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ORIGINAL STUDY

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Resection of the femoral neck: a new technique for the treatment of mallory type I intraoperative femoral fracture during total hip arthroplasty

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Intraoperative femoral fracture is a common complication during cementless total hip arthroplasty (THA). Cerclage wiring has been used for this type of fractures to attain intraoperative stability of the femoral stem. We designed a new technique to treat Mallory type 1 intraoperative femoral fractures. We excised fractured femoral neck fragment and without additional fixation and lightly tapped down the femoral stem to obtain a tight contact to the femoral cortex at the subtrochanteric level. In this case series, we described this technique and reported its outcomes.

From January 2015 to December 2017, 600 cementless THAs (557 patients) were done with use of a proximally coated tapered stem design at our department. Among the 600 THAs, Mallory type 1 intraoperative femoral fracture occurred in 8 hips (8 patients), and all of them were treated with the excision of the fractured femoral neck. Mean age of the 8 patients was 58.1 years (range, 30.4 to 81.3 years) at the time of surgery. We report the results of this new technique at postoperative 2 to 5 years (mean, 3.4 years).

All stems were placed in the neutral position. There was no revision and no stem showed any evidence of subsidence or loosening during the follow-up. The mean Harris hip score was 85.9 points at the latest follow-up.

We recommend to use the femoral neck excision technique for the treatment of Mallory type 1 intraoperative femoral fractures.

Keywords: hip, arthroplasty, femoral neck, intraoperative fracture.

INTRODUCTION

Most cementless stems have tapered geometry. During a press fit of cementless stem, fractures of the proximal femur can occur usually at the femoral neck[1-9]. The incidence of the intraoperative femoral neck fracture is increasing along with popular use of cementless stems. Reportedly, the incidence ranged from 1.5% to 27.8% in previous studies[1-9]. This type of fractures have been fixed to establish a firm stem stability, because intraoperative stability is mandatory to achieve a long-term integrity of the femoral stem after total hip arthroplasty (THA).

In 1989, Mallory et al. classified this entity into 3 types according to the fracture extent. Type 1 involves the femoral neck and the lesser trochanter; type 2 extends below the lesser trochanter to 4 cm proximal from the stem tip; and type 3 extends distal to this 4 cm marking (Fig. 1)[10]. In their series of 56 femoral fractures, type 1 fractures comprised 80% (45/56), type 2 fractures 16% (9/56) and type 3 fractures 4% (2/56)[11].

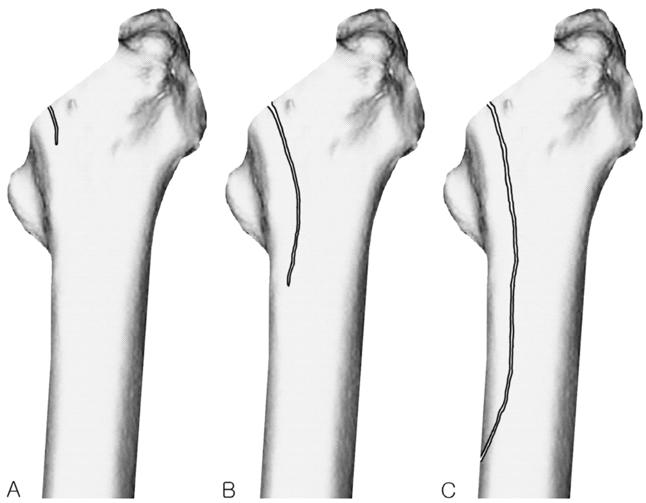

Fig. 1. — Mallory classification of intraoperative proximal femoral fractures.

In another retrospective review of 11 intraoperative calcar fractures, five (45%, 5/11) were type I fractures, five (45%, 5/11) were type II fractures, and one was type III fracture[12].

Generally, cerclage wiring or cabling has been used for the treatment of type 1 and type 2 fractures, while type 3 fractures have been treated with stem change and/ or fixation of the fracture[10,11,13]. However, the wiring or cabling process prolongs the operation time and needs additional dissection, which damages surrounding soft tissue in the proximal femur. Late complications including persistent pain, bursitis and wire breakage might occur after the procedure[14].

To avoid this problematic cerclage, we developed a technique: excision of the fractured portion of the femoral neck in 2015. Since then, we have used it for the treatment of Mallory type 1 fractures instead of the cerclage fixation. In this report, we present the technique and the results of this procedure.

MATERIALS AND METHODS

From January 2015 to December 2017, 600 primary THAs (557 patients) were performed at our department. During the period, we exclusively used cementless implants and intraoperative femoral fractures occurred in 14 hips. Among them, 6 were Mallory type 2 fractures, which were treated with cerclage wiring. The remaining 8 type 1 fractures (8 patients), which were treated with the femoral neck excision, were subjects of this study.

There were 3 men (3 hips) and 5 women (5 hips), and their mean age at the time of operation was 58.1 years (range, 30.4 to 81.3 years). The underlying diagnoses for THA were secondary arthritis in 3 hips, osteonecrosis of the femoral head in 2 hips, femoral neck fracture in 1 hip, subchondral insufficiency fracture of the femoral head in 1 hip and degenerative arthritis in 1 hip. Six hips had Dorr type C femurs and two had Dorr type B femurs (Table I)[15].

All operations were done by two high volume (>200 hip surgeries/year) hip surgeons using the posterolateral approach of Kocher-Langenbeck. The fracture occurred during the femoral rasping in 2 hips and during the insertion of the femoral stem in 6 hips. When a proximal femoral fracture was identified, the fracture was exposed by full length to the distal end of the fracture. In Mallory type 1 fractures, which did not extend below the lesser trochanter, we removed the fractured femoral neck with osteotome and rongeour. When the fracture occurred during rasping, we inserted and press-fitted the stem after the excision process. When the fracture occurred during the press-fitting of the stem, we did not remove the femoral stem. During the excision of the femoral neck, we took care not to damage the stem. After the excision of the fractured femoral neck, we fitted down the stem by multiple light tapping to obtain a tight contact at the subtrochanteric metaphysis of the femur (**Figs**. 2 and 3)

Bencox Mirabo cup and Bencox M stem (Corentec, Cheonan, South Korea) was used in all 8 hips. Delta ceramic-on-ceramic bearing (Biolox Delta: CeramTec AG, Ploghingen, Germany) was used in all hips. Diameter of the ceramic head was 32-mm in 4 hips and 36-mm in 4 hips.

We did not modify our routine postoperative ambulation program. On the first postoperative day, patients started wheelchair ambulation. On the second postoperative day, they started to stand and walk using an assistive device (walker or crutches). Patients were educated to use crutches for 4 weeks.

Routine follow-up visits were scheduled for postoperative 6 weeks, 6 months, 1 year, and every 1 year thereafter. The 8 patients were followed up for 2 to 5 years (mean, 3.4 years).

Two independent observers, who did not participate in the index THA or the follow-up evaluations, reviewed medical records and evaluated the radiographs. Clinical evaluations were performed using modified Harris Hip Scores (mHHS)[16].

Table I. — Demographic data of the patients with Mallory type I intraoperative femoral fractures

Patient	Age (years)	Sex	Side	Height (cm)	Weight (kg)	Koval grade	Dorr type	ASA score	Diagnosis
1	30	F	R	170	60	1	C	1	Secondary arthritis (SCFE)
2	77	F	L	144	59	1	C	2	SIFFH
3	40	F	R	155	55	1	C	1	Secondary arthritis (septic arthritis)
4	62	M	L	157	45	1	C	1	ONFH
5	61	M	L	166	61	1	B	1	Degenerative arthritis
6	64	M	L	174	74	5	B	2	ONFH
7	81	F	R	159	57	1	C	2	Femoral neck fracture
8	49	F	L	157	61	1	C	1	Secondary arthritis (DDH)

ASA, American Society of Anesthesiologists; SCFE, slipped capital femoral epiphysis; SIFFH, subchondral insufficiency fracture of the femoral head; ONFH, osteonecrosis of the femoral head; DDH, developmental dysplasia of the hip.

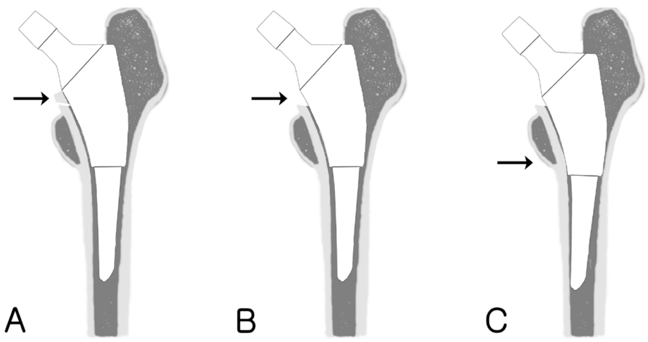

Fig. 2. — (A) When there is a tight contact between the femoral neck and the femoral stem, a hooping stress develops at the posteromedial corner of the femoral neck and a femoral fracture occurs during the press fitting. (B) The fractured segment of the femoral neck is removed. (C) The stem is fitted into the femur by multiple light tapping to obtain a tight contact at the subtrochanteric metaphysis of the femur.

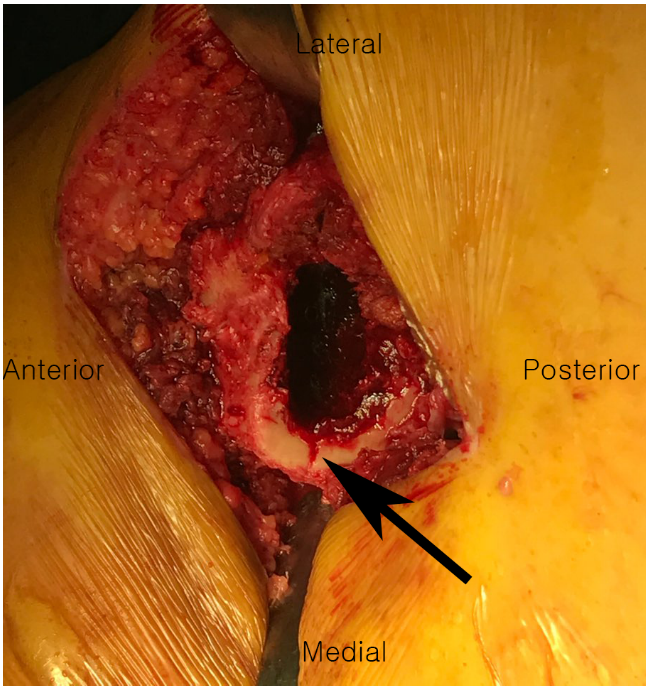

Fig. 3. — Intraoperative calcar fracture from femoral rasping. Trial stem was removed and medial calcar fracture was found (black arrow).

We were concerned about the possible complications: stem malposition, stem subsidence and stem loosening, which might be associated with deficient stem fixation at the femoral neck due to the excision of the femoral neck.

The six-week anteroposterior and cross-table lateral radiographs were used as the baseline for the radiological evaluations.

Stem position was determined by measuring the angle between the axis of the stem and the axis of the femur. The stem position was classified as neutral,

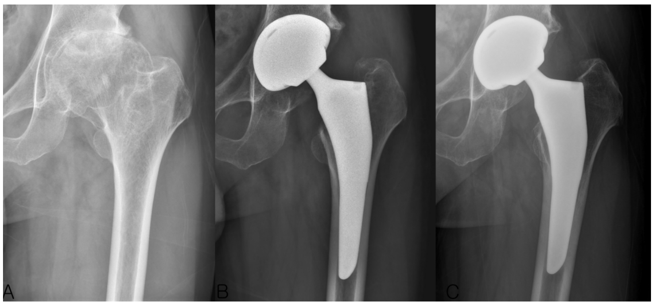

Fig. 4. — (A) A preoperative standing pelvis radiograph of a 61-year-old man who had osteoarthritis of the right hip. (B) During the insertion of the femoral stem, intraoperative calcar fracture occurred. The fractured segment of the femoral neck was removed and the stem was fitted into the femur. (C) There is no stem subsidence or loosening at 5-year follow-up.

valgus (>5° of lateral deviation), or varus (>5° of medial deviation)[17]. Stem subsidence and loosening were evaluated according to the method of Engh et al.[18] Osteolytic lesions were recorded according to the three zones described by DeLee and Charnley[19] on the acetabular side and the seven zones described by Gruen et al.[20] on the proximal femur. The stability of the femoral stem was determined with use of the method of Engh et al.[18] and that of the acetabular cup with use of the method of Latimoer and Lachiewicz[21]. Heterotopic ossification, if present, was classified according to the system of Brooker et al.[22].

RESULTS

All fractures involved the posteromedial corner of the neck cut (Fig. 1). The mean operation time and estimated blood loss were 114.3 minutes (range, 85 to 140 minutes) and 962.5 ml (range, 500 to 1500 ml), respectively. Three patients received transfusion and had no transfusion related complications. No patient had symptomatic deep vein thrombosis or pulmonary embolism. The mean length of stay in hospital was 6.5 days (range 6 to 7 days) and no patient had any surgical or medical complications postoperatively.

All stems were placed in the neutral position. No stem had measurable subsidence, all hips had bone-ingrown stability on both of acetabular and femoral sides. There was no focal osteolysis or periprosthetic joint infection (Fig. 4). No hips had heterotopic ossification. No hip was revised during the follow-up. The mHHS ranged from 70.4 to 96.8 points (mean, 85.9 points) at the latest follow-up. The mean follow-up period was 3.4 years (range 2 to 5 years).

DISCUSSION

Contemporary cementless femoral stems are about 1 mm larger than corresponding broaches to obtain a press-fit. This press-fit poses fractures of the proximal femur during insertion of the stem[23]. In accordance with the popular use of cementless stems in THA, the incidence of intraoperative femoral fracture has been increased. Intraoperative femoral fractures are more common in osteoporotic Dorr type C femurs[23]. In the literature, the incidence of this fracture ranged from 1.5% to 27.8%[1-9].

Various classifications of the intraoperative femoral fractures have been proposed according to the fracture location, extent and stem stability[2,10,24]. In this study, we adopted the classification system of Mallory et al.[10]. Previous studies reported various proportions of Mallory type 1 fractures among the whole intraoperative femoral fractures. In a study of Synergy stems (Smith and Nephew, Memphis, TN) and Corail stem (DePuy, Warsaw, IN), the proportion of type 1 fracture was only 2.65% (24/904)[25]. The proportion was 3.7% in a study of Omnifit stems (Stryker, Warsaw, IN)[26]. However, in a study on Mallory-Head stems (Biomet, Warsaw, IN), type 1 fractures comprised 80% (45/56) of intraoperative femoral fractures[11].

This variability in the proportion of the type 1 fracture is related with the stem design, severity of osteoporosis and morphology of the femur. In metaphyseal fitting stems, a short crack involving the femoral neck at the osteotomy site is frequent, while long linear fracture extending below the lesser trochanter is common in distal fitting stems[11]. In our study, the proportion of the Mallory type 1 fracture among the intraoperative femoral fractures was 57% (8/14).

In terms of treatment, cerclage wiring or cabling was recommended for type 1 and type 2 fractures, while fracture fixation with or without use of a long stem for type 3 fractures[10,11]. A recent biomechanical study demonstrated that there were no significant difference in the primary stability according to the fixation modalities (cerclage band, cerclage wiring, and lag screws) in Mallory type 2 femurs[27]. Therefore, for stable fixation, identification of the location and extent of fracture seems to be more imperative regardless of the fixation device when appropriately treated.

In this study, we used a technique: resection of the femoral neck in Mallory type 1 fractures, and the results were satisfactory. There was no stem malposition and all stems were fixed with bone-ingrown stability.

We note some limitations. First, we used a single stem design, which had had tapered geometry and proximal porous-coating. This stem was designed to have a tight contact at the subtrochanteric level not at the femoral neck. It is the most popular design among the stems currently in use. Second, our study was a retrospective review of only 8 Mallory type 1 fractures without a control group of cerclage fixation. Third, all operations were done by high-volume surgeons, and this technique might need a learning curve.

In our study, the femoral neck excision worked well in Mallory type 1 intraoperative femoral fractures. This method is less invasive than the cerclage wiring and can replace the cerclage method. Further studies involving a large number of type 1 fractures are warranted to verify the safety and effectiveness of this new technique.

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