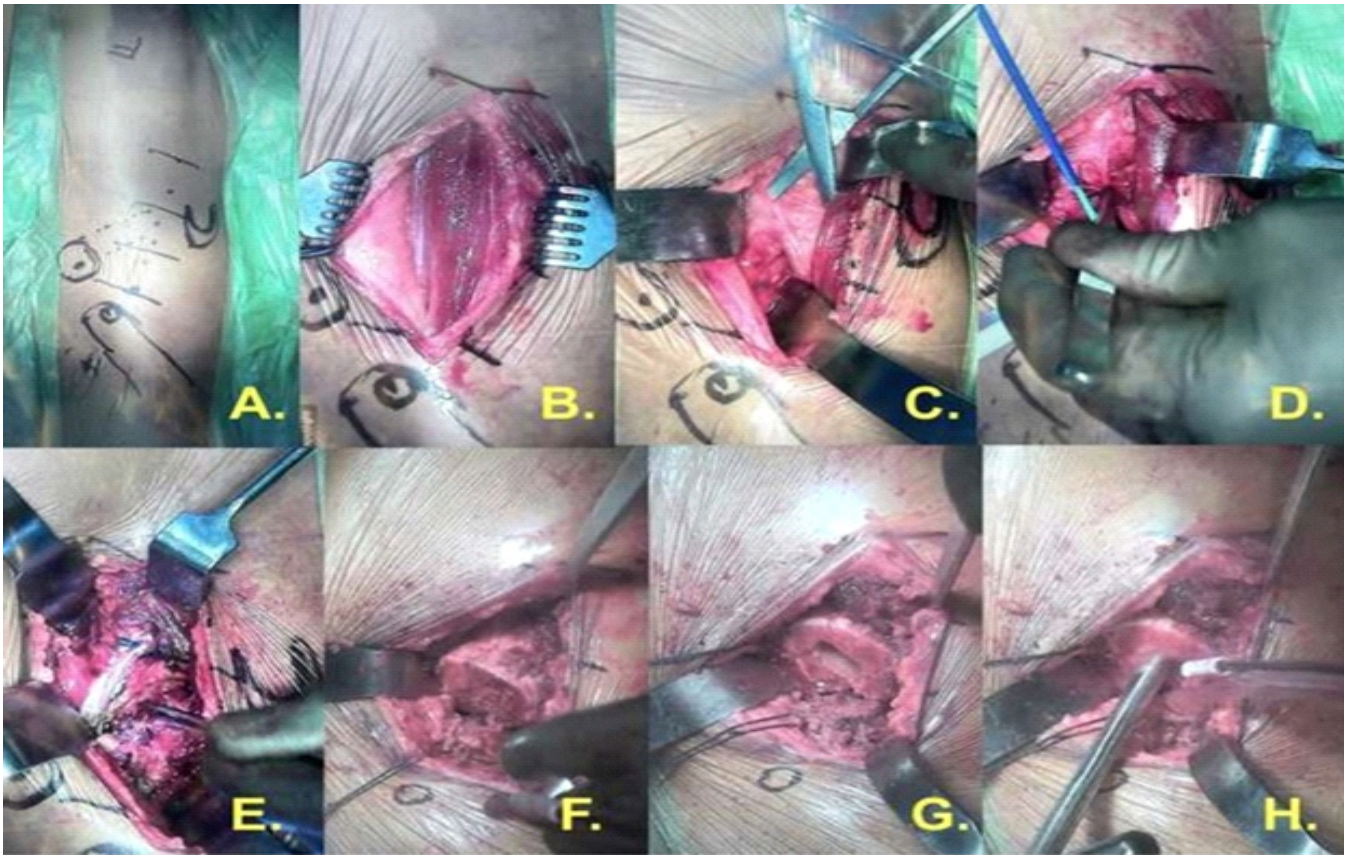

Figure 2: Operative steps of the procedure. (a, b, c, d, e, f, g, h). The figure illustrates the sequential steps of the procedure, beginning with supine patient positioning and anterior surgical exposure through the Hueter interval, followed by femoral head resection and femoral preparation.

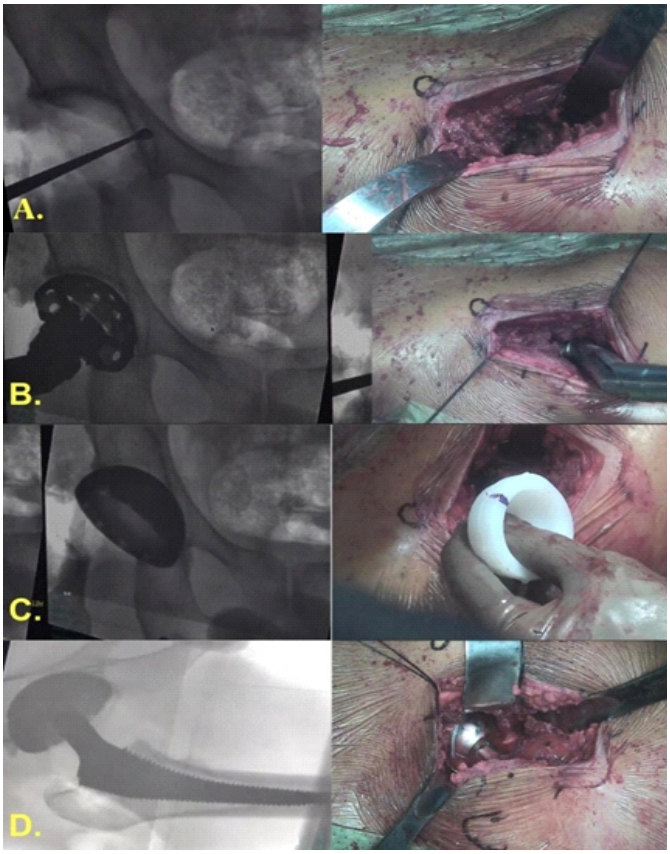

Figure 3: Acetabular preparation, implantation, and final assessment. (a) Acetabular preparation performed under fluoroscopic guidance with sequential reaming and trial cup placement, (b) implantation of the definitive acetabular cup with liner and definitive femoral stem, (c) final reduction with intraoperative assessment of leg length, offset, and hip stability, (d) Layered wound closure following confirmation of satisfactory implant position and stability.

classic literature [3]. Subsequent technical refinements and minimally invasive adaptations were described later [4]. Comparative studies have evaluated differences between anterior and posterior approaches [14].

Intraoperative fluoroscopy is another advantage of the supine position: Multiple series report that fluoroscopic guidance significantly reduces variability in cup placement and improves safe-zone alignment [6, 15]. Matta et al. (n = 494) found 96% of cups within target abduction (35–50°) and 93% within target anteversion (10–25°) using DAA with C-arm imaging [16], with a low dislocation rate (0.6%).

Despite growing DAA use in the West, data in Asian AVN patients are scarce. Registries show that AVN accounts for a majority of THA in India (~52%) and other Eastern populations [1], in contrast to <6% in the US. Young AVN patients have high functional demands, making muscle preservation and precise implant positioning imperative. We therefore report our operative technique of DAA THA with LPTS and fluoroscopy in an Indian center, together with early results (functional scores, radiographs, complications) for a consecutive series of AVN hips. We also compare our findings to existing literature on DAA, LPTS assistance, and intraoperative imaging.

Materials and Methods

This case series was conducted at a tertiary care hospital between 2022 and 2023 and included five patients (3 men, 2 women; mean age 34.6 years, range 27–38) who underwent primary THA for idiopathic AVN via DAA with an LPTS. All had advanced femoral head collapse (Ficat–Arlet stage III–IV on magnetic resonance imaging). Mean body mass index was 23.6 (range 19–26). Exclusion criteria were hip dysplasia, posttraumatic AVN, or prior hip surgery. All surgeries were performed by experienced arthroplasty surgeons familiar with the direct anterior approach. Demographics and outcomes are summarized in Table 1.

This study is a retrospective case series without a control group. Due to the small sample size, formal statistical comparative analysis was not performed, and results are presented descriptively.

Operative technique

The patient is positioned supine on a standard OR table fitted with a contralateral leg holder and a LPTS (Fig. 1). The perineal

Table 1: Demographics and early clinical outcomes

Parameter	Mean (±SD)
Patient age (years)	34.6±5.7
Gender (M:F)	3:2
Affected side (Rt:Lt)	3:2
Ficat grade (III/IV)	2:3
BMI (kg/m^2)	23.6±3.1
Preop HHS	41.6±3.5
Postop HHS	91.4±2.9
Preop HOOS-JR	49.8±4.2
Postop HOOS-JR	90.6±3.4
Preop PROMIS PF T-score	42.5±3.9
Postop PROMIS PF T-score	59.2±2.7
Lateral femoral cutaneous nerve palsy	1/5 (transient)
Other complications	None

Mean values (±SD) are shown for the 5 hips. All functional scores improved significantly, with no serious complications. HHS: Harris hip score, PROMIS PF: Patient-reported outcomes measurement information system physical function. The single LFCN palsy resolved by 3 months. At follow-up, all functional scores improved markedly, and no major complications were observed. LFCN: Lateral femoral cutaneous nerve, HOOS-JR: Hip disability and osteoarthritis outcome score-joint replacement, BMI: Body mass index, SD: Standard deviation

Figure 4: Schematic operative flowchart depicting the sequential steps of the procedure, beginning with patient positioning and progressing through skin incision and exposure, femoral head resection, femoral and acetabular preparation, final implantation, reduction and assessment, and concluding with closure and early rehabilitation.

post is placed against the medial thigh of the operative side to prevent excessive shift. The non-operative leg is secured in a padded abducted holder. The table is oriented so its length lies under the patient's center of gravity, allowing C-arm access [12,17]. Both feet are placed in traction boots; the operative foot is strapped to the LPTS foot holder. Lateral imaging is possible by adducting or externally rotating the contralateral leg in its holder. The surgical field (from iliac crest to mid-thigh) is prepped widely.

With the hip in neutral, an 8–12 cm incision is made starting 1–2 cm distal and 2–3 cm lateral to the Anterior Superior Iliac Spine, directed toward the fibular head. The fascia over the TFL is incised and the TFL retracted laterally; the interval between TFL and sartorius (innervated by superior gluteal and femoral nerves, respectively) is used [18]. A capsulotomy is performed to enter the joint. Retractors (standard anterior approach retractors) are placed: One on the anterior acetabular rim, one on the superior pubic ramus, and one on the medial femoral neck. The femoral neck is osteotomized and the head removed with traction and corkscrew.

After head removal, the LPTS is used to extend (and, if needed, externally rotate) the hip while maintaining gentle traction, which leverages the femur out of the socket. The modular LPTS allows smooth dynamic adjustment without detaching the leg from the table (Fig. 2).

Radiographically, version was confirmed by obtaining a true anteroposterior pelvic image and tilting the C-arm cephalad until the cup rim collapsed into a line- the tilt angle represented true anteversion. Inclination was judged radiographically as the acute angle between the cup opening plane and the inter-teardrop line. Acetabular reaming is performed with iterative fluoroscopic checks: The C-arm is rotated under the table until the acetabular opening is seen in profile (parallel to X-ray beam) [6]. Sequential reaming is done to fit an uncemented titanium cup (Fig. 3). The target cup orientation is ~ 40–43° abduction and ~15° anteversion; final cup position is confirmed under fluoroscopy [15]. A highly crosslinked polyethylene liner is impacted.

Attention then turns to the femur. The femur was externally rotated manually to the maximal safe degree. Medial and posterior releases were carried out sequentially from the lesser trochanter toward the neck, followed by superior capsular release to visualize the tip of the greater trochanter. With retractors in position, the femoral neck was delivered into view by extending (up to 90°), externally rotating (up to 140°), and adducting (~40°) the limb using the LPTS.

Soft-tissue release around the piriform fossa was completed. The conjoint tendon was released selectively when additional visualization was required, while the piriformis could be released if necessary. The obturator externus tendon was preserved to maintain dynamic hip stability.

A box cut was made at the base of the neck. To prevent canal perforation, a starter rasp was used to identify the femoral canal, followed by sequential broaching until optimal cortical contact was achieved. Femoral stem version was maintained parallel to the posterior cortex, referencing the obturator externus ("lighthouse") to preserve native anteversion. A calcar reamer was used to refine the neck cut, and fluoroscopy verified correct alignment of the trial stem. The trial components are reduced, and final leg length and stability are verified under fluoroscopy in flexion and extension. The definitive Metal head is placed, and the hip tested for impingement and stability. The wound is closed over a subcutaneous drain (Fig. 4).

Post-operative care

No hip precautions were imposed. All patients began mobilization with a walker on post-operative day 1. Pain control and thromboprophylaxis followed standard protocols. Early full weight-bearing as tolerated was allowed. Physical therapy emphasized gait training and abductor exercises. Patients were

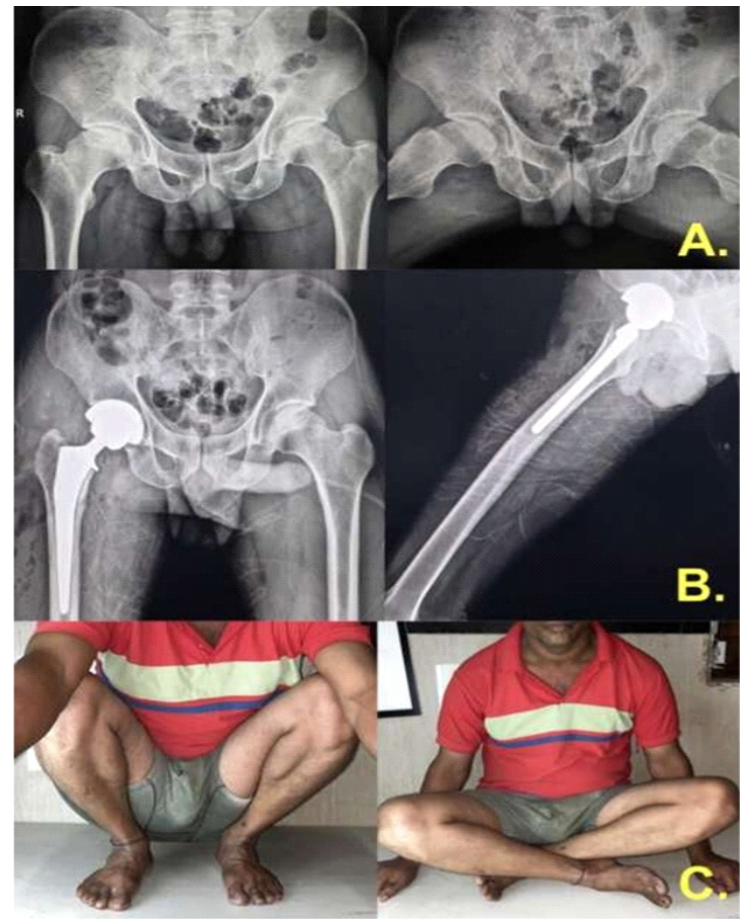

Figure 5: Radiological and functional outcomes. (a) Preoperative radiographs of the pelvis showing anteroposterior and lateral views of the affected hip, (b) Postoperative radiographs demonstrating right total hip arthroplasty performed via the direct anterior approach with satisfactory component positioning, (c) Clinical follow-up images showing excellent functional outcome, with the patient able to squat and sit cross-legged, indicating good hip mobility and stability.

discharged when ambulatory (mean hospital stay 2.4 days).

Results

Five hips were treated (Table 1). Four patients had unilateral AVN (stages III–IV); one had bilateral procedures staged 1 week apart (data above are per hip). At mean 14-month follow-up (range 8–18 months), all patients were pain-free, walking unassisted, and satisfied. Mean Harris Hip Score improved from 41.6 (standard deviation [SD] 2.5) pre-operatively to 91.4 (SD 2.9) post-operatively [19]. Mean hip disability and osteoarthritis outcome score for joint replacement (HOOS-JR) rose from 49.8 to 90.6, and mean patient-reported outcomes measurement information system physical function (PROMIS PF) T-score from 42.5 to 59.2 [20]. The single-leg support (Trendelenburg) test was negative in all cases.

Radiographic analysis showed well-centered, fully seated implants. Mean cup abduction was ~42°, anteversion ~16° (consistent with targets). No evidence of component loosening or subsidence was seen. There were no dislocations, periprosthetic fractures, infections, or heterotopic ossification. One patient (Case 2, left hip) had transient numbness over the lateral thigh consistent with LFCN neurapraxia; this resolved spontaneously by 3 months. No patient required a blood transfusion; the mean hemoglobin drop was <2 g/dL. No perioperative complications (deep vein thrombosis, wound issues) occurred (Fig. 5).

Although no patient required blood transfusion and operative times were consistent, detailed evaluation of intraoperative parameters such as radiation exposure and cost implications was not performed. These factors may be relevant when considering broader applicability of the technique.

Discussion

This case series suggests that DAA-THA with a leg-positioning traction system (LPTS) and fluoroscopy can achieve favorable early outcomes in young patients with AVN. All hips showed marked pain relief and functional improvement without major complications. These findings are consistent with previous reports demonstrating good outcomes with DAA in AVN patients; for example, Moharrami et al. reported similarly high Harris Hip Scores and low complication rates at mid-term follow-up [21].

Notably, our cohort represents a young and active patient population in whom preservation of abductor function is critical. The direct anterior approach spares the gluteus medius and minimus muscles, which likely contributed to the absence of Trendelenburg gait and early functional recovery observed in our series [22,23].

The use of an LPTS facilitated femoral exposure and implant insertion. Unlike fixed traction tables, the mobile LPTS allows intraoperative flexibility while maintaining controlled traction. This may help improve reproducibility of femoral preparation, particularly in challenging cases [11,12].

In our experience, the LPTS enabled smoother femoral elevation and external rotation without increasing operative time. Previous studies have reported comparable outcomes between traction table and standard table techniques, with some suggesting a lower risk of periprosthetic fracture with traction-assisted methods [17].

Intraoperative fluoroscopy played a key role in achieving accurate component positioning. The supine positioning in DAA allows easy C-arm access, and fluoroscopic guidance

reduces variability in cup orientation [6]. In our series, component alignment was consistently within target ranges, with no evidence of malposition-related complications.

These findings are in agreement with prior studies such as Matta et al., who reported a high proportion of cups within safe zones using fluoroscopy-assisted DAA [16]. Other authors have similarly emphasized the importance of fluoroscopic guidance in improving implant positioning accuracy and reducing complications [6,24].

Comparatively, several studies and meta-analyses have demonstrated that DAA is associated with faster early recovery and shorter hospital stay compared to posterior or lateral approaches [5,6]. In our cohort, all patients mobilized on postoperative day one and achieved early independent ambulation, supporting these observations.

The complication rate in this series was low. The only adverse event was a transient lateral femoral cutaneous nerve neuropraxia, which resolved spontaneously. LFCN injury is a known risk of DAA due to its anatomical proximity; however, careful surgical technique can minimize this complication. We observed no dislocations, infections, or periprosthetic fractures.

The strengths of this study include a detailed description of surgical technique, consistent use of fluoroscopic guidance, and focus on a young AVN population. Functional outcomes using validated scores (HHS, HOOS-JR, PROMIS PF) showed marked improvement, consistent with previously published literature [20,21].

However, certain limitations must be considered. This study represents a small retrospective case series involving only five hips, which limits the generalizability of the findings. The absence of a control group prevents direct comparison with other surgical approaches.

All procedures were performed by experienced surgeons, and outcomes may therefore be influenced by surgical expertise. The learning curve associated with the direct anterior approach was not specifically evaluated and may affect reproducibility in less experienced hands.

The follow-up duration was relatively short and insufficient to assess long-term outcomes such as implant survivorship, wear, or late complications. Additionally, the study population was highly selective, consisting only of young patients with advanced AVN, which may limit applicability to other patient groups.

Minor heterogeneity within the cohort, including unilateral and bilateral cases, may also influence outcomes. Furthermore, the independent contribution of the leg-positioning traction system and fluoroscopy could not be evaluated due to the absence of a comparison group.

Important intraoperative parameters such as radiation exposure and cost implications were not analyzed in detail. Additionally, the requirement for specialized equipment such as LPTS and fluoroscopy may limit the feasibility of this technique in resource-limited settings.

Future comparative studies evaluating DAA with and without LPTS and fluoroscopic guidance are needed to better define their independent contributions to surgical outcomes. These findings should be interpreted as preliminary and hypothesis-generating.

Limitations

This study is limited by its small sample size, retrospective design, lack of a control group, and short duration of follow-up. The outcomes may also be influenced by surgeon experience, and reproducibility across different settings remains uncertain. Additionally, the independent role of the leg-positioning traction system and fluoroscopy could not be assessed. Important intraoperative factors such as radiation exposure and cost were not analyzed in detail, and long-term complications may not be captured in this small cohort.

Conclusion

This study demonstrates that direct anterior approach THA using a leg-positioning traction system with fluoroscopic guidance can provide satisfactory short-term outcomes in selected young patients with AVN. However, given the small sample size, retrospective nature, and lack of comparative analysis, these findings should be interpreted with caution. Further large-scale, prospective, and comparative studies are required to establish the true benefits, reproducibility, and long-term outcomes of this technique, and these findings should be interpreted as preliminary and hypothesis-generating.

Clinical Message

Direct anterior approach THA with LPTS and fluoroscopy may aid in achieving accurate component positioning and early functional recovery in young AVN patients; however, careful patient selection and surgical expertise are essential, and current evidence remains limited.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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