Case study

A clinical case report: minimally invasive removal of the distal broken segment of hollow tibial intramedullary nail remaining for 12 years

ABSTRACT

AIM: Successful minimally invasive extraction of a broken intramedullary distal piece of the nail is very challenging. We herein report a case of the distal broken segment of the hollow tibial intramedullary nail remaining for 12 years, which was successfully removed using a home made minimally invasive broken nail extractor.

Case presentation: A 48-year-old male patient was admitted to our hospital for internal implant removal, whose right tibial fracture had healed and a broken intramedullary nail was retained at the distal of the tibial for 12 years. The preoperative X-ray films showed the broken intramedullary nail was cannulated and the outer diameter is 10 mm, larger than the isthmus of the medullary cavity.

Results: After reaming with Φ 11 mm drill, the home made broken nail extractor was inserted into the medullary cavity from the nail entry point and passed through the canal of the broken nail, and successfully pulled out the broken nail.

Conclusion: Our technique is a simple reproducible alternative that has

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high extraction success rate for distal broken segment of cannulated intramedullary nails.

Key words: Removal of internal fixation, broken intramedullary nail, broken nail extractor, minimally invasive, home made

INTRADUCTION

Intramedullary nailing of long bone fractures is an standard internal fixation method with the advantages of not disturbing the fracture hematoma and the biomechanical superiority over plating [1-3]. However, the incidence of difficult healing including nonunion or delayed union of long bone fractures after intramedullary nailing is 15%~20% [3-5]. In cases of difficult healing of a fracture stabilized with intramedullary nails, fatigue failure of the nail can occur due to cyclic loading. Extraction of the broken nail will be needed in the revision surgery. Closed exchange nailing is becoming now one of the preferred methods to treat nonunion of fracture tibia and femur. Multiple techniques had been described to extract a broken distal piece of the nail, yet the procedure still can be very challenging and the commonly used methods and tools can fail to extract the broken part [6-12]; thus, there is no guarantee which particular extraction technique will be most effective for any given case, so it is incumbent on the surgeon to be familiar with a variety of intramedullary nail extraction techniques and to have all potentially required equipment available. We herein report a case of the distal broken segment of hollow tibial intramedullary nail

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remaining for 12 years, which was successfully removed using a home made minimally invasive broken nail extractor.

CASE PRESENTATION

A forty-eight-year-old male patient was admitted to our hospital for removal of internal implant. He had closed tibial shaft fracture caused by a collision 15 years ago. He was treated with close reduction and intramedullary nailing fixation. Delayed healing occurred after operation. The nail was broken at a distal locking screw hole. The fracture healed after plaster fixation for 3 months. The internal implant was removed after 3 years of fracture, but the distal end of the broken intramedullary nail could not be taken out and remained in the medullary cavity of the distal tibia. **Fig.1.** The two times of operations were performed in a remote hospital. One year ago, the patient underwent open reduction and internal fixation in our hospital due to the fracture of the right distal radius, and the fracture healed smoothly after operation. His function of lower and upper limbs recovered well. It can be seen from the preoperative X-ray film that the remaining intramedullary nail was hollow, and the outer diameter of the broken nail was larger than that of the isthmus of the medullary cavity; through measurement, it is known that the outer diameter of the broken nail was 10 mm.

An minimally invasive broken nail extractor for cannulated intramedullary nails was manufacted, which included a guide pin and a spear. The

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diameter of the guide pin was 2.5 mm. The spear included contains two 1.0-mm-diameter pins with a 2.5-mm-long barb in one side. **Fig. 2.**

RESULTS

During the removal procedure, we made a hole at the entry point of tibia for intramedullary nail, inserted the guide needle and reamed the tibial medullary cavity with a drill bit with a diameter of 11 mm along the guide needle, **Fig.3**, flushed and sucked out the residue. We adjusted the diameter of the spear at the barb of the self made minimally invasive broken nail extractor to 3 mm, then inserted it into the medullary cavity and passed the broken nail extractor, **Fig.4**, finally pulled back, the barb hooked the canal wall, **Fig.5**, and successfully extracted the broken nail, **Fig.6**. The operation was performed under fluoroscopy.

DISCUSSION

According to whether the bone at the broken nail site is fenestrated, these techniques can be divided into two categories: minimally invasive extraction and extraction through the bone fenestration (fenestration method) [6-12].

Interference fit guide wire method and hook removal method are the main invasive extraction methods [6,7,12]. The interference fit guide wire method entails passing a ball-tipped guide wire and a nontipped guide wire or Kirschner wire through the nail canal, filling the canal as much as possible and extracting the broken nail using the resistance generated by

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the friction between the enlarged ball at the front of the wire and the canal wall [6,7]. The disadvantage of this method is that it is very difficult for the both of the nontipped guide wire and the Kirschner wire to pass through the canal of the broken nail along with the ball-tipped wire. The hook extraction method involves hooking a guide needle through the broken nail canal and extracting the broken nail. The disadvantage of the hook method is that it is very difficult for the wide front of the hooked guide needle to pass through the broken nail canal. Another defect is the minimally invasive extraction methods require multiple X-ray fluoroscopy, which subjects operators and patients to large doses of X-ray radiation, and their extraction success rate is not high.

The fenestration method entails the creation of a window on the bone at the location of the broken nail and then inserting a 2-mm-diameter and approximately 2-inch-long elastic nail or screw through the locking hole on the side of the broken nail. The ball-tipped guide wire is then pulled outwards. Because of the incarceration between the ball-tipped guide wire and the elastic nail or screw in the canal of the broken nail, the ball-tipped guide wire is closely connected to the broken site of the intramedullary nail. As a result, the broken nail is pulled to the nail entry point. After fenestration, the guide wire or a thick steel wire can be inserted through the hole of the broken nail in a retrograde manner, and the distal end of the guide wire can be bent, or the thick steel wire tied, so that the broken nail is

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extracted by pulling the guide wire or the thick steel wire at the nail entry point [5,7]. The fenestration method has a high success rate and basically avoids radiation exposure, but the disadvantage is that it creates relatively large surgical trauma.

Our technique is not only simple in manufacture, but also reasonable in design. The tip of the extractor is relatively small and is located in the center of the extractor; thus, it can easily enter the canal of the broken nail and guide the wide spear into the canal. The diameter of the spear at the barb can be reduced and expanded. After compression, the reduced diameter is less than 3 mm, allowing the body to pass smoothly through the canal of the broken nail. After passing through the canal, the body diameter expands to more than 3 mm, and the barb can easily hook the canal wall of the broken nail. The width of the barb is increased by approximately 2 mm after full expansion of the barb, which has exactly the same thickness as canal wall of the broken nail so it will not hook the medullary cavity wall and get stuck. The diameter of the barb is 1.0 mm and has certain resistance to bending, allowing the broken nail to be extracted.

The surgical essentials are as follows: when there is hyperplastic callus that blocks the marrow cavity leading to difficulty of the broken nail extractor to pass through the medullary cavity, especially the isthmus, a drill must be used to ream medullary cavity; secondly, the diameter of the broken nail extractor at the barb should be adjusted according to the internal diameter

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of the broken nail to be consistent with or slightly larger than the internal diameter.

4. CONCLUSION

Our technique is a simple reproducible alternative that has high extraction success rate for distal broken segment of cannulated intramedullary nails.

ETHICAL APPROVAL

As per international standard or university standard ethical approval has been collected and preserved by the authors.

CONSENT

Written & Oral informed consent was obtained from the patient before writing this manuscript.

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Figure legends

Fig. 1: Appearance of minimally invasive broken nail extractor.

Fig. 2: Preoperative X-ray films showing union of the right tibial fracture

associated with broken intramedullary nail remaining at the distal of the tibia.

Fig. 3: Intra-operative X-ray showing a drill was used along a guide needle to ream the medullary cavity.

Fig. 4: Intraoperative X-ray showing the broken nail extractor was inserted into the medullary cavity and passed through the canal of the broken nail.

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Fig. 5: Intraoperative X-ray showing the broken nail extractor was pulled back and the barb hooked the canal wall.

Fig. 6: The broken nail extractor extracted the broken nail.

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