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Treatment of Intertrochanteric Fractures in the Elderly with Minimally Invasive DAA for Hip Arthroplasty

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Abstract:	Objective Direct Anterior Approach (DAA) is a nervous muscle space approach, which theoretically does not damage muscles and nerves, with less intraoperative bleeding, quick postoperative recovery and low dislocation rates and without contraindicated positions. It is considered as a truly minimally invasive approach for hip arthroplasty. Methods 134 elderly patients with intertrochanteric fractures hospitalized from February 2019 to August 2023 were chosen for hip arthroplasty using DAA, including 70 women and 64 men aged 70-94, with an average age of 79.40 ± 4.80. Results The incision length for hip replacement surgery was 10.14 ± 2.34 cm in length, the duration of surgery was 74.72 ± 12.54 min, intraoperative blood loss was 125.27±17.29 ml, the volume of postoperative drainage fluid was 122.43± 163.45 ml, the time of postoperative ambulation was 1.41±0.65 d, and the Harris hip score at six months after surgery was 93.57±4.85 points. There were three patients who experienced local numbness in the lateral thigh and no patients that suffered dislocations.

	Conclusion Hip replacement for elderly patients with intertrochanteric fractures using DAA causes less damage to soft tissues with low complications, and contributes to early-stage functional exercise. It is a reliable minimally invasive therapy.

Treatment of Intertrochanteric Fractures in the Elderly with Minimally Invasive DAA for Hip Arthroplasty

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Data availability all data are presented in the manuscript. Further data would be available upon reasonable request.

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Treatment of Intertrochanteric Fractures in the Elderly with Minimally Invasive DAA for Hip Arthroplasty

Abstract

Objective: Direct Anterior Approach (DAA) is a nervous muscle space approach, which theoretically does not damage muscles and nerves, with less intraoperative bleeding, quick postoperative recovery and low dislocation rates and without contraindicated positions. It is considered as a truly minimally invasive approach for hip arthroplasty.

Methods: 134 elderly patients with intertrochanteric fractures hospitalized from February 2019 to August 2023 were chosen for hip arthroplasty using DAA, including 70 women and 64 men aged 70-94, with an average age of 79.40 ± 4.80.

Results The incision length for hip replacement surgery was 10.14 ± 2.34 cm in length, the duration of surgery was 74.72 ± 12.54 min, intraoperative blood loss was 125.27±17.29 ml, the volume of postoperative drainage fluid was 122.43± 163.45 ml, the time of postoperative ambulation was 1.41±0.65 d, and the Harris hip score at six months after surgery was 93.57±4.85 points. There were three patients who experienced local numbness in the lateral thigh and no patients that suffered dislocations.

Conclusion Hip replacement for elderly patients with intertrochanteric fractures using DAA causes less damage to soft tissues with low complications, and contributes to early-stage functional exercise. It is a reliable minimally invasive therapy.

Key words: Direct Anterior Approach; hip arthroplasty; intertrochanteric fractures in the elderly

Introduction

With population aging and changes in the social structure in China, more and more elderly patients suffer intertrochanteric fractures. For elderly patients, this might be the last fracture in their life. In the past, the posterolateral approach to hip replacement was mostly used for treatment, but there are drawbacks in this approach such as severe trauma and high chance of dislocation [1]. As the concept of enhanced recovery after surgery emerged and drew attention in recent years, more excellent surgery, rehabilitation, care programs are actively sought after to relieve pain in patients and reduce surgical complications, make care easy and realize fast recovery [2]. Direct Anterior Approach (DAA) is to access the joint from the Hueter gap (sartorius muscle/rectus femoris muscle-tensor fascia lata) and theoretically does not damage muscles and nerves with less intraoperative blood loss, fast recovery after surgery and a low rate of dislocation and without contraindicated positions. It is deemed as a truly minimally invasive approach for hip replacement [3]. However, intertrochanteric fracture using DAA was not widely reported in the previous studies. To explore the clinical effect of the DAA for hip arthroplasty in intertrochanteric fractures, 134

elderly patients with intertrochanteric fractures treated with DAA for hip arthroplasty from February 2019 to August 2023 were selected as the subject of study in this research. The detailed reports are as follows:

Materials and methods

Clinical materials

134 patients with traumatic intertrochanteric fractures hospitalized from February 2019 to August 2023 were selected for treatment with DAA for hip arthroplasty (bipolar femoral head replacement for 77 patients and total hip arthroplasty for 57 patients). According to Evans-Jensen classification, there were 58 cases of type III, 39 cases of type IV and 37 cases of type V, including 70 women and 64 men aged 70-94, with an average age of 79.40 ± 4.80.

Therapeutic methods

Preoperative preparation

Before surgery, AP pelvis and lateral hip radiographs, along with hip CT scans were conducted on all patients to learn the conditions of bone displacements, the size of the medullary cavity and the acetabulum and the acetabular anteversion as well as the femoral proximal anteversion angle. Routine ultrasonography of bilateral lower-extremity veins was performed before operations to rule out thrombosis. If deep vein thrombosis is found to develop, preoperative anticoagulant therapy will be conducted. After admission, the blood pressure, blood sugar levels and functions of important organs were proactively adjusted and related departments would be invited for timely consultation when necessary. Surgery should be completed 3d after admission as much as possible. 1g of Cefazolin Sodium is used to prevent infections and 1g of Tranexamic acid to reduce bleeding 30 min before operation. 2 assessors (LGB and LPQ) measured and record the data above respectively and the results were the mean value of the accessors. Any deviations outside 2 standard deviations were accessed by the 3rd assessor.

Anesthetization and position

Combined spinal-epidural anesthesia is preferable and general anesthesia is conducted when necessary.

Surgical methods

Surgical position and incision selection

Patients were placed in a supine position. Usually, the position of the anterior superior iliac spine was raised using a pad for hip hyperextension, femoral dislocation and acetabular exposure. The pelvis and the pad should be on the same horizontal line and if the position is mistakenly placed, the acetabular anteversion or retroversion will be affected. The skin incision was placed 1cm downward the anterior superior iliac spine and 2cm backward the anterior superior iliac spine and extended towards the fibular head along the direction of the tensor fasciae latae. The position of this

incision facilitates to protecting the lateral femoral cutaneous nerve. If access to the sartorius muscle and the tensor fasciae latae, the skin incision should be chosen at the muscular gap between the tensor fasciae latae and the sartorius muscle. Poor selection of the location of incision will easily cause difficulties in exposure of the proximal femur and complications from intraoperative femoral fracture occur easily when prostheses are implanted.

Acetabular exposure

Make a cut through the skin and subcutaneous tissue and fascia to expose the tensor fasciae latae, cut open the fascia of the tensor fasciae latae and bluntly mobilize the anterior fascia of the tensor fasciae latae and the muscle fiber of the tensor fasciae latae, put a small Hoffman retractor at the lower edge of the lateral greater trochanter and the lateral femoral neck respectively to retract the fascia lata outwards and use a thyroid retractor to retract in the medial; expose the ascending branch of the lateral circumflex femoral artery, divide and ligate the ascending branch of the lateral circumflex femoral artery, divide the fascia of the tendon of the lateral rectus femoris, and we can see the fat layer of the anterior hip joint capsule, i.e. the Hueter gap. Place a small Hoffman retractor at the medial joint capsule and expose the anterior joint capsule. After the anterior joint capsule is cut open, release the anterior-medial joint capsule until the lesser trochanter can be exposed.

Implantation of acetabular prostheses

Osteotomize the femoral neck with a power saw and take out the fracture bone and the femoral head to expose the acetabulum. Remove the osteophyte on the edge of the acetabulum and the acetabular labrum, and use an acetabular reamer to ream the acetabulum to an appropriate size, and implant the acetabular prosthesis after a mold test. When the acetabular prosthesis is implanted, use the standard points of acetabular anatomy (the transverse acetabular notch and the anterior acetabular notch) to position the acetabular prosthesis [4] and better keep the location of the acetabular prosthesis in a safe area (i.e. acetabular inclination angle: 40° ± 10°; acetabular anteversion angle: 15°± 10°) and thus reduce the chance of postoperative hip dislocation, prosthetic impingement, prosthesis wearing and other complications. If bipolar replacement is conducted, the acetabular side does not need to be dealt with.

Implantation of femoral prostheses

Femoral reaming is the most difficult step in the DAA operation. When the bone marrow is reamed in the DAA approach, it is necessary to raise the proximal femur to close to or out of the incision, otherwise it is hard to conduct proximal femoral operations. It is quite difficult to do reaming operation by raising the femur, and it is usually impossible to achieve ideal operations by purely releasing the joint capsule of the posterior-lateral hip joint. The research by scholars like Wang Yuji confirms that the release of the conjoint tendon (obturator internus, superior gamellus and inferior gemellus) can achieve the best raise height of the proximal femur [5], realize the formation of the femoral medullary cavity and smooth operation of implantation of

the prosthetic stem, hook the bone hook inside the proximal femoral medullary cavity, lift the proximal femur and adduct and externally rotate the lower extremities. At this point, the proximal femur can be fully lifted forward and outward. After the femoral neck is opened, ream it with a medullary cavity file in turn from small to large until the femoral stem sinks appropriately. The fracture block adhering to the externally rotated tendon in the intertrochanteric fracture has been divided and displaced, which means the release of the proximal femur has been done, so the release of the conjoint tendon is not required, the proximal intertrochanteric fracture cannot firmly fixed and the stability of the prosthesis depends on distal fixation. To realize distal fixation, all selected femoral stems are extended biological stems. After qualification in mold tests, check the range of hip joint movement and the length of the lower extremities and identify the type of prostheses. In the middle of the surgery, decide whether to use a wire for reduction and fixation according to the conditions of displacement of fracture blocks. By choosing short stems, beginners can obtain a smooth surgical learning curve, but for intertrochanteric fractures and bone destruction in the proximal femur, it is necessary to rely on distal fixation, therefore short-stem femoral prostheses are not suitable for this kind of fractures.

Postoperative handling

After the surgery, 1g of Cefazolin Sodium is administered routinely to prevent infections (the duration of medication is less than 24h). Ankle pumping exercises commence immediately after the surgery. Hip flexion and extension and leg raise exercises are conducted in the morning of the second day after the surgery and ambulation is encouraged starting from the noon. According to the conditions of drainage, the drainage tube is usually pulled out within 24h after surgery. Low-molecular-weight heparin calcium of 2,500 IU starts to be injected subcutaneously 8h after surgery, once a day for consecutive 5-7d. Rivaroxaban (10 mg) is taken orally for a change, once a day for up to 35 d following the surgery.

1.3 Observation of indexes

Observe and record the length of surgical incision, the duration of surgery, intraoperative blood loss, the volume of postoperative drainage fluid, the time of postoperative ambulation and the Harris hip score at six months after surgery, etc. In-hospital and postoperative complications: vascular nerve injury, periprosthetic fractures, joint dislocations, deep vein thrombosis, deep infections and prosthetic loosening, etc.

Results

This group received a 6 to 12-month follow-up. All the postoperative wounds in the patients are in the first stage of healing. The length of surgical incision is 8.14±1.34 cm, the duration of surgery is 74.72±12.54 min, intraoperative blood loss is 125.27±17.29 ml, the volume of postoperative drainage fluid is 122.43± 163.45 ml, the time of postoperative ambulation is 1.41±0.65 d and the Harris hip score at six months after surgery is 93.57±4.85 points. There were three patients who experienced local numbness in the lateral thigh and the symptoms disappeared in 3 months after

surgery. Six patients were found to have deep vein thrombosis in the lower extremities in color Doppler ultrasonography during hospitalization, which was eliminated or did not get worse after treatment with medication. No patients suffered complications such as dislocation, prosthetic loosening and periprosthetic infections during the follow-ups, and no patients needed to undergo revision in the last follow-up. See Fig.1 and 2 for typical cases.

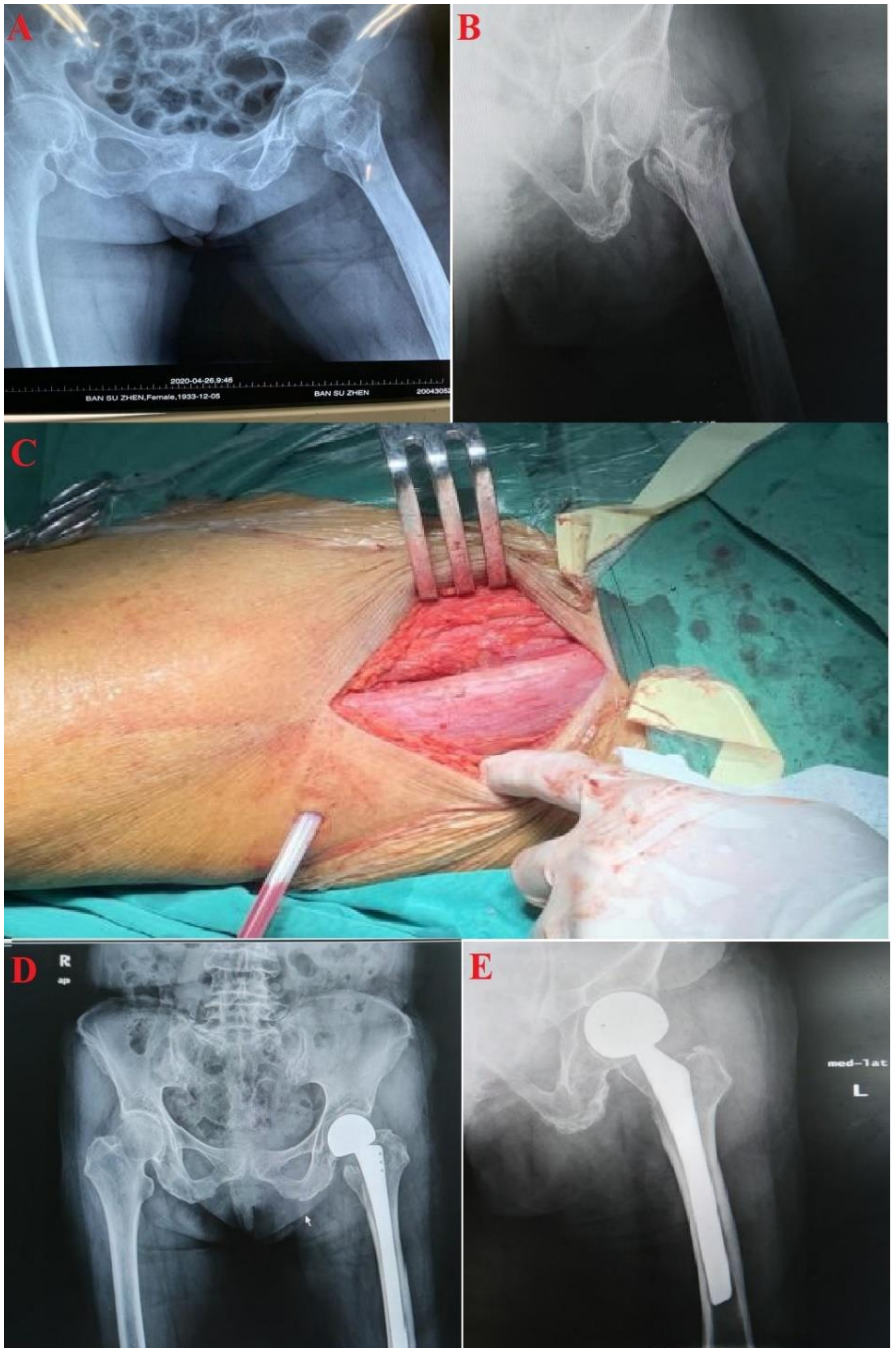

Figure 1: DAA Hip Arthroplasty for Intertrochanteric Fracture (Case 1). (A) Preoperative radiograph showing an intertrochanteric fracture. (B) Surgical incision used for the DAA approach. (C) Postoperative radiograph showing the implanted prosthesis.

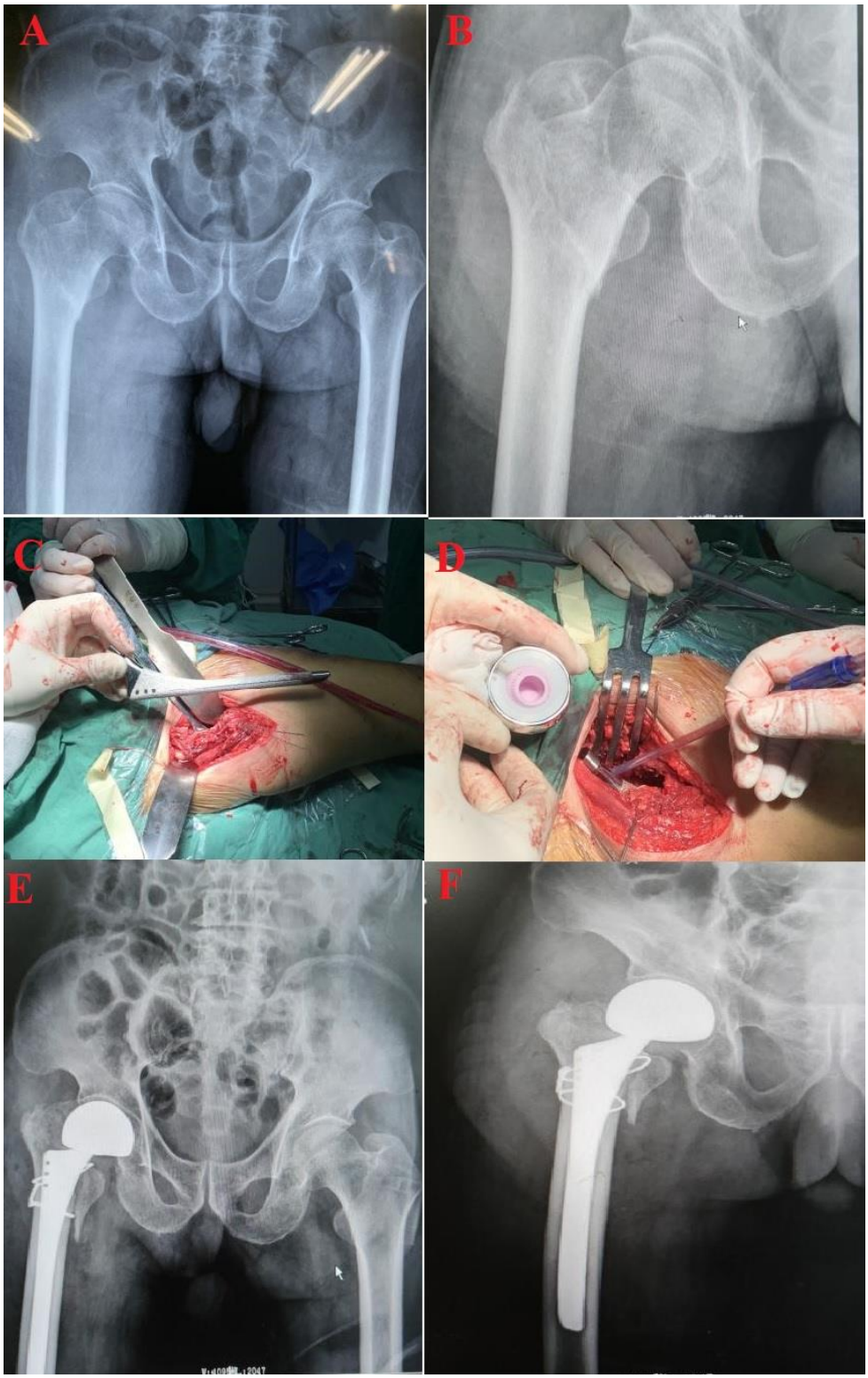

Figure 2: DAA Hip Arthroplasty for Intertrochanteric Fracture (Case 2). (A) Preoperative radiograph demonstrating an intertrochanteric fracture. (B) Intraoperative images showing the surgical field during the procedure. (C) Postoperative radiograph displaying the final placement of the prosthesis.

Discussions

Elderly patients are generally in poor physical health and usually have multiple chronic diseases such as diabetes, hypertension and coronary artery disease. After a few days of bed rest after suffering from intertrochanteric fractures, they will see a significant decline in mental health and develop worse complications including hypostatic pneumonia, deep vein thrombosis and bedsores [6]. A large amount of literature shows that treatment of elderly patients with femoral neck fracture with hip arthroplasty offers the possibility of gradually starting out-of-bed activities in the early stage after surgery and greatly reduces bed-rest pain [7]. So far, the posterolateral approach has been widely used. Its biggest advantage is a broad range of observations and facilitating surgical procedures, but its disadvantage is equally evident, with larger surgical wounds that cause worse muscle injury, and greater intraoperative blood loss. Moreover, the posterolateral approach causes damage to posterior anti-dislocation mechanisms such as posterior joint capsule and lateral rotator brevis muscle [8]. Minimally invasive is the direction of development of modern surgery, with small incisions and more importantly, less damage to neuromuscular tissues, etc. and the possibility of fast recovery after surgery [9]. DAA is to access the joint cavity from the neural interface gap between superior gluteal nerve innervation zone and the femoral nerve innervation zone, without needing to cut the muscle, causing little damage. It complies with the concept of modern minimally invasive surgery and is deemed as the most accurate minimally invasive technology. Currently, the domestic application of DAA is in the primary stage and it needs gradual acceptance from patients [10]. DAA can be made with small incision and little scars, cause less postoperative pain and allow patients to get out of bed and walk with crutches 1 day after surgery as fast as possible. These advantages have been recognized by many orthopedic surgeons. As more and more elderly people from one-child families show up in the hospital nowadays, early children of the “China one” generation are inclined to let aging parents return to the family and society in the fastest way rather than to save on medical expenses given that they not only are busy with work, but also have a heavy burden of taking care of aging parents and children. If patients recover fast, the burden of their family for caring for them during hospitalization and after discharge will be relieved and their own quality of life will be improved as well. DAA for hip arthroplasty basically does not limit hip mobility and facilitates ambulation and fast recovery, so it becomes popular among patients and their families.

Dienstknecht et al. [11] compared DAA with the routine posterolateral approach with regard to C-reactive protein, Hemoglobin, Creatine Kinase and other indexes and argued that DAA does less damage to muscle, accelerates the alleviation of postoperative pain in patients and thus facilitates the recovery of hip functions in patients after surgery. Kamada et al. [12] and Bremer AK et al. [13] proved that DAA could better protect the soft tissue of muscle through mechanical induction measurement and MRI assessment. Clinical observations in this research found that DAA also has a smaller influence on postoperative gaits. The surgery for this group was finished by the same group of skilled surgeons, with small incision, a small intraoperative blood loss and a small volume of postoperative drainage fluid. The results of this research

suggest that the intraoperative damage to soft tissues is little and postoperative patients can perform joint mobility exercises in a wide range of motion in the early stage, with low risk of complications.

In addition, compared to the routine posterolateral approach employed in a lateral decubitus position, DAA exposes the acetabulum and its surrounding structures more clearly. With patients in a horizontal supine position, the lead surgeon can control the anteversion angle and the inclination angle of the acetabular prosthesis more intuitively and more accurately [14]. The intertrochanteric fracture blocks are bound with a wire during surgery, which means short external rotators are reconstructed so that the joint becomes more stable, with the incidence of dislocation as low as 0.96%-1.50% [15,16]. In this study, the legs were sterilized. During the surgery, the affected limb was adducted and externally rotated in an extreme way and placed on the folding bed to make it easy to operate on the proximal femur, without needing a traction table. Both legs were in the same plane for comparison, contributing to better judgment on whether the two lower extremities are the same length. Moreover, supine patient positioning facilitated performing bedside radiography examination and reduced infection rates [17].

Of course, DAA is not perfect. It is selective to some extent and not suitable for patients with obesity, too big muscles or severe developmental dysplasia of the hip and other symptoms. Due to small visual fields, it has high requirements for operators [18,19]. DAA has a long learning curve and is time-consuming at the early stage of implementation [20]. Although, exposure of the acetabulum side is better compared with the posterolateral approach, exposure of the femur side is relatively difficult, especially for patients with obesity and small offsets [24]. Yet, we have to admit the limitations in this study, such as small sample size and lack of a control group. Also, long-term follow-up gait analysis should be recorded to further validate the clinical outcomes of intertrochanteric DAA.

To sum up, treatment of intertrochanteric fractures in the elderly with DAA for hip arthroplasty can significantly reduce intraoperative damage to soft tissues and quickly recover the hip functions and quality of life of patients. Mastering this technique can remarkably improve clinical efficacy. DAA THA for intertrochanteric fracture enhances post-operative rehabilitation, for lesser intraoperative soft tissues interferences and more accurate implant positions.

References

1. Vicente JRN, Croci AT, Camargo OPD. Blood Loss in the Minimally Invasive Posterior Approach to Total Hip Arthroplasty: A Comparative Study. *Clinics* 2008; **63**(3): 351-6.
2. Lee SH, Kang SW, Jo S. Perioperative Comparison of Hip Arthroplasty Using the Direct Anterior Approach with the Posterolateral Approach. *Hip Pelvis* 2017; **29**(4): 240-6.
3. Bergin PF, Doppelt JD, Kephart CJ, et al. Comparison of minimally invasive direct anterior versus posterior total hip arthroplasty based on inflammation and muscle damage markers. *J Bone Joint Surg Am* 2011; **93**(15): 1392-8.

4. Ha YC, Yoo JJ, Lee YK, Kim JY, Koo KH. Acetabular component positioning using anatomic landmarks of the acetabulum. *Clin Orthop Relat Res* 2012; **470**(12): 3515-23.
5. Zhao G, Zhu R, Jiang S, Xu C, Xu N, Wang Y. Soft tissue restrictors of femoral elevation in direct anterior approach—an anatomic study. *Journal of Orthopaedic Surgery and Research* 2018; **13**(1): 308.
6. Liu M, Liu L, Huang F, Fang Y, Zhong G, Zhou X. Perioperative treatment of femoral neck fracture with deep venous thrombosis: A case report. *Chin J Traumatol* 2015; **18**(2): 109-12.
7. Stambough JB, Beaulé PE, Nunley RM, Clohisy J. Contemporary Strategies for Rapid Recovery Total Hip Arthroplasty. *Instr Course Lect* 2016; **65**: 211-24.
8. Lee GC, Marconi D. Complications Following Direct Anterior Hip Procedures: Costs to Both Patients and Surgeons. *J Arthroplasty* 2015; **30**(9 Suppl): 98-101.
9. Sculco TP. Minimally invasive total hip arthroplasty: in the affirmative. *J Arthroplasty* 2004; **19**(4 Suppl 1): 78-80.
10. Kwak S, Chun Y, Rhyu K, Cha J, Cho Y. Quantitative analysis of tissue injury after minimally invasive total hip arthroplasty. *Clin Orthop Surg* 2014; **6**(3): 279-84.
11. Dienstknecht T, Lüring C, Tingart M, Grifka J, Sendtner E. Total hip arthroplasty through the mini-incision (Micro-hip) approach versus the standard transgluteal (Bauer) approach: a prospective, randomised study. *J Orthop Surg (Hong Kong)* 2014; **22**(2): 168-72.
12. Kamada S, Naito M, Nakamura Y, Kiyama T. Hip abductor muscle strength after total hip arthroplasty with short stems. *Arch Orthop Trauma Surg* 2011; **131**(12): 1723-9.
13. Bremer AK, Kalberer F, Pfirrmann CW, Dora C. Soft-tissue changes in hip abductor muscles and tendons after total hip replacement: comparison between the direct anterior and the transgluteal approaches. *J Bone Joint Surg Br* 2011; **93**(7): 886-9.
14. Rathod PA, Bhalla S, Deshmukh AJ, Rodriguez JA. Does fluoroscopy with anterior hip arthroplasty decrease acetabular cup variability compared with a nonguided posterior approach? *Clin Orthop Relat Res* 2014; **472**(6): 1877-85.
15. Hoell S, Sander M, Gosheger G, Ahrens H, Dieckmann R, Hauschild G. The minimal invasive direct anterior approach in combination with large heads in total hip arthroplasty - is dislocation still a major issue? a case control study. *BMC Musculoskeletal Disorders* 2014; **15**(1): 80.
16. Tsukada S, Wakui M. Lower Dislocation Rate Following Total Hip Arthroplasty via Direct Anterior Approach than via Posterior Approach: Five-Year-Average Follow-Up Results. *Open Orthop J* 2015; **9**: 157-62.
17. Nam D, Sculco PK, Abdel MP, Alexiades MM, Figgie MP, Mayman DJ. Leg-length inequalities following THA based on surgical technique. *Orthopedics* 2013; **36**(4): e395-400.
18. Chen DW, Hu CC, Chang YH, Yang WE, Lee MS. Comparison of clinical outcome in primary total hip arthroplasty by conventional anterolateral transgluteal or 2-incision approach. *J Arthroplasty* 2009; **24**(4): 528-32.
19. Jin MW, Zhang L, Chu XB, et al. Comparison of clinical efficacy between direct anterior approach and posterolateral approach in primary total hip arthroplasty. *Eur Rev Med Pharmacol Sci* 2023; **27**(12): 5604-13.
20. Jahng KH, Bas MA, Rodriguez JA, Cooper HJ. Risk Factors for Wound Complications After Direct Anterior Approach Hip Arthroplasty. *J Arthroplasty* 2016; **31**(11): 2583-7.