



## Total Hip Arthroplasty for Failed Internal Fixation After Femoral Neck Fracture Versus That for Acute Displaced Femoral Neck Fracture: A Comparative Study



Zhouyuan Yang, MM<sup>a</sup>, Huifang Liu, MD<sup>b</sup>, Xiaowei Xie, MD<sup>a</sup>, Zhen Tan, MM<sup>a</sup>, Tianqiang Qin, MM<sup>c</sup>, Pengde Kang, MD<sup>a</sup>

<sup>a</sup> Department of Orthopedics, West China Hospital, Sichuan University, Chengdu, China

<sup>b</sup> Department of Rehabilitation Medicine, West China Hospital, Sichuan University, Chengdu, China

<sup>c</sup> Chinese Evidence-Based Medicine Centre/Cochrane Center, West China Hospital, Chengdu, China

### ARTICLE INFO

#### Article history:

Received 5 November 2014

Accepted 23 February 2015

#### Keywords:

total hip arthroplasty  
femoral neck fracture  
internal fixation  
perioperative period  
complication

### ABSTRACT

The outcome of total hip arthroplasty (THA) for failed internal fixation after femoral neck fracture (FNF) versus that for acute displaced femoral neck fracture is still controversial. This study retrospectively analyzed a consecutive series of 130 THAs for acute displaced FNF (64, group I) and for failed internal fixation (66, group II). Results showed THAs in group II were more technically demanding procedures with longer operative time and larger amounts of drainage compared to that in group I. Furthermore, multivariate analysis revealed that the associations between THAs (group II) and hip complications were notable (OR = 4.15,  $P = 0.017$ ). These increased risks should be paid much attention to, not only for choosing the appropriate treatment option, but also for providing effective perioperative care.

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With population growth and aging, femoral neck fracture (FNF), accounting for nearly half of all hip fractures with the majority occurring in elderly patients after simple falls [1], continues to increase in numbers and significance [2–4]. The annual estimated worldwide direct and indirect costs of hip fractures are expected to rise to \$131 billion by 2050 from the estimated \$34.8 billion in 1990 [2]. Among the main three surgical strategies including internal fixation (IF), hemiarthroplasty (HA) and total hip arthroplasty (THA) for FNF, THA could be effective in pain relief and provide superior and more durable function in a subset of patients with displaced FNF when compared to HA or uncomplicated osteosynthesis [5]. Accumulating of high quality evidence demonstrates that THA has a larger role in the treatment of displaced FNF than it has in the past, resulting in less short-term complications and/or better long-term implant survival [6–14]. Furthermore, currently available data [15–17] support the use of THA as a more cost-effective treatment strategy in this specific population, despite relatively higher costs at the initial admission or early follow-up compared to IF or HA. The increased upfront cost appears to be offset by the improved functional results.

However, in spite of high failure rate for IF, the method is still recommended for this specific cohort by some authors. It is claimed that preserving the natural femoral head will obtain better hip function than replacing it with an artificial one. It is also argued that, even if the IF failed,

salvage THA could also yield good results comparable to primary THA [18–20]. On the contrary, previous studies have also found THA following failed IF after FNF led to increased risk of early complication, inferior hip function and higher revision rate [21–23]. Whether salvage THA for failed IF—as compared to primary THA obtains similar results is a matter of vigorous debate. Moreover, we are unaware of any studies focusing on comparison of perioperative outcomes including operative difficulties and complications between primary and salvage THA for FNF. The main purpose of our study therefore, is to assess the immediate results of salvage THAs following failed IF after FNF, compared with primary THAs for elderly patients with displaced FNF by retrospectively analyzing the prospectively collected data of joint arthroplasty cohort from our institution.

We hypothesized that salvage THA for failed IF would be a more technically demanding procedure with prolonged operative times, larger amounts of intra-operative blood loss and post-operative drainage and higher proportion of transfusion, and also be at increased risk of developing complications during perioperative period compared to primary THA for acute displaced FNF.

### Patients and Methods

#### Study Design and Subjects

With the approval of ethics committee of our institution, we conducted a retrospective cohort study employing joint arthroplasty data from the 2009 to 2014. These data were prospectively collected in a special database, Administrative System of Orthopedic Medical Records (Joint Arthroplasty), which was created and maintained by a team of assigned staff members since 2009. Patients once admitted to our

No author associated with this paper has disclosed any potential or pertinent conflicts which may be perceived to have impending conflict with this work. For full disclosure statements refer to <http://dx.doi.org/10.1016/j.arth.2015.02.037>.

Reprint requests: Pengde Kang, Ph.D., M.D., Department of Orthopedics, West China Hospital, Sichuan University, Chengdu, Sichuan, China, 610041.

Department of Joint Surgery were all registered into this database. The register contains patient demographics, surgery-related information, prosthesis information and records of clinical and radiographic assessment during perioperative period.

In present study, potentially eligible patients who underwent primary THA for FNF were identified with algorithms using procedure and diagnosis codes (ICD-10) in the database from 2009 to 2014. Patients aged 60 or over were included for further selection. Of the consecutive series of 174 initially screened THAs, there were 70 THAs due to FNF, 68 THAs due to failed internal fixation (group II), 33 patients due to sequelae of FNF with conservative treatment and another three patients with unavailable data. Acute FNF was defined as a fracture treated within 3 weeks of occurrence. Only patients with acute displaced FNF (Garden III, Garden IV) [24] were included into the primary group (group I). Patients diagnosed with sequelae after FNF, without an earlier operation for the fracture were excluded. Patients were also excluded for infection after internal fixation or incomplete data. Finally, a total of 64 patients were included in group I meanwhile 66 in group II.

Unilateral THA was performed for each patient. Two in group II developed deep infection after IF following FNF and these patients underwent a two-stage THA (the first operation was performed for hardware removal, thorough debridement and implantation of temporary prosthesis composed of acrylic cement impregnated with antibiotic, and the second was performed for prosthesis implantation after some time of infection healing) and thus were not included into group II.

#### Operative Details

Five senior surgeons who had carried out more than 200 joint arthroplasties annually performed the THAs in a modern operating room with ultra-clean air filtration and vertical laminar air flow. The patients were in the lateral decubitus position, under general anesthesia (almost all, 125/130). Operations were carried out using a posterolateral surgical approach with implants produced by Depuy or Stryker Orthopedics Company. The choice of using either a cemented or an uncemented component depended upon the quality of bone stock and femoral canal anatomy. All patients received perioperative antibiotics, standard postoperative anticoagulation, closed suction wound drainage (removed on the first postoperative day), ice bags upon wounds (intermittently within 24 hours after operation) and pneumatic compression with foot pumps. The standard rehabilitation program consisting of weight bearing as tolerated with walking aid started the day after surgery for 2 weeks.

#### Information of Interest

Information on patient age at the index surgery, gender, weight, height, preoperative comorbid conditions (defined by the Deyo index [25], adapted Charlson comorbidity index [26]), reasons for IF failure, type of internal fixation, prosthesis type, prosthesis fixation method, and femoral head size was extracted from records in the database. The primary outcomes of interest contain length of stay (LOS, including preoperative LOS, postoperative LOS), operative time, blood loss, transfusion volume, perioperative complications including general medical complications (postoperative nausea and vomiting (PONV), gastroenteric stress ulcer, deep venous thrombosis (DVT), pulmonary embolism (PE), acute coronary syndrome (ACS), respiratory tract infections, pneumonia, urinary retention, urinary tract infection, acute renal failure, paralytic ileus) and hip complications (hematoma, fat liquefaction of incision, peripheral nerve injury, infection (wound infection and periprosthetic infection), dislocation, periprosthetic fracture).

#### Statistical Analysis

Statistical analysis was performed by two investigators using SPSS (version 16.0, Chicago, Illinois, USA). Continuous variables were described with mean and standard deviation, or median and range while categorical variables with frequencies and percentage. Normal

distribution and homogeneity of variance was examined using the Kolmogorov–Smirnov test and the Levene's test respectively for quantitative variables. Categorical variables were compared between the two groups by using chi-square test (or Fisher exact tests where appropriate) while continuous variables were compared by using t tests for two independent samples or analysis of variance (ANOVA) for multiple groups. Multiple comparisons were conducted following ANOVA by using the LSD's (least significant difference) post hoc tests. Significant difference was considered present with a two-side *P* value less than 0.05.

Univariate and multivariate logistic regression analysis was used to determine the effect of patient-based factors such as age, gender, BMI, comorbidity, surgery type (salvage VS primary) on the development of overall perioperative complications as well as general medical complications or hip complications. Patients' age was categorized as sixty to sixty-nine years of age, seventy to seventy-nine years of age, or eighty years of age and older. Since all patients were Chinese, body weight index (BMI) was categorized as <24 and ≥24 kg/m<sup>2</sup> based on epidemiological survey of Chinese BMI [27]. The threshold value distinguishing different body weight statuses in China is distinct with Western Europe and North America. Patients' Deyo index (modified Charlson comorbidity index scores) ranged from 0 to 4, but this was dichotomized into presence or absence of comorbidities due to skewed frequency distribution with a low median and few high scores. The five independent variables aforementioned were all entered into the final multivariate model.

Both perioperative antibiotic prophylaxis and surgical approach were not included in the model as all patients in this consecutive series received prophylactic antibiotics and moreover, were operated using the same traditional surgical approach, posterolateral approach. The Hosmer–Lemeshow goodness-of-fit test was used to assess the fitness of the logistic regression model. Significant independent predictors were determined to be those that maintained *P* value of <0.05 with the odds ratio (OR) or 95% confidence interval (CI) exclusive of 1.0.

#### Result

Of the total 130 THAs, 128 patients were implanted with a cementless THA, one with a cemented THA, and one with a hybrid THA. Ten cups were additionally fixated with screws.

There were 38 (59.4%) of 64 primary THA patients implanted with ceramic-on-ceramic (C/C) bearings, 15 (23.4%) of 64 with ceramic-on-polyethylene (C/P) bearings, 6 (9.4%) of 64 with metal-on-metal (M/M) bearings, 2 (3.1%) of 66 with metal-on-polyethylene (M/P) bearings, and 3 (4.7%) of 66 with ceramic-on-metal (C/M) bearings. Comparatively, 40 (60.6%) of 66 salvage THA patients were implanted with C/C bearings, 18 (27.3%) of 66 with C/P bearings, 4 (6.1%) of 66 with M/M bearings, 1 (1.5%) of 66 with M/P bearings, and 3 (4.5%) of 66 with C/M bearings.

The THAs in group I were performed with a head size of 28 mm (*n* = 8), 32 mm (*n* = 25), and 36 mm or greater (*n* = 33) respectively, while those in group II were 28 mm (*n* = 10), 32 mm (*n* = 31), and 36 mm or greater (*n* = 23). The differences of fixation methods, bearings types and head size between group I and group II were all not statistically significant.

Of the 64 THAs in group I, 61 were performed due to simple falls and the other three were due to high energy trauma. In group II, 49 patients were initially treated with 2 or 3 cannulated screws, 6 with dynamic hip screws, 3 with Kirschner wires and the remaining were treated with other internal fixation (unknown in details) and there were 34 of the patients with retained hardware at the index surgery. The reasons necessitating patients to undergo THA in group II were as follows: 50 cases suffered from osteonecrosis of femoral head, 9 cases suffered from nonunion, 4 cases suffered from posttraumatic arthritis, and 3 cases suffered from aseptic loosening of fixation devices. The time from first symptoms after IF to salvage THA was 2 years (median) and ranged from 1 month to 30 years.

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