

Original Article

Direct anterior approach with enhanced recovery protocols in outpatient total hip replacement

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Abstract: Direct anterior approach (DAA) total hip replacement (THR) has become more and more popular, as it is a minimally invasive procedure. The present retrospective study was conducted to evaluate the effectiveness of DAA with enhanced recovery protocols in outpatient THR. A total of 40 cases were treated with DAA and enhanced recovery protocols. An additional 40 cases were treated with posterior approach (PA) and traditional recovery management. One case of a wound infection and four cases of lateral femoral cutaneous nerve injuries were found in the DAA group. In the PA group, one case developed femoral vein thrombosis, while another case showed a leg-length discrepancy. No re-hospitalizations or reoperations occurred in either group. Harris hip scores of the DAA group were better than those of the PA group 1 month after the operation ($P < 0.05$). Direct anterior approach combined with rapid rehabilitation provides a safe and effective environment for outpatient hip replacement.

Keywords: Direct anterior approach, outpatient surgery, hip replacement, enhanced recovery

Introduction

Total hip replacement (THR) has helped to save thousands of patients with hip diseases, enabling them to regain good joint function and improving patient quality of life. Traditional hip replacement technology and perioperative management measures have been widely used and have won the recognition of millions of patients and surgeons. However, patient demands are increasing, as many hope to complete hip replacement surgery through outpatient surgery. The definition of the outpatient surgery mode varies slightly in different countries [1]. However, it generally refers to patients with certain indications that are hospitalized, undergo an operation, have a short postoperative observation period, and are discharged within 1 or 2 days. In recent years, with the development of minimally invasive hip replacement technology and application of rapid rehabilitation measures, it has become possible for hip replacement to follow an outpatient surgery model in certain populations. This has greatly sped up the recovery of patients with hip disease.

In traditional hip replacement, the posterior approach (PA) in the lateral position is often used. This can cause some damage to the posterior structure of the hip joint, such as the external rotation muscles. This may result in intraoperative bleeding and postoperative pain, as well as dislocation of the artificial joint. Direct anterior approach (DAA) THR is a representative minimally invasive hip replacement technology. It results in less injury to muscle and soft tissues and less pain after the operation. Thus, many clinical studies have reported faster recoveries, compared with traditional surgery [2]. Enhanced rehabilitation after surgery (ERAS) technology optimizes and integrates a series of perioperative management measures, including preoperative education, psychological counseling, pain control, blood management, and early exercise, speeding up postoperative recovery and achieving good clinical results [3]. The combination of DAA and ERAS can not only make outpatient surgery possible for hip replacement but also saves medical resources and reduces expenses.

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Table 1. Patient data for DAA and PA groups

| | DAA+ERAS | PA+TR |
|---------------------------|--------------|--------------|
| Cases | 40 | 40 |
| Gender (male/female) | 18/22 | 21/19 |
| Age | 65.27 ± 4.95 | 62.64 ± 5.21 |
| BMI | 25.70 ± 3.68 | 24.38 ± 4.01 |
| Disease | | |
| Osteoarthritis | 7 | 5 |
| Rheumatoid arthritis | 3 | 2 |
| Development dysplasia hip | 11 | 13 |
| Avascular necrosis | 19 | 20 |
| ASA1 | 14 | 17 |
| ASA2 | 26 | 23 |

DAA: direct anterior approach; ERAS: enhanced rehabilitation after surgery; PA: posterior approach; TR: traditional rehabilitation; BMI: body mass index; ASA: American Society of Anesthesiologists.

Ensuring patient safety and quality of care is always an important prerequisite regardless of how THR is performed. Therefore, in previous studies, almost all patients with THR undergoing outpatient surgery were in American Society of Anesthesiologists (ASA) classes 1-2 [4]. They had no serious underlying diseases, especially heart disease. It has been found that total hip replacement is difficult for elderly patients and patients with severe chronic disorders. These factors can lead to complications, including infections, deep venous thrombosis, and impaired cardiopulmonary function. Therefore, outpatient THR should be performed in relatively young and healthy patients. The present retrospective study was conducted to evaluate clinical efficacy and safety levels of DAA THR combined with ERAS for outpatient surgery.

Materials and methods

Subjects

The current retrospective study was approved by the Shanghai General Hospital Institutional Review Board. From September 2017 to October 2018, a total of 264 patients with hip diseases were treated. All patients required primary unilateral total hip replacement. Eighty cases met the inclusion criteria of this study, including 39 males and 41 females, with an average age of 63.8 years. Forty cases were treated with direct anterior approach combined with fast recovery (DAA group). The other forty cases were treated with posterior approach and traditional recovery management (PA group).

Inclusion criteria

Patients involved in this study were between 50 and 70 years old and were first diagnosed with aseptic necrosis of the femoral head, osteoarthritis, rheumatoid hip arthritis (normal ESR, CRP and Hb > 100 g/L), or congenital dysplasia of the hip (except Crow IV). There was no previous history of ipsilateral hip surgery. There were no serious underlying diseases. Blood pressure and blood glucose control levels were good. Patients were in ASA classes 1 or 2. Included patients also had good social and family support after discharge. They could go home immediately or enter rehabilitation institutions. Body mass index levels of the involved cases were less than 35. Both upper limbs were intact with the opposite lower limb able to bear full weight. According to the data, length of hospitalization times was also limited in this study. In the DAA group, patients were discharged on either the same day as admission or the following day. In the PA group, patients were discharged on the third day or later.

Exclusion criteria

Elderly patients, as well as those with a previous history of ipsilateral hip surgery, infective arthritis, or active rheumatoid arthritis, were excluded. Extremely obese patients and those with type IV congenital dislocation of the hip with osteoarthritis were also excluded. Patients of ASA class ≥ 3 or with severe chronic disease were excluded. Furthermore, unattended elderly patients were not candidates for this study.

The experimental group was treated with minimally invasive DAA hip replacement and ERAS protocols. The control group was treated with conventional posterior approach hip replacement with traditional perioperative rehabilitation management. Basic data of the two groups are shown in **Table 1**.

Surgical methods and perioperative management

Eighty cases in both groups underwent operations by the same three doctors and all cases were under general anesthesia. In the DAA group, anterior hip replacement was performed in the supine position with a common surgical bed. In the PA group, posterior hip replace-

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ment was performed in the lateral position. Specific operation methods and procedures for the direct approach and posterior approach followed those of previous published papers [5]. In the DAA group, fourteen cases underwent posterior capsule release during femoral side preparation. Twenty-one cases retained the anterior capsule and were sutured at the end of operation. In the PA group, a posterior capsulectomy was performed and the piriformis tendon and conjoint tendon were sutured. An M/L Taper femur prosthesis and Trabecular Metal acetabular system (Zimmer, Warsaw, Indiana, USA) were inserted in all 80 cases.

Patients in the DAA group were instructed to arrive at the hospital at about 8:00 a.m. on an empty stomach. The operation began around 9:00 a.m. and ended before noon. One gram of tranexamic acid and 1.5 g of cefuroxime were used, intravenously, half an hour before the operation. Twenty-one cases retained the anterior articular capsule. Before closing the incision, 0.75% ropivacaine was used for infiltration anesthesia of the articular capsule, iliopsoas muscle, and tensor fasciae latae. The fascia of tensor fasciae latae and skin were sutured continuously. No drainage tubes or catheters were placed. No intravenous analgesia pumps and femoral nerve blocks were used. After 1-1.5 hours of anesthesia resuscitation, the patients were transferred to the ward to receive intravenous parecoxib, beginning active muscle contraction exercises of the lower limbs. Patients were encouraged to use walkers to reach the ground and go to the bathroom unassisted two hours after the operation. They were assessed and recorded every hour until all discharge criteria were met. Intravenous antibiotics and tranexamic acid were used again, 4 hours after the operation. Parecoxib was given again before discharge. After discharge, oral analgesics were given (200 mg Celebrex twice a day). Rivaroxaban was administered orally on the first day after the operation, as well as the next 35 days.

Discharge criteria: patients were discharged when they were able to go to bed independently, use the bathroom independently, walk with aids for more than 30 meters continuously, and had no complications requiring further treatment.

PA group: on the day of the operation, the patients were admitted to the hospital on an empty stomach. The operation was completed that morning. Intravenous antibiotics and tranexamic acid were also routinely administered half an hour before the operation. A traditional posterior incision in the lateral decubitus position was used to cut the insertion points of the piriformis tendon and short lateral rotator tendon. They were sutured after the operation. Before closing the incision, 0.75% ropivacaine was used for infiltration anesthesia around the articular capsule. The gluteus maximus fascia and skin were sutured continuously. Drainage tubes and catheters were placed and removed 24 hours after the operation. Intravenous tranexamic acid was given again 6 hours after the operation. An intravenous analgesia (parecoxib) was given twice a day for the first three days after the operation. Afterward, Celebrex and Tramadol were given orally. Intravenous antibiotics were also given twice a day for the first three days after the operation. Rivaroxaban was administered orally on the first day after the operation and for the next 35 days. On the day following removal of the drainage tubes and urinary catheters, active lower limb movement and walking aids were encouraged. Under the supervision of the medical staff, patients were instructed to carefully turn over and use the toilet to prevent dislocation. After 2 days, the patients were assessed daily until they met all discharge criteria, the same as those of the DAA group (**Table 2**).

Follow-up and evaluation

The patients were followed-up and evaluated by surgeons. The DAA group was followed-up by telephone on the first day after discharge. Three outpatient follow-up visits were conducted at 4 days, 1 month, and 3 months after the operation. The PA group received two follow-up visits at 1 month and 3 months after the operation. Complications, treatments, and outcomes of the two groups were observed and recorded. Harris hip scores were recorded, as well as any re-hospitalizations or reoperations within 3 months after the operation.

Statistics

SPSS 19.0 software (IBM Corp., Armonk, NY, USA) was used to analyze all statistical data of the two groups. Student's t-tests were used to

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Table 2. Perioperative management of DAA and PA groups

| | DAA+ERAS | PA+TR |
|------------------|--|--|
| Antibiotics | 1.5 g Cefuroxime intravenous twice (before and after operation) for one day | 1.5 g Cefuroxime intravenous twice a day for three days |
| Pain control | Local infiltration anesthesia with ropivacaine; intravenous parecoxib twice for one day; oral celecoxib; no use of analgesic pump and nerve block anesthesia | Local infiltration anesthesia with ropivacaine; intravenous parecoxib twice a day for three days; oral celecoxib and tramadol hydrochloride; no use of analgesic pump and nerve block anesthesia |
| Bleeding control | Intravenous administration of 1 g of tranexamic acid before and after operation | Same |
| VTE prophylaxis | Rivaroxaban was administered orally on the first day after operation and for the next 35 days | Same |
| Drainage | No drainage tube | Drainage tube for 24 hours |
| Catheter | No use of catheters | Catheter for 24 hours |
| Rehabilitation | Active muscle exercises and walking activities 2 hours after operation | Active muscle exercises and walking activities one day after operation |

DAA: direct anterior approach; ERAS: enhanced rehabilitation after surgery; PA: posterior approach; TR: traditional rehabilitation; VTE: venous thromboembolism.

compare the two groups. *P*-values < 0.05 are considered statistically significant.

Results

Length of hospital stays

Each of the 80 patients were followed up for 3 months. In the DAA group, 35 patients were discharged on the day of operation. Two patients met the discharge criteria but were discharged after 1 night of observation, due to anxiety. Three patients were discharged the day after the operation. This was due to vomiting and symptomatic hypotension. The average total hospitalization time of the DAA group was 10.2 hours, while that of the PA group was 105.6 hours ($P < 0.05$).

Complications and treatment

None of the 80 patients had serious postoperative complications. One case in the DAA group had a superficial wound infection two weeks after the operation. This patient was treated with oral antibiotics for 7 days by the Outpatient Department. The wound healed well. There were four cases of lateral femoral cutaneous nerve injuries in the DAA group, all of whom showed numbness of the proximal and lateral thigh skin. Three of these patients recovered completely at 3 months after the operation, while the numbed area in the remaining case was significantly reduced but remained somewhat. In the PA group, one case was examined 1 month after the operation. Thrombosis was found via ultrasound. The D-dimer concentration was 1.09 mg/L (reference

value: 0-0.55 mg/L). Rivaroxaban was continually given, orally, and immobilization was instructed for 2 weeks. After 6 weeks, the D-dimer concentration was 0.71 mg/L, leg swelling was normal, and the thrombus had disappeared, according to the ultrasound. One patient had a leg-length discrepancy, in which the affected lower limb was 1.5 cm longer than that of the healthy side. The patient was treated with an elevated insole on the healthy side. No re-hospitalizations or reoperations occurred in the two groups. Harris hip scores of the DAA group were better than those of the control group 1 month after the operation ($P < 0.05$). Moreover, there were no significant differences between the two groups at 3 months after the operation ($P > 0.05$; **Table 3**).

Discussion

Although many studies have reported the feasibility of THR in outpatient surgery, many remain concerned about safety [6]. However, THR with traditional hospitalization is a very mature practice and has achieved good clinical efficacy. The present retrospective study is of great significance for the development and promotion of outpatient total hip replacement worldwide.

Results of the current study showed that, although the average hospitalization time of the DAA group was significantly shorter than that of the PA group, there were no serious complications, such as prosthetic dislocation, fractures, or artificial joint infections. Moreover, there were no re-hospitalizations or reoperations required. Present results are encour-

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Table 3. Outcomes and complications of DAA and PA groups

| | DAA+ERAS | PA+TR |
|------------------------|------------|---------------|
| Cases | 40 | 40 |
| Length of stay (hours) | 10.2 ± 3.7 | 105.6 ± 18.4* |
| Complications | | |
| Superficial infection | 1 (2.5%) | 0 |
| LFCN injury | 4 (10%) | 0 |
| DVT | 0 | 1 (2.5%) |
| Leg-length discrepancy | 0 | 1 (2.5%) |
| Dislocation | 0 | 0 |
| Readmission | 0 | 0 |
| Reoperation | 0 | 0 |
| Harris hip score | | |
| 1 month | 81.3 ± 6.2 | 76.0 ± 4.5* |
| 3 months | 92.7 ± 4.4 | 90.8 ± 5.7* |

LFCN: Lateral femoral cutaneous nerve; DVT: deep venous thrombosis; *P < 0.05.

aging and consistent with those of Glassou et al. [7], which indicated that outpatient THR is feasible in the ASA class 1-2 population.

Lateral femoral cutaneous nerve injuries are sometimes unavoidable in DAA surgery. In this study, the occurrence rate in the experimental group was 10%. Rates of 0-80% have been reported previously [8]. These may be related to the operation and the variation in the distribution of the lateral femoral cutaneous nerve in the surgical area [9, 10]. Although injuries of the lateral femoral cutaneous nerve may affect patient quality of life and satisfaction to some extent, they do not lead to joint dysfunction [8, 11]. One case of a superficial wound infection also occurred in the DAA group. This was related to a superficial skin contusion caused by improper operation and the relative difficulty of femoral exposure during DAA operation [12]. Although healing was good, following treatment with oral antibiotics, the infection reflects the necessity of paying close attention during follow-up observations after outpatient THR operations. Assessing lower limb length is a major advantage of DAA surgery [13], also demonstrated by the present study. This advantage is more obvious in a supine position than in the lateral decubitus position. Overall, results of the current study suggest that THR with outpatient surgery is safe and feasible in patients of ASA classes 1-2. Minimally invasive DAA replacement technology and a series of

measures for rapid rehabilitation help ensure the successful implementation of this operation mode [14].

With the development of minimally invasive hip replacement technology, the destruction of periarticular tissue structure by surgery itself has decreased. This reduces patient pain, speeds up the recovery of muscle strength to allow early active movement, and greatly increases the stability of the artificial hip joint after surgery. Currently, minimally invasive direct anterior hip replacement is increasingly being used by doctors [15]. Characteristics of the muscle and nerve gap approach minimize damage to the muscle around the hip joint [16]. Numerous studies have confirmed that it can speed up recovery and relieve pain, providing comparable or decreased incidence rates of complications observed in traditional operations [17]. This makes DAA an excellent option for outpatient THR.

It has been reported that the anterior approach of minimally invasive DAA can reduce injuries to muscle tissues and the degree of pain after the operation, compared with other surgical approaches. It not only leads to active joint movement earlier and faster but also reduces the use of analgesics [18], thus decreasing occurrence of drug-related nausea, vomiting, and other discomfort symptoms. These factors are conducive to outpatient surgery. At the same time, DAA does not cause direct injury to the gluteus medius or short external rotation tendons. The active function of the hip joint and the stability of the artificial joint are greatly enhanced in the early postoperative stage [16]. It allows patients to squat, wear shoes, and return to family and social life as soon as possible. Many studies have reported that, although there were no significant differences in surgical outcomes between DAA and other traditional surgical approaches, such as the posterior approach and direct lateral approach [2, 19], DAA had obvious advantages in early rehabilitation of joint function. These not only accelerate the recovery rate but also significantly improve patient satisfaction [2, 20]. The outpatient operation mode of THR is made feasible and safe precisely because of the advantages of minimally invasive DAA. Present results showed few complications in the DAA group (one case of a superficial wound infection and four

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cases of lateral femoral cutaneous nerve injuries). These were related to surgical techniques rather than the use of the outpatient surgical mode. Furthermore, there were no cases of artificial joint dislocation, deep infections, or other systemic complications in the DAA group. Moreover, there were no re-hospitalizations or reoperations within 3 months. In addition, Harris hip scores after the operation showed that recovery rates of joint function at 1 month were significantly better than those in the PA group. Results suggest that the outpatient surgical mode for THR has advantages over modes with traditional hospitalization, in accord with findings of many previous studies [4, 21, 22].

Rapid rehabilitation has been widely accepted in the field of joint replacement [23, 24]. Application of a series of measures, such as pain control, blood management, and anticoagulation, has greatly accelerated the recovery of patients after hip replacement. It has also reduced incidence rates of complications related to surgery, which is necessary for outpatient surgery. A previous study found that minimally invasive DAA, combined with rapid rehabilitation measures, can enable patients to move to the ground earlier after THR, shortening the time of using walking aids significantly [25]. Several recent reports have shown that DAA and rapid rehabilitation measures can shorten hospitalization times [26, 27]. In this study, there were no significant differences in pain control, anticoagulation, or infection prevention between the DAA group and PA group. However, the DAA group had significantly reduced intravenous infusion after surgery and abandoned the use of a drainage tubes and catheters. Patients were encouraged to exercise their lower limbs actively 2 hours after surgery. Application of these measures can minimize the discomfort of patients and return them to a preoperative state of life as soon as possible after surgery. Although it has been reported that urinary retention after surgery is a factor affecting the development of outpatient surgical modes [28], none of the 40 cases in the DAA group experienced such issues after surgery. This may be related to the choice of anesthesia methods, perioperative intravenous infusion volume, or preoperative education. In addition, the use of local infiltration anesthesia and intravenous analgesia, instead of an analgesic pump and nerve block, is more

conducive to the recovery of muscle strength after the operation, reduces the systemic reaction of analgesics [29, 30], and shortens the time required for postoperative hospitalization and observation.

The current study had some limitations, however. First, it was a retrospective study and the number of cases included was relatively small. Therefore, it cannot fully reflect all clinical situations, especially for some complications with low incidence rates. Second, the cases studied were in relatively good health. These patients have a higher degree of tolerance to surgical trauma and a relatively fast recovery rate. Third, this study conducted follow-ups for only 3 months. The clinical efficacy of the observation was limited to the early postoperative stage. Some clinical complications during the middle and late stages, such as delayed artificial infections, could not be predicted further.

Conclusion

Results of the current study suggest that outpatient hip replacement can be performed on patients with relatively good health using minimally invasive direct anterior hip replacement, combined with rapid rehabilitation measures. Clinical results of this method in the early postoperative stage are good, with excellent safety levels.

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Disclosure of conflict of interest

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