Total hip arthroplasty following the failure of intertrochanteric nailing: First implant or salvage surgery?

Solarino G et al. THA after intertrochanteric nailing failure

Giuseppe Solarino, Davide Bizzoca, Pasquale Dramisino, Giovanni Vicenti, Lorenzo Moretti, Biagio Moretti, Andrea Piazzolla

Abstract

BACKGROUND
Proximal femur fractures, including both intracapsular (femoral neck fractures, FNFs) and extracapsular fractures (intertrochanteric femoral fractures, IFFs), affect around 1.5 million people per year worldwide. Mechanical failures of intertrochanteric nailing in IFFs could be managed with revision total hip arthroplasty (THA).

AIM
To describe the surgical complexity and the procedure-related complication rates, in patients referring with trochanteric nailing failure and treated with THA.

METHODS
Patients referring to our level I trauma centre, between April 2012 and July 2018, with failed cephalomedullary nailing following trochanteric fractures, were retrospectively recruited. All patients underwent a salvage surgical procedure, i.e., cephalomedullary nail removal and conversion to THA. The same surgical and anesthesiology team performed the surgical procedures under spinal anaesthesia. All patients underwent clinical and radiographic follow-ups for up to 24 mo. Complications and re-operations were recorded.

RESULTS
Seventy-four patients met the inclusion criteria (male: 29; female: 45; mean age: 73.8 years old; range 65-89) and were included in the current study. The average operative time was 117 min (76-192). The average blood loss was 585 mL (430-1720 mL). Forty-three out of 74 patients (58.1%) required transfusion of 3 or more blood units. Two patients died within the day fourth after surgery, because of pulmonary embolism, whereas one died 9 mo after surgery for ischemic myocardial infarction. The complication rate in the 71 patients who completed the minimum 24-mo follow-up was 22.5%. In 3 cases out of 71 (4.23%) periprosthetic acetabular fracture was observed during the follow-up. One of these periacetabular fractures occurred intraoperatively. An intraoperative periprosthetic femur fracture was observed in 5 patients out of 71 (7%). Four of these patients needed a re-operation to fix the fracture with plates and cerclages; in one of these patients, femoral stem revision was also necessary. In 4 patients out of 71 (5.6%), an early THA dislocation was observed, whereas in one case only (1.4%) a late THA dislocation was observed. Three patients out of 71 (4.23%) developed a periprosthetic joint infection during the study follow-up.

CONCLUSION

The present study demonstrated that salvage options for IFF fixation failure are complex procedures with a relevant intraoperative and postoperative complication rate.

Key Words: Femoral nailing; Total hip arthroplasty; Proximal femur fractures; Osteoporosis

Core Tip: The present study demonstrated that salvage options for intertrochanteric femoral fracture fixation failure deal with intraoperative and postoperative complications at a higher rate compared to primary elective total hip arthroplasty.

INTRODUCTION

Proximal femur fractures (PFFs), including both intracapsular (femoral neck fractures, FNFs) and extracapsular fractures (intertrochanteric femoral fractures, IFFs), affect around 1.5 million people per year worldwide, thus constituting a major public health problem[1].

IFFs are the most common traumatic injuries in elderly people and significantly impact patients’ health status, potentially leading to a reduced quality of life, increased disability and higher mortality rate[2,3].

In Italy, PFFs have an estimated annual prevalence of 78000, with 90% of injuries occurring in patients older than 65 years[3]. Nonetheless, as life expectancy is constantly increasing, the annual number is supposed to steadily increase by reaching 8.2 million fractures in 2050 worldwide[3-6].

IFFs, accounting for more than 60% of PFFs, have an annual mortality rate of 15%-20%[4]. It has also been reported the incidence of IFF is increasing more than the incidence of PFFs in the elderly[7]. Fox et al[7], in a prospective study on 923 elderly patients comparing patients with IFF and FNF, observed patients with IFFs were older and showed a worse pre-injury health status; they also had less likely to recover to the pre-fracture level of functioning at 2 mo follow-up.

IFFs need surgical management and could be treated both with intramedullary and extramedullary implants[1,3]. However, a recent meta-analysis by Zhang et al[8] stated the current evidence indicates short intramedullary nails may be a better choice, than dynamic hip screws (DHS), in the treatment of IFFs. Compared to DHS, intramedullary nailing has the theoretical advantages of being less invasive and biomechanically superior, providing a buttress to limit fracture collapse[1]. Moreover, in patients
managed with cephalomedullary nails, a better recovery to pre-injury activity level, less blood loss and fewer complications have been reported[1,3,8].

The surgical planning of IFFs and implant choice is critically influenced by the stability of the fracture pattern[9]. A stable fracture resists displacement after adequate reduction and fixation and generally includes two fragment fractures with an intact posteromedial cortical calcar[9]. The intact medial buttress allows the proximal femur to redistribute stress and resist medial compressive loads[10]. On the other hand, unstable fractures may collapse even after adequate reduction and fixation[10]. Unstable patterns include fractures with a compromised medial calcar (comminuted patterns or fractures with a large posteromedial fragment) fractures with a subtrochanteric extension, reverse obliquity fractures, or intertrochanteric fractures that involve the lateral cortical wall[9,10].

Treatment of unstable fractures is still challenging, and several factors may influence the surgical technique and implant choice[9,10]. Cephalomedullary nailing revealed a biomechanical superiority compared with an extramedullary fixation for unstable fracture patterns since it can resist higher loading forces and provide greater stability reducing the distance from the implant and the hip joint diminishing the bending moment across the implant/fracture construct[11-15].

Fixation failure after surgery to treat IFF is a serious complication. Many factors seem to influence fixation’s stability during follow-up including the patient’s age, female sex, poor bone quality, device choice, fracture reduction quality, presence of neurological comorbidities that may affect the rehabilitation process[16].

This study aims to describe the surgical complexity and the procedure-related complication rates, in patients referring with trochanteric nailing failure and treated with total hip arthroplasty (THA) or hemiarthroplasty (HA).

**MATERIALS AND METHODS**

Patients referring to our level I trauma centre, between April 2012 and July 2018, with failed trochanteric nailing, were retrospectively recruited according to inclusion and
exclusion criteria. Ethical clearance was obtained from our centre’s clinical research ethics board as per the 1964 Declaration of Helsinki, and all patients gave informed consent before enrolment in the study.

Inclusion criteria: Age greater than 65 years old; good cognitive state; osteoporosis, defined as lumbar T-score ≤ -2.5 (all patients performed a DEXA scan during hospitalization).

Exclusion criteria: Moderate cognitive impairment (defined as mini-mental state examination < 19); a history of malignant neoplasm; haemoglobin (Hb) < 10 g/dL at baseline; severely obese patients, i.e., body mass index (BMI) ≥ 35 kg/m²; a life expectancy of fewer than three months; medical illness or cognitive disorders precluding participation in the follow-up examination; concomitant lower-limb fractures; traumatic head injury.

Patient demographics, including age, sex, BMI, and comorbidities were recorded at recruitment. All patients underwent THA via the Hardinge approach, with the patient positioned in lateral decubitus. Adhesions were cleared around scar tissue, fully exposing the trochanter and enabling assessment of the greater and lesser trochanters and calcar femoral. The surgical procedures were performed by the same surgical and anaesthesiology team, under spinal anaesthesia.

Cefazolin (2 g intravenously) or, if contraindicated, clindamycin (600 mg i.v.) was given 60 min before incision. Subcutaneous injection of low molecular-weight heparin (enoxaparin 4000 UI once a day, started 12 h after surgery) was administered for antithrombotic prophylaxis in all patients until the return to full weight-bearing.

Surgical time, blood transfusion rate and perioperative and major complications were assessed. All patients underwent a minimum 24-mo clinical and radiographic follow-up. Complications and reoperations were recorded.

Statistical analysis was performed using STATA/MP 14 for Windows (StataCorp LP, College Station, United States). All data were described as mean, median and standard deviation.
RESULTS

The main data of the study are reported in Table 1. Seventy-four patients met the inclusion and exclusion criteria (male: 29; female: 45; mean age: 73.8 years old; range 65-89) and were included in the current study. The recruited patients were originally referred with the following fracture patterns: 31-A1.2 (58 out of 74; 78.38%); 31-A1.3 (9 out of 74; 12.16%); 31-A2.2 (5 out of 74; 6.76%); 31-A2.3 (2 out of 74; 2.7%).

The trochanteric nail failure modality included: cut-out in 39 cases out of 74 (50.65%); non-union in 13 patients out of 74 (17.56%), peri-implant fracture in 12 patients out of 74 (16.20%), cut-through in 8 patients out of 74 (10.80%), femoral head avascular necrosis in 2 patients out of 74 (2.7%).

The average operative time was \(117\) min (min 76-max 192). The average blood loss was 585 mL (430-1720 mL). Forty-three out of 74 patients (58.1%) required transfusion of 3 or more blood units.

All the patients underwent nail conversion to THA. Cemented stems were used in 19 patients out of 64 (25.68%), whereas uncemented stems were employed in 55 patients out of 74 (74.32%); among the latter, long stems were used in 39 patients out of 74 (52.70%). Cemented cups were implanted in 18 patients out of 74 (24.32%), whereas in 56 patients out of 74 (75.68%) cementless cups were used; dual-mobility cups were implanted in 16 patients out of 74 (21.62%).

Table 2 shows the complications observed during the study follow-up. Seventy-one patients out of 74 completed the minimum 24 mo of clinical and radiological follow-up (range 25-85 mo). Two patients out of 74 (2.70%) died within day four after surgery, because of pulmonary embolism, whereas one patient out of 74 (1.35%) died 9 mo after surgery for ischemic myocardial infarction. The overall complication rate in the 71 patients who completed the minimum 24-month follow-up was 22.5%.

In 3 cases out of 71 (4.23%) periprosthetic acetabular fracture was observed during the follow-up. One of these periacetabular fractures occurred intraoperatively. In 5 patients out of 71 (7.00%), an intraoperative periprosthetic femur fracture was observed.
Four of these patients needed a re-operation to fix the fracture with plates and cerclages; in one of these patients, femoral stem revision was also necessary.

In 4 patients out of 71 (5.6%), an early THA dislocation was observed, whereas in one case only (1.4%) a late THA dislocation was observed.

Three patients out of 71 (4.23%) developed a periprosthetic joint infections (PJI) during the study follow-up. Two of them were early treated with Debridement, antibiotics, irrigation and retention of the prosthesis (DAIR) protocol; the other one was a late-onset infection requiring the THA explant and definitive conversion to Girdlestone procedure.

Table 3 shows the study data detailed by patients’ gender. Note that a higher percentage of perioperative complications has been observed in male patients.

**DISCUSSION**

IFF is a common fracture injury among the elderly. Conservative treatment can result in prolonged periods in bed and/or lower limb shortening with varus deformity and is limited to very unstable patients with high perioperative risk\(^{[17]}\). Surgical treatment with cephalomedullary nails, compression hip screw and the paracortical proximal plate has become the standard of care\(^{[9]}\). Despite the advanced acknowledge and skills in the surgical management of IFF, internal fixation is often associated with significant failure, ranging from 3% to 12%.

The patients at increased risk of failure are the elderly, females and osteoporotic patients\(^{[18,19]}\). Fixation failure depends on several factors, including poor bone quality, fracture comminution and biomechanical stability, quality of reduction and fixation. Despite several technological improvements that have been produced in the last two decades, fixation failure due to mechanical and biological complications still occurs and can lead to potentially devastating scenarios\(^{[20-23]}\). Mechanical complications are cut-out, cut-through, peri-implant fractures or implant fractures.

The most common mechanical complication observed in our study was the lateral mobilization of the cephalic screw, *i.e.*, cutting out (55.71% of cases). Many factors are
associated with a higher risk of cut-out, including a tip-to-apex distance greater than 25 mm, an unstable fracture pattern, an inadequate fracture reduction that may lead to a varus deformity of the femoral neck, positioning of lag screw outside of the centre-centre or inferior centre of the femoral neck. The medial mobilization of the cephalic screw or blade toward the hip joint is also called cut-through.

Salvage procedures currently used for failed internal fixation of IFF are revision osteosynthesis or conversion to hip arthroplasty. The term salvage procedures in patients undergoing salvage surgeries are used to indicate a considerable decrease in pain level and an increase in functional recovery after treatment.

Revision osteosynthesis is mostly addressed to patients younger than 50 years old, with high life expectancy and satisfactory bone quality. It implies femoral head sparing and re-fixation performed via hardware exchange (blade/screw), bone graft augmentation (autologous or allograft), acting as a plug-in case of joint perforation, and a new blade/screw insertion either cemented or uncemented.

On the other hand, conversion to THA as a salvage option is preferred for elderly patients with severely impaired articular surfaces allowing early weight bearing and mobilization. As already mentioned, salvage THA (sTHA) is a complex procedure and includes several technical hurdles hindering successful surgical outcomes: Bone loss and/or deformity, poor bone stock, and the presence of non-union or malunion.

Our study differentiated salvage procedure-related complications into intraoperative and postoperative complications. Intraoperatively, we considered major complications: An increased skin-to-skin operative time compared to primary THA implant, intraoperative blood loss and intraoperative fractures. Intraoperative fractures were the most common intraoperative complication: 1 acetabular fracture and 5 femoral fractures occurred during acetabular reaming and femoral canal broaching, respectively. They may be related to a combination of factors: previous osteoporosis, incomplete fracture union and weakening of bone after hardware removal.
Intraoperative acetabular fractures may be related to disuse osteopenia and/or the presence of previous osteoporosis. Great trochanter fractures may be attributable to an amount of bone loss to the medial aspect of the greater trochanter due to a wider diameter of proximal nails, a lateral entry site of the lag screw in the greater trochanter and excessive stress during hardware removal[35].

Skin-to-skin operative time and intraoperative bleeding were higher. Compared to patients undergoing primary THA, salvage procedures provide two steps. The first operative time provides for adhesion clearance around scar tissue, exposure of greater trochanter and hardware removal. The second operative time provides for prosthetic joint implantation. This procedure is challenging and technically demanding because of distorted proximal femur anatomy, poor bone stock, medial or lateral wall incompetence and the presence of screw holes causing potential cement extrusion[30,31].

During the postoperative period, after patients’ discharge, complications were further categorized as early major and late major complications. Early major complications included four cases of dislocation and two PJIs. Late major complications were one case of late dislocation and one case of periprosthetic infection.

Early postoperative dislocation is an important orthopaedic complication after the salvage of THA. The dislocation rate in patients undergoing salvage arthroplasty after fixation failure of IFF seems to be higher compared to patients undergoing primary THA or salvage arthroplasty for FNF. This complication may be related to many factors: Loss of abductor mechanism, shortening of limb length and misorientation of prosthetic components[32].

The surgical site infection risk rate increases with an increasing number of revision surgeries performed. Our results (two early and one late PJI), similar to other results available within the current literature, revealed an increased PJI rate in salvage options compared to primary elective THA[36,37].

CONCLUSION
Surgical treatment for IFF fixation failure is a challenging procedure. Despite updated surgical skills in the surgical management of IFF, internal fixation failure rates are diagnosed in up to 12% of cases. Salvage options are the mainstay of their treatment allowing early weight bearing and stimulating functional recovery to pre-injury level. This study analysed difficulties met when performing a salvage procedure, *i.e.*, cephalomedullary nail removal and THA implant, after failed fixation of IFF. The present study demonstrated that salvage options for IFF fixation failure deal with intraoperative and postoperative complications at a higher rate than primary elective THA. Based on the present study findings, it is mandatory to adequately plan the surgical treatment in patients referring with PFFs, since a revision surgery, in such a kind of patients must be considered as a salvage procedure, with high rates of perioperative local and systemic complications.

**ARTICLE HIGHLIGHTS**

*Research background*

Proximal femur fractures (PFFs), including both intracapsular (femoral neck fractures, FNFs) and extracapsular fractures (intertrochanteric femoral fractures, IFFs), affect around 1.5 million people per year worldwide. Mechanical failures of intertrochanteric nailing in IFFs could be managed with revision total hip arthroplasty (THA).

*Research motivation*

To assess if the conversion of failed nailing to THA, in patients with previous PFFs, has a high perioperative complication rate.

*Research objectives*

To describe the surgical complexity and the procedure-related complication rates, in patients referring with trochanteric nailing failure and treated with THA.

*Research methods*
Patients referring to our Level I trauma centre, between April 2012 and July 2018, with failed cephalomedullary nailing following trochanteric fractures, were retrospectively recruited. All patients underwent a salvage surgical procedure, i.e., cephalomedullary nail removal and conversion to THA. The surgical procedures were performed by the same surgical and anesthesiology team, under spinal anaesthesia. All patients underwent clinical and radiographic follow-ups for up to 24 mo. Complications and re-operations were recorded.

**Research results**

Seventy-four patients met the inclusion criteria (male: 29; female: 45; mean age: 73.8 years old; range 65-89) and were included in the current study. The average operative time was 117 min (min 76-max 192). The average blood loss was 585 mL (430-1720 mL). 43 out of 74 patients (58.1%) required transfusion of 3 or more blood units. Two patients died within the day fourth after surgery, because of pulmonary embolism, whereas one patient died 9 mo after surgery for ischemic myocardial infarction. The complication rate in the 71 patients who completed the minimum 24-mo follow-up was 22.50%. In 3 cases out of 71 (4.23%) periprosthetic acetabular fracture was observed during the follow-up. One of these periacetabular fractures occurred intraoperatively. An intraoperative periprosthetic femur fracture was observed in 5 patients out of 71 (7.00%). Four of these patients needed a re-operation to fix the fracture with plates and cerclages; in one of these patients, femoral stem revision was also necessary. In 4 patients out of 71 (5.60%), an early THA dislocation was observed, whereas in one case only (1.40%) a late THA dislocation was observed. Three patients out of 71 (4.23%) developed a periprosthetic joint infection during the study follow-up.

**Research conclusions**

The present study demonstrated that salvage options for IFF fixation failure are complex procedures with a relevant intraoperative and postoperative complication rate.
Research perspectives

Based on the present study findings, it is mandatory to adequately plan the surgical treatment in patients referring with PFFs, since a revision surgery, in such a kind of patients must be considered as a salvage procedure, with high rates of perioperative local and systemic complications.

REFERENCES


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Grade C (Good): C

Figure 1 A case of complex femoral nailing failure in a female patient aged 81. A and B: Anti-rotational screw cut-out, concomitant varus deformity of the neck and cephalic screw cut-through; C: The patient underwent cemented bipolar hemiarthroplasty. Note the cement leakage through the former distal screw hole.
Table 1 Main data of the study, n (%)  

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<th>Patients (n = 74)</th>
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<tr>
<td>Age</td>
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<td>Mean ± SD</td>
<td>73.80 ± 7.85</td>
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<td>Range</td>
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<tr>
<td>Gender</td>
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<tr>
<td>Female</td>
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<td>BMI (kg/m²)</td>
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<td>Mean ± SD</td>
<td>28.70 ± 4.43</td>
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<td>Side</td>
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<td>Right, n (%)</td>
<td>43 (58.1)</td>
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<td>Mean operating time (mean ± SD, min)</td>
<td>77.0 ± 35.5</td>
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<td>Patients undergoing ≥ 3, blood transfusion</td>
<td>43 (58.1)</td>
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BMI: Body mass index.
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<td>Dead</td>
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<tr>
<td>Periprosthetic acetabular fractures</td>
<td>3 (4.00)</td>
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<tr>
<td>Periprosthetic femoral fractures</td>
<td>5 (6.76)</td>
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<tr>
<td>THA dislocation</td>
<td>5 (6.76)</td>
</tr>
<tr>
<td>Periprosthetic joint infections</td>
<td>3 (4.00)</td>
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THA: Total hip arthroplasty.
Table 3 Study data reported by gender, n (%)  

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<tr>
<td>Mean ± SD</td>
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<td>Mean ± SD</td>
<td>28.60 ± 4.03</td>
<td>28.90 ± 4.55</td>
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<td>Side</td>
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<tr>
<td>Right</td>
<td>17 (58.62)</td>
<td>26 (57.78)</td>
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<td>Mean operating time (mean ± SD, min)</td>
<td>84.0 ± 41.50</td>
<td>72.22 ± 32.34</td>
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<td>Dead</td>
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<td>0.001(^1)</td>
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<td>2 (6.89)</td>
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<td>1 (3.45)</td>
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<td>THA dislocation</td>
<td>2 (6.89)</td>
<td>3 (6.70)</td>
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<tr>
<td>Periprosthetic joint infections</td>
<td>2 (6.89)</td>
<td>1 (2.22)</td>
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\(^1\)Significant P value.

THA: Total hip arthroplasty; BMI: Body mass index.
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