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Internal fixation in goats for long bone fracture repair with low cost veterinary Cuttable plate

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Abstract
Study was conducted on six clinical cases of goats with long bone fracture which were subjected to internal fixation with Veterinary Cuttable Plate (VCP). Post–operatively the animals were evaluated for stability of Implant, Weight bearing, Radio graphical healing, Serum Calcium, Phosphorous and Alkaline Phosphatase on 0^{th}, 15^{th}, 30^{th} and 60^{th} day. The implant provided sufficient stability to the fractured fragments except in one case where there was bending of plate. The animals started showing mild to moderate weight bearing from 0^{th} to 15^{th} day however animals showed good weight bearing from 30^{th} to 60^{th} post-operative day. However one animal did not show weight bearing because of Supra scapular nerve paralysis. In radiographs, the periosteal callus was noticed by 15^{th} day and bridging of fracture gap was started from 30^{th} day onwards whereas, complete healing of fracture gap with cortical union was noticed on 60^{th} day. There were increased levels of Serum Calcium, Phosphorus and Alkaline Phosphatase on 15^{th} day, 30^{th} day and 60^{th} day compare to day 0. The Veterinary Cuttable Plate provided sufficient stability at the fracture site and is affordable and economic to use it for internal fixation in goats.

Keywords: Goats, fracture, veterinary Cuttable plate

1. Introduction
Fracture in goat is most common orthopaedic (Singh and Nigam, 1981) [7] and non-infectious cause of lameness (Mathews. 1999) [4]. Goats are very much prone to fracture as goats because of their dense population in urban areas which predisposes them to accidents, dog bites resulting in various orthopaedic problems. The fractured bone can be treated either by either by external immobilisation or internal immobilisation. The external immobilisation with plaster of paris or fibre glass is economic however it has certain demerits like delayed union, non-union and mal union (Singh *et al*. 1984) [8]. Various other complications like formation of large callus, weakening of tendons, nuscle atropy (Mbuiki and Byagagaire, 1984) [5], delay in weight bearing, cast slippage, wetting of cast, cast interfering with radiographic evaluation, softening of cast which ultimately hikes the cost of re-application which is economic concern for marginal farmers. With the above known facts, the alternate methods such as internal fixation with low cost implants like Veterinary Cuttable Plates which neutralises all the forces acting on the bone and aids in early weight bearing with minimal complications. In context with above mentioned factors, the research study was done on goat fracture with Veterinary Cuttable Plate for internal fixation through weight bearing, radio graphical study and biochemical alteration.

2. Materials and Methods
The study was conducted in 6 clinical cases of long bone fracture in goats. The details of goats and fracture are given in table 1. Veterinary Cuttable Plate (Fig.1) was used for internal immobilisation to accomplish better fracture reduction and early functional weight bearing in goats. Veterinary Cuttable Plate is low cost steel plate which is malleable and can be bent along the contour of bone. It comes in two sizes namely 2mm and 2.7mm hole dimension. In this study, 2.7mm hole dimension plate was used. It is about 300mm in length and 8mm wide and have 50 holes with a space gap of 6mm each. Pre-operatively, Radiographs were taken to know the type of fracture and length of the plate. The animals were administered with Inj. Meloxicam @0.3mg/kg and Inj. Amoxicillin- Cloxacillin @ 10 mg/ kg body weight, one hour prior to surgery. The animals were sedated using Inj. Dexmedetomidine @ 2.5µg/kg body weight and followed by Inj. Ketamine @ 6mg/kg body-weight for induction. The animal was maintained on 1- 2% Isoflurane. The bones were approached through standard procedures i.e.

radius was approached by cranio-lateral side, tibia from medial side, humerus from cranio-lateral side. Care was taken not to severe any artery, muscle or nerve. The fractured fragments were reduced and immobilised with Veterinary Cuttable Plate (Fig.2). Post-operatively, the animals were given Inj. Meloxicam @0.3 mg/ kg bodyweight and Inj. Amoxicillin- Cloxacillin @20 mg/ kg body weight. Splints was applied to the fractured limb for 3 days. Radiographs were taken to know the correct fixation of plate to bone. The animals were evaluated for weight bearing on 0^{th}, 3^{th}, 7^{th}, 15^{th}, 30^{th} and 60^{th} day. The weight bearing in animals was graded as mild, moderate, good, very good and no weight bearing. Radiographs were taken to check the healing process on 15^{th}, 30^{th} and 60^{th} day. Post-operatively, the animals were also checked for implant stability, implant failure, infection, oedema and self- mutilation of wounds. The blood serum was collected for estimation of serum calcium, phosphorous and serum Alkaline phosphatase levels on 0^{th}, 15^{th}, 30^{th} and 60^{th} day. The data obtained from biochemical studies were subjected to statistical analysis by student 't' test (Snedecor and Cochran, 1994).

Fig 1: Veterinary Cuttable Plate

Fig 2: Fracture in tibia Stabilised using VCP

Table 1: Case details of animals with type of fixation

Animals	Type of fracture	Location of fracture	Bone affected	Fixation technique
1	Simple Transverse	Upper metaphyseal	Metatarsal	10 holed VCP with 2 screws in proximal and 3 in distal fragment
2	Simple Transverse	Mid shaft	Radius/ ulna	13 holed VCP with5 srews in proximal and 3 in distal fragment
3	Simple Short oblique	Distal $1/3^{rd}$	Tibia	18 holed VCP with 5 screws in proximal and 2 in distal fragment
4	Simple Short oblique	Mid shaft	Tibia	18 holed VCP with 5 screws in proximal and 3 in distal fragments
5	Simple Transverse	Distal $1/3^{rd}$	Humerus	11 holed VCP with 3 screws in proximal and 2 in distal fragments
6	Simple Transverse	Distal $1/3^{rd}$	Radius	16 holed VCP with 5 in proximal and 3 in distal fragments

3. Results and Discussion

The animals were evaluated for weight bearing, radiological evaluation, biochemical alterations and complications.

3.1. Weight bearing

On day zero, five out of six animals showed no weight bearing on day zero both during standing and walking, however one animal with fracture of radius and ulna showed mild weight bearing. The weight bearing on day 3 was similar to day zero. On 7^{th} day, four out of six animals showed mild weight bearing (Fig. 3) and the one with radius ulna showed moderated weight bearing and the one animal with humerus fracture showed no weight bearing. On day 15, 4 animals showed moderate weight bearing (Fig.4) and one showed good weight bearing and the animal with humerus fracture didn't showed any weight bearing. On day 30, 5 animals showed good weight bearing (Fig. 5) while one didn't showed any weight bearing. On 60^{th} day, 5 animals showed very good weight bearing while one did not showed any weight bearing. During the study, animals showed mild to moderate weight bearing from 0 to 15 days and good to very good weight bearing from 30 to 60 days. The early weight bearing could be attributed to the good plate fixation to the bones neutralising all the forces acting on the bone and also providing adequate strength and stability to the fracture site. These findings were in agreement with that of findings of Dharmendra (2016) [2] who used DCP plate with various bone substitutes for fracture repair in goats and found complete weight bearing in goats started after 30 days and with Sudarshan (2015) [11] who used veterinary cuttable plates for elastic plate osteosynthesis for femoral fracture in dogs where the author noticed good weight bearing after 3- 5 weeks.

Fig 3: Female goat with tibia fracture showing mild weight bearing on 7^{th} day.

Fig 4: Female goat with tibia fracture showing moderate weight bearing on 15^{th} day.

Fig 5: Female goat with tibia fracture showing good weight bearing on 30^{th} day.

3.2. Radiological evaluation

Pre-operative and immediate post-operative (0 day) radiographs evaluation was done to confirm type of fracture and proper placement of the plate and screws, apposition and alignment of the fracture fragments in all the six goats (Fig. 6). On 15th day, there was initiation of periosteal callus (Fig.7). On 30th day, bridging callus was noticed filling the gap of fracture (Fig.8). In two cases, one with metatarsal fracture in upper metaphyseal region and one case with radius ulna fracture showed healing with osteosynthesis with minimal callus formation. On 60th day, radiographic evaluation revealed complete union with radio dense callus between fractured fragments of bones, fracture line was not visible and cortical union was noticed (Fig.9). In one case with humerus fracture, there was no activity with respect to bone healing and there was no callus formation. The minimal callus might be due to rigid fixation causing no or minimal movement at the fracture site resulting in healing with minimal callus formation. The findings were similar to that Dharmendra (2016) [2] found complete healing of fracture line by 45th day when used DCP for fracture repair in goats with minimal callus formation. Shivaprakash and Singh (2003) [6] also quoted that use of steel plate's results in minimal callus formation due to rigid fixation in goats and dogs. Similar results were noticed by Sudarshan (2015) [11] who observed absence of fracture lines with periosteal callus and bridging callus by 3 weeks and complete bone cortical union by 7th week during fracture repair of femur with elastic plate osteosynthesis using VCP

Fig 6: Cr- Cd view of radiograph showing radius fracture stabilised by VCP in goat on day 0

Fig 7: Cr- Cd view of radiographs showing periosteal callus at the fracture site on day 15th

Fig 8: Cr- Cd view of radius showing bridging callus a with slight cortical union at the fracture site

Fig 9: Cr- Cd view of radiograph of radius showing cortical union with bridging callus on day 60

3.3. Complications

There were no auto- mutilation, infection and oedema. However there was slight bending of plate in one case with tibia fracture after 15th day (Fig.10) and one animal with humerus did not showed any weight bearing due to supra-scapular nerve paralysis (Fig.11). The slight bending of plates was might be due faulty management or might be due to slightly heavy weight of animal.

Fig 10: Slight bending of plate on 15th post-operative day.

Fig 11: Animal not showing weight bearing due to supra scapular nerve paralysis.

3.4. Biochemical Alterations

3.4.1. Serum Calcium

Blood serum was collected on 0th, 15th, 30th and 60th day to estimate calcium levels. The values are shown in table 2. There was significant increase in the levels of serum calcium on 15th day compared to day 0 and gradually reduced up to day 60. Increased levels of serum calcium in the initial levels could be attributed to increased osteoclastic activity, leading to resorption of dead bone. A gradual decrease in the serum calcium levels at 60th day could be due to deposition of excess calcium at the fracture site. Similar results were noticed by Dharmendra (2016) [2] who used DCP with various bone substitutes for fracture in goats. He observed rise in serum calcium levels by 3rd week onwards that return to normal levels by 7th week onwards. Umarani and Ganesh (2003) [12] noticed reduction in calcium level on seventh day after internal fixation of femur fracture in goats, followed by a significant rise in concentration from day 15 to reach the normal level gradually by day 60 of fracture healing.

Table 2: Mean ± S.E. of serum calcium (mg/dL) on post-operative days

Days	Calcium levels
0	7.83 ± 0.40
15	9.83 ± 0.70*
30	10.64 ± 0.84*
60	8.34 ± 0.49

* = Means bearing superscript differs significantly ($P < 0.05$) from day 0 within the group

3.4.2. Serum Phosphorous

Blood serum was collected on 0th, 15th, 30th and 60th day to estimate Phosphorous levels. The values are shown in table 3. There was significant increase in the levels of serum phosphorous on 15th day and 30th day compared to day 0 and gradually decreased upto day 60. Higher levels of serum phosphorous levels at initial levels can be attributed to osteoclastic activity leading to the resorption of dead bone thereby increase in the levels of serum phosphorous. The above results were in agreement with Umarani and Ganesh (2003) [12] noticed a significant elevation of serum phosphorous levels upto 15 days after internal fixation of femur fractures in goats, followed by gradual decline towards the normal. Daron (2013) [1] also reported increase in serum phosphorous on 15th and 30th day when compared the POP and fiber glass for long bone fracture repair in goats.

Table 3: Mean ± S.E. of serum inorganic phosphorous (mg/dL) on post-operative days

Days	Phosphorous levels
0	4.34 ± 0.42
15	6.67±0.42*
30	5.34 ± 1.06
60	4.34 ±0.31

* = Means bearing superscript differs significantly ($P < 0.05$) from day 0 within the group

3.4.3. Serum Alkaline Phosphatase

Blood serum was collected on day 0, 15, 30 and day 60 to estimate serum alkaline phosphatase levels. The values are shown in table 4. There was significant increase in the levels of alkaline phosphatase on 15th day compared to day 0 and it reduced gradually on day 60. The rise in the alkaline phosphatase levels in 15th might be due to increased osteoblastic activity. Osteoblast secretes large quatity of alkaline phosphatase which is involved in the bone matrix formation and its mineralisation. Similar observations were noticed by Manjulkar (2000) [3] also studied the biochemical changes during healing of long bone fracture in goats. He noticed that serum alkaline phosphatase levels increased up to day 15, after which it declined till day 45 to reach the normal value. Singh *et al.* (2008) [9] noticed that the pattern of alteration was same with fibre glass and plaster of Paris when used for external immobilisation of long bone fracture in goats *i.e.* They observed that the serum alkaline concentration rose significantly upto day 15 of fracture healing and gradually declined to the normal by day 45.

Table 4: Mean ± S.E. of serum alkaline phosphatase (IU/L) on post-operative days

Days	Alkaline Phosphatase levels
0	152.00 ± 4.01
15	173.67 ± 5.90*
30	170.16 ± 2.82
60	159.00 ± 3.34

* = Means bearing superscript ** differs significantly ($P < 0.05$) from day 0 within the group

4. Conclusion

The Veterinary Cuttable Plate provided good stability to the fracture site as evident by weight bearing and radiographic study. The plate is also affordable and economic for use in internal fixation in goats.

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