Original Research

Comparative Evaluation of Veterinary Cuttable Plate and Polypropylene Mesh Impregnated PMMA Plate for Fracture Repair of Tibia Bone in Goats

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Abstract

The study was conducted in 12 goats with tibia fracture and these goats were randomly divided in two groups with six animals each. In group I, the fractures were immobilised by internal fixation with Veterinary Cuttable Plate (VCP) and in group II, the fractures were immobilised by polypropylene mesh impregnated PMMA plates and evaluated based on weight bearing and radiographic evaluation to study the healing of fracture with both plates. In group I, the animal showed mild to moderate weight bearing by 0 to 15th day and group II, the animals showed mild to moderate weight bearing by 7th to 15th day. Both the groups showed good to very good weight bearing by 30 to 60th day. Upon radiography, the group I showed minimal callus at the fracture site where as, the group II showed more callus formation on the far cortex side. It could be concluded from study that The polypropylene mesh impregnated PMMA plates has sufficient strength to provide stability of fracture site The veterinary cuttable plate provide slightly better stability at fracture site compared to polypropylene mesh PMMA plates as evidenced by radiographic study. Both the plates are very much economical and feasible for use in internal fixation in goats.

Key words: Goat, Fracture, PMMA, Tibia, VCP

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Introduction

Fracture is a highly complex injury and the result in the discontinuity in the body framework. In animals, fractures are mainly caused by the trauma and mechanical forces such as compression, bending and twisting can cause long bone fractures (Adams and Fessler, 1974). Fracture in long bones of goats are very common (Singh and Nigam, 1981) and one of the important cause of non infectious lameness in goats (Mathews, 1999). The economical fixation available is application of external splints, plaster of Paris and fibre glass. However, these methods have various demerits like malunion, delayed union and

non union (Singh *et al.*, 1984) and other demerits includes large callus formation, weakening of tendons, muscle atrophy (Mbuiki and Byagagaire, 1984), delay in weight bearing, interferes with radiographic evaluation, slippage of plasters, softening of plaster cast, wetting of cast due to faulty management which ultimately leads hike of expenses because of reapplication. With the above known facts the alternate methods like bone plating with cheap available implants like veterinary cuttable plates and Polymethylemethacrylate plates, which provide rigid fixation and early weight bearing can be used economically in the goats. In context with above mentioned factors, the research study has been conducted to compare the veterinary cuttable plates and polypropylene mesh impregnated polymethylemethacrylate plate for internal immobilisation of long bone fractures in goats through weight bearing and radiographic study.

Materials and Methods

The study was conducted on 12 clinical cases of tibial bone fractures in goats with two different techniques of internal immobilisation in these animals with an objective to accomplish fracture repair with early functional weight bearing. Diagnosis of fracture was made on clinical and radiographic examination. Clinical cases of goats with tibial bone fractures were randomly divided into two groups consisting of 6 animals each. In group I, Six animals which had long bone fractures were treated with veterinary cuttable plate (VCP) depending upon the radiographic length of contra lateral limb. Veterinary cuttable Plate is available as stainless steel plate with 2 variants. One with 2mm and another 2.7 mm hole dimension. In this study, the 2.7 mm hole dimension plate was used which was of 300 mm in length and 7mm in width with 50 holes (Fig. 1).

Fig.1: 50 holed VCP plate

Fig. 2: Polypropylene mesh impregnated PMMA

The veterinary cuttable plates are malleable and can be cut up to desired length as required during fracture fixation. Case details and fixation technique adopted is given in Table 1. In group II, internal

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immobilisation with fabricated Polymethylemethaacrylate (PMMA) plate impregnated with enrofloxacin and Polypropylene mesh.

Table 1: Case details of veterinary cuttable plate (VCP) fixed animals

Group	Animals	Age (months)	Sex	Type of Fracture	Location of Fracture	Bone Affected	Fixation Technique
I	1	6	F	Simple Transverse	Upper 1/3rd	Tibia	15 holed VCP with 2 screws in proximal and 3 in distal fragment
	2	12	F	Simple Transverse	Mid shaft	Tibia	13 holed VCP with5 screws in proximal and 3 in distal fragment
	3	18	F	Simple Short oblique	Distal 1/3rd	Tibia	18 holed VCP with 5 screws in proximal and 2 in distal fragment
	4	4	M	Simple Short oblique	Mid shaft	Tibia	18 holed VCP with 5 screws in proximal and 3 in distal fragments
	5	36	F	Simple Transverse	Distal 1/3rd	Tibia	16 holed VCP with 5 screws in proximal and 3 in distal fragments
	6	3	F	Simple Transverse	Distal 1/3rd	Tibia	11 holed VCP with 3 in proximal and 2 in distal fragments

The PMMA is available as polymer (powder) and monomer (liquid). For preparation of plates, iron moulds were fabricated and in that moulds a thin layer of polymer was layered and then polypropylene mesh was added. To the former layer, again polymer was added up to 3mm thick and then antibiotic was added to the former layer and monomer (liquid) was added as per standard manufacturing protocols. The plate was allowed to set. After setting of plate, it was removed from iron mould and holes were drilled as per standard DCP plate holes. The average length of plate was ranged from 10 cm to 14 cm length and with width of 8mm and 3mm thick (Fig. 2) case details and type of fixation technique adopted in given Table 2.

Pre-Operative Preparation of Patient

The animals of both the groups were given with Melonex @ 0.3mg/kg IM and amoxicillin with 10mg/kg IV. The animals were prepared surgically and sedated using Dexmeditomidine @ 2.5µg/kg IV and followed by Ketamine for induction @ 6mg/kg IV followed by maintenance on Isoflurane by 1-2%

Approach for Tibia and Application of Plates

The tibia was approached through medial approach and in group I, the fractures were stabilised with VCP as neutralisation plate and in group II, the fractures were stabilised using polypropylene mesh impregnated PMMA plate.

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Table 2: Case details of enrofloxacin and polypropelene mesh impregnated PMMA plates

Group	Animals	Age (months)	Sex	Type of fracture	Location of fracture	Bone affected	Fixation technique
II	1	6	M	Simple oblique	Mid shaft	Tibia	8 holed , 10cm PMMA plate with screws 2 proximal and 3 distal fragments
	2	5	F	Simple short oblique	Mid shaft	Tibia	8 holed , 10cm PMMA plate with screws 2 proximal and 3 distal fragments
	3	6	M	Simple short oblique	Mid shaft	Tibia	8 holed , 10cm PMMA plate with screws 2 proximal and 3 distal fragments
	4	6	F	Transverse	Mid shaft	Tibia	8 holed , 10cm PMMA plate with screws 2 proximal and 3 distal fragments
	5	12	F	Simple communited	Mid shaft	Tibia	10 holed , 14cm PMMA plate with screws 2 proximal and 3 distal fragments
	6	6	M	Simple Short oblique	Mid shaft	Tibia	8 holed , 10cm PMMA plate with screws 2 proximal and 3 distal fragments

Post-Operative Management of Patients

Post-operatively, animals were checked for any implant failure, breakage in plates, oedema, any infection or auto- mutilation. Animals were given post-operatively with anti-inflammatory drugs like Tramadol @ 2mg/ kg body weight for 2 days and then with Meloxicam @0.3 mg/ kg body weight and antibiotic amoxicillin @ 10 mg/kg body weight for 6 days. To avoid application of splints, animals were confined to restricted moments.

Clinical Evaluation of Animals

The animals were evaluated by weight bearing. The weight bearing in animals were graded as mild (+), moderate (++), good (+++), very good (++++) and no weight bearing (-) on 0, 3, 7, 15, 30 and 60 post-operative days and for infection, oedema, implant failure and auto-mutilation.

Radiological Evaluation of Animals

The animals were evaluated for healing of fracture by both the plates on 15, 30, 60 post-operative days. On day 0 the radiographs were taken pre-operatively and post-operatively to confirm type of fracture and proper alignment of fracture post-operatively.

Results and Discussion

The animals were evaluated clinically for weight bearing and fracture healing radio graphically.

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Weight Bearing

In Group I the goats on day 0 were lifting their hind limbs above the ground level pre and post-operatively except one animal which showed moderate weight bearing while standing and slight limping. Similar results were noticed on day 3. On day 7, four animals showed mild weight bearing (Fig. 3) and one with good and one with non weight bearing. On day 15 4 showed moderate (Fig. 4) and one with good and one with mild weight bearing. On day 30, 5 animals showed good weight bearing and one showed moderate and on day 60, all animals showed very good weight bearing (Fig. 5) while standing and walking. During the study of animals of this group, animals had mild to moderate weight bearing from 0 to 15 days while good weight bearing was observed from 30 to 60 days.

Fig. 3: Animal showing mild weight bearing on 7th day

Fig. 4: Animal showing moderate weight bearing on 15

Fig. 5: Animal showing very good weight bearing on day 60

In group II on day 0, all the six animals were lifting their hind limbs above the ground level pre and post-operatively. Similar observations were noticed on day 3. On day 7, one animal showed good weight bearing while rest showed mild weight bearing (Fig. 6). On day 15, 4 animals showed moderate weight bearing (Fig. 7) while one showed good and another one showed mild weight bearing. On day 30, all animals showed good weight bearing and on day 60 all animals showed very good weight bearing (Fig. 8) while standing and walking. The details of weight bearing of both the groups are shown in Table 3.

Fig.6: Animal showing mild weight bearing on 7th day

Fig.7: Animal showing moderate weight bearing on 15th day

Fig.8: Animal showing very good weight bearing by 60 day

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Table 3: Weight bearing in animals of both the groups

Group	Case No.	Day 0 Before treatment	Day 0 After Treatment	Day 3	Day 7	Day 15	Day 30	Day 60
I	1	-	-	-	+	++	+++	++++
	2	-	-	-	+	++	+++	++++
	3	-	-	-	+	++	+++	+++
	4	-	-	-	+	++	+++	++++
	5	-	-	-	+	++	++	+++
	6	-	++	++	+++	+++	++++	++++
II	1	-	-	-	+++	+++	++++	++++
	2	-	-	-	+	++	+++	++++
	3	-	-	-	+	+	++	++++
	4	-	-	-	+	++	++++	++++
	5	-	-	-	+	++	++++	++++
	6	-	-_	-	-_	+	+++	++++

The animals in group I showed mild to moderate weight bearing by day 0 to day 15 whereas, in group II the animals showed mild to moderate weight bearing by day 7 to 15. The early weight bearing in group I animals compared to group II animals could be attributed to rigid plate fixation to the bones which was obtained by using VCP plate, neutralising all the forces acting on the bone while in group II, the results indicate polypropylene mesh impregnated PMMA plate require slightly more time compare to VCP for stable fixation. These findings were in agreement with that of findings of Dharmendra (2016) who used DCP plate with various bone substitutes for fracture repair in goats and found complete weight bearing in goats started after 30 days , Singh *et al*. (2013) who evaluated T plate for Salter Harris Type II fracture in tibia of goat and reported good weight bearing by the end of 6th week and complete weight bearing by 3 months onwards whereas, Yuvraj *et al*.(2007) used Gentamicin impregnated PMMA plates found weight bearing in dogs after 8 post-operative days and Sudharshan (2015) who used veterinary cuttable plates for elastic plate osteosynthesis for femoral fracture in dogs where he noticed good weight bearing after 3- 5 weeks and Mukherjee (2007) who also used PMMA plates for femur fracture in dogs and found complete limb function by 45 days.

Complications

During the study period, none of the animals showed any of the complication like oedema, infection or auto-mutilation and implant failures.

Radiographic Evaluation of Fracture Healing

Radiographic study in both the groups were performed on 0 day, 15th day, 30th day and 60th day post-operatively

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Radiographic Study in Group I

Pre-operative and immediate post-operative (0 day) radiographs evaluation was done to confirm type of fracture (Fig. 9)and proper placement of the plate and screws, apposition and alignment of the fracture fragments in all the six goats (Fig. 10).

Fig. 9: Dorsoplantar view of radiograph Showing transverse fracture in tibia On day 0

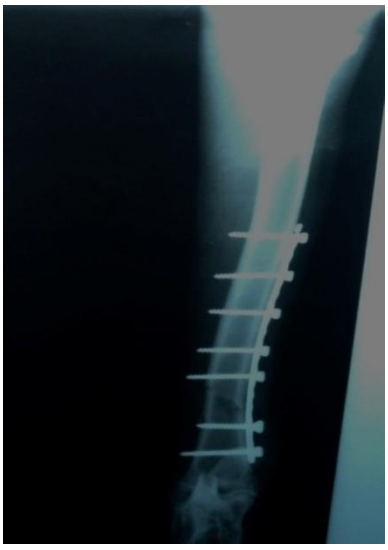

Fig. 10: Dorsoplantar view of radiograph showing alignment of fractures by VCP on day 0

Initiation of periosteal callus was noted at the fracture line at 15th post-operative day. On 30th day, bridging callus was noticed filling the gap of fracture with slight cortical union and visible fracture line (Fig. 11). On 60th day, radiographic evaluation revealed complete union with radio dense callus between fractured fragments of bones (Fig. 12).

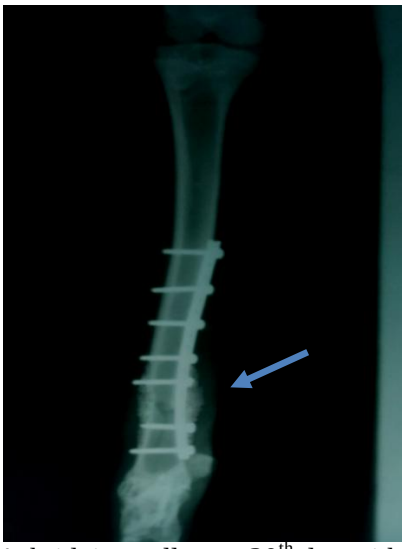

Fig. 11: bridging callus on 30th day with slight cortical complete union (arrow)

Fig. 12: Radiograph showing cortical union after 60 days (arrow)

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Radiographic Study in Group II

Pre-operative and immediate post-operative (0 day) radiographs evaluation was done to confirm type of fracture (Fig. 13)and proper placement of the plate and screws, apposition and alignment of the fracture fragments in all the six goats (Fig. 14).

Fig. 13: Radiograph showing transverse Fracture in tibia on day 0 using

Fig. 14: Radiograph showing alignment of fracture polypropylene mesh PMMA on day 0

On 15th day, slight periosteal reaction was evident at the fractured site. In one case with tibia fracture had distortion in the bone fragments. On 30th postoperative day, more callus formation was noticed on the far cortex side of plate comparatively there were fewer calluses on the near cortex of the plate (Fig. 15).

Fig. 15: Radiograph showing bridging callus complete on 30th post-operative day (arrow)

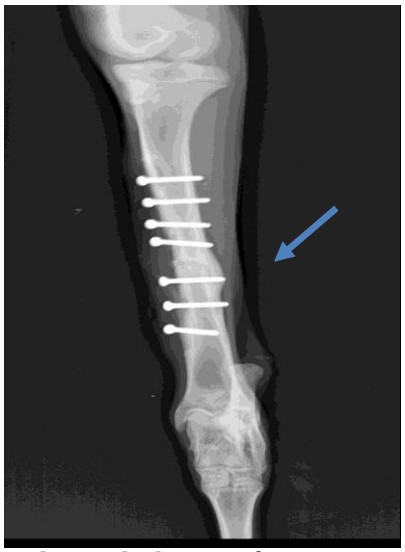

Fig. 16: Radiograph showing fracture union by day 60 (arrow)

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Bridging of fracture line was incomplete. The fracture line was clearly evident. On 60th post-operative day, massive callus completely filling the fracture site (Fig. 16) and callus was smoother and radio-opaque. Callus formation was comparatively more than group I animals.

In present in group I, The minimal callus might be due to rigid fixation causing no or minimal movement at the fracture site resulting healing with minimal callus formation and in group II may be due to less rigid fixation resulting in micro movements between the fracture fragments resulting in more callus formation. Periosteal reaction was noticed by day 15 in both the groups and by 30th day bridging callus and by 60th day complete union with absence of fracture line. The findings of group I were found similar Dharmendra (2016) found complete healing of fracture line by 45th when he used DCP for fracture repair in goats with minimal callus formation and Shivaprakash and Singh (2003) who quoted that use of steel plates results in minimal callus formation due to rigid fixation in goats and dogs, Da-cheng *et al.* (2010) who compared novel locking plates with DCP in goats and found the fracture line disappeared in the locking plate group on 8th post-operative weeks as compared to dynamic compression plate in which line was still visible. While the findings of group II were similar to that of Shivaprakash and Singh (2003), found more callus formation when used teflon, nylon, cadaver and horn plates in goats and dog and reported more callus may be due to movements at the fracture site. Similarly, Singh and Sahay (2005) conducted radiographic evaluation of transfixation osteosynthesis for tibial fracture repair in goats. They observed the formation of bigger external callus and delayed initiation of osteogenesis when three pins were used for stabilisation. Also Umarani and Ganesh (2002) evaluated the healing of mid shaft fracture of femur in goats by radio graphical observations. They noticed a late periosteal reaction and bigger callus with irregular borders in animals treated with Kuntshner nails.

Conclusion

The polypropylene mesh impregnated PMMA plates had sufficient strength to provide stability of fracture site. The veterinary cuttable plate provided slightly better stability at fracture site compared to polypropylene mesh PMMA plates as evident by radiographic study. The weight bearing in animals fixed with both the plates were similar from 7th to 15th day on an average. Both the plates are affordable and feasible for use in internal fixation in goats.

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