Broken Femoral Intramedullary Locking Nails with Nonunion A difficult combination!

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ABSTRACT

Background: The diaphyseal fracture of femur is universally treated with intramedullary interlocking nails. Non-union with properly done interlocking nail is not very common. When broken nail and non-union coexist, it becomes a real challenge. We reviewed our isolated femoral shaft fractures treated with antegrade interlocking nails that presented with broken nails, bolts and non-union. We discuss our simple technique of retrieval of broken nail units, their management and results with revision nailing.

Materials and methods: We reviewed our cases of femoral intramedullary locking nails operated from 2012 November to 2017 November and observed that, out of 197 cases; Eight cases of broken nails were managed in our center Nepalgunj medical college Nepalgunj. Patients were operated in lateral position under combined spinal epidural anaesthesia. We removed the broken nail segment with our simple yet less destructive technique and revised with bigger nails.

Results: Out of 197 cases of fracture shaft femur treated with IM nail, 8 cases were found to have broken nails. Seven cases were associated with non-union of femur. In one case, the femur united in spite of broken nail. In all the cases broken nail were removed in a similar manner and was struggle free. Exchange nailing was done in seven cases and only one case was augmented with bone graft from ipsilateral iliac crest. Union was achieved in all seven cases.

Conclusion: IMIL nail is the well-established, minimally invasive osteosynthesis for long bones fracture. Nonunion and broken implant when coexist the management becomes difficult.

Keywords: *Broken nail; Broken nail with nonunion; Femoral fracture; IMILN; nonunion; revision nail.*

INTRODUCTION

Retrieval of broken intramedullary locking nail is a real challenge. Proper planning and preparation minimizes the surgical time and complications as well. The fatigued nails may break during removal, so one should be prepared to deal with a broken nail in each case of a nail removal [1]. The use of hooks, pliers, arthroscopic clamps, impacted guide wires, basket forceps and biopsy forceps are described for their removal [2-8]. In worst situations, non-union has been dealt with plate and external fixator ignoring a retained piece of nail as such [9]. Broken implant is usually associated with poor stabilization, delayed union and non-union [10, 11]. The design of the nail itself contributes maximum stress concentration at its proximal and distal ends making them prone to get fractured at these sites [10]. Unusually, the fracture may not heal before fatigue failure of the implant occurs due to cyclical loadings and nail breaks at the fracture site [12]. This happens when weight bearing is permitted before features of clinico-radiological healing. We reviewed our cases of femoral intramedullary locking nails managed in our center. We discuss our management with broken femoral intra medullary interlocking (IMIL) nails and their outcomes. We also discuss our simple technique of retrieval of broken segment of intramedullary nail that we utilized in all our cases.

MATERIALS AND METHODS

This retrospective study was conducted in our tertiary care hospital at Nepalgunj Medical College, Nepalgunj. We reviewed our cases of femoral intramedullary locking nails operated from 2012 November to 2017 November and observed that, out of 197 cases; Eight cases of broken nails were managed in our center Nepalgunj medical college Nepalgunj. Closed fracture femurs those were managed with anterograde intramedullary interlocking nail were included in this study. The nails we used are local made stainless steel IMIL nail. Open and segmental fractures were excluded from the study. Cases of multiple fractures were also excluded from the study. Out of 197 isolated femur fractures stabilized with intramedullary locking nails, 8 femurs presented with broken implant. Broken nail removal and secondary procedures were carried out in 7 patients.

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All patients were operated under combined spinal epidural Anaesthesia (CSEA). Patients were kept in lateral position with the affected side up. Previous skin incisions were utilized to remove proximal and distal locking bolts. The proximal portion of nail was approached from the previous skin incision proximal to tip of greater trochanter. An attempt was made to negotiate straight-tipped guide wire (used for humerus nailing) from the proximal end of nail including the distal broken end. If distal broken fragment was displaced and guide wire negotiation was unsuccessful proximal broken nail piece was removed with the help of nail extractor with back slap hammer attached to it. After the removal of proximal broken piece of nail, the straight tipped guide wire was negotiated under Image Intensifier inside the broken distal nail. The knee was flexed to 60 degree and the guide wire was advanced with the help of T-handle attached to it. Once the exit point was noted under Image Intensifier from the intercondylar notch close to anterior cortex it was made to come out from stab incision displacing the patella manually [Fig. 1a, b].

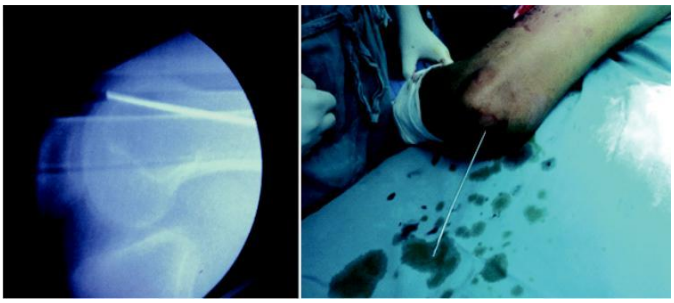

Fig. 1a, b: Guide wire being delivered close to the Anterior cortex. Flexion displaces patella downward.

The deeper dissection was done up to femoral cortex with the help of artery forceps. A hollow mill was mounted over the guide wire and the distal femoral cortex was drilled. The straight tipped guide wire was bent completely so as to form a bulb at the tip. It was then withdrawn slowly with pliers till the bulb crosses the distal femur and reached close to the tip of nail [Fig 2a, b].

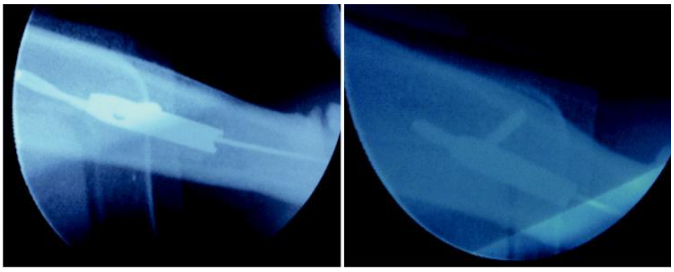

Fig. 2a, b: Bent guide wire being engaged inside the hollow of nail

A hollow with back slap hammer was mounted over guide wire and stabilized with T-handle with chuck. Gentle but repeated back slap facilitates the migration of broken nail, which was visualized under image and removed [Fig. 3, 4].

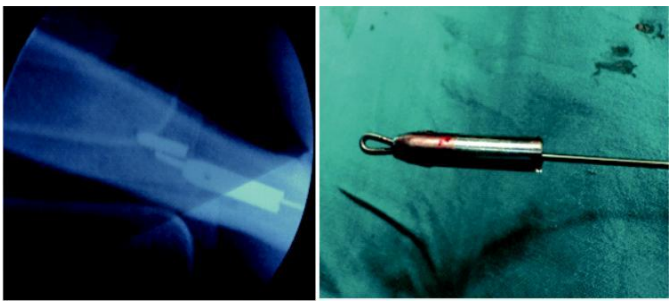

Fig. 3: Nail piece being delivered. Broken locking bolt fall inside medullary canal which was retrieved from the same locking hole enlarging its diameter under image guidance with the help of artery forceps.

Fig 4: Removed nail piece. Note the complete bend and bulb of guide wire and the tip inside nail

When exchange nailing was planned serial reaming up to 2-3 mm more of the previous canal size was done and 2 mm more the size of previous nail was inserted. Both the proximal and distal holes were locked and nail was stabilized. In one of our cases, the fracture site was grafted from the ipsilateral iliac crest. However, the fibrous tissue was not disturbed much in this case.

RESULTS

We reviewed Radiographs of 197 cases of isolated fracture femur treated with IMIL nail. Out of which only 8 cases were found to have broken nail. Seven cases were associated with non-union of femur. In one case, the femur had united in spite of broken nail, where nail was broken proximal to the fracture site [Fig. 5].

Fig. 5: Early weight bearing and nail failure. Fracture united despite nail failure.

In one case both nail and locking bolt were broken [Fig 6, 7a, b, c,].

Fig. 6: Post operative AP and Lateral X-ray of thigh showing short, samll diameter nail with single proximal and distal locking bolts in a comminuted mid shaft femur.

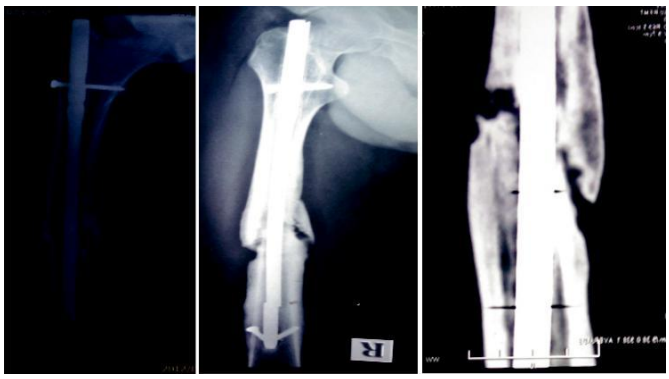

Fig. 7a, b: AP and lateral X-ray of same patient (Fig 6) showing broken nail distal to non union site with broken bolt.

Fig. 7c: Non union evident in CT scan.

Two nails broke at the fracture site and resulted in non-union. In rest of the four cases nail broke distal to fracture site. In all the cases broken nail was removed in a similar manner and was struggle free. The remaining broken intramedullary screw was approached enlarging the screw entry hole and holding it with artery forceps under image guidance. Exchange nailing was done in 7 cases and only one case was augmented with graft form ipsilateral iliac crest [Fig 8].

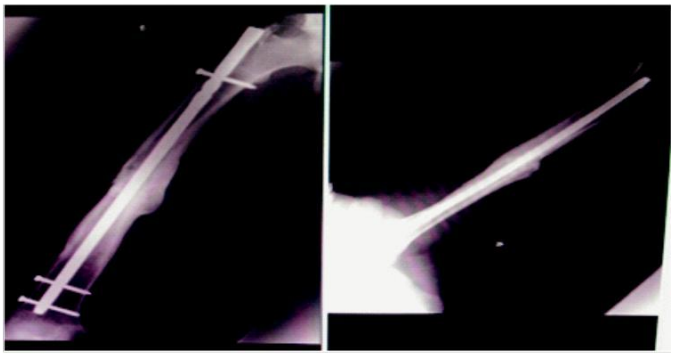

Figure 8: AP and lateral X-ray of same patient (Fig 6) after revision nail and bone grafting helped solid union. Proximal static locking bolt was removed to dynamize the nail after 2 months.

Union was achieved in all 7 cases. Table 1 summarizes the results of all cases.

Case No	Fracture site in femur	Nail failure site	Presentation	Surgery	Probable reason of nail failure	Union time (weeks)
1	Proximal 3rd	Proximal to # site	United fracture with nail failure	Nail removal	Early weight bearing	
2	Distal 3rd	Distal to # site	Non union with nail failure	Exchange nail	Early weight bearing	20
3	Mid shaft comminuted	Distal to # site	Non union with nail failure	Exchange nail + BG	Short small diameter nail	24
4	Distal 3rd	Distal to # site	Non union with nail failure	Exchange nail	Small diameter nail	16
5	Distal 3rd	Distal to # site	Non union with nail failure	Exchange nail	Small diameter nail	24
6	Mid shaft	# site	Non union with nail failure	Exchange nail	Short nail	28
7	Proximal 3rd	# site	Non union with nail failure	Exchange nail	Fall	20
8	Distal 3rd	Distal to # site	Non union with nail failure	Exchange nail	Small nail, single distal locking bolt outside hole (failed distal locking)	28

Table 1

DISCUSSION

Intramedullary interlocking nail for femoral shaft fracture offers many advantages. Small incision distant to the zone of injury, undisturbed fracture hematoma, bone grafts form reaming, and physiological load transmission down the mechanical axis of bone make it universal for diaphyseal fractures of long bones. Nail failures have been reported in 0.5 - 3.3% of cases with stainless reamed nail in literature [13]. Retrieval of the distal fragment of a broken nail without destructive surgery can be a challenge. Many surgical techniques have been described for the retrieval. We share our experience with broken femoral nails and their management.

Distal locking holes are the weakest points that are expected to fail because of stress concentration caused by the hole effect and slot effect. Nicking the area by drill bit around the distal

holes during locking further weakens the nail strength. Nail breakage can also occur when weight bearing begins before the fracture regains 50% of its original stiffness [14]. Protected weight bearing till clear radiographic union avoids loading the nail beyond its limit of endurance [10]. The smaller diameter nails of inadequate length may cause failure because of increased concentration of stress at the locking holes. The screw hole area of these small nails can occupy up to 50% of the diameter (normally 30%) [14]. The comminuted and unstable fracture patterns may incur additional stress on the locked nails.

Another reason for nail breakage is the biomechanical properties of nail. Affordability is the determining factor for the standard of nails in developing countries. Such locally available nails may not withstand the cyclical loading stress imposed by walking if they are permitted to bear weight with caution. Since we use locally made low cost implants the ratio of nail breakage goes higher than the standard nail.

Various techniques have been described for the extraction of distal fragment of broken tibial and femoral nails, including the use of hooks, long forceps, cerclage wires, multilple guidewires, hand remaers and push-out techniques [2-8]. Similar technique may not work in all and needs individualization. Standard broken nail retrieval sets are available from the different manufactures like Synthes and Zimmer but these sets are not available in our set up. So we are left with customized and improvised techniques. We tried to remove the distal broken nail with ball tipped guide wire. For which, the smooth tip guide wire was inserted from pyriform fossa and taken out from the intercondylar notch close to anterior cortex under image. Skin and deeper tissue was dissected till the cortex and hollow mill was used to make a hole larger in the distal femur. From the same tract ball tipped guide wire was inserted and delivered from pyriformis fossa. We encountered an unusual complication with this technique that ball of the ball tipped guide wire detached from the guide wire and entered inside knee joint [Fig. 9a, b].

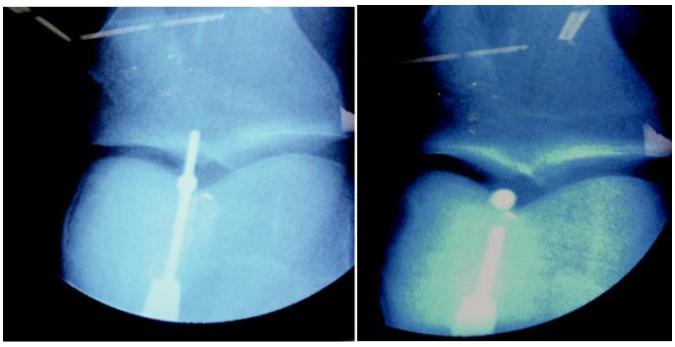

Fig. 9a, b: Retrograde ball tipped guide wire inserted to deliver broken nail segment. The ball slipped from the guide wire and entered inside joint.

So we improvised our technique. We then passed a smaller size guide wire that is used for humerus nail. The guide wire was passed from the pyriformis fossa and entered inside the nail under image guidance. Guide wire was attached with T handle and with rotatory movement taken out from knee flexing the knee joint. The straight tipped guide wire was bent completely so that it forms a bulb at the tip. It was then withdrawn slowly with a plier till the bulb crosses the distal femur and reaches close to the tip of nail. A hollow with back slap hammer was mounted over guide wire and stabilized with T-handle with chuck. Gentle but repeated back slap facilitates the migration of broken nail, which was visualized under image. After the success of the index case we were following the same technique in all the case. We retrieved all the distal broken nail fragments in the similar way. We suggest passing the guide wire without removing the proximal nail fragment in case of complete but undisplaced broken nails. Whereas, in case of displaced broken nail removal of proximal fragment and negotiation of guide wire inside the distal segment of nail under image is helpful. Only the bent at the tip of guide wire distally also serves the purpose, but with repeated blow the bent tip may straighten and give away. So a complete bent with bulb at tip prevents such problems.

Additional bone grafting is not usually required as suggested by previous authors. We grafted only one case where the nonunion was of prolonged duration. Otherwise, bone grafting was not required for satisfactory healing in our series too.

Ours is a simple, reproducible and successful technique to deal with the broken femoral nails. Only disadvantage is a caution to take out the guide wire from intercondylar notch nearer to the anterior cortex. Otherwise, cruciates and meniscus are at risk to get injured. The guide wire therefore should be monitored under image. The flexion of the knee and manipulation of patella would prevent the injury to patella as well.

CONCLUSION

If the principles of nailing are followed properly, nail breakage can be prevented. Distal third fractures are prone to nail breakage. Increasing the “fracture –locking hole” distance, delayed weight bearing; dynamisation and protected weight bearing may prevent nail breakage. Early intervention of deformed nail would prevent the time taking and destructive procedures. Our technique is simple and easily reproducible to

deal with cases where standard broken nail extraction sets are not available.

Conflict of interest statement: No conflict exists.

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