The Pharma Innovation Journal 2022; SP-11(10): 1872-1877

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(10): 1872-1877

www.thepharmajournal.com
Received: 07-09-2022
Accepted: 12-10-2022

Madhav Ajjodi
MVSc Scholar, Department of Veterinary Surgery and Radiology, Veterinary College, Hebbal, Bangalore, KVAFSU, Bidar, Karnataka, India

Nagaraja BN
Head of department, Department of Veterinary Surgery and Radiology, Veterinary College, Hebbal, Bangalore, KVAFSU, Bidar, Karnataka, India

Suresh L
Head of department, Department of Veterinary Surgery and Radiology, Veterinary College, Gadag, KVAFSU, Bidar, Karnataka, India

Ansar Kamran C
Professor, Department of Veterinary Medicine, Veterinary College, Hebbal, Bangalore, KVAFSU, Bidar, Karnataka, India

Girish MH
Assistant professor, Department of Veterinary Anatomy, Veterinary College, Hebbal, Bangalore, KVAFSU, Bidar Karnataka, India

Corresponding Author:
Madhav Ajjodi
MVSc Scholar, Department of Veterinary Surgery and Radiology, Veterinary College, Hebbal, Bangalore, KVAFSU, Bidar, Karnataka, India

Supercutaneous plating for the treatment of traumatic compound metatarsal bone fracture in bovines

Madhav Ajjodi, Nagaraja BN, Suresh L, Ansar Kamran C and Girish MH

Abstract
Bovine long bone fracture treatment is always challenging for a veterinary orthopaedician. Post-operative care and control of sepsis are important in successful outcome of these surgeries. A trending demand for minimally invasive procedures in treatment of fracture is increasing in recent times. Hence the present study was undertaken to investigate the supercutaneous plating technique for the repair of compound metatarsal bone fractures in bovines. Six bovine clinical cases with compound metatarsal fractures were selected and were stabilized by supercutaneous plating technique using special 4.5 mm/ 5.0 mm locking compression plates and locking head screws. Occurrence of metatarsal fracture was more in less than a year aged calves and relatively more males were affected than females. Variation in the physiological and hematological parameters were statistically non-significant. The biochemical parameters like serum calcium, phosphorus showed statistically non- significant variations. Whereas, serum alkaline phosphatase levels were elevated up to 30th postoperative day and returned to normalcy by the end of the study period. Radiographic evaluation revealed satisfactory bone healing with sufficient callus formation at the fractured site on 45th to 60th post-operative days. All the animals started partially bearing weight immediately after surgery and gradually, complete weight bearing starting from 15th post-operative day till 60th postoperative day. By controlled-dynamization and staged disassembly of screws, implant was removed on 60th post-operative day based on radiographic clinical union and callus formation at the fractured site to allow gradual load-sharing on operated limb. Based on the observations of the study, it could be concluded that the supercutaneous plating technique for the repair of metatarsal fractures in bovines showed effective immobilization of the fracture fragments, quick to apply, minimally invasive, adaptable and feasible to be used in the field conditions.

Keywords: Bovines, compound metatarsal fracture, supercutaneous plating, radiography, weight bearing pattern and statistical analysis

Introduction
Fractures in cattle were common as a result of self-inflicted damage or external sources such herd mates or farm machinery (Velavan *et al*., 2014) [33]. The prognosis is influenced by the severity of the injury (open or closed), the bone involved, the location, and the kind of fracture (St-Jean and Anderson, 2014) [23]. Long bone fracture is a common surgical complication in the clinical practice in large animals among them, metacarpus and metatarsus are the most common appendicular fractures in bovines, followed by the tibia, radius and ulna, humerus, and femoral bones. The tremendous stresses exerted on the appendicular bones, as well as the lack of soft tissues that support them, are the key causes that lead them to get fractured (Tulleners, 1986) [29]. Fractures of the metacarpus and metatarsus were the most common bone injuries found in young calves accounting to 32 percent of all long bone fractures (Singh *et al*., 1995) [21]. But, due to their great size and weight, the distinctive shape of their extremities, and sleeping position, a veterinarian frequently confronts a range of challenges in the treatment of large animal orthopaedics. The most typical method of immobilization for metatarsal fractures is to use external co-optation techniques such as casts or Schroeder-Thomas splints, transfixation pins with or without casts and others are internal fixation techniques (Greenough *et al*., 1972; Ferguson, 1982; Turner, 1984) [6, 7, 31]. An ideal fixation approach would keep fracture fragments in place during the healing process, allow joint use as long as it fits the requirements, preserve blood and nerve supply, be easily detachable, well tolerated, and cost effective (Bradley and Rouse, 1980) [4].
The Supercutaneous plating technique was used in humans to treat open, non-union fractures, septic arthritis, and distraction osteogenesis (Kerkhoffs *et al*., 2003) [9] and further was used for

the treatment of a tibial fracture in a cat (Tommaso and Federico, 2017) [27]. The reduction of fracture gap exposure, which lowers soft tissue stress, is one of the most significant advantages of supercutaneous plating over other minimally invasive osteosynthesis procedures. (He *et al*., 2014) [8]. As a result, the extraosseous blood supply is retained to a large extent, allowing for faster secondary bone regeneration (Pozzi *et al*., 2013) [14]. Unlike other treatments such as minimally invasive plate osteosynthesis and minimally invasive nailing osteosynthesis, supercutaneous plating allows for quick implant removal without the requirement for general anaesthesia (Qiu *et al*., 2014) [15]. Also, in comparison to external skeletal fixation, the supercutaneous plate has a lower and flatter profile that may be easily pre-contoured along the skin surface and does not strike the contralateral limb when employed in the medial areas (Tommaso and Federico, 2017) [27]. Hence, supercutaneous plating or any minimally invasive surgical techniques could prove successful with satisfactory outcome.

Materials and Methods

Six bovines with traumatic compound metatarsal bone fractures presented to the Department of Veterinary Surgery and Radiology, Veterinary College Hospital, Hebbal, Bengaluru were selected for the study. The animals were sedated with Inj. Xylazine hydrochloride @ 0.1 mg/kg BW IM and after 15 minutes, animals were restrained in lateral recumbency with the affected limb placed upwards (Fig. 1). intravenous regional analgesia was induced by administration of 10 ml of 2% lignocaine hydrochloride into the lateral superficial saphenous vein, after application of a tourniquet above the tarsus.

For supercutaneous plating of the fractured fragments mainly, 4.5mm/5mm locking compression plate (LCP) and locking (self-tapping) screws of various sizes and lengths were used. Based on the dimensions of the bone in pre-surgical radiograph, nature of the fracture, size of the animal and length of the fractured metatarsal bone, the type of LCP bone plates and number of holes in it were selected. Corresponding locking screws of 5mm diameter of various lengths and orthopedic drill bits of size 3.7mm and 4mm diameter were used for the fracture fixation. Types of LCP used in this study were Narrow Locking DCP plate 4.5mm/5mm and distal femoral locking compression plate. With the fractured fragments reduction to their near normal anatomical position, the plate was contoured according to the shape of the bone and placed supercutaneously on the lateral side of the fractured metatarsal bone as this approach was devoid of the neurovascular structures and very minimal musculature. Using an orthopedic drill bit of suitable length and diameter, hole was drilled lateromedially through the predetermined plate holes in the proximal fracture fragment supercutaneously piercing both the bone cortices but not skin on the medial side, simultaneously physiological normal saline solution flown along the length of drill bit to prevent thermal tissue necrosis (Fig. 2). A depth gauge was used to measure the distance from the plate to far bone cortex for selection of suitable length locking cortical screw (self-tapping) and was inserted into the drilled hole allowing enough, but minimal distance (10 mm) between the skin and plate (Fig. 2). Once the alignment of the fracture fragments in both planes was assessed, the same procedure was also followed for rigid fixation and stabilization of the distal fracture fragment to the bone plate. Subsequently, drilling was performed and screws were inserted at the remaining proximal and distal fragments and all the screws were locked to the plate maintaining 10 mm plate to skin distance. Overall, six bi-cortical locking screws were used: 3 screws in each of the major fragments on both sides of the fracture gap. All the screw-to-skin contact sites were covered with 5% povidone iodine soaked roller gauze. Entire implants were covered with sterile gauze, cotton padding and protective bandaging (Fig. 3). Pre and post-operative injection Ceftriaxone tazobactum @ 10 mg/kg BW IV and injection Meloxicam @ 0.2 mg/kg BW IM was administered to all the animals.

All the physiological, haematological and biochemical parameters were assessed at regular intervals. During the study period the clinical weight bearing pattern was recorded as non-weight bearing, partial weight bearing, moderate weight bearing and complete weight bearing and usage of the affected limb by the animals was recorded before (Fig. 4) and after surgery on 1st, 7th, 15th, 30th, 45th and 60th post-operative days during the study period. Radiographs of affected metatarsal bone (Latero-medial and Anterio-posterior view) were taken before the surgery (Fig. 6) to study the location and type of fracture and plan for selection of suitable size locking compression plate and screws based on the diameter of bone and on 1st, 7th, 15th, 30th, 45th and 60th post-operative days to check implant position and assess bone healing. All the results of physiological, hematological and biochemical parameters were statistically analyzed using one-way Analysis of variance (ANOVA) using computer based statistical programme, Graph Pad Prism and interpreted as per the procedure described by Snedecor and Cochran (1996) [22] to arrive at a conclusion.

Results and Discussion

The occurrence of metatarsal fracture was 28.57% (n=8) out of all the bovine fracture cases (n=28) reported. The results were in accordance with Feist *et al*. (2019) [5]. Relatively more bovine metatarsal fractures were recorded in males (n=5, 62.5%) than in females (n=3, 37.5%). Higher incidence of fractures in younger animals less than one-year age was recorded, this might be related to their agile temperament and also due to fairly soft, weak, less mineralized and lower density of young bones. Highest occurrence of metatarsal fractures in bovines were recorded due to automobile accidents, this might be due to the dense and fast moving traffic in the city area where these animals were left on roads for a living in recent years Kurumurthy (2019) [10]. Occurrence of metatarsal fractures was highest in Holstein Friesian cross (n=6, 75%) followed by non-descript (N/D) buffalo (n=2, 25%). This might be due to more rearing of these breeds for their high milk yielding property of Holstein Friesian cattle. Six animals were subjected for supercutaneous plating technique for treatment of traumatic compound metatarsal bone fracture. Both Physiological and haematological parameters varied non-significantly throughout the study period. Similar observation made by Varalakshmi (2016) [32] and Tejas Yadav (2021) [26]. A significant increase in the peak value of serum alkaline phosphatase was observed from 1st post-operative day to 30th post-operative day and receded to normalcy by 60th post-operative day. This finding in the present study was in accordance with Manojkumar (2018) [13] and Tejas Yadav (2021) [26].

Weight bearing pattern was recorded regularly and on 15th post-operative day, three animals showed complete weight bearing, one animal showed partial weight bearing and two

animals showed moderate weight bearing. This finding was in accordance with the findings of Rajendra Prasad (2013) [17] and Raghunath *et al*. (2013) [16]. On 60th post-operative day all the animal showed complete weight bearing with nearing to normal gait (Fig. 5). Similarly Shivaprakash (2012) [12] and Tejas Yadav (2021) [26] reported complete weight bearing in treated animals by 8 weeks post operatively. Thus, an early ambulation and reduced post-operative pain was observed in all the six study animals.

Radiographs taken at different intervals revealed gradual and progressive mineralisation of bone callus at different stages of healing. The radiographs obtained immediately and 1st day after the surgery revealed good alignment and clear contour of fracture fragments and all SCP implant screws *in-situ* with properly placed into both cortices. Radiographs obtained on 7th post-operative day showed, slight periosteal reaction in three cases among the six cases, this early sign of periosteal reaction revealed improved blood supply to the periosteum. The callus was not visible in any of the cases and implant was stable. Radiographs obtained on 15th post-operative day revealed fracture consolidation had started and the fracture line visibility decreased, improved blood supply to the periosteum and very small amount of the callus was visible in all cases. This finding was in concurrence with Rajendra Prasad (2013) [17], Siddiqui *et al*. (2013) [20] and Belge *et al*. (2016) [2]. Radiographs obtained on 30th post-operative day revealed formation of mild to moderate intensity thin periosteal callus and bridging callus cuff at fracture site. Similar findings were also recorded by Siddiqui *et al*. (2013) [20], Tamilmahan *et al*. (2017) [25] and Tommaso and Federico (2017) [27]. The radiographs obtained on 45th and 60th post-operative day revealed delineated and indistinctly visible fracture line (Kurumurthy, 2019) [10] and intensified but sufficient amount of callus formation at fracture site and fracture line almost disappeared with cortical continuity and decrease in callus size, respectively (Fig. 7). These results were in concurrence with the findings of St-Jean *et al*. (1991) [24], Aithal *et al*. (2004) [1], Raghunath *et al*. (2013) [16], Siddiqui *et al*. (2013) [20], Tamilmahan *et al*. (2017) [25] and Tejas Yadav (2021) [26].

The supercutaneous plating technique was found to be stable in all the treated cases, without any implant failure. These results are consistent with Ma *et al*. (2013) [11]. There was no patient self-mutilation of the implant in any cases and animals tolerated the supercutaneous plating comfortably. There were no signs of osteomyelitis (Bilgili *et al*., 2008) [3] or infection in any of the six cases, however, only screw tract drainage was observed at one screw site near the fracture site in one out of six treated animals during first 30 days of the study, later it subsided after flushing tract with povidone iodine mixed normal saline solution daily and extended antibiotic therapy. Similar complication was observed by Mahesh (2009) [12].

The implant was removed based on the radiographic evaluation of the clinical union of fracture evident by the presence of callus at fracture site. In all the animals, staged disassembly and controlled-dynamization of the implant screws from closest to fracture site was done to allow gradual load sharing on the healing bone. This is in agreement with Woon *et al*. (2010) [34], Tommaso and Federico (2019) [28] and Sehgal *et al*. (2021) [18]. On 60th post-operative day based on radiographic evaluation implant was removed performed in an outpatient setting since there was sufficient minimal callus without requirement of additional surgery as in ORIF techniques allowing for a quicker and hassle-free procedure. This is in agreement with Bilgili *et al*. (2008) [3], Woon *et al*. (2010) [34], Tulner *et al*. (2012) [30], Qiu *et al*. (2014) [15] and Tommaso and Federico (2017) [27]. The technique allowed satisfactory limb usage after removal of implant. The results were in concurrence with Tommaso and Federico (2019) [28].

Summary and Conclusion

Supercutaneous plating for repair of compound metatarsal fractures in bovines had satisfactory outcomes since the technique was simple to use, easy, less time consuming, provided satisfactory stability to the fractured fragments, better patient acceptance and assisted in early limb usage and weight bearing. The procedure was minimally invasive, requires no incision at the fracture site as the bone plate is applied on the skin and then removed without requirement of second surgery and had negligible complications.

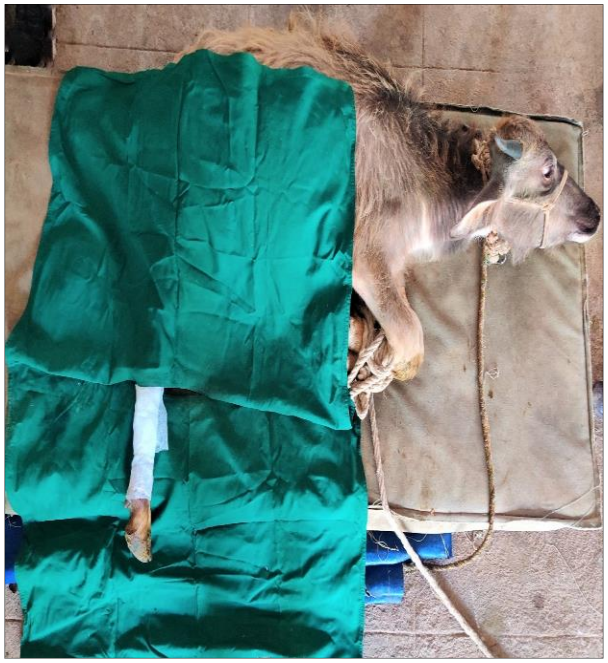

Fig 1: Photograph showing positioning of animal on lateral recumbency with fractured limb upwards and aseptically prepared and draped surgical site

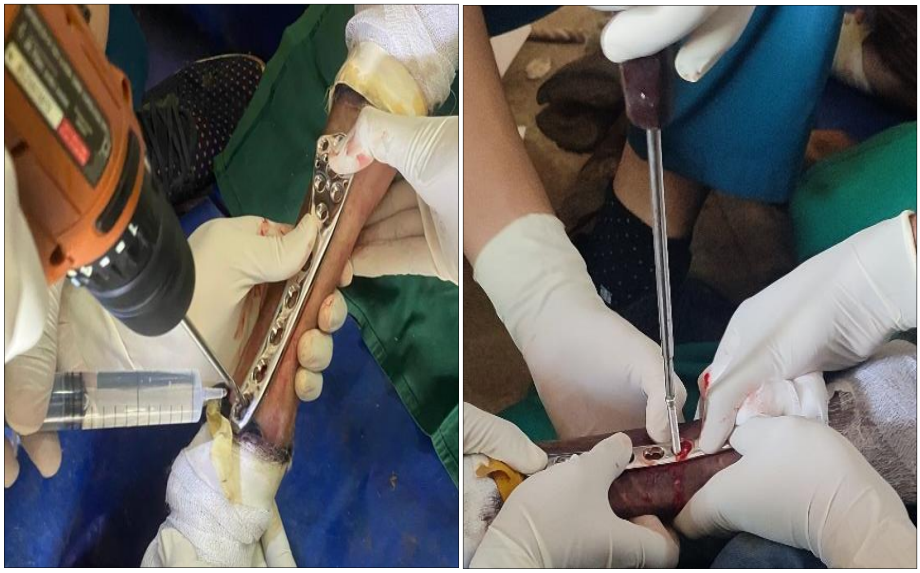

Fig 2: Proper reduction of fracture, alignment of the pre-contoured plate over the metatarsal region and power drilling using drill bit and inserting of locking screws.

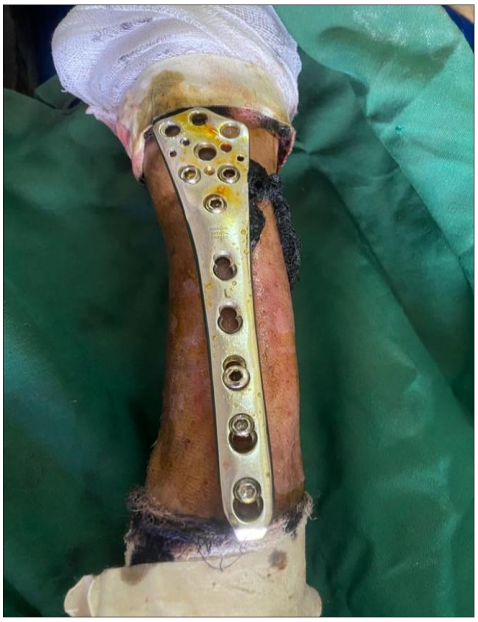

Fig 3: Photograph showing fixed Supercutaneous plating implant and dressing with 5% povidone iodine soaked gauze

Fig 4: Photograph showing animal non-weight bearing on (pre-operative) 0th day

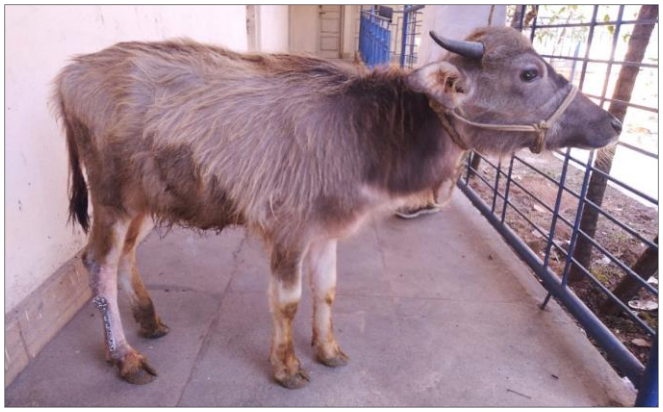

Fig 5: Photograph showing animal complete weight bearing on post-operative day 60

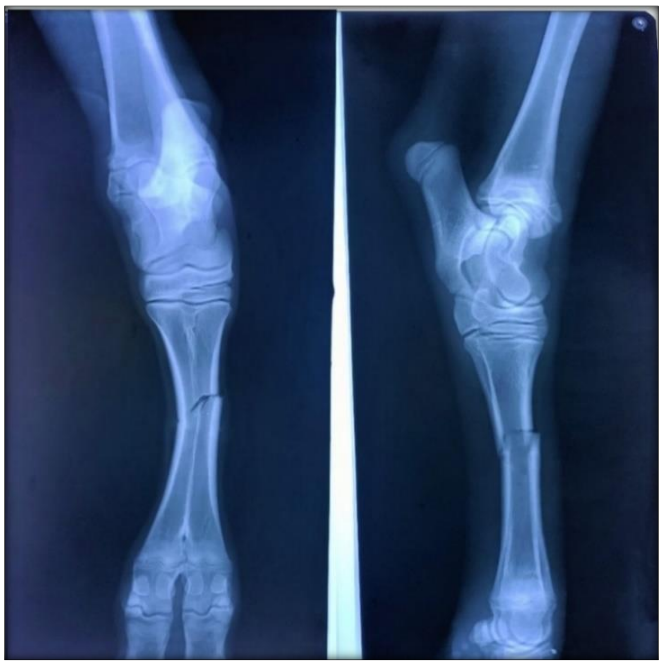

Fig 6: Anterio-posterior and Latero-medial radiographic views of compound diaphyseal oblique metatarsal fracture on (pre-operative) 0th day

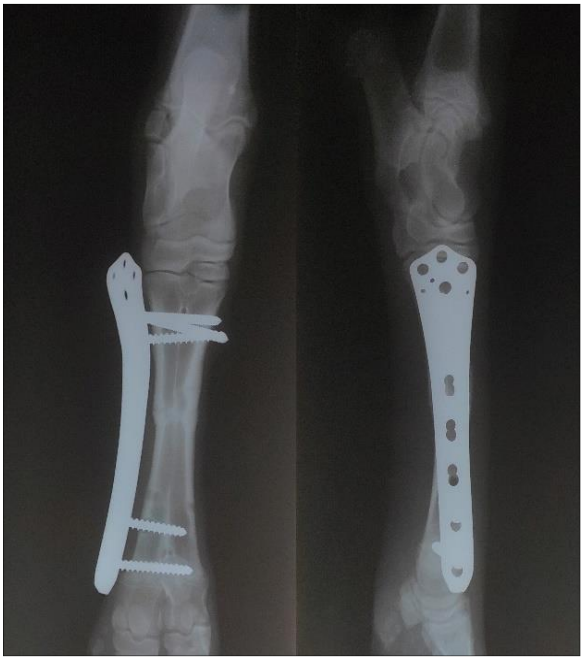

Fig 7: Anterio-posterior and Latero-medial radiographic views showing completed bone healing with cortico-medullary continuity and removed screw tract in distal fragment on day 60

References

1. Aithal HP, Singh GR, Hoque M, Maiti SK, Kinjavdekar P, Amarpal Pawde AM, *et al*. The use of a circular external skeletal fixation device for the management of long bone osteotomies in large ruminants: an experimental study. J Vet. Med. Assoc. 2004; 51:284-293.
2. Belge A, Akin I, Gülaydin A, Yazici MF. The treatment of distal metacarpus fracture with locking compression plate in calves. Turk. J. Vet. Anim. Sci. 2016;40(2):234-242.
3. Bilgili H, Kurum B, Captug O. Use of a circular external skeletal fixator to treat communited metacarpal and tibial fractures in six calves. Vet. Rec. 2008;163:683-87.
4. Bradley RL, Rouse GP. External skeletal fixation using the through and through Kirschner - Ehmer splint. Am. Anim. Hosp. Assoc. 1980;16:523-530.
5. Feist M, Rieger A, Müller C, Knubben-Schweizer G. Long bone fractures in cattle: A retrospective study of treatment and outcome in 194 cases. Schweiz. Arch. Tierheilkd. 2019;161(9):509-521.
6. Ferguson JG. Management and repair of bovine fractures. Compend. Contin. Educ. Pract. Vet., 1982;4:128-135.
7. Greenough PR, Mac Callum FJ, Weaver DA. Lameness in cattle Philadelphia, J.B. Lippincott.co, 1972, 309-314.
8. He X, Zhang J, Li M, Yu Y, Zhu L. Treatment of segmental tibial fractures with supercutaneous plating. *Orthopedics.* 2014;37(08):712-716.
9. Kerkhoffs GM, Kuipers MM, Marti RK, Van der Werken C. External fixation with standard AO-plates: technique, indications, and results in 31 cases. J Orthop Trauma. 2003;17(01):61-64.
10. Kurumurthy A. Clinical study on efficacy of minimally invasive plate osteosynthesis in long bone fracture repair in small ruminants. MVSc Thesis, P. V. Narsimha Rao Telangana Veterinary University, Telangana, India, 2019.
11. Ma CH, Wu CH, Tu YK, Lin TS. Metaphyseal locking plate as a definitive external fixator for treating open tibial fractures-clinical outcome and a finite element study. Injury. 2013;44(8):1097-1101.
12. Mahesh V. Studies on external skeletal fixation for radius fracture treatment in dogs. Ph.D. Thesis, Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, Karnataka, India, 2009.
13. Manojkumar K, Deviprasad V, Dhanalakshmi N, Raju NKB. Evaluation of biochemical parameters for assessment of fracture healing in dogs. J. Pharm. Innov. 2018;7(3):577-580
14. Pozzi A, Hudson CC, Gauthier CM, Lewis DD. Retrospective comparison of minimally invasive plate osteosynthesis and open reduction and internal fixation of radius-ulna fractures in dogs. Vet Surg. 2013;42(1):19-27.
15. Qiu XS, Yuan H, Zheng X, Wang JF, Xiong J, Chen YX. Locking plate as a definitive external fixator for treating tibial fractures with compromised soft tissue envelop. Arch. Orthop. Trauma Surg. 2014;134(03):383-388.
16. Raghunath M, Singh N, Singh T, Gopinathan A, Mohindroo J, Atri K. Defect nonunion of a metatarsal bone fracture in a cow. Vet Comp Orthop Traumatol, 2013;26(3):233-237.
17. Rajendra Prasad HS. Modified type 2 external skeletal fixation for the repair of metatarsal fracture in bovines. MVSc thesis, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, Karnataka, India, 2013.
18. Sehgal M, Awasthi B, Kaur R, Pathak S, Singh S, Sandhu GS. LCP as supracutaneous plate vs IMLN tibia for open grade I and II distal tibial fractures. A comparison study (RCT) on functional outcome between a conventional method and a novel technique. J. orthop. Exp. 2021, 27446.
19. Shivaprakash BV. Compound fractures in bovines and its clinical management using transfixation pinning and external casts: A study in 30 patients. *Intas polivet.* 2012;13(2):367-370.
20. Siddiqui SA, Siddiqui MI, Telfah MN, Hashmi S. Fixation of metatarsal fracture with bone plate in a dromedary heifer. Open Vet. J. 2013;3(1):17-20.
21. Singh AP, Singh GR, Singh P. Fractures. *In:* Ruminant Surgery. CBS Publishers, New Delhi., 1995, pp:365.
22. Snedecor CW, Cochran WG. *In*: Statistical Analysis. *Edn* 8th. Oxford and IBH publishing Co. New Delhi, 1996, p. 335-345.
23. St-Jean G, Anderson DE. Decision analysis for fracture management in cattle. Vet. Clin. North Am. Food Anim. Pract. 2014;30(1):1-10.
24. St-Jean G, Clem MF, Debowes RM. Transfixation pinning and casting of tibial fractures in calves: Five cases (1985 -1989). J. Am. Vet. Med. Asso. 1991;198(1):139-143.
25. Tamilmahan P, Arunprasad A, Senthilkumar S, Vijayakumar M. Surgical Management of Metacarpal and Metatarsal Fractures-A Study of Five Bovines. Intas Polivet. 2017;18(2):462-464.
26. Tejas Yadav P. Studies on percutaneous tibial fracture repair by intramedullary pinning in bovines. MVSc Thesis, Karnataka Veterinary and Fisheries Sciences University, Bidar, Karnataka, India, 2021.
27. Tommaso N, Federico L. Supracutaneous plating using a locking plate for the treatment of a tibial fracture in a cat. Can. Vet. J. 2017;58(6):585.
28. Tommaso N, Federico L. Supercutaneous plating for the treatment of traumatic injuries of the appendicular

skeleton in dogs. Vet. Comp. Orthop. Traumatol., 2019;32(2):149-157.
29. Tulleners EP. Management of bovine orthopedic problems, Part I: Fractures. Compend. Contin. Educ. Vet., 1986;8:69-79.
30. Tulner SA, Strackee SD, Kloen P. Metaphyseal locking compression plate as an external fixator for the distal tibia. Int. Orthop., 2012;36(9):1923-1927.
31. Turner AS. The musculoskeletal system. In: Practice of large animal surgery. Jennings, P.B. (ed.), W.B. Saunders Company, Philadelphia, 1984, pp.768.
32. Varalakshmi A. Studies on modified type II external skeletal fixation for the repair of tibial fracture in bovines. M.V. Sc thesis. Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, Karnataka, India, 2016.
33. Velavan A, Sivaraman S, Krishnakumar K. Successful management of a compound fracture in a buffalo using a fabricated polyvinylchloride splint in a field setting. Buffalo Bull., 2014;33(3):246-250.
34. Woon CYL, Wong MK, Howe TS. LCP external fixation-external application of an internal fixator: two cases and a review of the literature. J. Orthop. Surg. Res. 2010;5(1):1-6.