



Figure 1 Exposed calcaneous bone with multiple abrasion of the right hind limb.



Figure 2 Cranial-caudal and latero-medial radiographs, red arrow; comminuted fracture at midshaft of metatarsal bone, yellow arrow; Salter Harris type IV fracture at distal end of tibia.

Treatments and diagnostic workup

The affected limb was stabilized with a Modified Robert Jones (MRJ) bandage before further diagnostic work-ups were carried out. The patient was hospitalized and treated with intravenous isotonic crystalloid fluid therapy: Lactated Ringer (50 mL/kg/day i.v. replaced on day one for 24 hours) (Compound Sodium Lactate, B. Braun Medical industries, Malaysia), flunixin meglumine (2.2 mg/kg, i.m., q24h; Flunixin, Norbrook Laboratories Limited, Northern Ireland), procaine penicillin and dihydrostreptomycin sulphate (1 ml/25 kg, i.m., q24h) (Norbrook), biodyl® (2 ml/animal, i.m., q24h) (Biodyl®, Merial, France) and multivitamin (2 ml/animal, i.m., once) (Vitavet, Nova Laboratories Sdn. Bhd, Malaysia). Complete blood count and serum biochemistry and right hind limb radiography were assessed as pre-screening evaluation for surgical intervention.

Complete blood count (CBC) and serum biochemistry findings include hemoglobin (77.2 g/L; reference range, 80-120 g/L) and PCV (0.24 L/L; reference range, 0.22-0.38 L/L), eosinophilia ($1.37 \times 10^9/L$; reference range, $0.05-0.65 \times 10^9/L$), mild hypoproteinaemia ($56 \times 10^9/L$; reference range, $60-75 \times 10^9/L$) mild phosphataemia (1.25 mmol/L; reference range, 1.6-2.3 mmol/L), mild decrease in creatinine (66 $\mu\text{mol/L}$; reference range, 88-160 $\mu\text{mol/L}$), whereas, mild to moderate increase in aspartate aminotransferase (116.2 U/L; reference range, 50-100 U/L) and creatine kinase (564 U/L; reference range, 100-200 U/L).

Latero-medial and cranial-caudal (CRCD) of right hind limb radiographic findings revealed an opened comminuted fracture at the mid shaft of metatarsal bone and Salter-Harris fracture type IV of the distal tibial bone (**Figure 2**). A mid femoral amputation was considered and recommended to the owner after factors such as cost constrain, severity of the injury, owners' compliances and post-operative care were taken into consideration.

Surgical Procedure

The patient was fasted approximately 12 hours to avoid regurgitation during the procedure. Pre-operative analgesia, included tramadol hydrochloride (3 mg/kg, i.v., once) (Analab injection, Biolab Co. Ltd, Thailand) was administered. General anaesthesia was induced with a mixture of ketamine hydrochloride (3-4 mg/kg, i.v) (Narketan®-10, Vetoquinol UK Limited, UK) and diazepam (0.1-0.2 mg/kg, i.v) (Diapine, Atlantic Laboratories Corp., Thailand). Following endotracheal intubation, general anaesthesia was maintained with Isoflurane (1.5%-2.5%) (Isoflurane USP 100%, Piramal Healthcare Limited, India) vaporized in 100% oxygen with a rebreathing system. A mechanical ventilator was connected to the rebreathing system throughout the procedure. The affected limb was prepared aseptically in a routine manner using chlorhexidine, painted with tincture iodine and positioned upright for easy manipulation during the procedure.

The patient was administered intra venous fluids (Lactated Ringer's solution) at a surgical rate of 10 ml/kg/hour, i.v., and vital parameters were heart rate, respiration, capillary refill time (CRT) including mucous membrane colour were monitored closely every 5 minutes. Following aseptic preparation of the fractured limb, elliptical skin incision around the distal third of femur was performed. Once the skin flap was reflected, blunt dissections were made on the fascias' to expose the muscle bundles and femoral vessels. Femoral artery and veins which run on the medial aspect of the femur were isolated and ligated with a three-clamp and transfixation suture technique. Bundle of gracilis and caudal sartorius muscles were then transected at mid-femoral, followed by pectineus muscles and cranial sartorius at its musculotendinous junction and mid-belly respectively (**Figure 3a**). Both quadriceps muscle and biceps femoris muscle were transected at same level proximal to the patella. The sciatic

nerve was isolated and ligated before incised (**Figure 3b**). Other caudal muscles (semimembranosus, semitendinosus and adductor muscles) were also transected at mid-femoral level. The femur was then cut using a sterile surgical hand saw at the proximal mid one-third of the diaphysis (**Figure 3c**). The muscle bundles were apposed in a manner, so that the distal end of the femur or stump was completely covered. Vicryl® 2-0 absorbable sutures (Polyglactin 910, Ethicon®, Belgium) was used to apposed the muscles with a simple continuous suturing pattern. Subcutaneous tissues and skin were closed with Vicryl® 3-0 using modified cushing and Ethilon® 0 (Polyamide 6, Ethicon) using cruciate suture pattern respectively (**Figure 3d**).

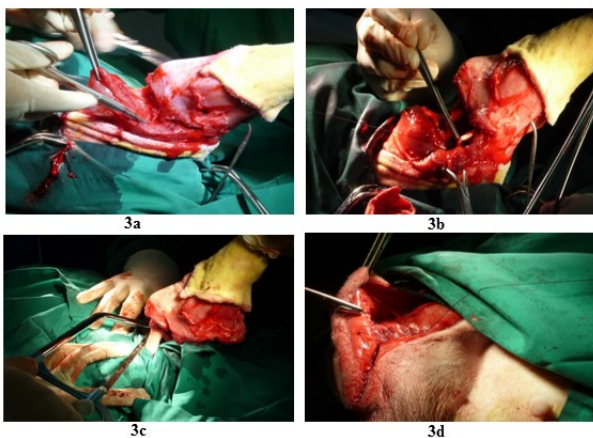


Figure 3a-3d Skin flap was reflected, and blunt dissection were made on the fascias' to expose the muscles bundles and femoral vessels (a) Vastus lateralis, sartorius, and biceps femoris muscles were separated and transected. (b) The sciatic nerve was isolated and ligated prior transection. (c) Osteotomy was carried out using a sterile hand saw. (d) Muscle bundles were apposed to hide the distal end of the femur stump.

Post-operative Care

Post-operative treatment in the kid included antimicrobial, procaine penicillin and dihydrostreptomycin sulphate (Pen and Strep; 1 ml/25 kg, i.m., s.i.d for 7 days), anti-inflammatory medication, flunixin meglumine (2.2 mg/kg, i.m., s.i.d for 5 days), analgesic, tramadol hydrochloride (3 mg/kg, s.q., t.i.d for 3 days and tapered down to b.i.d for another 2 days), biodyl® (1 ml/animal, s.q., b.i.d. for 3 days), and fercobsang® (2 ml/animal, i.m., s.i.d. for 3 days) (Fercobsang®, Vetoquinol S.A., France) as an anti-anemia were prescribed. An Elizabethan collar was placed to prevent licking at the incision site. Daily wound care was performed with diluted chlorhexidine gluconate and povidone iodine with 1:20 ratio until complete healing. Wound cleaning was done to avoid surgical site contamination as the surgical wound was left opened without any bandages. Skin sutures were removed 14 days post-operatively.

The post-surgical recovery was good with expression of normal behavior. The patient started to consume food later on the same day after the surgery (**Figure 4**). The wound healing at the amputation site was satisfactory. No evidence of excessive inflammation or infections, such as excessive heat, pain, swelling or discharge was noted by the time of suture removal and adequate healing had occurred. On one-month follow-up of post-amputation, the patient was able to regain ambulatory function by a hopping motion to obtain food and water in the farm.



Figure 4 Animal able to bear weight and express normal mentation post-operative.

Discussion

Fractures involving the appendicular bones (fore-limbs and hind-limbs) are common especially in calves following trauma or as a result of manipulation during dystocia [4]. However, reports of fractures involving goats especially in kids are uncommon. In cattle, most common fractures are involving the metacarpus and metatarsus; followed by fracture of the tibia, ulna and radius; and the humerus [5]. Fractures involving the femur, pelvis, phalanges, and axial skeleton is considered less common and rare [4]. Decision regarding any options in treating fractures in ruminants are primarily based on the prognosis of the animal relating to the severity and nature of the fractured limb, cost of treatment, economical and genetic potential value of the animal, complexity of the procedure, unpredictable post-operative complications, prolong post-operative care, and poor quality of life issues [3,6]. Fractures involving the limbs can be managed with splints, casts, external skeletal fixation (ESF) and transfixation pinning and casting (TPC) [5]. Amputation is considered an alternative to euthanasia in severe injuries where genetic preservation or sentimental value to the client is high [3,4].

In the case reported here, amputation of the right hind limb at the level of the mid femur was selected as an alternative to euthanasia, after considering the severity of the injury, cost constraint and sentimental value of the animal to the client. Amputation of the limbs can be performed through disarticulation or at the diaphysis [3]. Stifle joint disarticulation was not a choice as prosthesis was not considered in this case.

In addition, if prosthesis was considered, daily management and best care of the stump is crucial and essential to maintain a maximized well-being of the animal. Simple splints and casts were not an option as both are indicated for close transverse and short oblique fractures [7]. Various reports have shown that open fractures increase the likelihood of complications as well as poor prognosis [3-5,7,8]. Based on the Gustilo open fracture classification (Gustilo score III injuries, [3]), amputation must be considered when there is extensive damage to the skin, muscular and neurovascular, high speed crush injury, highly comminuted fracture and contaminated. Although ESF and TPC could be considered as surgical correction in this case, economical constraint and the client compliances were major obstacles faced to consider such options. Economic limitation dictates the choices of treatment.

A common question that arises against amputating an animal's limb is the weight of the animal. Previous studies on amputation in dogs suggested that the larger and heavier breed dogs have more difficulty in locomotion and adaptation with three legs, however there were no evidence showing that heavier dogs adapt less well compare to lighter dogs [9]. Based on a survey conducted on clients experiences with their dogs after a limb amputation, no significant association were found between weight, age and quality of the dogs to the speed of adaptation [9]. Nevertheless, one should bear in mind that the long-term prognosis depends on the management of the environment and dedication of clients in giving the best care to an amputated animal, as well as taking into consideration of the contraindications for amputation which includes severe orthopedic or neurological disease on other limbs and extreme obesity [3,9].

Conclusion

In conclusion, amputation at the level of the mid-diaphysis of the femur should be considered as an alternative to euthanasia in young goats with severely comminuted metatarsal and tibial fractures where other limb sparing techniques are not applicable. Limb amputation may be considered, as it provides a rapid resolution of pain in severe fracture cases. Many would want to avoid amputation and try

to salvage the affected limb, given that the decision should only be made based on the multi-factorial aspect involving the nature of injury, economic limitation, animal's value, owner's compliances and the veterinarian surgical skills and experiences.

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