Stabilization of femoral fractures in calves using intramedullary interlocking nailing

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Journal of Livestock Science (ISSN online 2277-6214) 17: 643-648
Received on 22/8/25; Accepted on 18/8/26; Published on 23/8/26
doi. 10.33259/JLivestSci.2026.643-648

Abstract

The paper documents the successful use of intramedullary interlocking nailing (ILN) for the treatment of two different femoral fracture configurations in two young, growing calves, each with its surgical challenges. Two crossbred heifer calves presented with highly unstable femoral fractures were operated with ILN with successful clinical outcome. Both the calves showed early ambulation with excellent fracture healing. The productivity and reproductivity of these young dairy animals could be restored which otherwise might have lead to amputation or culling leading to financial loss to the dairy farmers and hence, ILN can be recommended in unstable comminuted long bone fractures in young calves.

Key words: Comminuted fractures, Femur bone fracture, heifer calves, Interlocking nailing.

Introduction

Interlocking nails allow rigid fracture stabilization and present biomechanical advantages when compared to other immobilization techniques (Arican *et al.,* 2023). Several factors like hormonal, biomechanical, cellular, pathological and biochemical factors also influence the fracture healing process in bovines (Basith *et al.*, 2018, Kumar *et al.,* 2021). Femur which is a long proximal bone of the hind limb, carries the body weight and pushes the body in forward direction while moving (Kurum, 2012). The femur in young calves has thin cortex and a wide medullary cavity and fracture of femur results in disability of the limb and its repair in these animals constitutes a challenge (Bellon and Mulon, 2011). Comminuted fractures in the diaphyseal region are common in the high energy injuries (Kulkarni *et al.,* 2012). Due to high instability, severe associated soft tissue injuries and disruption of periosteal and intramedullary vascularity from the fractured ends, the management of long oblique or comminuted fractures remain a challenge. Femur fractures cannot be managed by simpler methods of closed reduction and external co-optation techniques such as casts, splints and therefore internal fixation is necessary to stabilize them. The stability offered by bone plates to achieve biological osteosynthesis of these comminuted fractures necessitates a wide operative exposure with extensive stripping of soft tissues resulting in increased loss of blood and a longer operating time and also failure of the plate to hold fractured fragments. Intramedullary nails are frequently used for the treatment of long bone fractures because of the advantages of low cost, easy application and removal, minimal damage to the epiphyseal plate and shorter operation time than for plating (Nuss *et al.,*2011). Interlocking nails (ILN) are an alternative to bone plates, and its simple surgical approach makes it more suitable for achieving early union in the diaphyseal fractures (Raghunath *et al.,* 2012). ILN is a system constituting a modified IM pin with four predrilled screw holes in each proximal and distal ends to interlock the implant with the screws to the bone after placing it in the medullary canal of the bone to stabilize the fracture. ILN is an effective method of internal stabilization for neutralizing all fractures forces post operatively. In ILN, the pin placed in neutral axis shows resistance to bending forces just as IM pins, while locking in of the system with the screws provides maximum resistance to rotation, compression, shear, and traction stresses. (Kurum, 2012). Furthermore, it provides greater movement of inertia when compared to bone plating. This report documents the successful use of ILN for the treatment of two different femoral fracture configurations in two young, growing calves, each with its surgical challenges.

Materials and methods

Two crossbred heifer calves were presented to Department of Veterinary Clinical Complex, College of Veterinary Science Tirupati, with non weight bearing hind limb lameness after automobile accidents. Clinical examination revealed severe pain at the thigh region with swelling and crepitus upon palpation. Radiographic evaluation of 1st calf revealed complete distal 1/3rd oblique femur fracture with cranial displacement of proximal fragment and caudal displacement of distal fragment (Fig. 1) and of the 2nd case revealed complete proximal 1/3rd long oblique femur fracture with a wedge and fracture fragments showing overriding and displacement (Fig. 3). Both the cases were advised for open reduction and internal fixation with Interlocking nailing. The calves were operated under caudal epidural anaesthesia along with local infiltration anaesthesia with 2% lignocaine and anaesthesia was maintained with Midazolam and Ketamine combination given intravenously.

The femur diaphysis was approached by standard craniolateral skin incision as per Newton and Nunamaker (1985). The subcutaneous fat and superficial fascia were dissected under the skin incision. The fascia lata was incised along the cranial border of the biceps femoris muscle along the entire length of the skin incision. Cranial retraction of the biceps femoris muscle and caudal retraction of vastus lateralis muscle exposed the shaft of the femur. The exact diameter and length of the nail in each case was estimated based on pre-operative radiographs and intra- operative assessment of the bone. The 8 mm/16cm nails engaged 3.5mm cortical screws for which holes were drilled with 2.5 mm drill bit and tapped with 3.5 mm tap. An opening into the medullary cavity of proximal fragment was made by equal sized simple intramedullary pin as that of the selected nail. The interlocking nail was inserted into the medullary cavity of proximal fragment. Fracture ends were reduced and nail was driven into the distal fragment. The distal fragment was locked first with cortical screws after drilling and tapping of the appropriate hole. The same procedure was repeated to lock the proximal fragment. Once the screws were tightened, the aiming device was detached from nail, leaving nail inside the bone. Two full cerclage wiring with a 20 G SS orthopedic wire was done for stabilizing the longitudinal fissures in both the cases as an ancillary support. The fracture site was irrigated with normal saline to clear the debris. The fascia lata was closed using polyglycolic acid 910 no. 0 with simple continuous pattern and subcutaneous tissue with 2-0 polyglycolic acid 910. The skin was closed in routine manner using No: 1 braided silk in cross mattress pattern followed by over the hip padded bandage. Immediate post operative X-ray revealed good fracture reduction, cortical contact and good implant position with locking screws (Figs. 2 & 4).

Standard post operative management included administration of inj. Cefotaxime @ 20mg/kgbwt and inj, Meloxicam @ 0.2mg/kgbwt, along with oral calcium supplement. The antiseptic dressing and bandaging was changed on every third day and skin sutures were removed after 12 days of surgery. The owners were advised to allow only limited activity of the animals for 15 days.

Results

Post operatively there was decrease in inflammation with gradual improvement in weight bearing on the operated limb with hoof completely touching the ground by fourth post operative day. One month post operative follow up revealed normal weight bearing without any signs of lameness. Both medio lateral and cranio caudal radiographic views of the operated bone were taken at 60th post operative day which revealed signs of bridging periosteal callus with stable implant (Figs.5 & 6). The 90th post operative day radiographs of both the calves revealed complete union of fracture, no evidence of fracture line and signs of remodeling (Figs. 7 & 9). Both the calves made uneventful clinical recovery, with normal ambulation, complete weight bearing and no signs of lameness (Figs.8 &10) and were destined to have normal reproductive and productive life.

Fig. 1. Preoperative radiograph of Calf 1 with complete, distal 3rd ,oblique femur fracture

Fig. 2. Immediate post operative radiograph of calf 1 with reduced fragments stabilized with ILN.

Fig. 3. Preoperative radiograph of Calf 2 with complete, oblique, over riding, proximal third femur fracture

Fig. 4. Immediate post operative radiograph of calf 2 with fracture stabilized with ILN and full cerclage wiring

Fig. 5. 60th post operative radiograph of calf 1 with bridging callus and intact implant.

Fig. 6. 60th post operative radiograph of calf 2 with bridging callus and intact implant.

Fig. 7. 90th post operative day radiograph of calf1 with complete fracture healing

Fig. 8. Calf 1 showing good clinical outcome with complete weight bearing

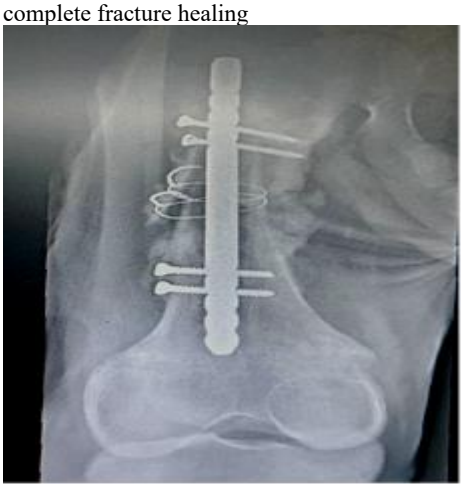

Fig. 9. 90th post operative day radiograph of calf 2 with complete fracture healing

Fig. 10. Calf 2 showing good clinical outcome with complete weight bearing

Discussion

In both the cases of femur fracture, anatomical fracture reconstruction with stable internal fixation using static intramedullary interlocking nailing resulted in satisfactory clinical outcome due to uneventful bridging osteosynthesis that was characterized by classical radiographic features of secondary fracture healing. Considering reduction, immobilization and fracture healing time provided in diaphyseal femur fractures with ILN, this technique can be a successful alternative to other osteosynthesis methods. This was in accordance with Raghunath *et al*., (2012) who reported anatomical reduction, good cortical contact and stable implant in all the cases operated with ILN. In both the calves, the operated limb was touching the ground by 2nd postoperative day and the hoof with complete weight bearing on the ground by 4th post operative day. Similar findings were recorded by Raghunath *et al.,* (2012) who reported that immediate weight bearing was possible in patients fixed with large diameter nails with high fatigue strength as this allowed rapid mobilization for the patients. In both the operated femoral bones, the periosteal reaction could be seen at the fractured ends by 15th postoperative day which may be due to perfect stabilization and good cortical contact. Raghunath *et al.,* (2012) also noticed periosteal reaction at the fractured ends by 10th postoperative day. Secondary bone healing with large callus formation was observed by the end of one month and complete fracture healing was evident by the end of third month. This was in accordance with Sakshi *et al.,* (2022) who conducted ILN for fixation of femoral diaphyseal fractures in dogs and inferred that this technique can be used successfully to bring bridging osteosynthesis.

The inter locking nail presented satisfactory biological conditions due to preservation of fracture hematoma, early fracture site vascularization thereby leading to abundant peripheral callus which was mechanically stable, Mulon (2013). The fracture site immobilization was not rigid and allowed certain flexibility, enabling micro- environment and intermittent compression during walking and muscular contractions. These findings were in parallel to Sakshi *et al.,* (2022) who stated that with the use of ILN, the periosteal vascularization was not disturbed or destroyed as that with bone plating. Bellon and Mulon (2011) evaluated the intramedullary nailing in young calves and concluded that this was a novel technique as it highly suits for unstable diaphyseal femur fractures in calves and it does not allow any compression of fracture site and maintains bone length and alignment. Similarly, Marturello *et al.,* (2019) documented the successful use of angle stable interlocking nailing for the treatment of two different tibial fracture configurations in two young, growing calves and concluded that interlocking nailing provided safe and effective alternative to osteosynthesis without any effect on its growth. Further, Daolagupu *et al,* compared intramedullary interlocking nailing and minimally invasive plate osteosynthesis in extra articular distal tibial fractures of patients and concluded that IMLN group was associated with lesser duration of surgery, earlier weight bearing and union rate, lesser incidence of infection and implant irritation which makes it a preferable choice for fixation of extra-articular distal tibial fractures.

Based on the clinical outcome, it may be concluded that ILN can be used effectively as an alternative to bone plates or ESF in immature productive animals with highly unstable long bone fractures to attain early limb ambulation, excellent fracture healing with complete weight bearing and without any implant related or fracture healing complications.

Conclusion

ILN proved to be an effective and reliable method for the surgical management of unstable femoral fractures in young calves, promoting early ambulation and excellent fracture healing. Its successful application not only restored the animals' productivity and reproductive potential but also prevented potential economic losses, highlighting ILN as a preferred treatment option for managing comminuted long bone fractures in growing calves under good post-operative conditions.

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