



Clinical Outcomes of Total Hip Arthroplasty for Displaced Femoral Neck Fractures in Patients 80 Years of Age and Older Selected by Clinical Frailty Score

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Purpose: The utility of total hip arthroplasty (THA) for the treatment of displaced femoral neck fractures in elderly patients (≥ 80 years of age) remains controversial as a patient's general condition is an essential factor impacting recovery. This study aims to determine if THA is a valuable option for appropriately selected elderly patients.

Materials and Methods: All patients underwent cementless THA using a direct lateral approach with a rectangular stem. Eighty-two patients ≥ 80 years of age underwent THA due to a displaced femoral neck. Clinical frailty scale (CFS) scores < 5 were indicated for THA. The modified Harris hip score (mHHS), visual analogue scale (VAS), and patient satisfaction were used to assess outcomes.

Results: Nine of 82 patients died in the study period with another underlying disease. One, a 90-year-old male with pneumonia expired in the intensive care unit at 7-day postoperatively, while the other eight died due to causes unrelated to THA. Of the remaining 73 patients: (i) mean mHHS score increased to 80.57 ± 21.36 at 1-year postoperatively; (ii) VAS was 2.3 ± 0.9 points six-months postoperatively; and (iii) 78.7% of patients reported that they were very satisfied or satisfied 1-year postoperatively. The number of perioperative complications was 10.8% (9 hips) without the need for revision surgery.

Conclusion: The use of THA in patients ≥ 80 years of age with low CFS scores (< 5) described here yielded favorable results and a relatively low rate of complications. However, a well-controlled comparative study or randomized trial is required to further refine selection criteria for THA in this patient population.

Key Words: Femoral neck fractures, Osteoporosis, Elderly, Total hip replacement, Frailty

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INTRODUCTION

Hip fractures are a problematic health care issue with a high rate of mortality and morbidity in elderly patients. With increases in life expectancy and the prevalence of osteoporosis, the incidence of hip fractures will continue to rise in the future. An untreated femoral neck may result in multiple comorbidities, which may ultimately lead to death, it is crucial to treat this fragile fracture in elderly patients with surgery¹⁾. However, the optimal treatment approach remains a matter of controversy²⁾. Several authors reported that total hip arthroplasty (THA) in elderly patients is advantageous in that it leads to superior functional outcomes and lower reoperation rates compared to hemiarthroplasty (HA)³⁾. With increased activity and independent elderly population, the use of THA for managing femoral neck fracture is likely to increase.

Importantly, however, concerns on the suitability and safety profile of THA in elderly patients remains. For instance, dislocation are a significant problem after primary THA, especially in elderly patients with a femoral neck fracture⁴⁾. Commonly suggested reasons for acute dislocation in this age group include relative laxity of the hip capsule, use of posterior approach, and small femoral head size of the prosthesis. The posterior approach is still commonly used in THA, even though it is a risk factor for dislocation⁵⁾.

The proper selection of patients for THA can be more difficult in those 80 years of age and older. The factors to consider when choosing whether to proceed with THA or HA for a displaced femoral neck fracture are the patient's chronologic and physiologic ages, level of activity, bone quality, and associated comorbidities. Importantly, however, the optimal choice of arthroplasty approach remains a source of debate.

Based on the background mentioned above, we have designed the current study to validate whether it is safe to perform THA if the patient is appropriately selected. This study aims to determine whether THA is a valuable option for those 80 years of age or older if the patient is appropriately selected using the clinical frailty scale (CFS).

MATERIALS AND METHODS

The institutional review board approved this study (Jeonbuk National University Hospital, IRB no. CUH 2017-10-002-008), a retrospective review of a prospective database. In our institution, THA for displaced femoral neck

fracture is indicated when patients are >65 years of age and have previously been independent outdoor walkers (with or without walking aids). However, when patients are ≥ 80 years of age, and have multiple comorbidities, a bipolar HA is commonly selected. In this study, we reviewed records from patients ≥ 80 years of age who were treated with THA for a displaced femoral fracture. Exclusion criteria were: (i) a CFS (>5 of 9); (ii) any level of cognitive dysfunction; or (iii) more than two of four significant medical comorbidities (e.g., cardiac, pulmonary, hepatic, or renal disease). CFS is a simple and rapid screening tool that can help predict health and aging by assessing levels of frailty in older adults. Frailty scale scores range from 1 (very fit) to 9 (terminally ill). Levels 1 to 5 are defined as follows: 1: very fit and exercise regularly; 2: well without active disease symptoms; 3: managing well and medical problems are well controlled; 4: vulnerable, but dependent on others for daily help; 5: mild frailty, and requires assistance with high-order instrumental activities of daily living. Of the initial 121 patients presenting with a displaced femoral neck fracture, 82 patients (82 hips) were selected based on inclusion and exclusion criteria (Fig. 1). Patients were followed for a minimum of 12 months, and had scheduled follow-up visits at six weeks, three months, six months, and 12 months.

Age, sex, height, weight, body mass index, American Society of Anesthesiologists (ASA) physical status classification, and time from admission to surgery were documented. A 9-point CFS was recorded at the time of the admission to assess patient status before the fracture event. Additionally, patient outcome measures were collected, including modified Harris hip score (mHHS) and visual analogue scale (VAS). Patient-reported satisfaction was collected as very satisfied, satisfied, neutral, dissatisfied, or very dissatisfied during the follow-up period. Length of hospitalization, duration of surgery, and complications were also reviewed using hospital records. The study group included 47 female and 35 male with a mean age of 84.1 ± 4.1 years (range: 80-97 years). The mean time from time of admission to the surgery was 5.81 ± 3.4 days and the mean surgery time (from skin incision to skin closure) was 99.3 ± 21.6 minutes. The mean T-score was -3.02 ± -0.68 .

All operations were performed by a single surgeon using a direct lateral approach. The capsule was opened in line with the abductor and vastus lateralis complex with stay sutures allowing adequate closure. All patients received a cementless acetabular component (Delta PF cup; Lima, Udine, Italy), cementless rectangular femoral stem (C2 stem; Lima), ceramic liner and a ceramic head (Lima). Delta or

forte-ceramic was used on the ceramic on ceramic (CoC) bearing surface, and the largest head was used according to the size of the acetabular cup (32, 36, or 40 mm ball head). Patients received pre- and postoperative cefazolin antibiotics prophylaxis. All patients had similar postoperative rehabilitation and were permitted to bear approximately 10 to 50% of their weight on the treated extremity for six weeks. No braces were used postoperatively to prevent dislocations.

A low molecular-weight heparin was used in the pre- and postoperative period to help reduce the risk of deep vein thrombosis, pulmonary thromboembolism, and cardiovascular complications. Clinical data (e.g., patient demographics, medical comorbidities, surgical procedures), were collected from medical records, and clinical outcomes were assessed using mHHS, VAS, and a 5-point patients satisfaction scale. Postoperative axiolateral radiographs were available for all patients to evaluate stem and acetabular cup positions. Acetabular inclination and anteversion angle were measured by two orthopedic fellowship-trained observers. Preoperative and postoperative (immediately after surgery;

6-month and 12-month follow-up visits) anteroposterior and axiolateral view radiographs of the hip joint were obtained. Other outcomes were also assessed at 12-month follow-up. Ten patients were unable to visit the outpatient clinic for their scheduled 12-month follow-up visit; a detailed telephone interview was therefore conducted for these individuals. No patient was lost to follow-up.

Statistical analysis was performed using IBM SPSS version 21.0 for Windows software (IBM Corp., Armonk, NY, USA). The student *t*-test was used to analyze the results of patients-reported outcome scores; $P < 0.05$ was set as statistically significant.

RESULTS

1. Survival

Nine of 82 patients died in the study period. A 90-year-old male patient with pneumonia expired in the intensive care unit at 7-day postoperatively, resulting in a 1.2% 30-day mortality. Two patients aged 86, and 87 died within 12

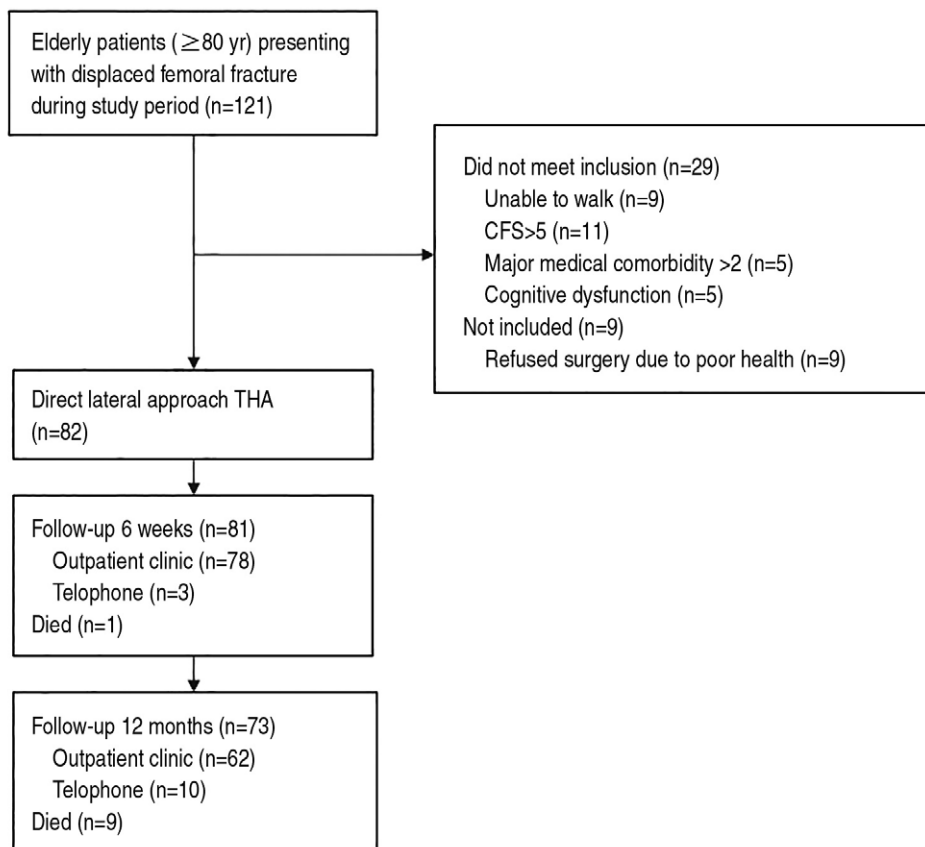


Fig. 1. Outlines of inclusion and exclusion criteria of total hip arthroplasty of femoral neck fracture. THA: total hip arthroplasty, CFS: clinical frailty scale.

months due to lung cancer and renal failure with chronic kidney disease, respectively. The other five patients died within the study period due to unknown causes. It is important to note that deaths were due to an unrelated cause confirmed by a spouse or close family member and that the THAs were free of complications with minimal pain.

2. Clinical Results

The mean hospital stay was 18.8 ± 8.8 days, the mean surgical time was 91.7 ± 21.5 minutes. Substantial improvement in pain relief following THA—as assessed with the VAS—was reported VAS 5.4 ± 1.3 , preoperatively and VAS 2.3 ± 0.9 , six months postoperatively ($P < 0.0001$). mHHS were 81.83 ± 12.87 and 80.57 ± 21.36 preoperatively and one-year postoperatively, respectively ($P = 0.67$). Preoperative and one-year postoperative CFS scores were 2.8 ± 1.1 and 3.6 ± 1.6 , respectively ($P = 0.0003$). According to the satisfaction scale administered one-year postoperatively, 53.75% (n=43) were very satisfied, 25.00% (n=20) were satisfied, 10.00% (n=8) were neutral, 5.00% (n=4) were dissatisfied, and 6.25% (n=5) were very dissatisfied (Table 1).

3. Radiographic Results

Serial radiographs of all 80 cementless stems with a minimum follow-up 12 months demonstrated stability without sinking in all cases. Furthermore, none of these cementless femoral components revealed evidence of mechanical failure. Serial radiographs demonstrated that all surviving cementless acetabular cups were stable without loosening at the last follow-up. The mean acetabular cup inclination angle measured by two observers was $40.6 \pm 5.0^\circ$ (range: $34.2\text{--}46.1^\circ$) and $43.6 \pm 5.6^\circ$ (range: $38.1\text{--}49.3^\circ$), respectively. The acetabular anteversion angle was $22.5 \pm 8.9^\circ$ (range: $14.4\text{--}30.1^\circ$) and $27.3 \pm 8.6^\circ$ (range: 19.3--

35.1°), respectively.

4. Complications

In this study of 83 hips, perioperative complications occurred in nine hips (10.8%). One patient (1.2%) experienced an intraoperative periprosthetic fracture around the trochanteric region, which was treated by cerclage wiring. Two patients (2.4%) had superficial wound infections that required debridement and treatment with antibiotics without significant revision surgery. One patient (1.2%) had a single dislocation due to delirium in the early postoperative period, which was managed with closed reduction; no further dislocations were noted during the study period. One pulmonary thromboembolism (1.2%) was identified postoperatively and treated with seven months of warfarin. There was no ceramic breakage during the follow-up period.

DISCUSSION

This study demonstrates that THA may be a safe and beneficial option for treating displaced femoral neck fracture in patients ≥ 80 years of age if they have minimal comorbidities and a CFS of < 5 . The results of this study are consistent with previous randomized controlled trials (RCTs), which demonstrate that THA is the surgery of choice for elderly patients with displaced femoral neck fractures^{6,7}.

Some authors have reported that THA has better results than HA for long-term pain relief and functional outcomes in elderly patients^{8,9}. The results of a matched analysis by Squires and Bannister¹⁰ demonstrated that acute femoral neck fractures treated with THA or HA resulted in good or excellent results in 86% and 12% of patients, respectively. In a four-year follow-up of a randomized trial, THA demonstrated superior outcomes in terms of hip function and quali-

Table 1. Clinical Scores of Total Hip Arthroplasty for Elderly Femoral Neck Fracture 80 Years of Age Older

	Preoperative	Postoperative	P-value
Visual analogue scale (n=73)	5.4 ± 1.3	2.3 ± 0.9	< 0.0001
Harris hip score (n=73)	81.83 ± 12.87	80.57 ± 21.36	0.67
Clinical frailty scale score (n=73)	2.8 ± 1.1	3.6 ± 1.6	0.0003
Patient-reported satisfaction		Very satisfied 53.75% Satisfied 25.00% Neutral 10.00% Dissatisfied 5.00% Very dissatisfied 6.25%	

ty of life as compared with HA in elderly, lucid patients with a displaced fracture of the femoral neck³. In this study, a perioperative medical complication occurred in association with 4.8% (4 patients) of the 83 operations, however, there was one death caused by pneumonia at postoperative day seven. The survival rate after one-year surgery was 89.1% (74 of 83 patients), and 63 patients (75.9%) indicated using a survey designed to assess patient-reported satisfaction that they were very satisfied or satisfied with the results of the surgery. Frailty index turned out to be a better predictor of mortality, 30-day residence, and length of inpatient stay¹¹. The favorable mortality demonstrated in this study appears to be the result of excluding patients with a relatively high CFS (i.e., 5-9). The Charlson comorbidity index and the CFS are well known risk factors for postoperative outcomes of elderly patients, however, there is no consensus as to which is the best predictor of postoperative mortality and morbidity after hip fracture surgery. All randomized, prospective studies that compare HA and THA record a high hip score after THA⁶. These studies have revealed that in patients followed long term, THA yields the best clinical results and is also the most cost-effective treatment^{6,12}.

The choice of surgical approach will affect the frequency and nature of complications following THA for femoral neck fractures. THA is assumed to have a high rate of dislocation in this patient group, but the literature is controversial, perhaps due to the influence of variable factors such as surgical approach¹³. One study demonstrated that the use of the direct lateral approach in patients with displaced femoral neck fractures decreased the risk of dislocation from 8% to 2% when compared to the previously used posterior approach¹⁴. In this study, one patient had one dislocation episode in the early postoperative period. There was no recurrent dislocation or need for revision surgery. A minimum follow-up period in the patients included here is >12 months, a length of time sufficient to characterize the risk of dislocation. The direct lateral approach may be associated with hip-abductor dysfunction, leading to limping gait and a positive Trendelenburg sign during the early postoperative period. These complications may impede the postoperative rehabilitation process, resulting in longer hospital stays. Only one modern RCT compared the direct lateral and posterior approach in HA that revealed no difference in the rate of complications or hip scores¹⁵. The risk of hip-abductor dysfunction can be minimized using suture anchor repair in the author's direct approach. In this study, there were no cases of severe abductor dysfunctions requir-

ing repair during the follow-up period. Pronounced prefracture functional limitations in frail hip fracture patients may out-weigh the subtle differences between the direct lateral and posterior approaches¹⁴.

Another controversy in using arthroplasty for femoral neck fractures in elderly patients is the use of cement or cementless implants. It has been suggested that the cemented THA is preferred in elderly patient since it may provide a more favorable fixation in the early postoperative period. However, the use of cementless stems is increasing globally, including for elderly patients¹⁶, however, the advantage of cementless stems over cemented fixation remains unproven⁶. While initial stability may be an issue, cementless stems can provide several benefits to elderly patients compared with cemented fixation (e.g., shorter operation times, reduction of cardiopulmonary stress and risk of embolization). Nonetheless, the revision rate after cementless hip replacement is higher than that of the cemented one in elderly patients¹⁶.

There is moderate evidence supporting the use of cemented femoral stems in elderly patients undergoing arthroplasty for femoral neck fractures¹⁷. RCTs demonstrate that cemented THA is similar if not superior to cementless¹⁶ and there was no difference in mortality or the rate of postoperative complications. The use of a cementless prosthesis in this physiologically frail age group is an advantage over arthroplasty with cement in terms of shorter surgical time and decreased blood loss. The insertion of bone cement is associated with embolization of fat and bone marrow contents and intra-operative risk, which has been a well-documented result of cement injection and pressurization¹⁸. Although cemented arthroplasties are thought to be less expensive and therefore a more appropriate option for the elderly, the total cost of implantation between cemented and cementless type is not significantly different. Cementless stems increase the risk of reoperation due to periprosthetic femoral fracture (PFF) by 20 times¹⁹. PFFs were associated with advancing age, sex, developmental hip dysplasia, and cementless metaphyseal engaging components, mainly flat wedge tapers²⁰.

The cementless stem cannot be recommended for octogenarian patients due to stem subsidence or PFFs²¹. In this study, there was only one (1.2%) intraoperative PFF manageable using cerclage wirings. According to Khanuja et al.²², the results presented here might be due to the use of a rectangular, tapered, conical stems that are grit-blasted across their entire length (type 3C). In this study, at a mean follow-up of 9.4 months, all femoral components were

Table 2. Summary of the Studies Published Previously about Results of Arthroplasty for Elderly Femoral Neck Fracture

Study	Approach	Age (yr)	Patient (n)	Follow-up (mo)	Dislocation (%)	HHS	Operation time (min)	Mortality (%)	Hospital stay (day)
Baker et al. ²³⁾	Lateral	74	40	36	7.5				
Blomfeldt et al. ²⁴⁾	Anterolateral	81	60	12	0	87.2	102	5	
Dorr et al. ²⁵⁾	Posterior	69	39	48	17.9			18	
Jacquot et al. ²⁶⁾	Postero-posterolateral	79	102	1.5	0		100		6.8
Macaulay et al. ²⁷⁾	Posterolat/Anterolateral	82	17	24	5.8	84.2	89.1	23.5	7.7
Park et al. ²⁸⁾	2-incision	72	44	24	4.5	88.3	70		15.1
Skinner et al. ²⁹⁾	Posterolateral	81	89	12	15.7				
van den Bekerom et al. ³⁰⁾	Posterolateral/ (Antero)lateral	82	115	60	7	75.2		54	18.4
Wani et al. ³¹⁾	Posterolateral	65	50	18	0	93.7	100		11.9
Thürig et al. ³²⁾	Anterior	75	86	20	2.3	94	90	16.7	11
Our study	Direct lateral approach	86	82	12	1.2	80.5	91.7	3.6	18.8

stable and their was evidence of bone ingrowth in all but one, which was deemed to have stable fibrous ingrowth. Mild thigh pain was present in 4 patients. When compared to the approaches used by other investigators, our group had a lower dislocation rate and mortality rate (Table 2)²³⁻³²⁾.

In this study, we selected only 32 or 36 mm CoC-bearing THA for femoral neck fractures. Although literature reports of CoC bearings describe a high risk of fracture and squeaking, none of the CoC bearing-associated complications (e.g., breakage of ceramic liner or head, squeaking) was observed in this study population. Squeaking might also remain undetected in elderly patients due to their more sedentary lifestyle. The CoC bearing is an attractive alternative surface because of its biocompatible characteristics include low frictional torque, better wettability, and fewer wear particles compared with polyethylene. Moreover, a recent international consensus study concluded that the incidence of periprosthetic joint infection is higher following the use of metal-on-metal bearings in THA³³⁾. Therefore, the CoC bearings used here might be associated with a lower risk of infection.

One of the limitations of this study is that there are no control groups that have undergone THA using a posterior approach in our clinic. Other limitations are that the sample size is small and that some patients had a relatively short follow-up (mean, 12.4 months). A one-year follow-up might be considered too short, however, this has been considered as the time when hip function reaches its maximum after surgery. More extensive comparative studies are required to further refine selection criteria for THA in this frail patient population. This algorithm using CFS and significant medical comorbidities substantially reduced the rate of complication and mortality in elderly patients with displaced femoral neck fractures.

CONCLUSION

The direct lateral approach with cementless CoC THA could result in fewer complications and good functional results for femoral neck fractures in selected elderly compared with other surgical approaches. If confirmed, this approach may provide a cost-effective solution with lower institutional demands and reduced hospital admissions. These results, however, require careful patient selection, proper training of surgeons, and the right choice of implants for these vulnerable patients. Ultimately, a well-controlled comparative study or RCT is required to further refine selection criteria for THA in this frail patient population.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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