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Management of an Open Comminuted Fracture of the Metacarpus using Circular External Skeletal Fixation in a Korean Water Deer (Hydropotes inermis argyopus)

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Abstract : A Korean water deer was rescued after being hit by a motor vehicle. Clinical and radiographic examination revealed a grade III open fracture of the right metacarpus with severe soft tissue injury. The water deer underwent closed reduction of the fracture, which was stabilized by the application of the Ilizarov method of 4-ring circular external skeletal fixation (CESF) as a minimally invasive technique. The water deer was successfully released into the wild. CESF was advantageous for the stabilization of open comminuted fracture and the management of a severely contaminated wound in a Korean water deer. CESF can be used successfully in wild deer with good tolerance and minimal complications.

Key words **:** circular external skeletal fixation, open fracture, soft tissue, trauma, Korean water deer.

Introduction

Open comminuted fractures frequently occur in wild mammals, particularly in the distal extremities where there is a paucity of soft tissue coverage (7,9,11,13). Conservative treatments such as a full limb cast or Thomas splint are unsuitable in open comminuted fractures due to the high risk of malunion and angular deformity (6). Internal fixation such as with bone plates and screws has provided good stability of the bone fragments. In internal fixation, however, disruption of the blood supply from the soft tissue is inevitable, which may lead to delayed union or nonunion (6). Closed reduction such as external fixation has provided good stability along with less disruption of the blood supply from the soft tissue. Moreover, these surgical procedures have also facilitated wound management of associated soft tissue injuries (6).

The circular external skeletal fixator (CESF), a type of external fixator, provides greater stability and allows for free movement of adjacent joints. The CESF has been successfully used for the repair of open comminuted fractures in dogs and cats (6). However, there are only a few reports of the use of the CESF for the repair of open and comminuted fractures in wild animals (3,10,11).

The purpose of this report is to describe the surgical technique and outcomes of use of the CESF in a Korean water deer (*Hydropotes inermis argyopus*) with an open comminuted fracture of the metacarpus.

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Case

A young, female Korean water deer weighing 14 kg was presented to Chonbuk Wildlife Rescue and Conservation Center with weight-bearing lameness on its right forelimb after being hit by a motor vehicle. She was alert and had an open fracture of the right metacarpal bone. Clinical findings were normal except that crepitation and an infected wound was observed in the metacarpus. Radiographic examination revealed an open comminuted fracture of the right diaphyseal metacarpus with soft tissue trauma (Fig 1). Based on the results of our examination, we diagnosed the deer with a type IIIB open fracture of the right metacarpus. After 3 days of hospitalization, we performed fixation with a CESF (IMEX veterinary Inc., TX, USA) for bone fracture and for soft tissue management.

Anesthesia was induced with medetomidine (60 μg/kg IV, Domitor®, Pfizer Ltd., USA) and ketamine (1.5 mg/kg IV, Yuhan ketamine 50 Inj® Yuhan Corporation, Korea). After intubation, general anesthesia was maintained with isoflurane (2-3%) in oxygen (1.5 L/min). A brachial plexus nerve block was performed by administration of 2% lidocaine (3 mg/kg, Lidocaine Hcl Daihan Inj®, Dai Han Pharm).

The surgery was performed with IMEX implants (IMEX veterinary Inc., TX, USA). The patient was positioned in lateral recumbency. The water deer underwent closed reduction of the fracture, which was stabilized by the application of the Ilizarov method of 4-ring circular external skeletal fixation as a minimally invasive technique. A CESF frame consisting of a 118 mm full ring was used on two rings in the proximal metacarpus and 2 rings in the distal metacarpus. Olive wires (1.6 mm) were inserted from the lateral to the medial distal

Fig 1. (A) Cranial-caudal and (B) lateral radiograph view of the right metacarpus of a water deer.

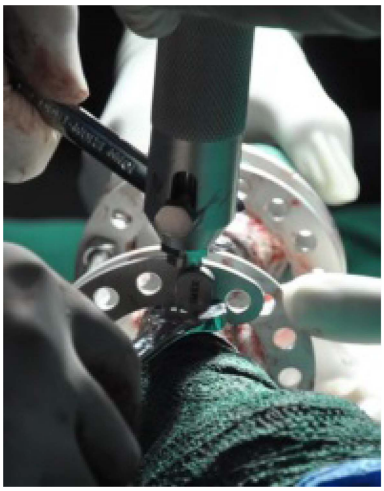

Fig 2. Wire tensioner with olive pins used in fixation with a circular external fixator.

Fig 3. Inflammation with poor soft tissue cover and a visible fracture site. Antibiotic-loaded bone cement beads (black arrow) were applied in the inflamed wound.

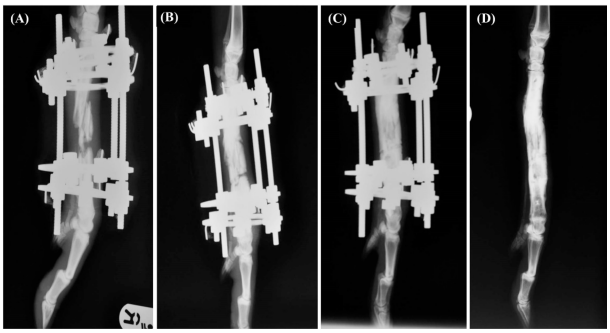

Fig 4. Lateral radiograph views of the right metacarpus in a water deer. (A) Immediately after fixation of the metacarpus using a circular fixator; (B) Two months after surgery, showing a good bridging callus at the comminuted bone fragments; (C) Three months after the surgery, showing bony reduction and a bridging callus; (D) Removal of the CESF used to repair the comminuted fracture, with remodeling shown at the fracture site.

diaphysis. The wire intersection angle was between 60 and 90 degrees. The frame was temporarily secured to the bone with two 1.6-mm transosseous olive wires on the distal ring. The other olive wires were placed through each metacarpal site and each wire was connected to the full rings in a similar manner. Once the appropriate position and alignment were obtained, all olive wires were secured by fixation bolts and nuts after being tightened by a wire tensioner (Figs 2 and 4A).

After surgery, meloxicam (0.2 mg IM q 24 h, Metacam®, Boehringer Ingelheim Vetmedica, USA) and amoxicillin sodium/clavulanate potassium (5 mg IM q 12 h, CLAMOXIN INJ®, Shin Poong Pharm, Korea) were administered for one week. Debridement of the inflammatory tissue was performed and antibiotic-loaded bone cement beads were applied (Fig 3). The lesion was not closed. The wound was managed using wet-to-dry contact dressings on the day of presentation to debride unhealthy tissues until the appearance of healthy granulation tissue after surgery for fracture repair. The fixator was maintained and tolerated well by the deer until the fracture healed (Fig 4B and C). The water deer was sedated with medetomidine (60 μg/kg IV, Domitor®, Pfizer Ltd., USA) and ketamine (1.5 mg/kg IV, Yuhan ketamine 50 Inj®, Yuhan Corporation, Korea), and the CESF device was removed 3 months postoperatively (Fig 4D). Weight bearing was immediately increased on the affected limb, but moderate lameness was noticed on the affected leg. Four months after the surgery, the Korean water deer was capable of full weight-bearing on the right forelimb and exercised well. She was moved to a rehabilitation area with high solid stockade fencing for one month. One hundred sixty-five days after admission, the water deer was successfully released in the area where she was originally found.

Discussion

This case supports the use of a CESF system for fracture

management in Korean water deer (H. inermis argyopus) with open comminuted fracture of the metacarpus. Various techniques have been reported for the treatment of fractures in veterinary orthopedics. Of these, the bone plate system has commonly been used for comminuted fractures in dogs and cats because of its high mechanical stability and bone healing rate (6). Although bone plates in open fractures have shown satisfactory outcomes in small animals, they are difficult to use in open fractures with infections and loss of soft tissue (5). External skeletal fixators with closed reduction are ideal for the management of open fractures with severe loss of soft tissue. They have advantages including implants being located away from the fracture site, easy access for open wound management, and minimal damage to the bone and soft tissue (13). Studies have reported the successful use of an external skeletal fixator in comminuted fractures in wild animals (2,9-11). To the best of our knowledge, there has not been a previous documented case of CESF being used in a Korean water deer with an open comminuted fracture of the metacarpus.

Several factors should be considered in fracture management in wild animals. Some wildlife clinicians advise against fixation techniques for fractures in deer because of the prolonged recovery and lengthy captivity (8). Conservative treatments such as full limb cast or the Thomas splint are recommended for many fractures. However, in the author's experience, these methods have shown poor outcomes and impair fracture healing in Korean water deer with traumatic fractures. Although, retrospective studies on the treatment and outcomes of traumatic fractures in deer are severely limited, one study documenting the results of traumatic injuries in deer found a high mortality rate after the treatment of open fractures (9). Limb amputation is one option with open fractures of deer limbs (1,12). One case study examining exoskeletal prostheses in deer after limb amputation documented good function and general health after the treatment of an open fracture (4). However, deer with limb amputations cannot be returned to the wild. We successfully released the described Korean water deer with an open fracture after treatment with a CESF. Rehabilitated deer should have restricted human contact to enhance post-release survival, and it takes a considerable amount of time to rehabilitate an animal for release into the wild after CESF of an open fracture.

CESF was advantageous for the stabilization of open comminuted fracture and the management of a severely contaminated wound in a Korean water deer. We believe that CESF can be used successfully in wild deer with good tolerance and minimal complications.

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고라니에서 발생한 손허리뼈 개방 복합골절의 원형 외부골격고정법 적용

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요 약 : 고라니가 교통사고 후 구조되었다. 임상검사와 방사선검사에서 손허리뼈에 심한 연부조직손상을 동반한 3형의 개방골절로 진단되었다. 골절은 4개의 원형 외부고정 링을 이용하여 비개방정복으로 비침습적으로 정복 후 고정하였다. 술 후 고라니는 성공적으로 자연으로 복귀되었다. 고라니에서 원형 외부골격고정술을 이용하여 심한 감염성 상처와 개방골절을 치료 할 수 있었다. 원형 외부골격고정술은 고라니에서 부작용 없이 사용할 수 있을 것으로 사료된다.

주요어 : 원형 외부골격고정, 개방 골절, 연부조직, 외상, 고라니