Abstract. – OBJECTIVE: The aim of this study was to retrospectively analyze the clinical efficacy of the direct anterior approach (DAA) vs. posterolateral approach (PLA) in primary total hip arthroplasty (THA).

PATIENTS AND METHODS: A total of 382 patients who underwent primary THA in our hospital from March 2016 to March 2021 were identified as research subjects, with 183 patients in the DAA group and 199 in the PLA group. Outcome measures included operation time, intraoperative blood loss, postoperative creatine kinase (CK), Harris score, visual analogue scale (VAS), postoperative hospital stay, and postoperative complications.

RESULTS: DAA resulted in significantly longer operative time but lower intraoperative bleeding volume vs. PLA. Three months postoperatively, patients receiving DAA showed significantly lower visual analogue scale (VAS) scores and higher Harris scores than those given PLA. No hip dislocation was observed in the DAA group.

CONCLUSIONS: DAA results in less intraoperative hemorrhage and muscle damage, better postoperative recovery, and a lower incidence of hip dislocation.

Key Words: Total hip arthroplasty, Direct anterior approach, Posterolateral approach, Clinical efficacy.

Introduction

Total hip arthroplasty (THA) is a common treatment method for various end-stage hip diseases, such as hip osteoarthritis, femoral head necrosis, hip dysplasia, etc. THA has achieved outstanding clinical efficacy. The traditional posterolateral approach (PLA) requires the severing of the obturator and piriformis muscles and causes soft tissue injuries and certain damage to the posterior stability, resulting in severe postoperative pain and a high risk of dislocation. By contrast, the direct anterior approach (DAA), with the intramuscular approach, provides multiple benefits such as reduced intraoperative muscle damage, rapid recovery, and a low incidence of dislocation. However, it has been argued that DAA has a long learning curve and is associated with risks such as long operation time and heavy bleeding.

The aging of the population has led to an increase in the number of clinical cases requiring hip replacement surgery. With the widespread concept of enhanced recovery surgery, minimally invasive joint replacement surgery has won the attention of scholars. DAA can effectively preserve the hip muscles by manipulating the muscle gap to the front of the joint. In recent years, there has been a resurgence in the field of joint surgery in China, and it has gained widespread attention and application. Statistics indicate that DAA is the preferred surgical method for 18% of joint surgeons and is still increasing year by year. However, there is a longer learning curve, and there may be more complications in the early stage: the lateral femoral cutaneous nerve may be injured, resulting in proximal femoral fracture or poor incision healing. Reportedly, the incidence rate of DAA injury to the lateral femoral cutaneous nerve was 31.9%. Pain is a common symptom of nerve damage, and 45.6% of patients with lateral femoral cutaneous nerve injury symptoms reported pain, which also led to more patients with mixed neuropathic pain after DAA. With the improvement of people’s living standards, surgical patients are eager for accelerated postop-
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To this end, this study aims to retrospectively analyze the clinical efficacy of DAA vs. PLA.

**Patients and Methods**

**Case Data**

This was a retrospective, single-center, observational study approved by our hospital’s Medical Ethics Committee, and informed consent was obtained from all the patients. From March 2016 to March 2022, a total of 382 patients underwent primary THA in our hospital. Though this study was a single-center study, and the included hip diseases were different, it will not influence the results and conclusions since the surgery was performed by the same surgeon.

Inclusion criteria: (1) patients who had hip joint diseases (femoral head necrosis, hip arthritis, or hip dysplasia) and underwent joint replacement; (2) patients with primary hip arthroplasty; (3) BMI <30 kg/m²; (4) preoperative assessment indicated a good surgery tolerance, no medical symptoms were detected in clinical tests, and no surgical contraindications were found; (5) patients younger than 85 years old; (6) The patients were informed of the treatment plan and can cooperate with the study.

Exclusion criteria: (1) patients with simultaneous bilateral total hip arthroplasty; (2) patients with a medical history of previous hip surgery; (3) BMI greater than 30 kg/m²; (4) patients with severe heart, brain, liver, kidney organic lesions, and severe functional disorders; (5) patients with coagulation dysfunction; (6) patients with systemic infection; (7) patients who have received anticoagulation therapy or drugs that affect coagulation function such as warfarin or aspirin before surgery; (8) patients who have been bedridden for a long time before surgery; (9) patients who have a history of lower extremity thrombotic diseases; (10) patients who have multiple fractures; (11) open hip fractures with vascular and nerve damage; (12) allergies to drugs or allergic constitution.

The original sample size calculation estimated that 60 patients in each group would be needed to detect a 3-point difference between groups in a 2-sided significance test with a power of 0.8 and an alpha error level of 0.05.

The study protocols were approved by the Ethics Committee of The First Hospital Affiliated to Zhejiang Chinese Medical University. The study was done in accordance with the protocol, its amendments, and standards of Good Clinical Practice. All participants provided written informed consent before enrolment.

**Surgical Methods and Perioperative Management**

All operations were performed by surgeons with abundant surgical experience. Standardized perioperative management methods were performed, including anesthesia, multimodal pain management, and postoperative rehabilitation programs. All patients received bio prostheses. Tranexamic acid for hemostasis and low molecular weight heparin were routinely used to prevent perioperative thrombosis.

In the DAA group, the patients were maintained in a lateral position, and a 2 cm-long incision was made downward and outward from the anterior superior iliac spine to the capitulum fibulae. The skin and subcutaneous tissue were opened layer by layer, and the sartorius muscle gap of the tensor fascia lata was exposed, followed by the exposure of the articular capsule. The femoral distance was
at 1-1.5 cm, the femoral neck was severed, the femoral head was removed, the acetabulum was fully exposed, the acetabular fossa was cleaned, the acetabulum was ground to the appropriate size, and the acetabular cup and lining were implanted. The affected limb was rearward extended, externally rotated, and adducted, the joint capsule and muscle tissue of the proximal femur were released, then the prosthesis stem and head of appropriate size were implanted, and the joint was reset. When installing the prosthesis, the contralateral hip provided references for matched length. During the operation, the height of the rotation center of the femoral head was measured, and the lower poles of the patella on both sides and the heel were touched to determine whether the two lower limbs were of the same length. The hip joint could be moved at an unlimited angle, without the dislocation of the prosthesis.

In the PLA group, the patients were maintained in a lateral position, and the incision was made with the center at the apex of the greater trochanter, the skin and subcutaneous tissue were incised successively, the gluteus maximus was bluntly separated, and the gluteus medius and quadratus femoris were retracted. Part of the short external rotator muscles was severed, and the posterior joint capsule was exposed. The femoral distance was kept at 1-1.5 cm, the femoral neck was cut off, and the prosthesis was implanted (the implantation method was the same as that in the DAA group).

On the basis of the treatment in the two groups, Xuduan Jiegu Tang was added: Drynaria 15 g, Dipsacus asperoids 15 g, Salvia 10 g, Psoralea 15 g, Pyritum 10 g, etc. It was decocted to 300 ml and taken in the morning and evening, one dose per day, the course of treatment spanned 1 month (Figure 1).
**Evaluation Indicators**

(1) Surgery-related indices: operation time, intraoperative bleeding volume, perioperative hemoglobin decline (the lowest postoperative hemoglobin – preoperative hemoglobin), hospital stay, and level of creatine kinase (serum muscle injury marker).

(2) Clinical function score: visual analogue scale (VAS) score and Harris score were recorded respectively before the operation, 6 weeks after the operation, 3 months after the operation, and 6 months after the operation.

VAS score: 1 straight line was divided into 9 equal points, with the two ends representing 0 points of no pain and 10 points of severe pain. Patients marked the straight line according to their subjective feelings to reflect the pain level. The measurement was required before and after treatment.

Harris score: the content includes four aspects of pain, function, deformity, and joint mobility, and the total score is 100, with 90 points or more for excellent, 80-89 points for good, 70-79 points for moderate, and less than 70 points for poor.

(3) Postoperative complications: postoperative complications included hip dislocation, incision infection, periprosthetic infection, intraoperative periprosthetic fracture, and intraoperative nerve injury.

**Statistical Analysis**

Statistical analysis was performed with SPSS 19 (IBM Corp., Armonk, NY, USA). Normally distributed measurement data were expressed as mean plus or minus standard deviation (±s). Comparisons of means between two groups were first performed with a Chi-squared test; an independent sample t-test was used for Chisquared data and an independent sample t-test for non-Chi-squared data; paired sample t-test was used for intra-group pre-post comparisons. The t-test was taken to compare the measurement data, and the χ² test was taken to compare the enumeration data of the two groups of patients. p<0.05 was considered to be statistically significant.

**Results**

**General Clinical Data**

A total of 382 patients underwent primary THA, among which DAA was given to 183 patients, including 102 males and 81 females, aged 38-85 (61.1±10.1) years, and PLA was given to 199 patients, including 109 males and 90 females, aged 37-87 (60.8±10.7) years. There was no significant difference in age, sex, BMI and primary disease between the two groups (Table I).

**Surgery-Related Indices**

The operation time of two groups was similar. DAA resulted in significantly less intraoperative blood loss, shorter hospital stays, and lower perioperative hemoglobin levels vs. PLA. The creatine kinase levels were significantly increased after treatment in both groups, with lower levels observed in the DAA group (Table II).

**Clinical Function Score**

The DAA group obtained higher Harris Hip Score (HHS) and lower VAS scores than the PLA group within 3 months after the operation, and this difference was absent 6 months after the operation (Table III).

| Table I. Comparison of general clinical data between DAA group and PLA group. |
|----------------------------------|------------------|------------------|------|
|                                  | DAA (n=183 cases) | PLA (n=199 cases) | p-value |
| Age                              | 61.1±10.1         | 60.8±10.7         | 0.286 |
| Sex (Male/Female)                | 98/85             | 89/110            | 0.085 |
| BMI                              | 25.7±4.3          | 25.1±4.5          | 0.675 |
| Left and right side              | 101/82            | 112/87            | 0.830 |
| Primary disease                  |                  |                  |      |
| Hip Osteoarthritis               | 43 (23.5%)        | 52 (26.1%)        | 0.552 |
| Necrosis of the femoral head     | 67 (36.6%)        | 76 (38.2%)        | 0.750 |
| Congenital hip dysplasia         | 28 (15.3%)        | 29 (14.6%)        | 0.842 |
| Femoral neck fracture            | 45 (24.6%)        | 42 (21.1%)        | 0.417 |
Perioperative Complications

During the follow-up period, 2 patients had a hip dislocation, both of whom were from the PLA group. Both of them did not have hip dislocation again after manual reduction under anesthesia. There were no periprosthetic fractures in both groups. In the DAA group, there were 3 cases of lateral femoral cutaneous nerve injury, which recovered 6 months after operation. In the PLA group, there were 2 cases of sciatic nerve traction, which basically recovered within 1 year after operation. During follow-up, there were 2 cases of surgical incision infection in each group, which were successfully managed after anti-infection treatment. One patient in the PLA group developed periprosthetic infection six months after the operation. Due to ineffective anti-infection treatment, prosthesis exclusion and revision surgery were performed. One patient in the DAA group developed intraoperative periprosthetic fracture (greater trochanteric fracture), which was bundled with cables during the operation (Table IV).

Discussion

With the continuous development of medical technology, the relevant surgical approaches have also become diversified. At present, DAA and PLA are the most adopted approaches. PLA allows for full vision and easy operation. However, due to the intraoperative destruction of the external rotator muscle group, which destroys the joint’s posterior lateral stabilizing structures, PLA requires restrictions on some special positions to prevent complications such as joint dislocation, thus compromising postoperative recovery.12
The DAA was first proposed and operated in 1881, and the DAA currently used in clinical practices is improved by the Smith-Petersen approach\textsuperscript{28,29}. DAA preserves the intact periprosthetic muscle groups, has less surgical damage, allows early postoperative mobility, has no postural restrictions, results in a much lower incidence of prosthetic dislocation, and provides good rehabilitation outcomes\textsuperscript{18}.

**Clinical Results**

There was no significant difference in operation time between the two groups. The operation time is considered to be correlated with factors such as the surgeon’s experience, complete surgical instruments and cooperation with skilled assistants. However, PLA causes a higher risk of posterior dislocation when the affected limb is inadvertently placed in the adducted, flexed, and internally rotated after the operation. The patients in the DAA group are theoretically less prone to the risk of dislocation than those in the PLA group, as DAA does not cause muscle injuries and has good stability. A previous study\textsuperscript{19} recommended acetabular cup abduction of 35-50° and anteversion of 10-25° as a safe range. An angle exceeding the safe range may be attributed to the dislocation of the poorly positioned prosthesis. Hartog and Vehmeijer\textsuperscript{6} found that the more experienced a surgeon has with DAA, the shorter the operative time. It has been reported\textsuperscript{20} that the incidence of dislocation after DAA operation is low, ranging from 0.6% to 1.2%.

In this study, there was no significant difference in operation time between the PLA control group and the DAA group, and postoperative imaging showed that the position of the artificial hip prosthesis in the two groups was basically within the ideal range. However, there were 2 cases of dislocation after the operation in the PLA group, while no case of dislocation in the DAA group was detected. It is suggested that the short external rotator is critical for the stability of the prosthesis, especially for elderly patients. In the DAA group, the prosthesis entered directly from the intramuscular gap without cutting off any muscles around the joint, which well protected the soft tissue around the prosthesis. Therefore, postoperative joint stability was significantly strengthened, and patients were less prone to dislocation and other risks.

The DAA has advantages in functional recovery, gait walking, hip pain and hospital stay. It facilitates the early recovery of patients, reduces medical expenses and improves the satisfaction of patients. Bremer et al\textsuperscript{21} stated that through postoperative MRI scanning analysis, the DAA results in significantly less damage to soft tissue than PLA. According to the research results of Christensen and Jacobs\textsuperscript{22}, patients in the DAA group experienced significantly shorter time to perform off-bed activities and shorter hospital stay, could walk and recover muscle strength without the assistance of external tools at an earlier stage, and obtained higher Harris score and lower VAS score than those in the PLA group. By combining with gait analysis, Zhao et al\textsuperscript{23} found that due to less muscle damage, the gait analysis results of patients in the DAA group were closer to normal within 3 months after the operation, yet there was no significant difference in the gait and functional recovery of the two groups 6 months after surgery. In the present study, patients in the DAA group had milder pain, longer walking time and distance, and significantly better motion range of the joints than those in the PLA group. This indicated that the recovery in the early postoperative period of patients in the DAA group was better than that of the PLA group. But over time, 3-6 months after the operation, there tended to be no significant difference between the two groups of patients regarding the motion range of the joint, pain, and functional exercise.

Bergin et al\textsuperscript{24} analyzed the levels of inflammation and muscle damage after THA treatment via DAA and PLA and found that the creatine kinase level in the PLA group was significantly higher than that in the DAA group. The results of this study are similar to those of the above-mentioned study\textsuperscript{24}, which all indicate that THA treatment via DAA has less muscle damage and provides more adequate soft tissue protection vs. PLA. It facilitates the rapid recovery of joint function and the reduction of local inflammatory reactions. The reason may be related to factors including the intraoperative cutting of the ascending branch of the lateral femoral circumflex artery and the blood loss caused by blunt muscle dissection.

**Complications**

Compared with the PLA, DAA features a longer learning curve, which is correlated with the incidence of complications. Moskal et al\textsuperscript{25} suggested that the incidence of perioperative complications in the THA treatment via DAA was closely related to the surgeon’s experience and familiarity with surgical techniques. Perioperative fractures and lateral femoral cutaneous nerve injury
are the most common complications. There are large differences in reports in terms of lateral femoral cutaneous nerve (LFCN) injury caused by various factors during skin incision and separation of superficial muscles, with the incidence ranging from 0 to 31.9%. The incidence of greater trochanter fracture is about 1%, and the incidence of femoral fractures is 1.6%-8%39. According to research, the incidence of complications can be significantly reduced after learning from 57-100 cases of DAA operations. In the present study, there were 3 cases of lateral femoral cutaneous nerve injury and 1 case of greater trochanteric fracture. The reasons are as follows: 1) The nerve damage was caused by unclearly distinguished body surface marking, incision position, and intramuscular space, incorrect incision plane, excessive intraoperative stretch, and incision injury. 2) Injuries were caused by unclear levels of suturing and mistakenly sutured cutaneous nerve due to insufficient experience. 3) Fractures resulted from the violent external rotation of the affected limb to fully expose the proximal femur when the soft tissue was insufficiently released during the operation. 4) Fracture of the greater trochanter resulted from the improper force in peeling off the soft tissue around the greater trochanter with the instrument, especially in patients with osteoporosis. In terms of long-term prosthesis revision, Ponzo et al31 conducted a follow-up study of more than 4 years and found that the revision rate of patients in the PLA group was 2.7%, while that in the DAA group was 0.7% in the same period, indicating that DAA also provides benefits in prosthesis stability and durability. Periprosthetic infection is one of the major problems with orthopedic prosthetic surgery. The incidence of periprosthetic infection varies depending on the site of intervention, with different published case studies reporting a rate of 0.5% to 3.0% for first implantation, with a significantly greater risk of infection. In this study, the infection rates of both groups were low. This may be related to the shorter follow-up, but it also indicates that the surgical modality in our hospital has a significant safety profile.

Reflections

Bender et al33 suggested that patients with BMI <30 kg/m², good hip mobility, no evident soft tissue contracture, no abnormal hip anatomy, and no medical history of previous joint surgery are better for surgeons unfamiliar with DAA. Moreover, the anatomical structure should be accurately identified during the operation, and the lateral femur requires adequate release of the muscles around the greater trochanter and the joint capsule to avoid serious complications such as fractures.

The conventional DAA approach is mostly performed with the patient in the horizontal position but requires a special surgical bed with folding capabilities, which may not be available in some hospitals. Chen et al34 adopted a lateral DAA approach and obviated the need to re-adjusting the surgical bed intraoperatively by simply moving the affected limb and exposing the proximal femur. In the present study, all the surgeries were performed in the lateral position with a normal surgical bed. The angle of prosthesis placement was similar to that of the posterior lateral when dealing with the acetabular side intraoperatively. The lateral femoral operation was performed without adjusting the position of the surgical bed, with the active limb in the posterior extension internal and external rotation position, and with more flexibility and ease of adjustment according to soft tissue release, to achieve optimal exposure of the proximal femur and complete the prosthesis preparation for implantation.

Many types of hip diseases have different pathogenesis, and most conventional conservative treatments fail to obtain a complete cure. Under the condition of conforming to the indications for artificial total hip arthroplasty, favorable treatment results could be achieved by integrating comprehensive preoperative preparation, prosthesis selection, strict intraoperative operation, and postoperative care. The THA should be performed according to the patient’s condition and the special features of the anatomical structure of the hip joint: 1) Preoperative examination of all aspects of the patient’s physical status should be performed, and advance bone traction, treatment of comorbidities, and nutritional supplementation are necessitated. 2) Suitable prostheses were selected based on the results of X-ray radiographs or CT scans. 3) The key link in the surgical process is to identify the true acetabulum and remove the surface cartilage in the acetabulum until the bone is revealed (during the operation of removing the acetabular cartilage, the patient can be kept in an abduction position of 40-45° and an anterior tilt position of 15-25°). Force should be applied to the posterior wall of the acetabulum to minimize the wear of the anterior wall and to ensure stable and good bony support around the prostheses. For patients with different fractions of hip damage, flexible adjustments should also be carried out to
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effectively reconstruct the hip joint’s normal center of rotation and restore the lower extremity’s normal length. ④ Patients with Garden type III and IV should consider bone fusion of the acetabular prosthesis when performing prosthetic replacement, and the abnormal matching between the head and socket can be improved by various methods, including smaller socket cups, structural bone grafting of autologous bone in the bone defect area, high-level reconstruction of the hip center, and inversionplasty of controlled fractures of the medial acetabular wall. ⑤ After the procedure, drainage and administration of anti-thrombotic drugs and antibiotics are performed to prevent the occurrence of deep vein thrombosis and infection in the lower extremities.

In recent years, Traditional Chinese medicine (TCM) has shown unique advantages in adjuvant therapy after fracture surgery, and TCM adjuvant therapy after hip replacement has gradually become a focus of clinical research. TCM believes that fractures and surgical trauma are diseases in which the limbs are damaged externally, and the qi and blood are damaged internally. The postoperative recovery process of patients undergoing hip replacement is a process of removing blood stasis and regenerating new ones. It is believed that promoting blood circulation and removing blood stasis can regulate qi and blood in the whole body and promote the repair of surrounding tissue damage. Fractures, surgical injuries, etc., can cause injury to the meridians, resulting in an evident imbalance of qi and blood, in insufficient qi and blood, and obstruction of the bones and collaterals. Additionally, elderly patients have different degrees of osteoporosis (bone atrophy, low back pain, bone paralysis, etc.), and the growth and development of bones are closely related to the essence and qi of the kidney. Therefore, adjuvant therapy such as invigorating qi and promoting blood circulation, invigorating kidney and strengthening bones can improve the postoperative rehabilitation effect of elderly patients with hip arthroplasty. Xuduan Jiegu Decoction is composed of Drynaria, Dipsacus Asperoids, Salvia, Psoralea, Pyritum. Among them, Drynaria can promote the absorption of calcium by bone, and improve the level of blood calcium and blood phosphorus, which is beneficial to bone calcification. It forms with bone salt and promotes the activity of acid phosphatase and the decomposition of proteoglycan in tissues. Dipsacus Asperoids promote blood circulation and remove blood stasis and have evident effects on blood stasis, swelling and pain, and fractures. Psoraleae can promote the osteogenesis of osteoblasts in the body, so that the osteoblasts on the inner and outer periosteum actively produce an increase in the number of inner and outer callus so that the fracture can heal as soon as possible. Pyritum promotes blood circulation and removes blood stasis, establishes bone, and relieves pain, which is conducive to the healing of fractures. Astragalus is a traditional Chinese medicine for tonifying qi and deficiency, which has the effects of tonifying qi and raising yang, firming the surface and stopping sweating, detoxifying and expelling pus, and diuresis and swelling. In this study, Xuduan Jiegu Decoction was used for symptomatic treatment to achieve the effects of invigorating the kidney and strengthening the bones, promoting blood circulation and removing blood stasis, invigorating the kidney and helping the yang, and renewing the tendons and healing injuries.

Limitations

1) The short follow-up failed to determine the long-term efficacy of DAA. 2) This study was a single-center study with small sample size. 3) There is a lack of research on obese people and patients with significant soft tissue contracture due to end-stage femoral head necrosis. Despite the above deficiencies, this method can be applied to the routine treatment of patients with hip disorders in various medical institutions. It is expected that future clinical studies with larger samples can provide more clinical evidence for this treatment method.

Conclusions

DAA group has no evident restriction for body position, extremely low risk of prosthesis dislocation, and results in rapid functional recovery, reduced pain, improved quality of life, and shortened hospital stay vs. PLA. Further trials are required prior to clinical promotion.

Ethics Approval

The study was approved by the Ethics Committee of Zhejiang Chinese Medical University, Zhejiang Province, China, with number: 2015-5258/234.

Informed Consent

The informed consent was signed by the patients and their families.
Availibility of Data and Materials
All data are available upon request to the corresponding author.

Conflict of Interest
The authors declare no conflict of interest.

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Authors' Contributions
All authors contributed equally to the study.

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