Case report

Removal of the broken femoral nail with T-reamer technique: A three-case report

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ABSTRACT

Nonunion of femoral shaft fracture is an uncommon complication after closed intramedullary nailing which often leading to nail breakage. Removal of the broken femoral nail with closed manner is a challenging procedure for orthopedic surgeons. The removal technique with the T-reamer is a closed method, which does not require either a nonunion site opening or knee exposing. We reported 3 cases of nonunion femoral shaft with broken slotted and non-slotted hollow nail which were successfully removed without any complication. All fractures healed uneventfully without open the fracture site or bone grafting.

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1. Introduction

Femoral shaft fracture is one of the common fractures of the lower extremities.¹ Intramedullary nailing of the femoral shaft fracture is one of the most predictable procedures, nevertheless nonunion of femoral shaft fracture following intramedullary nail fixation can occurs from 0.8 to 7.5%.^{2,3} The major problematic consequence after nonunion is the nail breakage, which is the challenging procedure to orthopedic surgeon for removal. Incidence of femoral nail breakage is up to 4.7%.⁴ Previous removal techniques have been described with satisfactory outcomes.^{5–15} Some of these techniques required nonunion site opening¹³ or knee exposing,^{6,7,9,11} which can increase morbidity or delay the healing process. The T-reamer is a standard orthopedic device which usually available in operating theater. We reported 3 cases of broken nail removal by closed technique using T-reamer, which did not require exposing the fracture site, the knee joint or any additional special device. These 3 cases report was approved by the Ethical Committee.

2. Cases reports

Three patients had been diagnosed with the femoral shaft nonunion with incarcerated broken femoral nail after repeated minor injuries. The first two cases were of slotted hollow nail without locking bolt, while the third case was of non-slotted hollow nail fixation with locking bolt. The surgical technique began with patient positioning in the supine position on fracture table under fluoroscope imaging, which could proceed reinsertion new larger size intramedullary nail in the next step. The proximal incision was performed through previous skin incision, the proximal nail fragment was removed by the conventional technique with a standard nail extractor. Inserted the guide-wire through the previous entry point to proximal tip of the distal nail fragment, reamed the proximal femoral canal large enough with a conventional femoral reamer to facilitate distal nail fragment removal. The guide wire was removed, the T-reamer with appropriated size was inserted and impacted into the distal nail fragment with gentle twisting the T-reamer until the T-reamer and the nail move as a single unit. The appropriated size of T-reamer was selected by the trial insertion to the removed proximal nail fragment. This careful selection size of T-reamer can prevent the problem of jamming of reamer with the broken nail. The distal nail fragment was removed simultaneously with the T-reamer, extracting them from the proximal femur. The exchange nailing with larger size of intramedullary nail was done under this surgical

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Table 1

Indications, advantages and disadvantages of T-reamer technique for removal of the broken femoral nail.

Indications

Removal of the broken intramedullary hollow femoral nail including slotted and non-slotted type

Advantages

No requirement of a nonunion site opening or knee exposing

No requirement of any special removal device

Able to apply for both broken slotted and non-slotted hollow nail

Disadvantages

Requirement of the preparation of other solution operation in case of unsuccessful procedure e.g. stuck of broken part or unavailable of appropriated size of T-reamer

exposure without the need of an additional surgical approach at the fracture site or knee exposing. All three procedures were successful without any complication. The indications, advantages and disadvantages of this technique are summarized in Table 1.

2.1. Case 1

An 18 year-old female developed sudden right thigh pain after a slotted hollow intramedullary femoral nail fixation for one year with no repeated significant trauma or clinical of infection. The radiographs showed a hypertrophic nonunion at mid-shaft of the right femur and complete femoral nail breakage just below the nonunion site (Fig. 1). The patient was positioned in supine on fracture table in which the proximal femoral nail fragment was removed with a conventional extractor (Fig. 2A–C). A guide wire was antegradely inserted through the nonunion site via the previous approach and the femoral reamer was then inserted for enlarging the canal as much as possible (Fig. 2D). The T-reamer was inserted to the tip of distal nail fragment and tightly twisted (Fig. 2E). The distal nail fragment was extracted while pull out the T-reamer. The exchanged nailing was performed under conventional procedure with a successful outcome and without any complication. Complete healing was shown at 4 month postoperatively (Fig. 3).

2.2. Case 2

A 30 year-old male developed sudden right thigh pain following Kuntscher nail (slotted hollow nail type) fixation after one year. Radiographic findings showed hypertrophic nonunion femoral

Fig. 1. Case 1: anterior (A) and lateral (B) radiographs show the nonunion of the mid-shaft of right femur with intramedullary nail breakage just below the nonunion site.

shaft and breakage of the intramedullary nail, presented at the same level without any evidence of infection (Fig. 4). The removal procedure could be successfully performed under the previously described T-reamer technique without any complication or additional exposure (Fig. 5).

2.3. Case 3

A 46 year-old male developed left thigh pain after slipped on the floor. He was operated with the non-slotted hollow interlocking nail of left femur 14 years ago. The preoperative radiographs

Fig. 2. Case 1: intraoperative fluoroscopic images (A) and demonstrating illustration (B) of conventional nail extractor usage and after proximal nail fragment removal (C). The conventional femoral canal reamer was then inserted to the tip of the distal nail fragment following the insertion of the guide wire for enlarging proximal femoral canal as much as possible and facilitating the removal of the distal nail fragment (D). The demonstrating illustration shows a tight impaction of the T-reamer to the distal nail fragment by the twisting technique (E).

Fig. 3. Case 1: final skin closure after the success intramedullary nail revision (A), and post revision radiograph (B). Radiographs of anterior (C) and lateral (D) views show complete healing at 4 month postoperatively.

Fig. 4. Case 2: preoperative radiographs of anterior (A) and lateral (B) views revealed hypertrophic nonunion with complete linear breakage of the intramedullary nail at the same level.

(Fig. 6) showed atrophic nonunion of the femoral shaft and nail breakage at the nonunion site. This broken non-slotted nail was also successfully removed under same T-reamer technique (Fig. 7) without any complication.

3. Discussion

According to previous reports, nonunion of a femoral shaft fracture is not an uncommon complication after femoral shaft

Fig. 5. Case 2: postoperative radiographs of anterior (A) and lateral (B) views after successful intramedullary nail revision with the larger-size nail. The revision procedure could be performed through the previous approach (C) which did not require additional exposure or exposing the knee joint.

Fig. 6. Case 3: preoperative radiographs of anterior (A) and lateral (B) views show atrophic nonunion of the left femoral shaft with nail breakage at the level of the nonunion site.

fracture nail fixation, which can occur up to 7.5%.³ Breakage of the intramedullary femoral nail has an incidence of 4.7%.⁴ The broken nail removal is a challenging procedure for orthopaedists.

Several broken nail removal surgical techniques have been described in previous case studies. Pretell et al.¹³ introduced a combined technique for removal the three segment of broken nail. A pull out technique for the middle nail segment removal required a small opening of fracture site and the cement ronguer

application. For the distal nail fragment removal, a curved thin hook was required.

Some reported techniques could be achieved with closed manner but required knee exposing. Liodakis et al.⁶ has described a technique for removal the incarcerated femoral nail with retrograde hit at the tip of the distal nail through the infrapatellar incision. Antegrade impaction removal technique through a medial parapatellar approach was also reported by de Amorim et al.⁷ Magu et al.⁹ used a closed technique by insertion a beaded guide wire loaded with a washer through intercondylar notch, and then removed the broken nail retrogradely without nonunion site opening. Riansuwan et al.¹¹ reported the retrograde impaction technique with application of a Harrington rod through the intercondylar notch. Metikala et al.⁸ also reported a closed removal technique which used a ball-tipped guide wire and inserted a cannulated drill bit via the infrapatellar approach.

The alternative removal techniques could be performed with the closed manner and not required the knee exposing. The closed techniques could preserve the surrounding soft tissue around nonunion or fracture site which did not disturb the healing process. The procedures through the approach which avoid the knee exposing also did not increase the morbidity. The removal technique with the multiple guide wires has been described by Middleton et al.¹⁰ This technique might not be achieved in the case of femoral canal occlusion with the callus or debris tissue. Steinberg et al.¹² and Park et al.¹⁴ performed the closed retrograde removal technique without knee exposing by using a Steinmann pin and modified smooth guide wire respectively.

Removals of the broken femoral nails with T-reamer technique were successfully done in all three cases. The T-reamer is the instrument which is included in all intramedullary nail instruments which means it does not required additional special instrument for this removal technique. It is a simple and reproducible technique which does not require additional exposure and can be applied for both of slotted and non-slotted hollow nail. The limitation of this technique is it could be applied only in undeforming hollow broken nail and cannot used for the nail broken above isthmus with distal part jammed in narrow medullary canal. Alternative removal methods should be prepared in case of this technique cannot be achieved.

Fig. 7. Case 3: intraoperative fluoroscopic imaging (A, B) of using the T-reamer for the non-slotted distal femoral nail fragment removal with demonstrating illustrations (C, D).

4. Conclusion

Femoral intramedullary nail breakage is the problematic consequence following the nonunion of a femoral shaft fracture. The T-reamer technique is one of the simple and reproducible procedures of broken nail removal without any additional special instrument.

Conflicts of interest

The authors have none to declare.

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