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Total Hip Replacement Using Imageless Computer Navigation for Femoral Neck Fracture in Elderly Patients

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Purpose: To determine the incidence of dislocation after total hip replacement (THR) using imageless computer navigation in older adults with femoral neck fractures.
Methods: A retrospective review of femoral neck fractures in older adults who underwent THR with imageless computer navigation between January 2018 and December 2019 was performed. We evaluated the dislocation rate as the primary outcome measure. Furthermore, we evaluated the acetabular component position using computed tomography, functional outcome using the Barthel index score, and perioperative complications as secondary outcomes.
Results: Of the 50 patients who underwent THR, no dislocation was found after a follow-up period of at least 6 months. The mean acetabular cup abduction and anteversion angles were 37.6° (range 32.5°-42°, SD = 1.91°) and 11.1° (range 8.9°-19.2°, SD = 4.02°), respectively. Functional outcomes evaluated using the Barthel index at 6 months follow-up showed that 86% were excellent (mean 17 of 20) (range 7-20, SD = 3.27). A total of 87% of all patients returned to their pre-injury status. Five patients (10%) died after 6 months of follow-up, and all 5 died within 30 days after surgery. There were no cases of revision surgery at 6 months follow-up.
Conclusions: THR with imageless computer navigation can provide promising stable hip replacement in elderly patients with femoral neck fractures without dislocation during short-term follow-up.

Keywords: total hip replacement, elderly, femoral neck fracture, dislocation, functional outcome, computer navigation

Hip fractures in older adults are a health problem worldwide[1-3]. These fractures, particularly acute and displaced fractures, present clinical challenges in short-term management and high mortality rates of up to 30%.[1,4,5]

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Surgery is recommended for the treatment of femoral neck fractures in patients who can tolerate the procedure and treatment is based on patient factors, location of the fracture, and the degree of displacement[6]. Internal fixation is recommended for surgery in young patients and non-displaced fractures. However, this still leads to unsatisfactory results, such as implant failure and nonunion. The re-operation rate following the use of internal fixation may be as high as 50%.[7-10] Nevertheless, internal fixation may be attempted in patients younger than 60 years, as long as great care is taken to obtain the best possible fracture reduction and stabilization[11]. Hip replacements

after femoral neck fractures have become common in elderly patients[7,9,10,12].

Controversies regarding the type of prosthesis remain. Hemiarthroplasty is more frequently used than total hip replacement (THR)[9,10,13]; however, studies have shown that THR provides superior functional outcomes[14,15], but THR is not as prevalent as would be expected[10]. Patients who require revision surgery exhibit decreased hip function[16-18] and score lower on the health-related quality of life (HRQoL) index[10,16-18]. The risk of dislocation may be a major reason why orthopaedic surgeons hesitate to perform a THR. Several studies have confirmed that the dislocation rate after a THR for a femoral neck fracture is considerably higher than that after a THR for osteoarthritis or rheumatoid arthritis[8,19-20].

Computer-assisted navigation has emerged as an important tool to improve the accuracy of implant positioning in THR[28,32], which may minimize dislocation and impingement. Thus, we conducted this study to determine the dislocation rate and functional outcome in elderly patients with femoral neck fractures who underwent THR using imageless computer navigation.

MATERIALS AND METHODS

Data on THRs performed in elderly patients with femoral neck fractures between January 2018 and December 2019 were used in this retrospective study. Patients older than 60 years old with displaced femoral neck fractures, who had pre-injury status as independent community ambulators, were included in our analysis.

THRs were performed by experienced orthopedic surgeons, who performed THRs more than 50 times per year, using the modified Hardinge approach; during the study period, we observed 50 cases of unstable fractures of the femoral neck that underwent THR. Prior to surgery, all 50 patients were evaluated by our anesthesiologist to identify the risk factors and classify the individual surgery risk level according to the ASA system. We also performed physical examinations to assess airway, cardiac, and pulmonary function, as well as the presence of anatomical changes in the lumbar spine. Moreover, we assessed the results of previous laboratory and imaging tests, if available. None of the patients were taking anticoagulants, including aspirin. Regional anesthesia was administered to all patients without intraoperative complications.

All patients underwent cementless THR with Excia wedge-type femoral component, Plasmafit acetabular component, Vitelene polyethylene liner, and 32-mm-metal head (B. Braun Aesculaps, Tutlingen, Germany). Imageless computer navigation was used in all cases with the THR cup-only software of the OrthoPilot system. This software provides the surgeon with data on the acetabular cup position, including abduction and anteversion angles, medial-lateral position, and caudad–cephalad position of the cup. We did not use computer navigation for the femoral component position because we used a cementless femoral component for all cases with hardly adjustable anteversion. Suksathien[28] reported on the benefit of computer navigation for both abduction and anteversion angles of acetabular cup placement. After the pelvic tracker was placed on the iliac crest, the anterior pelvic plane (APP) was created according to the software registration on both ASIS boney landmarks and pubic symphysis. After APP registration, patients were firmly positioned in the lateral decubitus position, and the modified direct lateral approach was used in all cases. The targeted abduction and anteversion angles of the acetabular cup under computer navigation guidance were 40° and 15°, respectively. The acetabular component position was evaluated using computed tomography after the surgery. We did not use a suction drain in any of the cases. All patients, except those allergic to cephalosporins and penicillin, received prophylactic intravenous 2 g of cefazolin, which was re-administered at 6-hour intervals until 24 hours after surgery. Patients who were allergic to cephalosporins and penicillin received 2 g of fosfomicin, which was readministered at 8-hour intervals until 24 hours after surgery. We used 10 mg/kg intravenous tranexamic acid to minimize bleeding if there was no contraindication.

All patients were required to move using a wheelchair or were encouraged to walk with a walker with-in 24 hours after surgery. Additionally, patients were encouraged to take a few steps with the help of a walker or 2 people, sitting for at least 1 hour afterward. Subsequent walking with a walker and physical therapy exercises were encouraged. After a well-trained rehabilitation program for patients and caregivers, patients were allowed to return to their homes after discharge from the hospital, where they were cared for by family members. Ambulation with a walker was encouraged during the first 30 days at home or until full recovery. To prevent dislocation, patients were advised about the caution positions for dislocation, such as extreme extension with external rotation and squatting during the first 6 months after surgery. Additionally, all patients were advised to perform mechanical prophylaxis such as foot and ankle pumping and perform early ambulation. Ten of the included patients (20%) who were at risk for thromboembolism were administered aspirin on the day after surgery until the 30-day follow-up.

The primary outcome of this study was the dislocation rate after THR in femoral neck fractures in elderly patients. The secondary outcome was the Barthel index at 6 months after the surgery. Other outcomes included: revision rate, length of hospital stay, surgical time, blood loss, transfusion rate, and other complications, such as prosthesis loosening, periprosthetic fracture, surgical-site infection, and venous thromboembolic event (VTE). The data collection is summarized with descriptive statistics, such as mean and standard deviation (SD).

RESULTS

The study group included 39 women and 11 men with a mean age of 78 years (range, 69-90 years, SD 6.69). One experienced surgeon performed all surgical procedures.

In our study, there was no dislocated THR after femoral neck fracture (50 cases) after 6 months of follow-up with the modified Hardinge's approach and imageless computer navigation. The mean acetabular cup abduction and anteversion angles, which were evaluated using computer tomography, were 37.6° (32.5°-42°) and 11.1° (8.9°-19.2°), respectively. Table 1 summarizes the demographic data and other results. None of the patients died during the surgery. However, five patients died within 30 days after surgery because of pulmonary and urinary infections, and 45 patients remained at the last follow-up visit. None of the patients underwent revision surgery for any reason. There were no early complications within 6 months after surgery, including deep vein thrombosis (DVT), pulmonary embolism, hematoma, surgical-site infections, and periprosthetic fractures. There were also no prosthesis-related complications, such as component migration, stem subsidence, and periprosthetic fracture. One patient had femoral nerve palsy after surgery, but fully recovered after 6 months without re-operation. Of the 45 patients who were evaluated, all patients alive in December 2019 were reassessed clinically and radiographically at the 6-month follow-up, with a mean Barthel index of 17 out of 20 (range 7-20; SD, 3.27). The Barthel index can assess the individual daily activity status of patients in terms of mobility, self-care, and sanitation. All patients were able to return to ambulation with or without a gait-aid at the 6-month follow-up. Radiographic analysis at the last follow-up showed no signs of prosthetic loosening in any patient. We also found well-fixed acetabular and femoral components in all the cases.

Table 1 Demographic data.

Parameter	Value (range, SD)
No. of hips	50
Gender (male/female)	11/39
Mean age (year) (range)	78 (69-90, 6.69)
Mean acetabular cup abduction	37.6 (32.5-42, 1.91°)
Mean acetabular cup anteversion	11.1 (8.9-19.2, 4.02°)
Mean Barthel index score	17 (7-20, 3.27)

Table 2 Complications.

Complication (6-month follow-up)	Value
Dislocation	0 (0%)
Revision due to any reasons	0 (0%)
Early complication (DVT, PE, Hematoma, infection and periprosthetic fracture)	0 (0%)
Prosthesis related complication (component migration, stem subsidence and periprosthetic fracture)	0 (0%)

DISCUSSION

In elderly patients with acute fractures of the femoral neck, many studies have shown that patient satisfaction and functional outcomes with THR are better than those with hemiarthroplasty[24-27]. However, one of the controversies concerning the use of THR in femoral neck fractures in elderly patients is the incidence of postoperative dislocations. According to one meta-analysis, dislocations after THR are reported to occur with an incidence of 0–22%, with a weighted mean of 6.9%.[13] More recently, dislocations were reported to occur at a rate of 8% after THR[29]. Conversely, dislocations were reported to occur at a rate of 13% after hemiarthroplasty[27].

In a study conducted by Blomfeldt et al, no dislocations were reported[32]. Tidermark et al.[17], who used a transgluteal surgical approach, reported low dislocation rates (2%) in patients who had displaced intracapsular fractures of the femoral neck and had undergone THR. Our study showed no dislocations, even with a small sample size. This confirms the possibility of achieving a very low dislocation rate with the transgluteal approach. Furthermore, computer navigation can help to minimize dislocation after THR, by providing precise acetabular component positions that are important for hip replacement stability. Suksathien[28] reported the benefits of computer navigation for both abduction and anteversion angles of acetabular cup placement. This study compared computer-navigated to non-computer-navigated THR in terms of acetabular cup placement. Computer-navigated THR provides no acetabular component position outliers from the Lewinnek safe zone. All cases in our study were performed with imageless computer navigation THR, which is a method to minimize dislocations by achieving good component positions.

The acceptable early mortality rate noted in our series is quite satisfactory, considering that we did not exclude any of our patients undergoing THR, even though the number of patients was reasonably low. The mortality rates shown in our study were 4%, 8%, and 12% at 1, 6, and 12 months of follow-up, respectively. These mortality rates were comparable to those reported in the literature[8,13,21,25,29]. When reviewing the long-term results of 126 cemented THAs performed in a sample of patients with a mean age of 75 years, Lee et al.[22] found that 118 patients were alive at the 1-year postoperative examination. This represented a mortality rate of 6.3%, which is comparable with the rate found in our study (8%). In a meta-analysis conducted by Bhandari et al.[13], mortality rates for the first 4 postoperative months were found to range from 4.3% to 20% after arthroplasty and from 0% to 12.1% after internal fixation procedures. One-year mortality rates ranged from 4.3% to 48% after arthroplasty and from 0% to 65% after internal fixation procedures. Total hip arthroplasty has a comparable mortality rate to either internal fixation or hemiarthroplasty in randomized trials.

One randomized trial comparing bipolar hemiarthroplasty with THR for intracapsular fractures of the femoral neck in older patients[14], 120 patients with a mean age of 81 years were allocated to be treated with one of these operations, and they were examined at 4 and 12 months after surgery. The 1-year mortality rates estimated for the THR and hemiarthroplasty groups were 6.7% and 5%, respectively. There were no differences in complications and mortality between the two groups, but THA provided a better function. However, Meek[21] reported a prospective randomizeed study comparing cemented THA with internal fixation and hemiarthroplasty for displaced subcapital fractures of the femur in terms of mortality, morbidity, and functional results. Mortality rates for the THA, hemiarthroplasty, and internal fixation groups after 1 year were 23%, 27%, and 25%, respectively. The 13-year results showed no significant difference between the groups in mortality rates. The mortality rates found in our study (5 of 50 cases) were comparable to the range reported in the cur-rent literature.

All patients who survived 6 months after surgery were clinically assessed using the Barthel index, which is widely used for functional outcome assessment in patients with femoral neck fracture[30,31]. Approximately 89% (41 of 46) of these patients returned to pre-injury functioning status at 6-months follow-up. Only 11% (5 of 46) of the patients did not achieve their former activity level.

None of the patients required revision surgery. Our preferred choice to treat femoral neck fractures in older adults is THR, which can be successful with both cemented and cementless prostheses[23,29,32]. Indeed, Rudelli[29] reported good results of cemented THR in older adult patients with femoral neck fracture without implant complications that need revision. In our study, we performed cementless THR for femoral neck fracture patients without implant complications and revision surgery. Similar to Klein et al.[23], very good results were obtained using a cementless, collarless, fiber-metal, proximally coated, distally tapered femoral hip prosthesis, with no need for revisions due to aseptic loosening.

The limitations of our study include its retrospective design, small sample size, and short follow-up duration. Further comparative studies are needed to confirm the benefits of this treatment option for elderly femoral neck fractures.

CONCLUSION

In summary, dislocation after THRs in patients with femoral neck fractures is a relatively common, severe, and an expensive complication to treat. With a computer-assisted navigation and transgluteal approach, the treatment of elderly femoral neck fracture with THR can be an option with very low dislocation incidence in short-term follow-up, good postoperative functional outcome, and low mortality. With a very low incidence of reoperation, as well as low mortality rates, the costs of computer-assisted navigation may be acceptable, considering the overall satisfactory results.

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