J Orthop Spine Trauma. 2021 March; 7(1): 27-30. DOI: http://dx.doi.org/10.18502/jost.v7i1.5964

Case Report

Reamer Breakage during Intramedullary Nailing in Tibial Shaft Fractures: A Case Report and Review of Literature

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Received: 21 October 2020; **Revised:** 27 December 2020; **Accepted:** 11 February 2021

Abstract

Background: Interlocked intramedullary nailing is the most common treatment for closed tibial fractures. Reaming is a fundamental step in this surgical technique, and reamer breakage is a rare yet challenging complication during this operation.
Case Report: A 34-year old male with a tibial shaft fracture was admitted for early closed tibial nailing. During the reaming process, the reamer broke and stuck in the medulla at the isthmus level. We extracted the broken piece by back hammering a cannulated T-handle placed on the ball tip guide pin.
Conclusion: In this closed and quick method, we did not use any extra device other than standard equipment of intramedullary nailing.

Keywords: Intramedullary Nailing; Orthopedic Fixation Devices; Tibial Fractures

Citation: Kazemi M, Sharafi M, Shayan-Moghadam R. **Reamer Breakage during Intramedullary Nailing in Tibial Shaft Fractures: A Case Report and Review of Literature.** *J Orthop Spine Trauma* 2021; 7(1): 27-30.

Background

Tibia fractures are the most prevalent long bone fractures, commonly reported in young males between 15 and 19 years old (1, 2). According to the fracture and dislocation classification of Arbeitsgemeinschaft für Osteosynthesefragen/ Orthopaedic Trauma Association (AO/OTA), the diaphyseal segment fractures of the tibia are coded as the number 42, and they are divided into three types: simple, wedge, and multifragmentary (3, 4). The most common treatment for this fracture is interlocked intramedullary nailing (5). The advantages of this technique are that 1) it avoids additional soft tissue injury, especially with closed fractures, improving the chances of bone union and early return to routine daily activities, and 2) it is cost-effective.

Reaming of the intramedullary canal is a crucial step in the nailing of long bones. Complications of this process are uncommon, including breaking, uncoiling, and incarceration of the reamer (6). Reamer breakage can be catastrophic for both patient and surgeon by increasing the duration of anesthesia, distracting the surgeon, and heightening the risk of infection (7).

In this report, we discuss the breakage and incarceration of a flexible reamer at the isthmus of the tibia, describe our simple removal technique, and systematically review the literature regarding this entity.

Case Report

A 34-year old male was admitted to the emergency department after crashing his motorcycle into a car. The emergency trauma team started the initial assessment and treatment according to the latest version of the Advanced Trauma Life Support (ATLS) guidelines. The spiral computed tomography (CT) scans of the brain, chest, and abdominopelvic cavity were unremarkable.

The chief complaint of the patient was pain and swelling of the left leg. Tenderness of the tibial shaft was detected in clinical examination. No wound, laceration, or abrasion was present in the area. The neurovascular examination was normal. Plain radiography (Figure 1) revealed a closed short oblique tibial shaft fracture with an intact fibula (AO/OTA 42A2).

Figure 1. Anteroposterior (AP) and lateral radiographs of the left leg

After appropriate workup, we prepared the patient for reamed interlocking intramedullary nailing. The proper nail diameter and the expected amount of reaming were measured using radiographs of the tibia. The patient was placed in a supine position and the injured leg was flexed on a simple two padded board. After prepping and draping, via a 3-cm incision below the patella, the patellar tendon was incised longitudinally. Using fluoroscopy, we located the appropriate entry point, which is just medial to the lateral tibial spine in the anteroposterior (AP) view and anterior to the articular surface in the lateral view. Then, we opened the medullary canal with an awl and inserted a ball tip guide pin into the canal while maintaining the fracture reduced.

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The reaming process was started with an 8-mm reamer and increased step-by-step (0.5 mm each time). With the 10-mm reamer and at the isthmus of the tibia, the reamer was stuck and the clockwise or counterclockwise reaming was not helpful. We assumed that the reamer was rotating, but it was neither going forward nor backward, so we stopped reaming. We managed to remove the shaft of the reamer with some effort, but the head remained in the canal. Fluoroscopic imaging indicated that the distal part of the reamer was broken, uncoiled, and stuck at the isthmus when it was passing through the fracture zone (Figure 2).

Figure 2. Fluoroscopic view of the broken reamer in the isthmus of the tibia

Since the guidewire in place was still a ball-tipped one, we used a slotted hammer and a cannulated T-handle for removing the distal part of the broken reamer. The T-handle was placed on the guidewire, and with hammering in a retrograde manner, while carefully maintaining the reduction at the fracture site, the broken piece was removed through the primary incision (Figure 3).

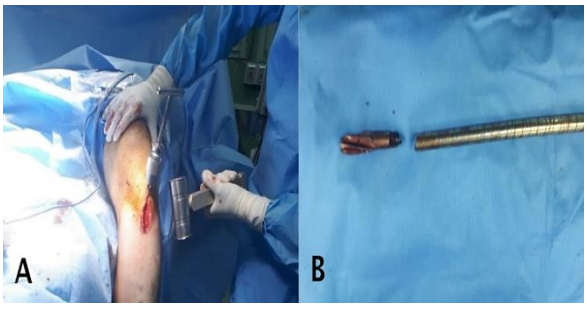

Figure 3. A. Backward hammering to remove the incarcerated reamer; B. Proximal and distal parts of the broken reamer after removal

Then, we continued reaming up to 11.5 mm and inserted a 10 mm × 34 cm nail. The postoperative X-rays were taken immediately after the surgery (Figure 4).

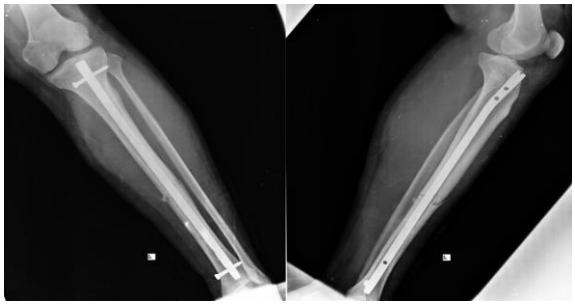

Figure 4. A Postoperative anteroposterior (AP) and lateral radiographs of the left leg

Discussion

Despite the high prevalence of intramedullary nailing for the treatment of tibial shaft fractures, the reamer breakage is a rare complication. Various reasons have been reported in different surveys, including instrument overuse, poor quality of instruments, technical deficiencies, and accumulation of reaming debris in the isthmus. Overuse can decrease the torsional tenacity of the reamer, causing wear and tear of the coils (8, 9).

To prevent reamer breakage or incarceration, some technical points should be considered: 1) reaming and extracting the reamer in a clockwise manner, 2) beginning the process with the smallest reamer size and gradually increasing the size, 3) avoiding force to put the reamer into the canal and proceeding smoothly (3, 10).

A few techniques have been introduced for reamer removal in femoral intramedullary nailing. To provide a comprehensive overview, we systematically searched the online databases, including PubMed (MEDLINE), Scopus, Web of Science, and Google Scholar, up to August 13, 2020. The following search strategy was used:

("Broken reamer" OR "Reamer breakage" OR "reamer" AND "Fixation, Intramedullary Fracture" OR "Fixations, Intramedullary Fracture" OR "Fracture Fixations, Intramedullary" OR "Intramedullary Fracture Fixation" OR "Intramedullary Fracture Fixations" OR "Osteosynthesis, Fracture, Intramedullary" OR "Intramedullary Nailing" OR "Intramedullary Nailing" OR "Nailing, Intramedullary" OR "Nailing, Intramedullary")

We included all interventional and observational studies (clinical trials, quasi-experimental studies, case reports, case series), and excluded conference papers, editorials, letters, commentary, short communications, notes, and non-English papers. We followed the principles of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (11).

A total of 245 articles were identified initially. After duplicate removal, two independent researchers screened 147 articles by title and abstract, and selected 31 titles for full-text assessment. Two more papers were added after checking the reference lists of the included studies. From the 33 articles that underwent full-text assessment, 7 titles were finally included in the review (Figure 5). Table 1 provides a summary of the included articles.

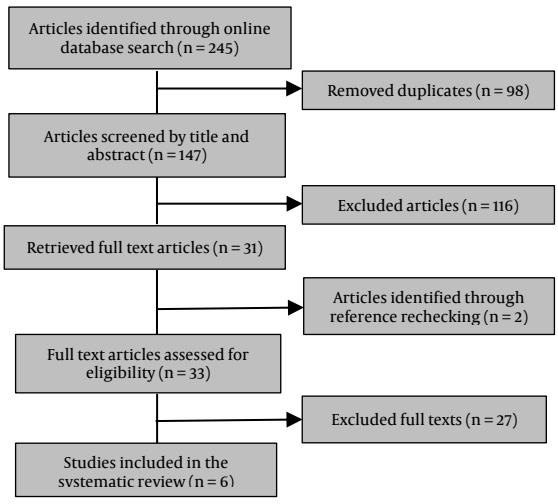

Figure 5. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram for identification and selection of the studies

Table 1. Summary of included articles

Study	Fracture type	Patient and trauma mechanism	Treatment	Surgical technique for reamer removal
Jiang et al. (12)	Comminuted intertrochantric fracture (31A2,3)	80-year-old female Falling	IMN (PFNA)	Opening a long strip bony window with an osteotome Inserting a detacher adjusting to the reamer Removing the broken reamer by knocking back the detacher and by using a Kocher's clamp
Low et al. (13)	Closed fracture of the femoral neck and midshaft	28-year-old male RTA	CMN	Removing the incarcerated reamer with corticotomy in three sites: just distal to the tip of the reamer head, in the middle of the reamer head, and just proximal to the reamer head
Meena et al. (14)	Displaced comminuted femoral shaft fracture	28-year-old male RTA (60 Km/h speed)	RIN	Positioning a slotted hammer over the reamer Removing the assembly with a drill
Boruah et al. (9)	Closed segmental femoral shaft fracture	50-year-old male RTA	IMN + distal femur locking plates	Back hammering over the jumbo cutter to unjam the broken reamer
Kumar et al. (15)	Closed subtrochantric fracture	35-year-old male RTA	CMN	Removing the broken cephalomedullary lag screw reamer by gentle blows with a hammer Removing two residual fragments of the reamer through the nail entry point with a small currete and Kocher forceps
Rijal et al. (6)	Tibial shaft fracture	25-year-old male RTA	IMN	Removing the broken reamer with a grasper used by laparoscopic surgeons for holding the gallbladder

CMN: Cephalomedullary nailing; IMN: Intramedullary nailing; Km/h: Kilometers per hour; PFNA: Proximal femoral nail antirotation; RIN: Reamed intramedullary nailing; RTA: Road traffic accident

Jiang et al. reported a novel technique for removal of the broken reamer in the femoral medullary canal in a patient with subtrochanteric fracture (12). They benefited from an open approach by creating a bony window and removing the reamer by detacher and Kocher's clamp.

Similarly, Low et al. used an open removal technique. Since they had not applied a ball tip guidewire during reaming, they pulled out the reamer by making three holes in the lateral cortex of the reamer with a drill: 1) just distal to the tip of the reamer head, 2) in the middle of the reamer head, and 3) just proximal to the reamer head. They successfully decreased the size of debris around the reamer head and facilitated reamer removal (13).

Other studies used a closed technique for reamer removal. Boruah et al. grasped the broken flexible reamer with a Jumbo cutter and back hammered to unjam it from the intramedullary femoral canal (9). Meena et al. reported that the uncoiled reamer was tapped out from the femoral shaft by a slotted hammer that was fixed over the reamer in the opposite direction of the drill attachment (14). Kumar et al. removed the broken reamer in the basicervical region with gentle hammer blowing (15). Rijal et al. extracted the distal part of the broken reamer in the tibia with a grasper frequently used in gallbladder surgeries by general surgeons (6).

Abbassi et al. reported 2 cases of reamer incarceration during femoral nailing. In the first case, the flexible reamer was uncoiled before passing the fracture site. They benefited from ball-tip guide wire for removing the uncoiled reamer. In their second case, a rigid reamer breakage happened before fracture site and they extracted the broken reamer by approaching the fracture in an open technique because they had not utilized a ball-tip guide wire (10). The technique they used in their first case was similar to ours but in our case the reamer was broken not uncoiled and this had occurred just after passing the fracture site

In our experience, we managed to extract the broken piece with a closed and straightforward technique. We did not use any special device for this procedure other than the standard equipment used in interlocked intramedullary nailing surgeries, nor did we use any additional incision. Using and keeping the ball-tip guide wire in the canal until the end of the reaming process was the most determining factor that efficiently helped us to remove the broken reamer. This technique did not increase anesthesia time and the operation was finished in less than an hour. Moreover, this technique is useful even when the reamer has passed the fracture site, provided that the reduction of the fracture site is maintained during back-hammering.

Conclusion

The breakage of an intramedullary reamer in the course of surgery can be challenging for orthopedic surgeons. We represented a closed and practical technique for resolving this issue, benefiting from common equipment used in intramedullary nailing procedures. The key point in our method was keeping the ball-tip guide wire in the canal until the end of the reaming process.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgments

None.

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