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Clinical management of tibial fractures by using type II linear external skeletal fixator in cattle

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Abstract
The present study was conducted on three clinical cases of tibial fractures. Mid-diaphysis was the most common fracture location in all cases. All the three cases of mid-diaphyseal tibial fractures were repaired by the use of type II linear ESF which was made of stainless-steel clamps and stainless-steel connecting rods corresponding to the size of the transcortical pins were used. Total time of surgery was 45-90 minutes in all cases. Two tibial fractures were close and one was open. All fractures were oblique in configuration. In two cases, cattle had good weight bearing with moderate lameness postoperatively. The linear external fixator was well maintained and tolerated by two cattle through fracture healing. One animal died due to unknown reason after post-operative care on 30th day. Joint mobility and limb usage improved gradually after linear external fixator removal. Linear external fixator provided a stable fixation of tibial fractures and healing within 60-70 days and functional recovery within 80 days. Linear external fixator can be safely and successfully used for the management of selected tibial fractures in cattle.

Keywords: ESF, cattle, fracture, tibia

Introduction

The long bone fracture in large animal is common. High incidence of fracture of tibia has been reported followed by metacarpal in bovines (Adams and Fessler, 1983) [2]. Tibial fractures are commonly encountered in every age group of breeding and fattening cattle. These fractures are often comminuted and can involve all parts of the tibia (Tulleners 1986) [29]. Angular placement of the bone and the conical shape of the limb make tibial fractures unsuitable for conservative treatment. Conservative treatment by application of a conventional full limb cast does not immobilize the stifle joint or adequately stabilize tibial fractures (Martens *et al*. 1998) [21]. Their treatment can be a real challenge, especially in heavy muscled animals.

Tibial fractures in cattle have been reported to heal satisfactorily with stall confinement and/or a modified Thomas splint or cast (Beckenhauer 1958, Adams and Fessler 1983, Adams 1985) [10, 2, 1]. Different types of hanging pin casts have also been applied successfully (Kendrick 1951, Kumar and others 1973) [15, 17]. The fracture can be reduced surgically by using bone plates, Rush pins, Kuntscher nails, cross-pinning and transfixation pinning (Verschooten and others 1972, Rao and Rao 1973, Hamilton and Tulleners 1980, Kumar and others 1981, Vijaykumar and others 1982) [30, 25, 13, 18, 31]. Bone plating remains the ideal immobilization technique for tibial fracture repair in large animals. Dual plate fixation, especially dynamic compression plates, applied on the craniomedial and the craniodorsal aspects of the tibia provides rigid fixation in adult cattle (Vijaykumar *et al.* 1982, Tulleners 1986 and Auer *et al*. 1993) [31, 29, 8].

The strength and stiffness of fixation device is very important in large animal orthopaedic surgery because restricting the movement and weight bearing is difficult (Singh *et al.* 2007a) [26]. Though linear fixator has been widely used in small animal practice, there are only a few devices developed specifically for large animals (Pattanaik *et al.*, 1996; Singh *et al.*, 2007b) [24, 27]. The basic linear external fixator frame is composed of connecting rods and a series of connecting clamps (Lewis *et al.,* 2001b) [20]. Connecting bars used in veterinary surgery are generally made of stainless steel or aluminum. External skeletal fixation (ESF) with transfixation pinning has been used successfully for the treatment of tibial fractures (St-Jean *et al.* 1991 and Hamilton and Tulleners, 1980) [28, 13]. On the basis of the available literature, it was observed that most of the work done on ESF is on young animals or small animals and very little work has been carried out in large adult cattle. Hence considering the various advantages offered by ESF, the present study was designed to further evaluate the Type II linear ESF system in its application and healing outcome of tibial fractures in clinical cases of adult cattle.

Materials and Methods

Three cattle of different age and sex were presented to the Veterinary Clinical Complex with fractures of tibia. These cases were examined for etiology, ability to stand, side of limb involved, body weight and soft tissue injuries (Table 1). These animals were also observed for loss of function, abnormal mobility, deformity or change in angulation of the affected limb, signs of local swelling, pain and crepitation at the fracture site. These cases were assessed preoperatively for fracture by clinical and radiographic examination. Pre-operatively, two orthogonal radiographic views i.e., medio-lateral and cranio-caudal view of the fractured bone were taken to assess the fracture location (proximal third/mid shaft/distal third of diaphysis), configuration (oblique/transverse/spiral/comminuted/multiple), cortical bone density, cortex to cortex diameter at different levels of fractured bone, length of proximal and distal bone fragment and overriding percentage, bone health and other findings related to bone.

The fractured limb was immobilized using bamboo splint, cotton padding and bandaging with niwar tape, to avoid further trauma to bone and soft tissue, till the date of surgery. Pre-operative analgesics and antibiotics were administered to reduce pain, inflammation and secondary bacterial infection at the fracture site.

Diameter of transcortical pins were based upon the body weights of the animals and the bone cortex to cortex diameter measured on the pre-operative radiograph. Stainless steel universal clamps and stainless-steel connecting rods (hollow conduit pipe with 11 mm diameter) corresponding to the size of the transcortical pins were used. Smooth shaft, trocar end Steinmann pin was used in all clinical cases of tibial fractures.

Application of LEF: The animals were sedated with xylazine hydrochloride intramuscularly (0.05-0.1mg/kg bwt). Anterior epidural analgesia with 2% lignocaine hydrochloride was also used. All the animals were restrained in lateral recumbency, with the affected limb positioned upward. The reduction of fracture was achieved by open method in 1 case and by close reduction in 2 cases. After the dressing of wound in open fracture case, bone fragments was exteriorized, the edges freshened and the fragments held in alignment, using a bone cutter.

A stab incision was made on medial side of skin over the pin insertion site. Transcortical pin was drilled percutaneously through safe corridors of the fractured bone using slow speed power drill machine with continuous dropping of cold sterile normal saline solution so as to reduce heat production and subsequent thermal necrosis. According to the length of fracture fragment at least two transcortical pins (half or full pins) were drilled through each proximal and distal fracture fragment. The half / full pins were applied perpendicular to the long axis of the bone sequentially guided through the preplaced clamps on the connecting bar and drilled through the bone. All the clamps were tightened with spanner taking care that the fractured fragments remained in anatomical alignment and apposition. Clamps and connecting bars were positioned close to the skin. Following this, the excess length of the transcortical pins and connecting bars were cut close to the clamps with the help of pin cutter and iron funner.

Post-operative care: Following surgery, a povidone iodine-soaked gauze pad was wrapped around the skin and pin interface. Wound was flushed with sterile saline solution containing povidone iodine and covered with sterile gauze pad. Then cotton padding was done and secured with bandage over the frame on the limb for external protection of LESF assembly and animal itself. Post-operatively, strepto-penicillin was administered, once a day, for 7 days and Meloxicam @ 0.2-0.5mg/kg body weight once a day, for 3 days, were administered through intramuscular route. Calcium-phosphorus and multi-vitamin preparation were prescribed per oral in the post-operative period. All animals were restricted to stall rest and allowed only limited movement in an open enclosure. The animals were examined carefully during first few days post-surgery for tolerance of the fixator and immediate weight bearing status. Fracture reduction, alignment and healing were constantly assessed both by clinical observation (e.g. wound healing, lameness, weight bearing, status of fixation device, status of trans-cortical pins, fracture site observation and pin tract sepsis) and every 15 days by radiographic examination. All animals were observed till radiographic healing.

Table 1: Detailed clinical finding of tibial cases

Case No.	Sex	B.Wt.	Age	Etiology	Type of fracture	Configuration/Location	Ability to stand
B1	F	160	36	Automobile	Close	Oblique/mid-diaphysis	Yes
B2	M	202	12	Falling	Close	Oblique/mid-diaphysis	Yes
B3	F	154	18	Automobile	Open	Oblique/mid-diaphysis	Yes

Result and Discussion

The present study was conducted on three clinical cases of tibial fractures. In two animals the fractures were caused due to automobile accident while in one case by falling from height. Similar findings were observed by many scientists (Chourasia *et al*. 2019; Nagar *et al*. 2019 and Aithal *et al*. 2019) [11, 22, 5] in their study. The fractures were close in two animals and open in one. Tibial fractures can easily become open on medial surface because of the minimal supporting soft tissue structures in this area (Tulleners 1986) [29]. Open fractures are less common in cattle than in horses because cattle have a thicker skin and more likely o protect a fractured limb from additional trauma (Admas 1985) [1]. Body weight wise, all the animals were ranged from 154-202 kg. In a similar study, Aithal *et al.* (2004) [7] used circular skeletal fixator for management of long bone fracture in cattle calves of 55-250 kg body weight. Martens *et al.* (1998) [21] studied conservative and surgical treatment of tibial fractures in cattle and body weight of treated animals varied between 35-800 kg. All fractures of tibia were oblique/mid-diaphysis in configuration and locations. Patil *et al.* (1991) [23] found that the highest occurrence of fracture was observed in diaphysis followed by proximal third and distal third. Aithal and Singh (1999) [3] recorded highest incidence of oblique fracture followed by transverse in animals. LESF can be used for immobilization of any type of location of fracture in lower limb bones. All animals, in the present study, had the ability to stand. The diameter of pins was 3.5-4.0 mm in all treated cases of tibial fractures.

Immediately after surgery, all cattle stood and started walking without any complications. Initial partial weight bearing was observed in two cases (B1and B2) at 1st and 4th days respectively (Fig.2). In two cases, the fixator was well tolerated and animals could easily lie down, stand and walk freely without any abduction or injury to contralateral limb. The associated joints had free movement except for slight reduction in hock flexion in one case (B3). Weight bearing slightly reduced during the 3rd and 4th week in two case (B1 and B2), but improved gradually at 6th and 8th week. However, slight medial bending of bone fragment was noticed from 5th day resulting in prolonged lameness and poor weight bearing and remained lame until fixator removal. Similar finding was observed by Aithal *et al.* (2004) [7], Aithal *et al.* (2007), Aithal *et al.* (2010) [4], Basith *et al.* (2018), Nagar *et al.* (2019) [22], Chourasia *et al.* (2019) [11]. A marked increase in weight bearing was observed after removal of fixator in two cases (B1andB2) of tibia, as the fracture union was achieved radiographically. Similar finding was observed by Aithal *et al.* (2004) [7], Aithal *et al.* (2007) [6] and Aithal *et al.* (2010) [4]. B3 case died due to unknown reason post-operatively on day 30.

Mild inflammatory swelling was observed during the first week of fixation in B2 case, which subsided gradually. The skin-pin interfaces remained dry during the first 2 weeks. A mild serous discharge occurred from some transosseous pins, more so associated with proximal bone fragments during 4th and 5th week postoperatively. Pin tract discharge was more pronounced from the proximal pins and also more on lateral surface of the bone. The wound was managed by cleaning and dressing with Povidone Iodine solution, after removal of transfixation pins. Similar finding was observed by Aithal *et al.* (2004 and 2010) [7], Chourasia *et al.* (2020) [12] and Kumar *et al.* (2016) [19]. Pin tract sepsis is one of the most common complications of linear or circular ESF (Harari, 1992).

The radiographs taken immediately after fracture fixation showed reduced fracture fragments with slight mal-alignment in two cases (B1, B3), but in B2 case poor alignment with presence of large gap between fracture fragments was observed. On the day of 30, bending of both proximal and distal pin was marked resulting in marked angulation and outward rotation of limb in B2 case, whereas in B1 case, good callus reaction was noticed between the bone fragments, but the bridging callus was not present. Pin-tract osteolysis was observed at the level of proximal pins in all cases, but more pronounced in B2 case. On the day 60, bridging callus between the fracture ends with complete bone healing and increased radiographic density was observed in B1 case, whereas in B2 case there was more periosteal callus formation with pin tract osteolysis and periosteal reaction around insertion and increased medullary density around the pins and exit point of transcortical pins was observed, which was similar to findings of Harari, (1992) [14], Chourasia *et al.*, (2019) [11] and Aithal *et al.* (2004 and 2010) [7].

After removal of the fixators (60-80 days), the discharge from the pin tract subsided within a week and pin tract wounds were healed completely within 2 weeks with improvement in weight bearing of limbs. The radiographs taken after removal of the fixator showed radiolucent areas along the pin-tract in B1case. The bone density at these sites gradually returned to normal which was similar to finding of Aithal *et al.* (2004 and 2010) [7]. Chourasia *et al*. (2019) [11] removed ESF around 60 to 70 days after the operation, when the dissolution of radiolucent fracture line stared with the presence of exuberant osseous callus. Kumar *et al.* (2018) [16] also removed the LESF system on 65 days, with complete bone healing with bridging callus on post-operative radiograph. The gait become almost normal in B1 case but in B2 case there was mal-unioun with fair weight bearing. The functional recovery was good and satisfactory in B1 case within 80 days.

Conclusions

The Type II ESF was well tolerated by all the cattle and showed remarkable improvement in limb function with good fixator stability till the completion of bone healing. The Type II ESF can be considered for fracture stabilization of tibial diaphyseal fractures in cattle. This is a biomechanically versatile technique and easy to apply, well tolerated by the patient, easy to disassembly. LEF using stainless steel components is inexpensive, most are reusable and sufficiently strong to maintain fracture fixation in cattle weighing up to 202kg.

Fig 1A: Pre-operative cranio-caudal and medio-lateral view of oblique fracture

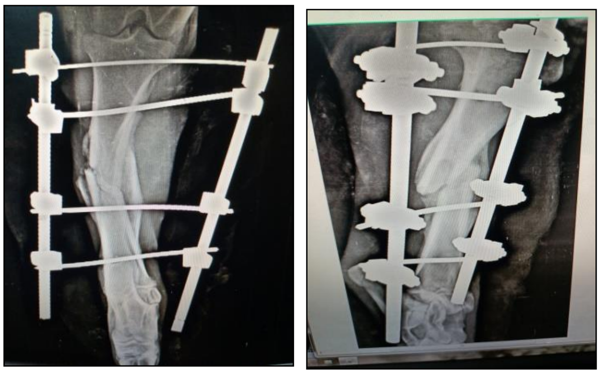

Fig 1B: 30th days post-operative

Fig 1C: 60th days post-operative

Fig 1D: After fixator removal

Fig 2A: Pre-operaive lameness

Fig 2B: 30th days weight bearing

Fig 2C: 60th days post-operative

Fig 2D: After removal of fixator

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