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Supra-cutaneous plating for repair of traumatic tibial fractures in sheep and goats

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Abstract
The objective of the present study was to report the outcome of supra-cutaneous plating technique for treatment of tibial fracture in six clinical cases of small ruminants. 3.5mm locking plate was fixed on medial side of the tibial bone with a minimum of two screws in the proximal fragment and two screws in the distal fragment. The technique was less invasive, avoided aggressive soft tissue dissection and manipulation of fracture hematoma. Radiographic evaluation revealed complete bridging of the fracture gap with well-developed hard callus on 45th day with normal weight bearing on the affected limb.

Keywords: Supra-cutaneous plating, tibial fracture, small ruminants, locking plate

1. Introduction
Small ruminants are generally known as "poor man's ATM." They are promising source of income for landless farmers in the rural socio-economic system. In small ruminants, long bone fractures are more prevalent, which either require conservative treatment or deliberate surgical intervention depending on the severity and owner affordability (Aithal *et al.*, 1998) [2].
Common surgical treatments for fracture management include external co-optation, external skeletal fixation (ESF), open reduction and internal fixation (ORIF) with a plate, intramedullary nailing, cerclage wires or lag screws and combinations of these methods. ESF as said to offer various advantages, notably a less invasive approach, avoiding aggressive soft tissue dissection and avoiding fracture hematoma manipulation (Marcellin-Little, 2002) [10].
Supra-cutaneous plating may be regarded as an alternative to ESF for the treatment of long-bone fractures in the future. Supra-cutaneous plating may be used to treat juvenile fractures that require quick and uncomplicated implant removal, as well as open and heavily comminuted fractures with inadequate soft tissue envelope and vascularization (Nicetto and Longo 2019) [13].
The present study describes the technique and results of supra-cutaneous plating for repair of traumatic tibial fractures in sheep and goats.

2. Material and Methods
The present study was conducted on six clinical cases of tibial fractures in small ruminants. The type and severity of the fracture was assessed by the clinical examination. Orthogonal radiographic views of the affected limb were taken to locate the site and type of fracture.

Table 1: Anamnesis of the animals under study

Case No.	Species	Breed	Age	Sex	Aetiology	Type of Fracture
1	Ovine	N.D	8 months	Male	Maliciously induced	Transverse
2	Ovine	N.D	11 months	Male	Automobile accident	Short oblique
3	Ovine	N.D	8 months	Female	Fall from height	Transverse
4	Ovine	N.D	12 months	Male	Automobile accident	Short oblique
5	Ovine	N.D	12 months	Male	Fall from height	Transverse
6	Ovine	N.D	12 months	Male	Automobile accident	Transverse

All the cases were prepared by withholding food for 24 hours and water for 12 hours prior to surgery and preoperative antibiotic Inj. Ceftriaxone @ 10 mg/Kg BW IV, as well as pre-emptive analgesia with Inj. Meloxicam @ 0.3 mg/Kg BW IM were administered.

All the animals were prepared for aseptic surgery and were sedated with Inj. Xylazine hydrochloride @ 0.05 mg/Kg BW IM 15 minutes prior to surgery. The fractured fragments were reduced to their normal anatomical positions by hanging limb method and by application of traction and counter traction to the fractured limb. Intravenous regional analgesia was induced by the administration of 5ml of 2% Lignocaine hydrochloride into the lateral superficial saphenous vein just below the stifle joint, after application of a tourniquet above the stifle joint.

The standard medial surgical approach was followed for tibial bone as it is devoid of the neurovascular bundle and has minimal musculature. A locking plate of 3.5mm was placed on the medial side of the tibia and was fixed with a K-wire at the proximal and distal ends of the locking plate (fig.1a). Using a low-rotation battery-operated power drill (125-200 rpm) connected to a 2.7mm drill bit, a hole was drilled perpendicularly into the proximal tibial fragment supra-cutaneously through a drill sleeve connected to the locking plate, involving both the cortex of the bone (fig.1b). During the process of drilling, the site was irrigated using normal saline solution. The depth of the bone, including the plate and 1 cm gap between the plate and the skin surface, was measured using depth gauze for the selection of screw of an appropriate length (fig.1c). Self-tapping 3.5mm locking cortical screws were inserted using 3.5mm hexagonal screw driver (fig.1d). The same procedure was followed to stabilise the distal fragment of the tibia. Finally, all the screws were locked to the locking plates with a minimum of two screws in the proximal fragment and two screws in the distal fragment to provide a rigid fixation (fig.1e). Similar procedure was followed for all the cases.

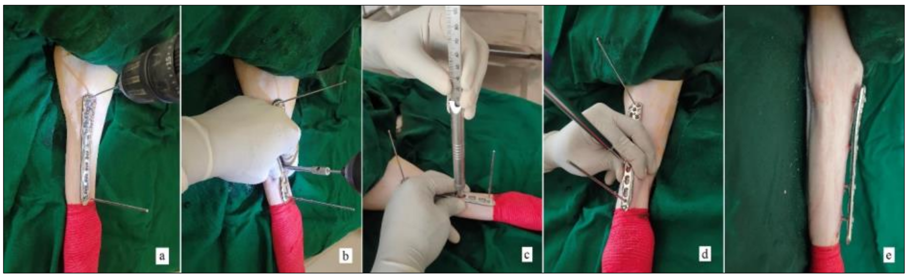

Fig 1: a. Fixing of locking plate with K-wire b. Drilling hole through drill sleeve connected to the locking plate c. Measuring dept using depth gauze for the selection of screw d. Fixing of self-tapping locking screws e. Fixed spracutaneous plate on medial side of the tibia

Post-operatively, Inj. Ceftriaxone and Tazobactam was given intravenously @ 15 mg/Kg BW, BID for one week and Inj. Meloxicam @ 0.3 mg/Kg BW IM, SID for three days to avoid surgical site infection and reduce post-operative pain respectively. The external bandage was removed to flush the pin tracts with povidone iodine (5%) solution, then reapplied every other day until the healing was complete. After surgery, owners were instructed to limit the animal's mobility for three weeks. AP and ML view radiographs were taken immediately after surgery and on 1st, 7th, 15th, 30th, 45th, 60th days to evaluate the fracture apposition, limb alignment and status of the implant.

3. Result and Discussion
3.1 Weight bearing
On the first post-operative day, four of the six animals showed Grade 3 lameness (touch down weight bearing) and two animals had Grade 4 lameness (non-weight bearing). All six animals showed grade 3 lameness on the seventh post-operative day. On 15th post-operative day four animals showed grade 2 lameness (partial weight bearing) and two animals showed grade 3 lameness. On the 30th post-operative day, four animals showed grade 1 lameness (weight bearing as tolerated) and two animals showed grade 2 lameness (partial weight bearing). On the 45th post-operative day, all six animals showed Grade 1 lameness (weight bearing as tolerated). On the 60th post-operative day, all the animals showed grade 0 lameness (complete weight bearing) with a near normal gait.

Over the course of the research, the lameness grade improved gradually from non-weight bearing to partial weight bearing between 0 to 15 days and between 30th to 45th day animal showed normal weight bearing. At the end of the study on 60th day, all the animals showed complete functional recovery which may be attributed to good operative procedure, post-operative management and antibiotic therapy (Fig.2). The findings were in concurrence with Vinit (2017) [16] who used veterinary cuttable plate for long bone fracture in goats and with Basith *et al*. (2018) [5] who reported use of epoxy putty ESF for long bone fracture in sheep and goat.

Fig 2: Picture showing weight bearing pattern on 1st,7th, 15th, 30th, 45th and 60th day.

3.2 Radiographic evaluation

Immediate post operative radiographs were taken in all the animals to evaluate the reduction of the fractured fragments and proper fixation of the implant. The radiographic healing of the fracture was recorded on 7th, 15th, 30th, 45th and 60th day (fig.3). On 7th and 15th day the fractured fragments were in proper alignment and opposition with no apparent callus at the fracture site (fig.3b&c). On 30th post-operative day thin feathery callus bridging the fracture gap was noted (fig.3d). Mukherjee and Sahay (1992) [11], Manjunath (2010) [9] and Vinit (2017) [16] likewise made similar observations. On the 45th post-operative day, the fractured line was indistinct with complete bridging of the fracture gap with well-developed hard callus, which could be related to the frame's adequate stiffness with early limb usage (fig.3e). This was in line with Pandiya *et al.* (1977) [14], Adamiak (2010) [1] and Rao *et al.* (2016) [15]. On the 60th post-operative day, radiographs demonstrated complete obliteration of the fracture line with well-developed callus at the fracture site (fig.3f).

Fig 3: Picture showing radiographic healing of the fracture on 1st, 7th, 15th, 30th, 45th and 60th day

The fixator frame was removed in stages, allowing for micromotion of the fracture fragments, which aided in early bone healing. In canine tibial fracture repair, Pandiya *et al.* (1977) [14] observed complete bone healing by the eighth week. These findings agreed with those of Mahesh (2009) [8], Da-cheng *et al.* (2010) [6], Hari Krishna *et al.* (2013) [7], Rao *et al.* (2016) [15] and Vinit *et al.* (2017) [16].

In the present study, the supra-cutaneous plate implant was fixed on the medial side of the tibial region which was well tolerated and did not interfere with contra-lateral limb mobility. The animals were able to lie down, stand and move freely while maintaining rigid stability with the fixator. The observations were in accordance with Nicetto and Longo (2017) and Bansal *et al.* (2020) [12, 4].

In all the six cases mild screw tract drainage was observed in early post-operative days, which later subsided, indicated that the fixator frame was stable and did not cause much movement of the fixator assembly. Similar observations were made by Basith *et al.* (2018) [5] and Ashok (2021) [3]. However, Nicetto and Longo (2019) [13] reported no screw site effusions.

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