Injury, Int. J. Care Injured xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Risk factors of fixation failure in basicervical femoral neck fracture: Which device is optimal for fixation?

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ARTICLE INFO

Keywords:
Hip fracture
Femoral neck fractures
Fracture fixation
Internal

ABSTRACT

Background: Basicervical femur neck fracture (FNF) is a rare type of fracture, and is associated with increased risk of fixation failure due to its inherent instability. The purpose of this study was (1) to investigate the incidence of fixation failure and (2) to determine risk factors for fixation failure in basicervical FNF after internal fixation.
Methods: To identify basicervical FNF with a minimum of 12 months follow-up, we retrospectively reviewed records of 3217 patients who underwent hip fracture surgery from May 2003 to March 2016. Among the identified 77 patients with basicervical FNF, 69 patients were followed up for at least 12 months. We evaluated the rate of collapse of fracture site and reoperation due to fixation failure. We performed a multivariable analysis to determine risk factors associated with fracture site collapse and fixation failure.
Results: Among the 69 patients with basicervical FNF, 17 (24.6%) showed collapse of fracture site, and 6 (8.6%) underwent conversion to arthroplasty because of fixation failure. In the multivariable analysis, use of extramedullary plating with a sliding hip screw was an independent significant risk factor for both collapse of fracture site (odds ratio 6.84; 95% confidence interval 1.91–24.5, $p = 0.003$) and fixation failure (odds ratio 12.2; 95% confidence interval 1.08–137.7, $p = 0.042$).
Conclusions: Basicervical FNF treated with extramedullary plate with a sliding hip screw is more likely to fail than that treated with intramedullary nail with a helical blade. Our results suggested that intramedullary nail with a helical blade is more recommended for basicervical FNF compared with extramedullary plate with a sliding hip screw.
Level of evidence: III, Retrospective cohort study.

Introduction

Femoral neck fracture (FNF) is one of the most serious fractures associated with increased risk of mortality and morbidity, and with decreased mobility in elderly patients [1–4]. Given that immobilization can lead to serious medical complications, such as pneumonia, urinary tract infection, sore, and venous thromboembolism [5–8], early surgical intervention is necessary in most of these patients [9–11]. Generally, non-displaced FNF is treated with closed reduction and internal fixation [12–17]. However, FNF is still known as "unsolved fracture", because it is frequently associated with avascular necrosis [18–20] or non-union [19,21,22] even after surgical treatment.

Among the FNFs, basicervical FNF is a rare type of fracture, which occurs through the base of the femoral neck at its junction with the intertrochanteric region [23]. It has a mismatch between the diameter of the cortical bone of the proximal and distal fragments. Due to this inherent instability, the internal fixation for this type of fracture might be associated with increased risk of fixation failure and reoperation [24–26].

Previous studies on fixation for basicervical FNF showed that internal fixation for basicervical FNF had poor clinical outcomes

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https://doi.org/10.1016/j.injury.2018.02.009
0020-1383/© 2018 Published by Elsevier Ltd.

[24–26]. However, previous studies with a small number of patients could not determine risk factors of failure after internal fixation [26,27].

Therefore, the purpose of this study was (1) to evaluate the rates of fracture site collapse and fixation failure, and (2) to determine risk factors of fixation failure in basicervical FNF after internal fixation.

Materials and methods

Study population

We retrospectively reviewed the medical records of 3217 hip fracture surgeries at four tertiary referral hospitals for a femoral neck fracture or an intertrochanteric fracture in patients older than 60 years from May 2003 to March 2016. The inclusion criteria were patients who had basicervical FNF, and they were followed up for a minimum of 12 months.

To identify basicervical FNF, the definition by Watson et al. [26] was used in this study. We included only those preoperative radiographs, which showed a 2-part fracture at the base of the femoral neck that was medial to the intertrochanteric line and exited above the lesser trochanter but was more lateral than a classic transcervical fracture. Fractures, in which the lesser trochanter was a separate fragment or the fracture line exited distal to the lesser trochanter or out the lateral cortex of the greater trochanter, were all excluded. We then reviewed the intraoperative and postoperative radiographs to ensure that there was no evidence causing us to reclassify these fracture patterns as either a transcervical or an intertrochanteric fracture.

After reviewing the radiographs, 77 fractures in 77 patients met the definition of a 2-part basicervical FNF. Of the 77 patients, 8 (10.3%) died before 1 year or were followed up lesser than 1 year. Thus, the remaining 69 patients, who survived and were followed up longer than 12 months postoperatively, were analyzed in this study; the mean follow-up was 31 months (range, 12–150 months).

There were 17 men and 52 women, and mean age at time of fracture was 81.3 years (range 63–92 years). Mean operative time was 62.3 min (range 20–125 min). Between 2003 and 2008, extramedullary plating with a sliding hip screw (SHS) was preferred, while intramedullary (IM) nailing with a helical blade was preferred between 2009 and 2016. Sliding hip screw was used in 29 patients and IM nailing was used in 40 patients (Table 1).

Surgical technique

All internal fixations using SHS or IM nail were performed using a standard basic technique. The patients were placed in a supine position on a fracture table. Closed reduction using an image intensifier was performed in all patients. In traction, the affected leg was abducted, adducted, and rotated to reduce the fracture. The acceptable reduction was when neck-shaft angle was reduced within $<5^\circ$ and fracture site displacement <4 mm as compared to normal side.

For SHS, guide pins were inserted into the femoral head center using an image intensifier. The tip of the hip screw was placed into the subchondral area of the femoral head.

For IM nailing, all operations were performed by using the Proximal Femoral Nail Antirotation-II System (PFNA-II, Synthes®, Solothurn, Switzerland). The manufacturer's instructions for the operative technique were followed. The PFNA-II includes a cannulated IM nail with a reduced angle of mediolateral bending (6°) to allow insertion into the greater trochanter, a helical blade, and an interlocking screw. After insertion of the nail, the guide pin for the helical blade was inserted into the femoral head center. The blade was placed in the middle-inferior 1/3 of the femoral neck on the anteroposterior view and in the middle 1/2 on the lateral view. The tip of the helical blade was placed into the subchondral area of the femoral head. Distal locking screws prevent the rotation of the nail within the femur.

After surgery, a tolerable range of motion of the hip was immediately permitted, and wheelchair ambulation was started at two or three days postoperatively. Patients walked with protected weight-bearing and used assistive devices (wheelchair, walker, crutches, or cane) 3–10 days after the operation. As their walking ability improved, their assistive devices were changed appropriately by a physical therapist.

After discharge, patients were routinely followed up at 6 weeks, 3 months, 6 months, and 12 months postoperatively and annually thereafter. When a patient had not returned on regularly scheduled visits, the patients or their family was contacted by telephone.

Outcome variables

We evaluated the rate of collapse of fracture site and fixation failure.

The collapse of fracture site was determined by comparing the immediate postoperative and the latest anteroposterior radiograph. The remaining length of the lag screw or blade available for

Table 1
Preoperative clinical details of patients.

Measures	Total (n = 69)	Fixation failure			Fracture site collapse		
		Yes (n = 6)	No (n = 63)	*p*-value	Yes (n = 18)	No (n = 51)	*p*-value
Age at operation (years)	81.3 ± 6.6	81.6 ± 7.2	80.0 ± 8.0	0.659	80.9 ± 7.7	79.9 ± 8.2	0.642
Female	52 (75%)	6 (100%)	46 (67%)	0.143	14 (77%)	38 (73%)	0.782
BMI (kg/m^2)	21.7 ± 3.7	19.3 ± 3.0	22.0 ± 3.8	0.096	21.2 ± 3.8	21.9 ± 3.7	0.498
FU period (months)	28.2 ± 18.6	25.2 ± 18.1	29.7 ± 19.0	0.429	26.6 ± 21.0	28.7 ± 14.2	0.791
ASA	2.3 ± 0.5	2.6 ± 0.5	2.3 ± 0.5	0.097	2.3 ± 0.5	2.6 ± 0.5	0.097
CCI	1.4 ± 1.2	1.5 ± 1.5	1.4 ± 1.2	0.869	1.3 ± 1.2	1.5 ± 1.2	0.554
TAD (mm)	17.8 ± 5.5	17.4 ± 7.6	17.8 ± 5.3	0.848	16.4 ± 6.4	18.2 ± 4.9	0.211
Anesthesia				0.503			0.212
General	18	1	17		7	11	
Spinal	51	5	46		11	40	
Fixation device				0.032			0.003
PFNA	40	1	39		5	35	
DHS	29	5	24		13	16	

Data are expressed as mean ± SD.
BMI = body mass index, FU = Follow-up, ASA = American society of anesthesiologist, CCI = Charlson comorbidity index, TAD = tip apex distance, PFNA = Proximal Femoral Nail Antirotation System, DHS = dynamic hip screw.

Please cite this article in press as: Y.-K. Lee, et al., Risk factors of fixation failure in basicervical femoral neck fracture: Which device is optimal for fixation?, Injury (2018), https://doi.org/10.1016/j.injury.2018.02.009