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Research Article

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Surgical management of limb fractures in calves and goats

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Abstract

The study was conducted to determine the occurrence of fractures in calves and goats at Veterinary Teaching Hospital (VTH), Bangladesh Agricultural University (BAU) and to compare the efficacy of fracture treatment with external and internal fixation using splints and bone plate/wire suture respectively. Patients brought to VTH with the history of automobile accident, trauma and clinical signs suggestive of fractures were subjected to detailed physical, orthopaedic and radiographic examinations to confirm fractures. A total of 6 calves and 4 Black Bengal goats were presented to VTH with limb fractures. Fractures were treated with close reduction and external fixation with splints and bandage, and open reduction and internal fixation with wire suture and bone plate. 50% and 75% fracture cases healed properly in calves and goats respectively. Among the affected animals, 60% were females irrespective of species. Metacarpal bone was the most susceptible for limb fracture. Three were open fractures and 7 cases were closed fracture with the occurrence of 70%. The healing percentage of open fracture treated with external fixation was very poor and amputation was needed in the fractured limb. Overall treatment success rate was 60%. Biochemical analysis revealed very significant ($p < 0.01$) difference in serum calcium level before and after healing due to hard callus formation. This study shows that bone plating fixation give a satisfactory results to calves with fracture. Moreover, the study could help veterinarians to set up proper treatment method depending on location of fracture.

Keywords: Fracture, external and internal fixation, bone plating, splints, wire suture.

INTRODUCTION

Fracture of long bones is one of the major common orthopaedic conditions encountered in goats and other small ruminants. Trauma is the most frequent cause of fractures caused by its mother or another cow while sleeping (Gahlot, 2000) or during transportation (Ferguson *et al.*, 1990; Steiner *et al.*, 1993) or as a result of traffic accidents (Aithal *et al.*, 2007), sports injuries, and other activities. Frightened or weary goat can be captured by the limb leading to serious fractures or dislocations (Smith und Sherman, 2009). The curiosity and climbing instincts of goats, fracture secondary to struggling and trauma from dog attacks are common causes of limb bone fractures in goats. Most of the fractures are seen in tibia, metatarsal or metacarpal bones, which have less muscle covering (Singh *et al.*, 2001; Aithal *et al.*, 2007).

Fracture management focuses mainly on restoration of function and physical integrity with the minimum deformity of bone. The most common treatments include use of splints, plaster of Paris, wire suture, combination of wire suture and bone pinning or bone plating casting, external fixator. External skeletal fixation can be used in small ruminants as a successful, economic and alternative to internal fixation. It can be used in any type of fractures like open, closed, simple or comminuted with least invasiveness and it offers much stability to fracture by preventing the fracture forces. Casts and splints are used separately or in combination in all types and sizes of ruminants as a successful, effective and economical method for fracture repair (Baird und Adams, 2014). The more distal the injury the more external fixation becomes the optimal method for success (Gangl *et al.*, 2006; Mulon und Desrochers, 2014; Vogel und Anderson, 2014). The internal fixation techniques such as bone plate, circlage wiring, screw, Dynamic Compression Plate (DCP), interlocking pins (Bellon und Mulon, 2011) were recommended in fixation of the dislocated, fragmented and complicated fractures (Martens *et al.*, 1998).

The decision to treat a fracture in a food animal is made by considering the cost and success rate of the treatment, the perceived or potential economic or genetic value of the animal, animal weight, the location and type of fracture and experience of the veterinarian (Anderson und Jean, 2008). In Bangladesh external fixation is done by plaster of Paris alone or in combination with wooden splints, but the success

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of treatment is rarely documented. As a result, a large number of goats and calves undergo premature culling every year which cause a great economic loss to farmers in our country. The current research study was undertaken to investigate the incidence of fractures and compare the efficacy of external fixation (splints) and internal fixation (bone plate and wire suture) for the management of limb fractures in calves and goats at Veterinary Teaching Hospital, Bangladesh Agricultural University.

MATERIALS AND METHODS

The research work was conducted in the Department of Surgery and Obstetrics, and Veterinary Teaching Hospital (VTH), Bangladesh Agricultural University (BAU), Mymensingh from January to October, 2017.

Study population

Six calves and four goats with the complaint of fractures (10 fracture cases) due to automobile or cycle accident, jumping, rope accident were included in this study. Age of calves and goats ranged from 14 days to 6 months with body weight of 20-35 kg in calves and 3-4 kg in goats. Among 10 fractured patients, 4 were males and 6 were females. Besides, surgical patients admitted to the VTH, BAU from January to October, 2017 were also recorded to observe the occurrence of fractures.

Diagnosis of fracture

Open fractures were notified instantly after physical examination of fracture site. For closed fractures, type and position were diagnosed through physical and radiological examinations. Clinical signs observed during physical examination were pain over the site of fracture, local swelling, hematoma, contusion, laceration in case of open fracture, abnormalities of positioning, presence of crepitus (considered as pathognomonic for complete fracture), presence of abnormal mobility, dysfunction of limb and lameness and unable to bear weight. Radiographic examination was performed using X-ray machine (ultra 9030 hf digital portable x-ray unit®, Gary Bukingham, Sd). Exposure factors were selected (55-60 kV, 10 mAs), depending on anatomical part to be radiographed. The affected bones were radiographed in lateral views. The x-ray films were processed by auto film processor (Triup x-ray film processor®, model-fp 350 × t) in appropriate time and temperature. Radiographic findings included a break in the continuity of a bone, a line of radiolucency when the fragments were distracted. A line of radio-opacity also observed when the fragments are superimposed.

Treatment of fracture

Mainly three management techniques were used for 10 fractured cases. They were close reduction and external fixation with splints and bandage, and open reduction and internal fixation with wire suture and bone plate. Splint and bandages were used in 6 cases, wire suture was performed in 2 cases and bone plating was performed in 1 case.

Close reduction and external fixation

After controlling the animal, the fractured part was palpated by hand and the two ends of the fractured limb were kept in proper apposition by extension and counter extension (traction). Four splints (made of bamboo stick and covered with cotton) were placed around the fractured part. First splint was placed on the fracture site after even rolling with gauze, and then another 3 splints were placed in other three sides in a same manner. After soaked with luke warm water, plaster of Paris was applied over the bandage for immobilization of the fractured limb (Figure 1a). The cast was re-inspected after 2 weeks and the cast was removed after observing the weight bearing capacity of calves and goats.

Open reduction and internal fixation

Requirements for surgery

In this study the following instruments and appliances were used: Surgical handle and blade, Straight scissors, Artery forceps (2 curved and 4 straight), Alli's tissue forceps, Bone saw, Bone drill, Bone plate, Tissue forceps and Toothed forceps, Needle holder, Draping towel, Towel clips, Plaster of Paris, Modified Thomas splint, Wire (stainless steel), Electric cautery, Catgut (Ethicon®, Medsurge Ind. Pvt. Ltd., India), cotton, nylon thread, gauze, syringe, sedative-Xylazine hydrochloride 2%, 2% Lignocaine hydrochloride (Jasocaine®, Jayson Pharmaceuticals Ltd., Bangladesh), Sulphanilamide powder (Sumid Vet®, Square Pharmaceuticals, Bangladesh).

Surgical procedure

The animal was sedated with Xylazine hydrochloride 2% @ 0.05mg/kg body weight. After clipping and shaving, the operation site was washed with soap water and then painted with antiseptic solution (Povin®). Local anaesthesia was performed with 2% Lignocaine hydrochloride (Jasocaine®, Jayson Pharmaceuticals Ltd., Bangladesh). Then a tourniquet was tied over the operation site. Intravenous normal saline (DNS®, Opso Saline Ltd. Bangladesh) was given to avoid the hypovolemic shock due to excess hemorrhage during operation. After draping of operation site, an incision was given on the diagnosed part. Skinning was done by blunt dissection. Tissue debris, blood clot, necrosed muscle, bone fragments and exudates were removed and then washed with normal saline (0.9% NaCl).

Major artery and vein were ligated with chromic catgut 1-0. In case of ridding or overlapping fractures, fractured bones were placed in apposition by classical method of reduction (extension, counter extension and manipulation). Internal fixation was performed by using bone plate with wire suture. In case of oblique fracture, fractured fragments were tied together with full circlage stainless steel wire. Full circlage sutures were placed according to the techniques described by Slatter (2002). For full circlage suture, the wire was wrapped

around the bone by applying equal tension on both sides (Figure 1b). Then two ends of wire were united by twisting the two ends. Muscle and fascia were sutured using catgut 2-0.

Sulphanilamide powder was applied locally and then skin was closed by using cross mattress or simple interrupted pattern with nylon. A saline tube was also inserted for drainage of the fluid and left in space after closing the skin in lower part. Tr. Bezoin seal was applied over the suture line and then modified Thomas Splint was applied in all cases for additional support for immobilization of the limb and of weight.

Bone plating technique

Round-hole compression plate was used for plating (Figure 1c and Figure 2). A 3.2 mm hole was drilled through the cortex, approximately 1 cm from the fracture line. The hole was measured using the depth gauge. The hole was tapped. The guide for the tension device was applied. The tension device was used to align and stabilize the fracture. The screws are placed and tightened in the fragment opposite the tension device. The tension device is tightened, applying compression to the fracture. The remaining open holes are filled with screws. All the screws are placed after the tension device is removed.

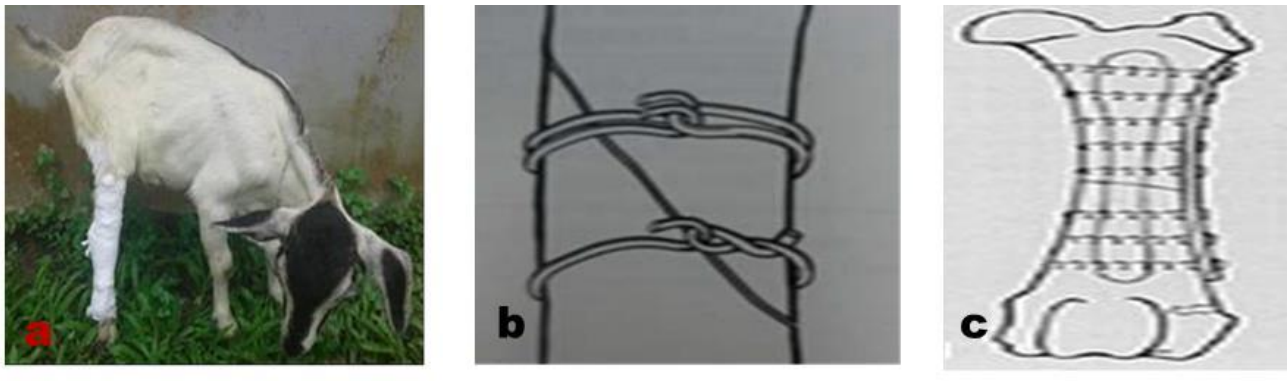

Figure 1: (a) Simple apposition using bamboo splints wrapped with cotton and gauze with the help of plaster of Paris for immobilization; (b) Full circlage wire suture; (c) Diagram of bone plating technique.

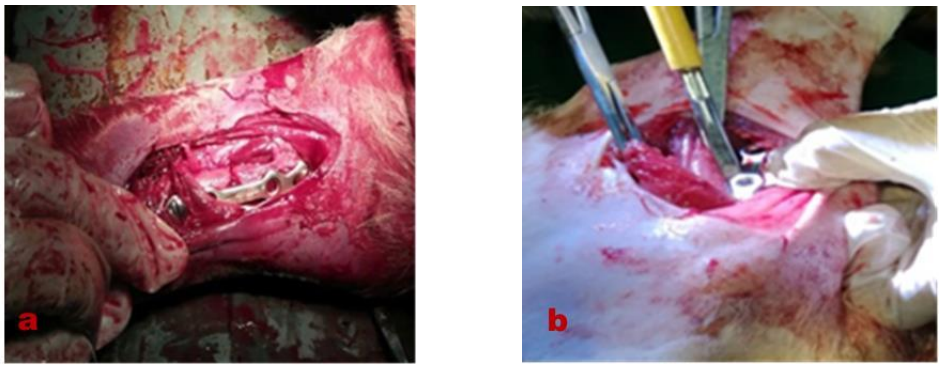

Figure 2: Bone plating of fractured radial bone in calf depicting a) placement of the bone plate and b) fixation of the bone plate using screw

Amputation of fractured limb

Four complete fractures were treated by amputation. The animal was sedated with Xylazine hydrochloride 2% @ 0.05mg/kg body weight. After clipping, shaving and antiseptic wash, local anaesthesia was performed with 2% Lignocaine hydrochloride (Jasocaine®, Jayson Pharmaceuticals Ltd., Bangladesh). Then a tourniquet was tied over the operation site and intravenous normal saline (DNS®, Opso Saline Ltd. Bangladesh) was given. After draping of operation site, a "u" incision was given on the diagnosed part. Skinning was done by blunt dissection. Tissue debris, blood clot, necrosed muscle, bone fragments and exudates were removed and then washed with normal saline (0.9% NaCl). Major artery and vein were ligated with chromic catgut 1-0. Joint of affected bone was cut and removed. Muscle was sutured by simple interrupted patter using catgut. Skin was closed by simple interrupted patter using nylon.

Post-operative care and observation

Systemic antibiotics, Penicillin and Streptomycin (Inj. Sp Vet® 0.5 gm, Acme Laboratory Ltd. Bangladesh) was given Penicillin 10,000-15,000 iu/kg body weight and Streptomycin 5-10 mg/kg body weight intramuscularly daily for 10 days after mixing with distilled water. The analgesic or non-steroidal anti-inflammatory injection, Ketoprofen (Inj. Kop Vet® Square Pharmaceuticals Ltd. Bangladesh) dosed at 3 mg/kg body weight was injected intramuscularly daily for 3 days to subside post-operative pain. A low dose (1 mg/kg body weight) of Pheniramine Meleate (Inj. Hista Vet®, ACI Animal Health, Bangladesh) containing pheniramine meleate was used in intramuscular route. The animals were completely restricted to their stalls and only limited movement was allowed. After 8 days, skin stitches were removed.

Calves and goats were allowed to move freely in an open enclosure after 15 days. Owners were advised to restrict the movement of the animal for two weeks after surgery and then to allow on leash walking. Restricted activity for next two months was advised. During the postoperative period, the animals were closely monitored for the presence of fever, severity of pain, their tolerance to the fixators by their degree of weight bearing and lameness, and the range of movement of the adjoining joints. Follow up of some cases was done by phone calls and visit to door of the owners. Periodical radiographic assessment (at 15 day, 30 day and 60 day of post-operation) was carried out to evaluate reduction and alignment of bone fragments, and callus formation and complications, if any. In all animals the wires were kept in situ.

The owner was advised to massage the operated limb to accelerate blood circulation and nerve function. Simultaneously, they were also advised to supply milk to calves and kids (bottle feeding) to avoid suckling, to keep calves separated from other animals and placed over soft bedding. The excess length of the pins projecting above from the stainless steel connecting bars were cut and removed. The tips of the pins were covered with cotton. The pin tracts were covered with cotton soaked in Tincture Benzoin. The suture line and pin entry points were covered with sterile cotton gauze pads and a bandage was applied with thick cotton padding. Suture lines as well as pin entry points were cleaned at two weeks interval depending on the severity of discharge. Plaster bandages were performed to operate extremities after wire suturing and bone plating operations. The cast was extended to the joint above and below the fracture site to reduce distracting forces. The post treatment period was followed by calling the owners.

Collection of blood and calcium analysis

Blood was collected on day 0 and day 2 and serum was processed and stored at –20°C until use. Biochemical analysis for serum Ca was performed using commercial kit (reagent reactivos gpl from Barcelona, Spain) and spectrometer (t80 uv/vis spectrometer from Germany).

Statistical analysis

Descriptive statistical analyses were performed using MS Excel 2010.

Table 1: Healing of limb fractures with respect to age of affected animals

Age groups (months)	**No. of fractured cases**	**No. of fractured cases healed**	**% of fractured cases healed**
0-02	4	3	75
03-04	4	2	50
05-06	2	1	50
Total	10	6	60

Table 2: Healing of limb fractures with respect to sex of affected animals

Sex	**No. of fractured cases**	**% of total fractured cases**	**No. of fractured cases healed**	**% of fractured cases healed**
Male	4	40	2	50.00
Female	6	60	4	66.66
Total	10	100	6	60.00

Table 3: Characteristics of treated fractures in calves and kids

Location of fracture	**Type of fracture**		**Technique of treatment implied**			**Prognosis**	
			Closed reduction and external fixation	Open reduction and internal fixation		Cure	Repeat intervention
				Wire suture	Bone plate		
Calves							
Metacarpal	Complete	Open	Yes	-	-	-	Amputed
Femur	Complete	Closed	Yes	-	-	Fair	-
Radial	Complete	Closed	-	-	Yes	Good	-
Metacarpal	Complete	Open	Yes	-	-	-	Amputed
Radial	Complete	Closed	Yes	-	-	Fair	-
Metatarsal	Complete	Open	Yes	-	-	-	Amputed
Goat							
Humerus	Fragmented	Closed	Yes	-	-	-	Amputed
Metacarpal	Incomplete	Closed	-	Yes	-	Good	-
Metatarsal	Incomplete	Closed	Yes	-	-	Good	-
Metacarpal	Complete	Closed	-	Yes	-	Good	-

Table 4: Serum Ca level (Mean $\pm$ SE) in treated animals.

Animals	**Day 0**	**Day 21**	**P value**
Calves	10.24 ± 0.34	8.56 ± 0.28	0.004
Kids	10.78 ± 0.37	9.09 ± 0.28	0.01

RESULTS

Occurrence of fractures with respect to species, age, sex was observed and results are presented in Table 1 and Table 2. Among 10 fractured cases, 6 were observed in calves and four cases were Black Bengal goats. Overall 60% fractured cases were completely healed. 50% and 75% fracture cases healed properly in calves and goats respectively.

Considering the age of animals, the occurrence of fracture (40%) was higher at 0-4 months of age and lower (20%) at the age of 5-6 months. The healing percentage of fractures decreased with the gradual increase in age. It was observed that percentage of healed fractures was higher (75%) at 0-2 months of age, 50% at 3-4 months of age and 50% at 5-6 months of age. Among the affected animals, 60% were female animals irrespective of species. The healing percentage was higher in female animals.

Position of fractured bone is very much important in case of limb fracture. Metacarpal bone was the most susceptible for limb fracture. Among 10 fractured cases, 4 metacarpal, 2 metatarsal, 2 radial, 1 humeral and 1 femoral fracture were treated and results are shown in Table 3. When the type of fractures was considered, 3 were open fracture and 7 cases were closed fracture with the occurrence of 70%. The healing percentage of open fracture after surgery was very poor and amputation was needed in the fractured limb (Table 3). But among 7 closed fractures, 6 cases were healed and the healing percentage was about 85%. The healing percentage of limb fracture with splint, wire suture and bone plating was 57.14%, 50% and 100% respectively.

Biochemical analysis of serum Ca level collected at the time of treatment and after healing was performed and serum Ca level is presented in Table 4. There was significant ($p < 0.01$) difference of serum Ca level before (Day 0) and after healing (Day 21), which indicate reabsorption of Ca due to hard callus formation.

DISCUSSION

The occurrence of limb fractures seen in this study was similar to the findings of Aksoy *et al.* (2009) and Nuss *et al.* (2011). The fracture was occurred in calves within 1-10 days of birth, in general. Neonatal bones have a low bone density and thin bony cortices (Adams und Fessler, 1996). Görgül *et al.* (2004) has also reported that the incidence of the disorders of extremities (80.6%) was caused by inappropriate manipulations during helping for birth in calves. Therefore, care of calves was very crucial after birth.

In this study, the variation in healing percentage of fracture may be due to higher healing power in goats than calves. The healing percentage of fractures decreased with the gradual increase in age. A successful outcome for internal fixation repair is inversely related to age, weight and size. The fracture must be evaluated to give an accurate prognosis. More highly comminuted fractures have a less favorable prognosis (Aithal *et al.*, 2010). It may be due to nutritional variation in difference of age (specially Ca and P) for which the healing percentage can vary. Considering the gender, the healing percentage was higher in females (66.6%) than males (50%). Due to the shortage of evidence on sex variation we could not compare it with others.

We observed 40% metacarpal, 20% metatarsal, 20% radial, 10% humeral and 10% femoral fractures in this study. Arican *et al.* (2014) found that fractures mostly occurred on the metacarpal bones (60.6%) followed by femur (14.9%), metatarsal bones (7.1%), tibia (8.8%), antebrachium ulna and radius (6%), and humerus (3.2%). Previous findings have reported that 14% femur, 50% metacarpus, and 50% metatarsus fractures (Bilgili *et al.*, 2008; Nichols *et al.*, 2010; Rodrigues *et al.*, 2012), and 7% radius-ulna fractures (Görgül *et al.*, 2004) are commonly seen in calves. The variation might be due to the scarcity of fractured cases in the study area. But the study result of occurrence of fractures between metacarpal and metatarsal bones was same to Steiner *et al.* (1993). In our present study we found the healing percentage in metacarpal, metatarsal, radial, humeral and femoral fracture was 50%, 50%, 100%, 0% and 100% respectively.

Bone plating in fracture fixation is very important. These include bone properties, plate material, screw- bone interface, number of screws, plate bone interface, placement of the plate relative to loading, and compression between fragments (Auer *et al.*, 1993; Fubini und Ducharme, 2004). The healing percentage of limb fracture was 57.14% with simple apposition, wire suture (50%) and bone plating with wire suture (100%). Like Hoerdemann *et al.* (2012) we found that there were no complications in the calves post operation in case of bone plating and bone plating could be more successful for approach and healing term.

It was observed that the serum Ca level of the fractured patients on day 0 was in normal level but decreased on day 21 in this study. The decrease in the level of serum calcium to a greater extent in the fractured animal may be due to faster healing process with more mobilization of calcium in the formation of callus (Deka *et al.*, 1994). Bone markers are used to determine effects of medication on bone formation, bone resorption or both. Serum calcium and inorganic phosphate are the markers of bone resorption while alkaline phosphatase is the marker of bone formation. Concentration of Ca and phosphate in the serum and extracellular fluids in a maximum amount helps to precipitate calcium-phosphate crystals to build new osteoid, causing it to harden and formation of strong bone (Michael *et al.*, 2005).

Among 10 fracture cases, 3 open and 1 close fracture treated with external fixation foots became gangrenous and fracture parts needed to be amputed. The fractured bone of all open fractured cases was amputated due to gangrene and osteomyelitis. It must be kept in mind that the fracture healing is affected by several factors such as an animal's age and overall health, the location and type of fracture, the severity of soft tissue injury, the presence of bacterial contamination, and the degree of motion at the fractures site (Gangl *et al.*, 2006). Like other studies, we found very poor prognosis in case of open fracture. The prognosis for long-term pain free survival is excellent for closed fractures and fair for open fractures managed in this manner. Open fractures with severely traumatized soft tissues often become infected, which significantly complicates the repair. Infection and instability were intolerable together. If contamination of the fracture site occurs and persistent infection develops, instability and failure of the repair are highly probable. Preoperative antibiotics are always recommended before fracture repair with internal fixation (Fubini und Ducharme, 2004). In addition, the condition of the surrounding soft tissues should be considered in evaluation of a fracture. The surrounding soft tissues are responsible for extramural blood supply to the fracture site (Nuss *et al.*, 2011).

In this study, metacarpal and metatarsal fractures were treated successfully with splints and wire suture in goat. In a case study, Joy und Venugopal (2014) have stated that metatarsal fracture in a goat is successfully managed with bilateral external skeletal fixation. Jawre *et al.* (2017) have reported that fixation of metacarpal and metatarsal fracture with plates and screws provided effective stabilization of the bone ends, however the soft tissue manipulation was more and wound edges were opposed with great tension. Internal fixation's major advantages are that it provides rigid stabilization of the fracture and immediate functional use of the limb. Multiple and repeated high quality radiographs may be necessary to demonstrate the fracture and monitor its healing (Ramzan und Powell, 2010). We could not monitor healing process in fracture case by radiography. Moreover, small group of animals were used. It is quite difficult to compare between wire suturing and bone plate because more cases were needed. Thus, plate fixation at the distal metaphysic was thought to be more suitable than fixation using wire suture. If we could apply more bone plating and wire suturing then it would be easier for us to compare between them.

This study concluded that metacarpal, metatarsal, and femoral, humeral fractures, which can frequently be diagnosed carefully and through palpation, have proved to be very suitable for surgical treatment. Internal fixation could be the method of choice for proximal limb fractures. Bone plating fixation gives a satisfactory result than wire suturing of calves

with fracture. Overall success rate of 60%, strongly recommended that surgical treatment of limb fractures should be performed in calves and goats.

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