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Case Report

Intramedullary reamer failure in orthopaedic surgery: Two case reports and practical recommendations for prevention

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ABSTRACT

Intramedullary reaming has been proven to be a safe and effective method for enhancing the union rates of long bone fractures. However, there is a risk of equipment failure, which can lead to severe complications. We present two cases of reamer failure during femoral nailing which illustrate the rare occurrence of intraoperative instrument failure. Our report also underscores the importance of routinely inspecting reaming equipment and provides technical insights to reduce the risk of failure.

Introduction

Locked intramedullary nailing is the preferred method of treatment for femoral shaft fractures and is associated with high union rates and few complications [1]. Reaming the intramedullary canal offers several biomechanical and biological advantages. For example, large diameter nails provide better cortical support, while the reaming process stimulates autologous bone grafting by reversing endosteal blood flow and expelling reaming debris through the fracture site [2]. Multiple clinical studies including two meta-analyses have demonstrated that reaming results in better and faster fracture healing [3–5].

While reaming is associated with several complications, including microemboli-induced adult respiratory distress syndrome (ARDS) and endosteal thermal damage, equipment failure is not commonly reported [3,6]. Intramedullary reamers, in particular, may fail for several reasons such as manufacturing defects, excessive wear and tear, and poor surgical technique [7]. Reamer failure frequently requires complex extraction techniques and extended operating times, and is therefore best avoided [7]. In this report we present two cases of intramedullary reamer failure during femoral nailing and discuss strategies for avoiding this complication.

Case report

Case 1

A 54-year-old female was admitted to the hospital with a left subtrochanteric fracture following a low energy fall (Fig. 1A). She had a 30-year history of ulcerative colitis and was taking long-term corticosteroids. The patient was stabilised and prepared for definitive

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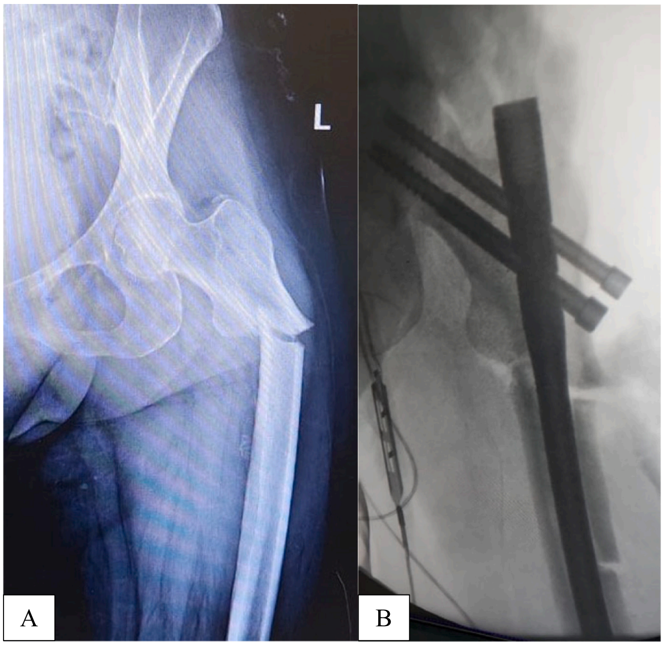

Fig. 1. Initial radiograph of displaced subtrochanteric fracture (A) and post-operative radiograph with reconstruction nail in-situ. Note lateral corticotomy.

fixation with a reconstruction femoral nail. During the operation, the femoral canal was sequentially widened starting with the 9 mm front-cutting reamer. However, while withdrawing the 12.5 mm reamer, the surgeon noted a sudden change in sound and resistance. Flouroscopy revealed that the reamer head and a part of the distal shaft was separated from the main body of the reamer but still cannulated by the guide wire. Attempts to remove the reamer head by withdrawing the ball tip guidewire were unsuccessful. Using a direct lateral approach, a corticotomy was made in the proximal femur allowing the reamer head to be easily removed (Fig. 2). The corticotomy was closed and the surgery completed in routine fashion (Fig. 1B). On post-operative day one (1), the patient suddenly became dyspneic and tachycardic before falling into a coma. Resuscitative efforts were unsuccessful and a post-mortem revealed that the patient died from a massive pulmonary embolism.

Case 2

A 60-year-old female sustained a gunshot injury to her thigh during a home invasion resulting in a Gustilo-Anderson IIIA comminuted fracture of the proximal femur (Fig. 3A). After stabilisation the patient was scheduled for definitive surgery using a reconstruction femoral nail. During the operation the surgeon encountered greater than anticipated resistance while using the 11 mm reamer to cross the fracture site but was able to ream the canal up to 12.5 mm. However it was while withdrawing the reamer that failure occurred leaving the head incarcerated distal to the fracture site (Fig. 4). It was impossible to remove the reamer head using the ball tip guide wire and a corticotomy of the proximal femur was used to retrieve the broken reamer (Fig. 3B). Despite a longer operation time, the patient tolerated the procedure well and 48 h later she was ambulating with a walker and discharged home.

Discussion

Ensuring the safe and effective use of power tools in the operating theatre is of utmost importance, as improper handling may result in serious injury. While appropriate training on the use of these tools is crucial, it is often overlooked, and many surgeons learn by observing more experienced colleagues. Adhering to proper technique not only mitigates the risk of injury but also reduces the incidence of complications, resulting in faster and more efficient procedures. Ultimately, adhering to the recommended technique while using power tools is essential for patient safety during surgical procedures.

Reaming technique

Establishing an accurate entry point and good fracture reduction are essential steps for successful intramedullary nailing. In addition, using a high-quality, rigid guidewire prevents kinking, which would impede the smooth motion of the reamer during surgery and increase the risks of incarceration.

A drill-reamer attachment which provides high torque at moderate speed minimizes the risk of thermal injury. Reaming should

Fig. 2. Picture of intramedullary reamer showing dissociation of the reamer head from the shaft. Note burnishing of the reamer shaft.

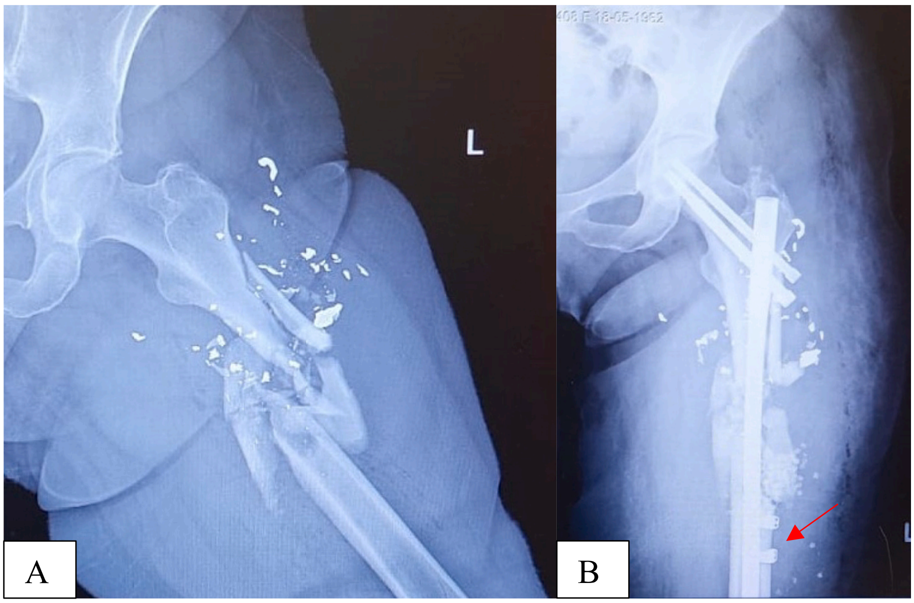

Fig. 3. A & B. Admission radiograph showing extensive comminution of proximal femur and bullet fragments (A) and post-operative radiographs with reconstruction nail in situ. Note the metal crimps (red arrow) used to close the corticotomy site.

Fig. 4. Intraoperative fluoroscopic image showing the broken distal end of the reamer shaft.

start with the front cutting reamer, with sequential side-cutting reamers increasing the canal diameter in 0.5 mm increments. Throughout the procedure the surgeon must maintain complete control, applying gentle but firm forward pressure while using a smooth action. Frequent imaging is recommended when greater than expected resistance is encountered. Under no circumstances should the reamer be stopped or reversed as this can cause uncoiling or incarceration. Reaming should continue until cortical chatter is felt and the reaming diameter is approximately 1.0–1.5 mm larger than the diameter of the nail.

It is critical that the surgeon remains alert to the tactile and auditory feedback from the advancing reamer, being vigilant to any indication that its path is obstructed. Frequent cleaning of the reamer head through irrigation and aspiration is recommended to remove endosteal debris that could impede the reamer. Finally the surgeon must recognise 'chokepoints' such as the femoral isthmus and fracture site as high-risk areas for reamer incarceration and exercise greater caution in these areas.

Quality assurance

There are many factors that can affect the risk of reamer failure. Müller et al. analysed the impact of reamer shape on failure and discovered that the Synthes® reamer generated the highest intramedullary pressure compared with other designs, potentially increasing the risk of incarceration [8]. Another study found that dull reamers increase intramedullary pressure and tangential strain leading to reamer failure, particularly if the reamer is damaged [9]. A Swiss study conducted across 10 hospitals investigated the impact of reamer use on their condition. The study showed that frequent use led to both damage and dulling of the reamers, with reamers between 11 mm and 13.5 mm exhibiting the greatest degree of damage and dullness. Predictably, the degree of damage and dullness were found to be directly proportional to the number of intramedullary nailing procedures performed in each hospital. Hospitals that conducted 40–60 procedures annually were observed to have the most damaged and dull reamers. These findings suggest a causal relationship between frequency of use and structural deterioration. The authors concluded that a protocol for maintenance and replacement should be established to minimize the risk of reamer failure [10].

Our local data at a single institution indicate that 80 intramedullary reaming procedures on average are performed annually at the hospital. The reaming sets have been used for over five (5) years and are used at several hospitals nationwide. We found no evidence that either set was inspected by the Biomedical department since being put into service. This is at odds with the industry standard that recommends regular medical equipment inspection to ensure proper and safe functioning.

Conclusions

Intraoperative failure of a flexible reamer is a serious complication which presents a challenging and uncommon problem for the surgical team. Surgeons should be familiar with different methods of extraction since there is no one method that can be successfully used in every situation. While extended use increases the risk of intraoperative failure this complication may be avoided by the timely replacement of damaged and worn reamers. Future studies should aim to develop metrics that determine the level at which worn or damaged should be replaced to avoid catastrophic failure during surgery.

Declaration of competing interest

None.

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