The Journal of Veterinary Medical Science

NOTE

Wildlife Science

Middle upper beak fracture in a Red-crowned crane that completely recovered with external skeletal fixation

Hiroko IIMA[1)] and Hiroki TERAOKA[2,3)]*

[1)]Kushiro Zoo, Kushiro, Hokkaido 085-0204, Japan
[2)]School of Veterinary Medicine, Rakuno Gakuen University, Ebetsu, Hokkaido 069-8501, Japan
[3)]NPO Red-crowned Crane Conservancy, Kushiro, Hokkaido 085-0036, Japan

J. Vet. Med. Sci.
83(4): 742–745, 2021
doi: 10.1292/jvms.20-0565

Received: 23 September 2020
Accepted: 15 February 2021
Advanced Epub:
11 March 2021

ABSTRACT. An adult Red-crowned crane in captivity that had a displaced compound fracture of the middle upper beak caused by an accident was treated by using Type I-a external skeletal fixator (ESF). The ESF that was equipped with a unilateral epoxy putty fixator and with five half-pins was fixed on the premaxilla bone. The crane with the ESF on the beak was able to feed smoothly by itself. The ESF was removed 49 days after the first surgery. Beak malocclusion, which was observed in the latter half period of fixing, spontaneously improved within one month after removal of the ESF. This is the first successful case of repair of an upper beak fracture in a Red-crowned crane.

KEY WORDS: external skeletal fixation, *Grus japonensis*, Kushiro Zoo, red-crowned crane, upper beak fracture

The Red-crowned crane *Grus japonensis* is one of the Special National Monuments designated by the Japanese Agency for Cultural Affairs and is listed as an endangered species in the International Union for Conservation of Nature and Natural Resources (IUCN) Red List and as a vulnerable species in the Japanese Ministry of the Environment (MOE) Red List. In Kushiro Zoo, located in eastern Hokkaido, the rescued wild Red-crowned cranes have been treated, and more than 35 Red-crowned cranes have been reared as a captive breeding group [3].

Cranes have a very long beak and beak fracture occasionally occurs due to sudden accidents in breeding cages [1, 2, 6, 7]. Although debeaked cranes, especially the cranes with significant discrepancies in beak length, manage to drink by themselves, they are not able to eat and preen [2]. According to our experiences, the debeaked cranes tend to have many problems including over-preening, feather lessness, skin disease dermatosis and severe ectoparasite infection (feather louse) (personal observation). They also look very pitiful. Therefore, a beak fracture in cranes needs to be treated as possible. For treatment of a beak fracture in a crane, Type II external skeletal fixator (ESF) (Supplementary Fig. 1) [2] and methods using dental acrylic [7, 9, 10] have been reported. It was previously reported that fractures in the middle upper beaks of the White-naped crane *Grus vipio* and Sandhill crane *Grus canadensis* were successfully treated to complete recovery by using orthopedic wire and a bis-acryl composite splint [6]. However, rate of successful repair with severely displayed fractures have been low, especially in species such as the Siberian Crane *Grus leucogeranus* which does not stop using its beak for probing after surgery [10]. Difficulty in pin retention of Type II ESF can be encountered with upper jaw fractures due to the large area occupied by the nares [2].

We treated an adult Red-crowned crane that had a displaced complete fracture of the middle upper beak caused by an accident by using a Type I-a external skeletal fixator (ESF) [5], because we thought that the ESF for upper beak fracture need more rigid pin retention, especially for tall cranes including Red-crowned cranes with longer beaks. We report here the first successful case of complete recovery from a compound beak facture of the middle upper beak in a Red-crowned crane.

A male Red-crowned crane (to 3 years of age) was rescued on January 13, 2016. At Kushiro Zoo, the crane was treated for a crush wound on the underside of the left wing, on the proximal side of the forearm. After recovery, the crane was kept in captivity because we judged finally that the crane could not fly.

On April 29, 2016 (Day 1), a fracture in the middle portion of the upper beak (10 mm distal from the external naris) occurred when the crane put the tip of his upper beak into the cage fence (Fig. 1A). The crane was immediately captured. The distal part of the fractured upper beak was hanging loose and we returned the distal part to its correct position almost immediately. The captured crane was restrained by using a restraining jacket and a blindfold mask was attached. The crane's upper and lower beaks

*Correspondence to: Teraoka, H.: hteraoka@rakuno.ac.jp
(Supplementary material: refer to PMC https://www.ncbi.nlm.nih.gov/pmc/journals/2350/)

were fastened together with surgical tape until surgery began. The crane weighed 6.6 kg and was injected subcutaneously with enrofloxacin (75 mg) (Baytril® 2.5% injection solution for dog and cat, Bayer Yakuhin, Ltd., Tokyo, Japan).

On Day 1, three hours after the accident, orthopedic surgery to repair the fractured upper beak was carried out. Radiographs showed complete fractures and separation of the underlying three bones (parts of the premaxilla) at the midpoint of the upper beak (Fig. 1B). The crane was anesthetized with isoflurane (isoflurane for animals, Mylan N.V., Tokyo, Japan) and oxygen (3–1.5% inhalant and 2 l/min oxygen) with an anesthetic mask (which we had specially made for cranes) and then intubated with an endotracheal tube (Medline cuffless 5.5 mm endotracheal tube, Medline Industries Inc., Tokyo, Japan). The open wound around the upper beak fracture was covered with hydrocolloid plaster (Fig. 1D).

For the median of the premaxilla, 1.1 mm (0.045”) Miniature INTERFACE® Fixation Half-pins (Part No. 03045, IMEX Veterinary, Inc., Longview, TX, USA [Kirikan Ltd., Tokyo, Japan]) were inserted with a hand drill: 2 half-pins at the distal end and 3 half-pins at the proximal end of the beak fracture (Fig. 1C). We connected these 5 half-pins with connector pins by epoxy putty (RECTORSEAL EP-200 Epoxy Putty, UNITEC Co., Ltd., Osaka, Japan) (Type I-a ESF, Fig. 1C and 1D, Supplementary Fig. 1A). The end of each of the 5 half-pins was cut (Fig. 1D), and the outside of the EFS was bound with adhesive bandage for protection (Fig. 2A). The surgery was completed in 98 min.

After surgery, the crane was kept at rest with the restraining jacket and blindfold mask, and was force-fed atka mackerel *Pleurogrammus azonus*, and had peroral fluid replacement until the evening of Day 2. On Day 1, three hours after the surgery, the crane had the peroral fluid replacement with 100 ml electrolyte liquid through the tube (SOLITA®-T GRANULES No.3, AY Pharmaceuticals Co., Ltd., Tokyo, Japan). Five hours after the surgery, the crane was force-fed two atka mackerel (total 153 g), and, 8 hr after the surgery, the crane was force-fed three atka mackerel (total 217g) and had peroral 100 ml electrolyte liquid. In the morning and noon of Day 2, the crane was force-fed three atka mackerel (total 210 g and 230 g, respectively).

On the evening of Day 2, the crane was moved to a closed outdoor cage for isolation and was encouraged to eat small atka mackerel cut in half (about 75 g per one atka mackerel) on his own. On Day 3, the crane began to eat small atka mackerel on his own from a feeding vessel containing shallow water. We used a shallow and large feeding vessel to minimize placement of the upper beak in water for eating or drinking. For the duration of treatment with the ESF fixator, the crane was fed only small atka mackerel without pellet food because a crane can swallow small atka mackerel with minimum use of its the beak. We also avoided leafy vegetables that need delicate movement of the beak for eating.

Antibiotics were administered until Day 5. On Day 1 midnight and Day 2 morning, enrofloxacin (75 mg) (Baytril® 150 mg Tab for dog and cat, Bayer Yakuhin, Ltd.) was given orally. On Day 2 evening, the crane was injected intramuscularly with a long-acting amoxicillin (1,050 mg) (AMOSTUAC® LA Inj., Meiji Seika Pharma Co., Ltd., Tokyo, Japan). On Days 3, 5, enrofloxacin (150 mg) was given once a day orally. For prevention of aspergillosis caused by stress, itraconazole (50 mg) (Itraconazole tab 50 “MEEK”, Kobayashi Kako Co., Ltd., Awara, Japan) was also given orally once a day on Days 1–3 and 5. We missed the medication on Day 4.

On Days 5, 14, 22, and 35, the fractured part was examined (Fig. 3). At an early stage, laceration and inflammatory reactions with swelling were observed around the fractured upper beak (Fig. 3A–C). On Day 35, the wound around the fractured upper beak showed gradual healing (Fig. 3D), and radiographs showed the beginning of callus formation; however, it was found that the upper beak was 30 mm shorter than the lower beak (Fig. 2A).

On Day 49, the ESF fixator was removed because beak malocclusion had worsened; however, some degree of synostosis of the beak fractures was confirmed (Fig. 4A). The open wounds on the superior part of the upper beak fracture and the holes made by removal of the pins were covered with hydrocolloid plaster (Fig. 4B and 4C). Within one month after removal of the ESF, the malocclusion was spontaneously improved and the open wound and holes had also recovered (Fig. 2B). Thereafter, the crane has had no particular problems for feeding and preening feathers with its beak (as of September 2020).

Treatment of middle upper beak fractures in cranes is challenging and often results in debeaking [2, 6, 10]. It is difficult to fix fractured beak bones with an ESF of sufficient strength in the case of cranes because of the delicate structure of the premaxilla and the spacious nasal cavity in the upper beak [2, 8]. In this case, 5 half-pins were inserted into the premaxilla on both sides of the fracture (Fig. 1), and the Type I-a ESF had sufficient strength for one and a half month until synostosis. The culmen length in adult male Red-crowned cranes is 162 mm on average [4], and it is long enough to place half-pins for the premaxilla in both sides of the fracture and to make the ESF with high fixing strength. In addition, as one of the successful factors in this case, the ESF fixator greatly limited movement of the upper beak, because the epoxy putty of the fixator made contact with the surface of the upper beak very tightly. The beak of a crane has resistance against heating that is required for curing of the epoxy putty.

Red-crowned cranes have longer beaks and larger nares, and the seizing power of their beaks is greater than other small cranes such as white-naped cranes and sandhill cranes. We failed to treat beak fractures in two red-crowned cranes with the Type II ESF (Supplementary Fig. 1B) in Kushiro Zoo for the last decade. Thus, we thought Type II ESF was not expected to be strong enough for Red-crowned crane. Our crane with Type I-a ESF (Supplementary Fig. 1A) was able to eat on his own during the period of fixation, though it has been reported that a crane with an upper beak fracture tends to lose the ability to eat independently [2, 6]. The Type I-a ESF also allows cranes to maintain their ability for self-eating during the period of fixation because the fixator is compact and may have weaker stress for cranes.

Beak malocclusion, which was observed in the latter half of the fixing period, spontaneously improved within one month after removal of the ESF and did not recur after that. The distal portion of upper and lower beaks continues to regrow on a daily basis [10], and it was thought that the beak malocclusion was caused by fixation of the upper beak. Nevertheless, we should had kept the fixation of the upper beak a little longer until stronger synostosis was confirmed.

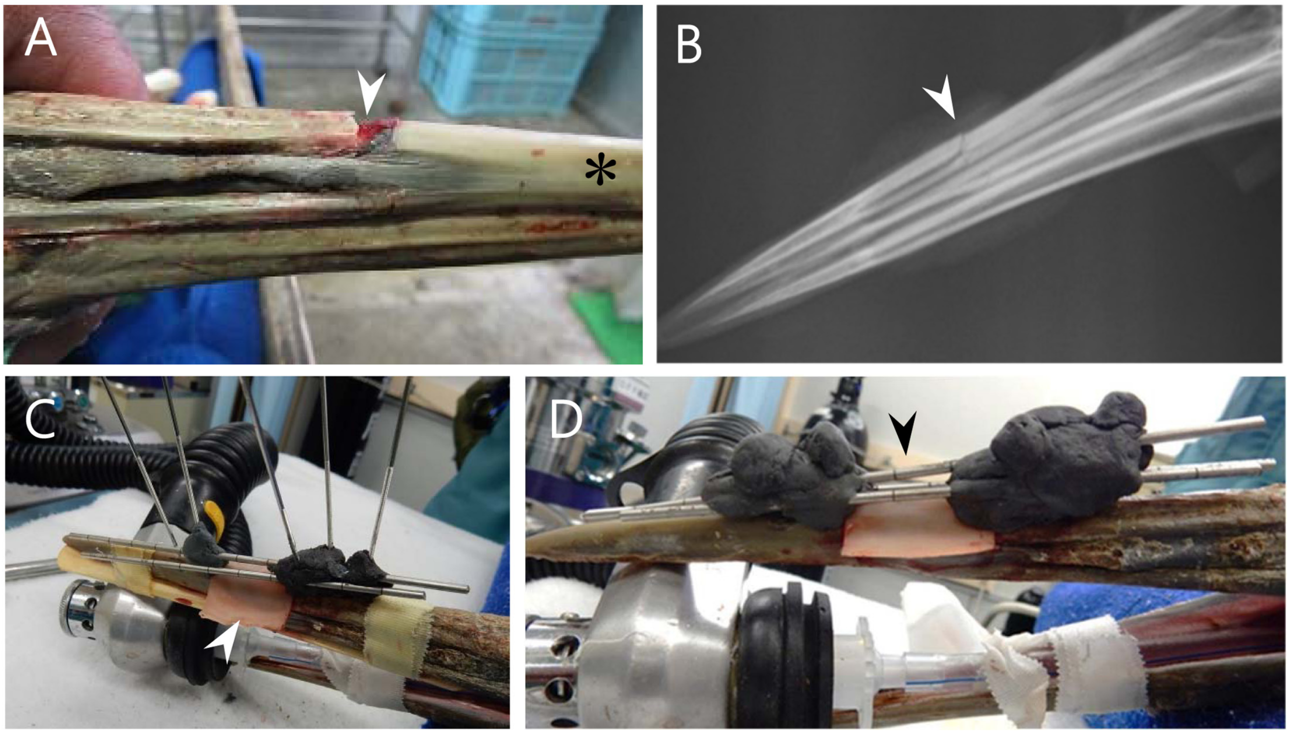

Fig. 1. [Day 1] Surgery for treating a middle upper beak fracture by a Type I-a external skeletal fixator (ESF) with a unilateral epoxy putty fixator. (A) Right-side view of the middle upper beak compound fracture. (B) Left-side radiograph of the upper and lower beaks before surgery. (C) The jointing 5 half-pins for the median of the premaxilla with epoxy putty during surgery. (D) The completed ESF placed on the upper beak. The arrowhead shows the site of the middle upper beak fracture (covered with a hydrocolloid plaster in C and D), and the asterisk shows the distal side of the upper beak.

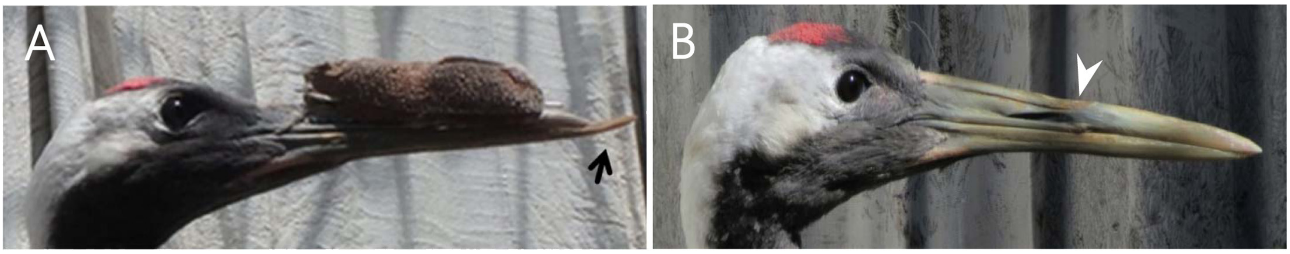

Fig. 2. The beak during and after treatment. (A) [Day 40] The crane lived with the external skeletal fixator (ESF) on its upper beak, but the crane showed beak malocclusion with the upper beak being shorter and the lower beak being longer (arrowheads). (B) [Day 154] The beak showed a normal shape. The arrowhead shows the site of the middle upper beak fracture.

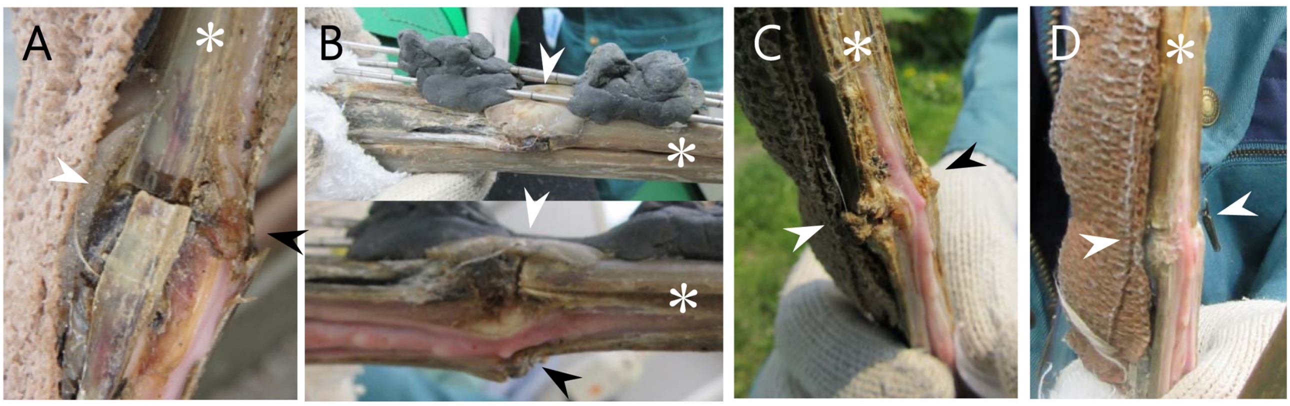

Fig. 3. Healing of the wound around the fractured upper beak. (A) [Day 5], (B) [Day 14], (C) [Day 22], (D) [Day 35]. The arrowhead shows the site of the middle upper beak fracture, and the asterisk shows the distal side of the upper beak.

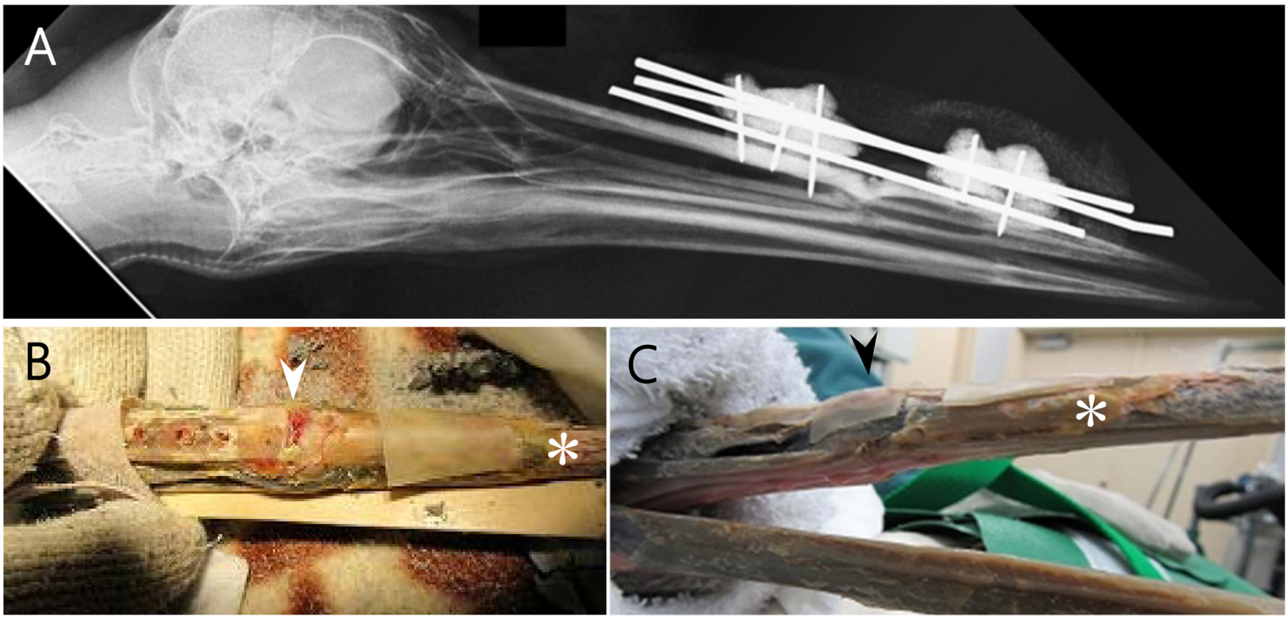

Fig. 4. [Day 49] Surgery for removal of the external skeletal fixator (ESF). (A) A radiograph of the right side before surgery showed bone healing. (B) Cranial and (C) right-side view of the upper beak after removal of the ESF. The arrowhead shows the site of the middle upper beak fracture, and the asterisk shows the distal side of the upper beak.

This is the first successful case of repair of a middle upper beak fracture in a Red-crowned crane. It is important to prevent various accidents and to keep cranes in a safe breeding cage, as well as a preparation for the treatment of the beak fractures due to sudden accidents.

POTENTIAL CONFLICTS OF INTEREST. The authors have nothing to disclose.

ACKNOWLEDGMENTS. We thank veterinarians of Kushiro Zoo, Mr. Fujimoto and Mr. Ai for their support. We also thank all staff members of Kushiro Zoo.

REFERENCES

1. Hartup, B., Niemuth, J. N., Fitzpatrick, B., Fox, M. and Kelley, C. 2010. Morbidity and mortality of captive whooping cranes at the International Crane Foundation 1976–2008. pp. 183–185. Proceedings of the Eleventh North American Crane Workshop, Wisconsin Dells.
2. Howard, P. 1989. Management of beak fractures in cranes. pp. 24–30. Proceedings of the 1989 Exotic Animal Dentistry Conference, Philadelphia.
3. Iima, H. 2016. Rescue of wild red-crowned cranes at Kushiro Zoo (Hokkaido, Japan). *Jpn. J. Zoo Wildl. Med.* **21**: 121–129. [CrossRef]
4. Inoue, M., Shimura, R., Uebayashi, A., Ikoma, S., Iima, H., Sumiyoshi, T., Teraoka, H., Makita, K., Hiraga, T., Momose, K. and Masatomi, H. 2013. Physical body parameters of red-crowned cranes Grus japonensis by sex and life stage in eastern Hokkaido, Japan. *J. Vet. Med. Sci.* **75**: 1055–1060. [Medline] [CrossRef]
5. James P. T. 2002. Small Animal External Skeletal Fixation with the IMEX-SK Fixator, NEW LLL, Tokyo (in Japanese with some English Tables).
6. Lothamer, C., Snyder, C. J., Mans, C., Soukup, J. W. and Hartup, B. K. 2014. Treatment and stabilization of beak symphyseal separation using interfragmentary wiring and provisional bis-acryl composite. *J. Vet. Dent.* **31**: 255–262. [Medline] [CrossRef]
7. Maclean, R. A. and Beaufrere, H. 2014. Gruiformes (cranes, limpkins, rails, gallinules, coots, bustards) (Chapter 19), pp. 155–164. In: Fowler's Zoo and Wild Animal Medicine, 8th ed. (Miller, E. R. and Fowler, M. E. eds.), Saunders, Philadelphia.
8. Olsen, G. H. 2003. Oral biology and beak disorders of birds. *Vet. Clin. North Am. Exot. Anim. Pract.* **6**: 505–521, vi. [Medline] [CrossRef]
9. Olsen, G. H. and Carpenter, J. W. 1997. Cranes (Chapter 56 in Section 8, Specific species) pp. 973–991. In: Avian Medicine and Surgery (Altman, R. B., Clubb, S. L., Dorrenstein, G. M. and Quesenberry, K. eds.), Saunders, Philadelphia.
10. Olsen, G. H., Langenberg, J. A. and Carpenter, J. W. 1996. Medicine and surgery. pp.137–174. In: Cranes: Their Bioligy, Husbandry and Conservation, 1st ed. (Ellis, D. H., Gee, G. F., Mirande, C. M., Ellis, C. H. and Shaulll, L. A. eds.), Hanncock House Publishers, Surrey.