Comparative Study

COMPARISON BETWEEN SUPERPATH APPROACH *vs* POSTEROLATERAL APPROACH IN PRIMARY TOTAL HIP ARTHROPLASTY: A 6-MONTH FOLLOW-UP

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ABSTRACT

Total Hip Replacement has become one of the most successful orthopaedic procedures, optimizing patients' life quality and postoperative mobility. In the last few years has rapidly grown a demand for novel mininvasive THA techniques. The supercapsular percutaneously assisted total hip (SuperPath) technique has gradually become more popular in THA surgery in recent years. Purpose of this paper is to compare difference between SuperPath approach and conventional posterolateral approach in total hip arthroplasty. This was a prospective, randomized controlled study, enrolling a total of 120 patients, 60 treated with a SuperPath and 60 with posterolateral approach, treated in our institution from August 2019 to Decembre 2022. General demographic characteristics, intraoperative data and hospitalization time were collected. As primary endpoint, the Harris Hip Score was calculated to assess functional recovery. Pain management, need for transfusion, and hospital stay were evaluated as secondary endpoints. HHS scores showed that these were significantly higher in the SuperPATH group than in the conventional group ($P<0.05$) at 1 month and 3 months after the intervention, while no significant difference was found at 6 months. Hospitalization time in the SuperPATH group was significantly shorter than in the conventional group ($P<0.05$). These results suggested that the SuperPATH approach promotes the speed of recovery for hip function and reduces pain in THA patients.

KEY WORDS: *total hip arthroplasty, SuperPath, posterolateral approach, comparison*

INTRODUCTION

Total Hip Replacement has become one of the most successful orthopaedic procedures, optimizing patients' life quality and postoperative mobility (1), especially in case of hip osteoarthritis. Driven by the aging of the world population, the demand for THA is expected to grow exponentially in the next two decades. Kurtz et al noted a 50% increase in the prevalence of THA from 1990 to 2002 and projected a 174% increase, in THA from 208,600 in 2005 to 572,000 in 2030 (2).

There are several surgical approaches that are used in primary THA. Currently, the posterior approach is the most common approach utilized in the world, even if the anterior approach has gained popularity in the last few years,

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while direct lateral approach (Hardinge modified) continues to be very used. There are many studies in which these approaches are compared in terms of functional results, pain suffering, recovery, risk of dislocation, but no one is able to provide a firm recommendation on which one is overall superior to the others (3).

These traditional THA approaches, however, frequently have drawbacks, such as significant bleeding and damage, high postoperative complications, and a lengthy recovery time (4). For these reasons, in the last few years has rapidly grown a demand for novel mininvasive surgery (MIS) in THA. MIS essentially involves the modification of conventional standard approaches with emphasis on reduction of skin incision length and decreased soft-tissue dissection. Nevertheless, they could overcome even other traditional approach problems, such as postoperative pain, blood loss and enhancing postoperative functional results. However, it is necessary to fully understand if their use could be related with a longer operative time, wrong acetabular cup or femoral stem implant, and higher complication rates in general.

The supercapsular percutaneously assisted total hip (SuperPath) technique has gradually become more popular in THA surgery in recent years (5) and consist in a combination of Superior Capsulotomy described by Murphy in 2004 (6) and percutaneously assisted total hip arthroplasty (PATH) described by Penenberg et al. in 2008 (7). Patients using SuperPath have smaller surgical incisions, which could lead to reduced scarring and decreased recovery time (8). The benefit of a minimally invasive technique that spares the iliotibial band and short external rotators, including the piriformis, is achieved by the SuperPATH method. Using the greater trochanter as a marker, the femur is broached in place. In this method, the hip does not have to be dislocated, allowing the piriformis to be preserved using the short external rotators. Comparatively to more conventional procedures, which demand surgical hip dislocation to prepare the femur and carry out the femoral neck cut, this provides protection against dislocations. Additionally, it uses percutaneous equipment to avoid the requirement for angled acetabular reamers and perform standard acetabular preparation and reaming from a more direct angle.

MATERIALS AND METHODS

Patients and grouping

The objective is to evaluate the difference between the SuperPATH approach and the conventional posterolateral approach in total hip arthroplasty in patients admitted to the Orthopedic and Traumatology of Policlinico di Bari and to assess short-term functional outcomes (up to 6 months postoperatively). Visual Analogic Scale (VAS) and Harris Hip Score (HHS) at 1, 3 and 6 months postoperative were considered for functional assessment of outcomes following THA implantation according to these techniques.

This was a prospective, randomized controlled study and performed in accordance with the ethical standards set forth in the 1964 Declaration of Helsinki. All patients involved in the study gave informed consent prior to their inclusion in the study. Patients who were to undergo primary THA for hip osteoarthritis, were enrolled and treated at Policlinico di Bari between August 2019 and December 2022. Inclusion criteria were primary hip osteoarthritis, age between 40 and 81 years, body mass index (BMI) between 20 and 29.9, and chronic history (for at least 4 months) of hip joint pain.

Exclusion criteria were inflammatory hip disease or acetabular dysplasia, infection, coagulopathy, previous hip surgery, history of deep vein thrombosis or pulmonary embolism, rheumatoid arthritis, pregnancy, and patients who were unable to understand and complete the procedure due to cognitive dysfunction or language barrier. Between August 2019 and December 2022, seventy patients with hip osteoarthritis were evaluated for eligibility for the present study. Five patients had previous hip surgery, three patients participated in another study, one lived in another country, and one died at the follow-up. Therefore, they were excluded from the study. Subsequently, 60 patients were included in two groups, 1) the SuperPATH group and 2) the postero-lateral group.

General demographic characteristics including age; sex; Body Mass Index (BMI); side of surgery; American Society of Anesthesiologists (ASA) score surgical time; intraoperative blood loss; length of hospital stay; preoperative hemoglobin; transfusion requirement; Visual Analogic Scale (VAS) and Harris Hip Score (HSS) were collected for each patient. Intraoperative blood loss was measured using total body volume (the formula of Nadler et al. (8) multiplied by the change in preoperative and postoperative hematocrit levels on day 1 and the addition of any volume of intraoperative blood transfusion if administered, as described by Sehat et al. (9) and previously used in the literature). Criteria for allogeneic blood transfusion were a postoperative hemoglobin level less than ≤ 8 g/dL or a postoperative hemoglobin level between 8 and 10 g/dL with clinical signs of hemodynamic instability. Pain was quantified using the VAS scale with scores ranging from 0 (no pain) to 10 (worst pain imaginable), collecting data at first, second, third day and at one month, 3 months and 6 months after surgery. Hip function was assessed using HHS. It consists of subscales for pain severity (1 item, 0-44 points), function (7 items, 0-47 points), absence of deformity (1 item, 0-4 points), and range of motion (2 items, 0 - 5 points). Scores ranged from 0 (worst disability) to 100 (least disability) (10). For HHS, data were recorded at the

following times: T0 (before surgical procedure); T1 (one month after surgery); T2 (three months after surgery); T3 (six months after surgery).

Mini invasive Super Path approach - Surgical technique

Before surgery, standardized anteroposterior pelvic X-ray and hip joint of the operated leg was performed. According to a standardized protocol, patients received antibiotic prophylaxis with cefazolin 2 g. Patients were operated under spinal anesthesia by a single experienced hip surgeon (GV) familiar with the posterolateral approach, performing a minimum of 130 THA procedures per year. Osteotomy location and femoral neck length were predicted. An appropriate type of prosthesis was selected based on preoperative planning. The patient was positioned in standard lateral decubitus. After standard aseptic preparation and draping of the operative site, a skin incision was made from the tip of the greater trochanter to the fascia of the great gluteus with a length of 5 to 8 cm and in line with the femoral axis.

The great gluteus was carefully divided and then, a Cobb's elevator was placed under the muscle. Next, Hohmann's spreader was placed in the space between the gluteus medius and the gluteus minimus to protect the gluteus medius. The hip joint was externally rotated. A Cobb's elevator was placed between the piriformis tendon and the gluteus minimus and then also replaced with a blunt Hohmann retractor. The capsule was then incised along the path of the skin incision. The trochanteric fossa was marked with electrocautery to ensure hemostasis. The acetabular rim was separated from the joint capsule, and the incision was extended 1 cm to expose the pyriform fossa, the tip of the greater trochanter, and the anterior femoral neck. The operated leg was rotated to a neutral position to expose the saddle of the femoral neck. An entry reamer was used to introduce the femoral canal. Then, a metaphyseal reamer was used to expand the incision.

Preparation of the medullary cavity with intramedullary broaching was performed. Then, to remove the handle, the femoral neck was cut using a narrow oscillating saw blade along the top of the intramedullary broach. The femoral head was removed. Retractors were placed by the acetabular margin to retract the capsule. Soft tissues in the acetabulum and labrum were removed. A cannula was inserted through a guided 1-cm skin incision device near the main incision. An acetabular reamer of appropriate size was inserted into the acetabulum from the main incision, the reamer holder passed through the cannula tube. After multiple reaming of the acetabulum, the appropriately sized cementless acetabular cup (MicroPort Orthopedics Inc., Arlington, TN, USA) was implanted. The highly cross-linked polyethylene liner was inserted and locked using an impactor through the cannula. Appropriately sized femoral head, modular neck, and stem components were tested.

Range of motion, leg length, and joint stability were evaluated. After removing the trial components, the uncemented modular femoral stem prosthesis and femoral head (MicroPort Orthopedics Inc., Arlington, TN, USA) were implanted. Finally, the capsule and gluteal fascia and skin incision were closed layer by layer (11). According to the principles of prevention of postoperative orthopedic venous thromboembolism as in knee replacement patients were routinely treated with low molecular weight calcium heparin (4000 IU, once daily) as an anticoagulant. Subsequently, the same rehabilitation program was used for all patients, consisting of full load and active mobility exercises on the day of surgery (Fig. 1).

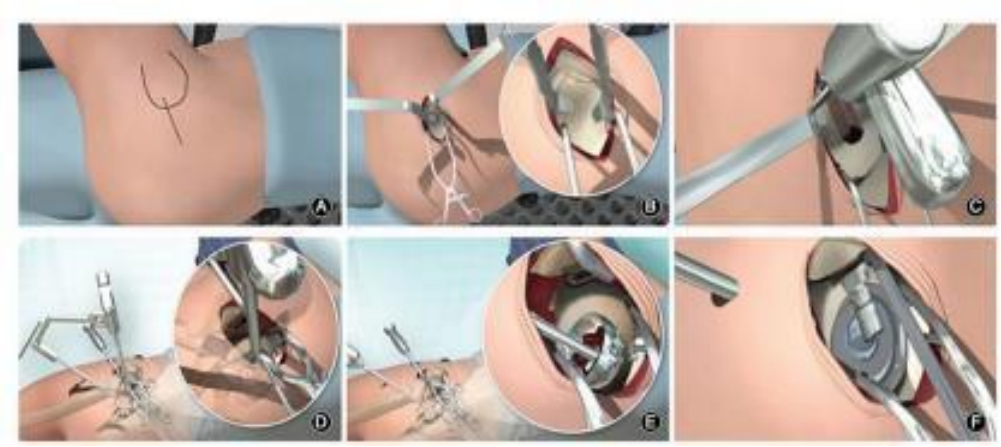


Fig. 1. *Surgical steps of a THA with mini-invasive Super Path approach: a) surgical incision; b) articular capsule exposition; c) femoral neck osteotomy; d) percutaneous acetabular approach; e) acetabular reaming; f) prosthesis implant.*

Postero lateral approach - Surgical technique

The patient is placed in lateral decubitus, and skin disinfection is performed, and then the surgical field is isolated with sterile drapes and covered with a transparent adhesive sheet; instrument connections are made, and a silk point is left as a repere for the length of the limb. The curvilinear incision is about 15 cm long and begins at 8 cm proximal to the greater trochanter, continues passing posterior to it, in line with the great gluteus, and once traversed in full, continues distally along the femoral diaphysis. The Fascia lata is dissected and passed along the lateral margin of the femur, exposing the vastus lateralis muscle; it continues in a proximal direction exposing the great gluteus muscle, dissected bluntly.

Pay attention to the superior and inferior gluteal arteries, and ligation should be done if necessary. The fibers of the great gluteus and the deep fascia of the thigh are spread apart, and the hip is rotated inward to expose the piriformis, internal obturator, twin, external obturator, and quadratus femoris muscles, and the sciatic nerve, whose common trunk is below the piriformis muscle, is moved away from the operative field. Near the quadratus femoris muscle, attention should be paid to the medial circumflex artery: if it bleeds, cauterization or ligation should be performed. Sutures are applied to the tendons of the pyriformis and internal obturator, just before their insertion on the greater trochanter, and the femoral insertion of these muscles is detached, preserving the quadratus if possible. The dissected muscles are then reflected to cover and protect the nerve. This provides access to the posterior part of the joint capsule, which can be incised longitudinally or in a "T" shape. In this approach, the prosthetic design was identical with that seen with the Super path approach (MicroPort Orthopedics Inc., Arlington, TN, USA), with uncemented femoral stem, uncemented acetabular cup and highly cross-linked polyethylene liner.

Data measurement

As the primary endpoint, the Harris Hip Score was calculated to assess functional recovery. Pain management, need for transfusion, and hospital stay were evaluated as secondary endpoints. A prospective randomized controlled single-blind clinical trial was conducted.

Data were collected and analyzed. Continuous data were expressed as mean±SD. The chi-square test was used to compare materials and count rates. Comparison between two groups was performed using unpaired Student t-test. Paired t-test was used to compare values before and after treatment in one group. For all tests, a p-value less than 0.05 was considered statistically significant.

RESULTS

Sixty patients treated with THA were considered with 30 cases in the SuperPATH group and 30 cases in the conventional postero-lateral group. The mean age of patients in the SuperPATH group was 68.23±12.77 while in the conventional postero-lateral group was 66.46±11.00.

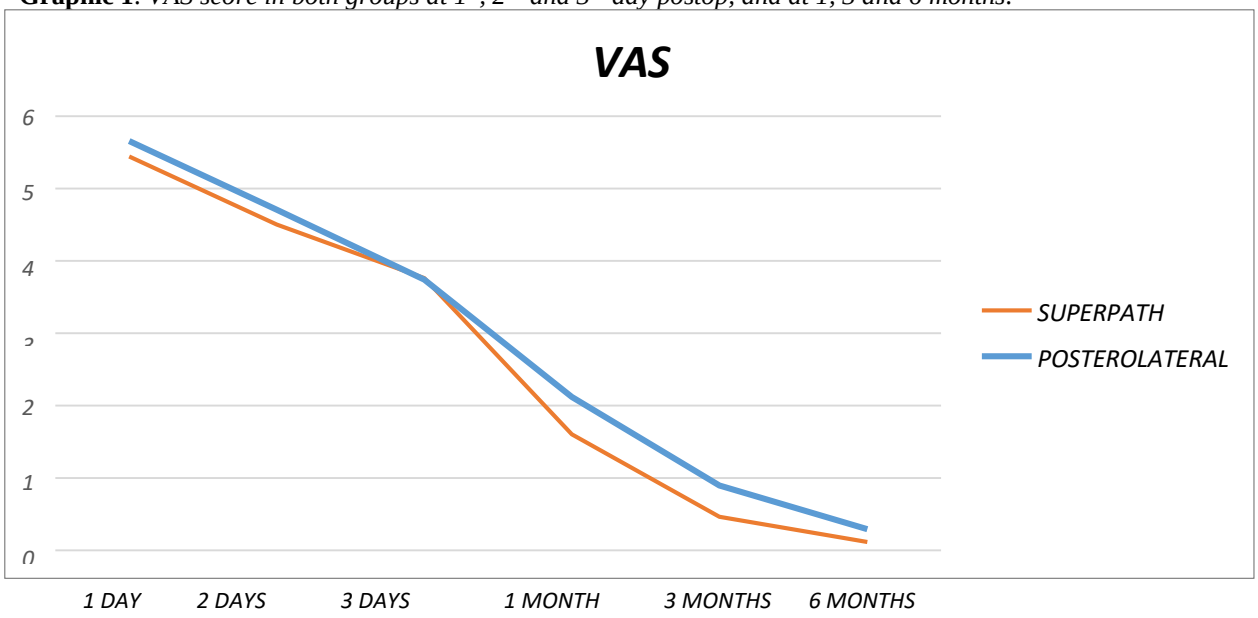
No significant difference was found in age, sex, BMI and other pathological types between the two groups. To compare the difference between the two groups, intraoperative indices including surgical time, mean blood loss and hospitalization time were analyzed. As shown in Table I, the average surgical time was significantly longer in the SuperPATH group than in the conventional group. Hospitalization time in the SuperPATH group was significantly shorter than in the conventional group (P<0.05).

Table I. *Comparison between super path and posterolateral group for general demographic characteristics and intraoperative values.*

Variables	Super Path group	Postero lateral group	P Value
Age (years)	68.23±12.77	66.46±11	*0.425*
BMC (Kg/m²)	24.59±3.28	24.78±3.13	*0.816*
Surgical time (minutes)	99.73±12.04	73.16±15.48	*0.182*
Blood loss (mg/dL)	2.95±1.18	2.6±1.13	*0.152*
Hospitalization time (days)	6.2±1.54	7.6±3.2	*<0.001*

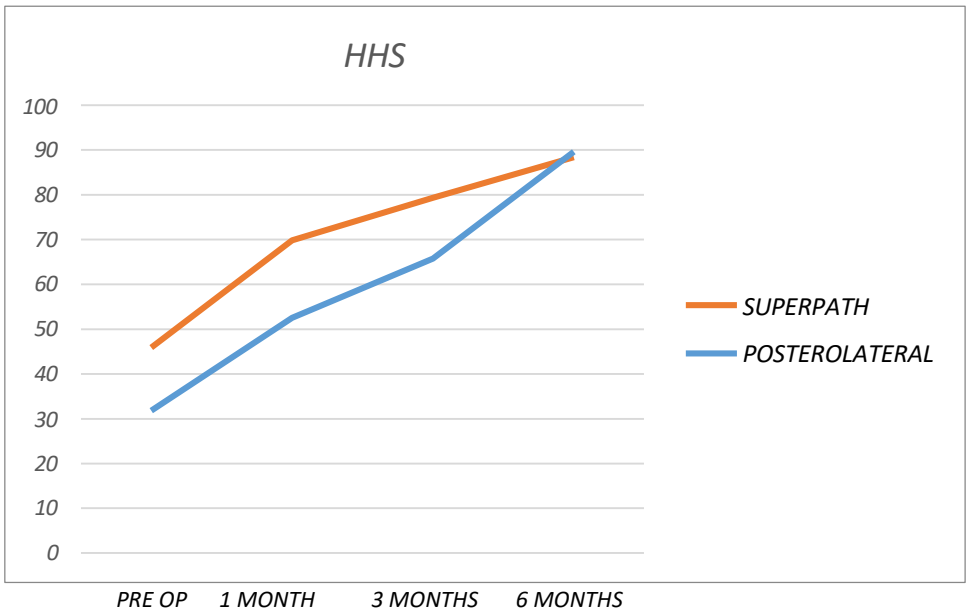
To compare postoperative recovery for hip function, HHS was assessed at 1 month, 3 months, and 6 months after surgery. After surgery, VAS scores decreased gradually and significantly, while Harris hip scores increased markedly and gradually compared with values before surgery (all P<0.05). Analysis and evaluation of the VAS scores showed that they were significantly lower at 3 days after surgery with gradual decrease in score at 1 month and 3 months after surgery (Graphic 1).

Graphic 1. *VAS score in both groups at 1st, 2nd and 3rd day postop, and at 1, 3 and 6 months.*



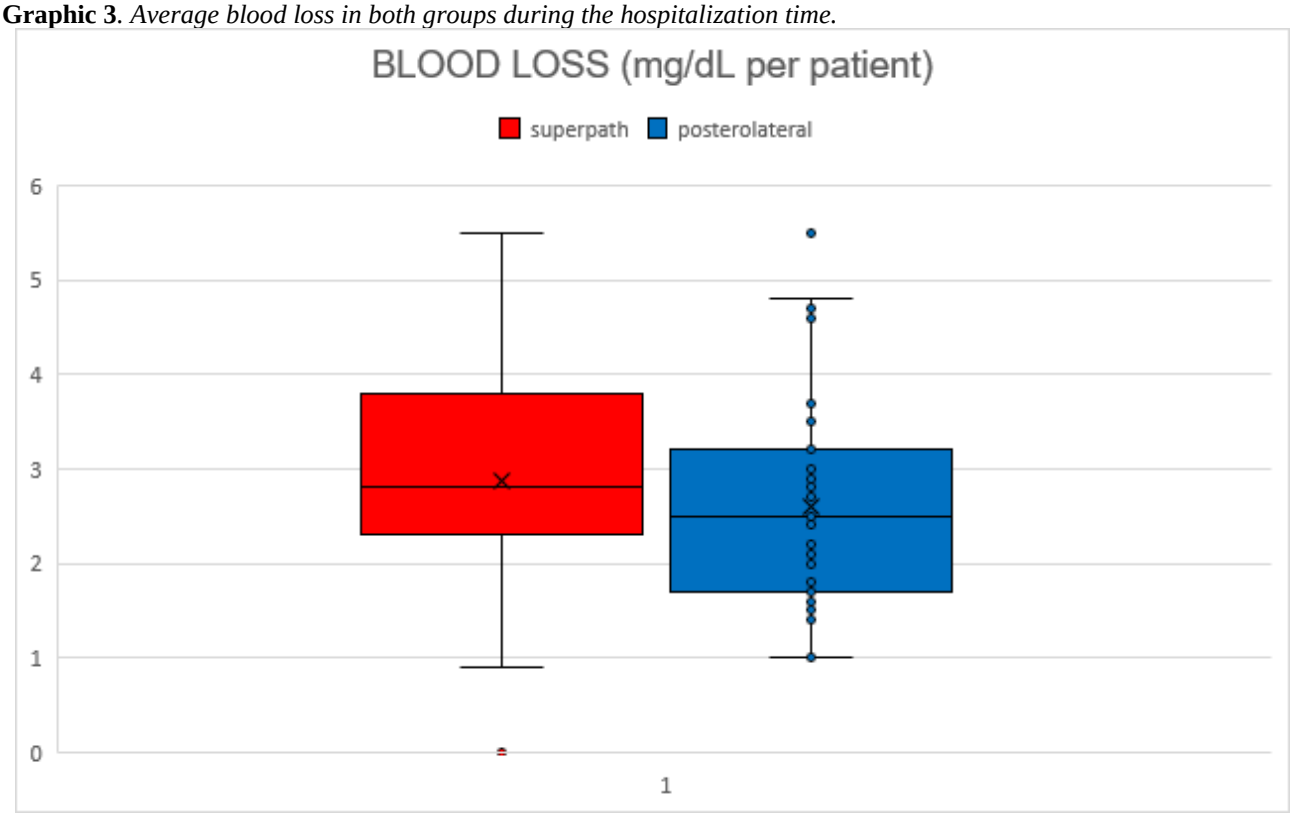
In contrast, the analysis of HHS scores showed that these were significantly higher in the SuperPATH group than in the conventional group (P<0.05) at 1 month and 3 months after the intervention, while no significant difference was found at 6 months (Graphic 2).

Graphic 2. *HHS score in both groups at pre-op, 1, 3 and 6 months.*



On the contrary, blood loss was slightly higher in Super path group (P=0,6585) (Graphic 3).

Graphic 3. *Average blood loss in both groups during the hospitalization time.*



These results suggested that the SuperPATH approach promotes the speed of recovery for hip function and reduces pain in THA patients.

DISCUSSION

Currently, total hip arthroplasty is still the main treatment method for patients with ischemic necrosis of the femoral head, femoral neck fracture and coxarthrosis, especially for elderly patients.

However, postoperative THA recovery is still a clinical challenge (12). In recent years, the development of the minimally invasive SuperPATH approach has been gradually adopted in THA (8, 13). In this study, we demonstrated that the minimally invasive SuperPATH approach causes less intraoperative injury and is better for patients' postoperative recovery than the conventional posterolateral approach. The minimally invasive SuperPATH approach is a recently developed surgical method in THA. Several studies have already reported its efficacy and safety.

In Australian research, the authors showed that although complications existed in patients with the SuperPATH approach, dislocations were rare, and most patients could recover activity within 4 weeks (14).

In another research, good postoperative efficacy was found in 150 patients with SuperPATH approach in THA with only two subluxations, one wound dehiscence and one femoral diaphyseal fracture after surgery (12). In this study, it was also found that the SuperPATH approach in THA had good efficacy, with better speed of recovery of hip function, pain, and gait condition.

For conventional posterolateral approach in THA, there are already many related studies, however, only very few studies have reported the difference between SuperPATH approach and conventional posterolateral approach in THA. Rasuli et al. compared the surgical time, transfusion rates and average length of stay and found that the surgical time was significantly longer in SuperPATH patients, could be due to the different surgical group and experience compared with the reference (15).

In a recent study in 2020, Meng et al found that SuperPATH approach patients had shorter incision length, longer operative time, and higher blood loss and better hip function (16). Another study showed that early hip function and pain status recovered more quickly in patients with SuperPATH approach (17).

In the present study, it was observed that the SuperPATH approach facilitated recovery of hip function and pain, and better recovery of gait condition was found in patients with the SuperPATH approach. However, further studies are needed to confirm the results.

The Visual Analog Scale (VAS) was collected as a parameter of early pain relief. Early postoperative pain relief and rehabilitation are two of the potential benefits cited for immediate postoperative walking ability following a new minimally invasive approach. Several studies on the minimally invasive procedure for THA have reported less intraoperative blood loss, reduced pain, and improved rehabilitation (18).

Most patients enrolled, reported a reduction in pain that allowed them to walk as early as the first postoperative day. Functional rehabilitation was initiated and walking with supports was performed for all patients in the groups analyzed from the first postoperative day. In addition, a surprisingly high decrease in VAS was shown at 1 and 3 months postoperatively, VAS values at 6 months follow-up were extremely low and stable. Limitations of this study include lack of randomization, short-term follow-up, and lack of radiographic outcomes such as anteversion and abduction of the acetabular cup. Our study has several strengths.

This was performed in a single center, a single experienced surgeon performed all surgeries using one type of anesthesia, implant, pain program and rehabilitation. In the future, a larger sample will be collected to confirm the findings of this study with the updated scoring methods.

The present study was able to suggest that the SuperPATH approach in THA provides better efficacy in postoperative recovery and better pain tolerance in the immediate postoperative period. These results could provide further clinical evidence for the application of SuperPATH in THA.

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