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Short Paper

The use of cerclage wire for surgical repair of unilateral rostral mandibular fracture in horses

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Summary

Fractures of the rostral mandible in horses are the most common type of jaw fractures. The present study was performed for stabilization of rostral mandibular fracture with cerclage wire. In a retrospective case series, six client-owned horses with unilateral mandibular fractures were admitted to our clinic and suffered from a major gingival wound at rostral part of mandible. Rostral mandibular fracture was diagnosed through clinical examination and radiography. Fractured region was repaired by cerclage wire under the effect of general anesthesia and wires were maintained for 6-12 weeks. The repair of mandibular fracture by cerclage wiring exhibited good fracture reduction and fixation in five horses and fair results in one horse. After twelve weeks, the fracture healing was excellent practically and cosmetically. Furthermore, the horses appeared normal without any evidence of teeth-related mastication problems, obstinate fracture-site fistula, or extreme callus formation. Radiographically, cerclage wire achieved good fracture fixation and fracture gap closure. Moreover, the formation of uniting callus was noticed at 6-12 weeks post-operatively. It was concluded that, unilateral mandibular fracture in horses can successfully be repaired by interdental wiring (IDW). All horses were returned to their usual activities without any fracture healing-related masticatory problems at the time of follow-up.

Key words: Cerclage wire, Horse, Mandibular fracture, X-ray

Introduction

The mandible is the most commonly fractured bone in the equine's head. They include fractures that involve the incisive region, the interdental space, the caudal horizontal ramus or the vertical ramus of the mandible (Auer, 2011). In horses, unilateral mandibular fractures of the horizontal or vertical ramus can occur following blunt trauma from kicks, falls or collisions, which are less frequent than those of the incisive mandibular part (Schneider, 1990; DeBowes, 1996; Auer, 2011). Mandibular fractures rostral to the cheek teeth are common fractures of the equine's head (Jansson, 2016). Bilateral, transverse or short oblique fractures of the interdental area are common (DeBowes, 1996). Radiographs of the region will show the precise location of the fracture, as well as the possible involvement of tooth root (Schneider, 1990; DeBowes, 1996; Auer, 2011). Open mandibular fractures are common, in which the fracture ends are usually seen in the oral cavity (Belsito and Fischer, 2001). Healing of mandibular fractures in horses is fast when adequate stability is provided due to good local vascularization. The most common complications of mandibular fractures are tooth loss, malocclusion, osteomyelitis, sequestration, as well as chronic discharge (Henninger *et al.*, 1999).

The surgical fixation techniques used for mandibular

fractures are intraoral wiring, screws and wires, intraoral application of a U-bar brace, external fixators and internal fixation using lag screws or plates (Schneider, 1990; Jansson, 2016; Karrouf *et al.*, 2017). In horses, cerclage wire was successfully used for surgical treatment of mandibular fractures (Naddaf *et al.*, 2015).

Although complications in horses with mandibular fractures are common, long term prognosis for functional and cosmetic outcomes are favorable when repaired with cerclage wire (Gopinathan *et al.*, 2013; Jansson, 2016). Delay or failure to repair these fractures may result in malocclusion, tooth loss, osteomyelitis, loss of function, and less than optimal cosmesis (Schneider, 1990; Henninger *et al.*, 1999).

The purpose of the current study was to achieve normal occlusion of mandible, enhance mandibular function, and avoid excessive soft tissue damage, via rigid fixation of unilateral rostral mandibular fracture in horses by cerclage wire.

Materials and Methods

Horses

The present study was carried out on a total number of six horses that were presented with major gingival wounds at the rostral part of mandible (Table 1). The mandibular fractures were caused by car accident, kicks

by other horses, and collisions into a tree. These animals were admitted to Mansoura Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Mansoura University, Mansoura, Egypt. The age of the affected horses ranged from 2-10 years. Diagnosis of rostral

mandibular fracture and gingival wound was carried out by clinical and radiological examinations (Figs. 1a, d; Figs. 2a, b). Horses suffered from unilateral mandibular fractures in the horizontal ramus that involved the incisive teeth (Fig. 1a).

Table 1: Clinical and radiographic features of unilateral rostral mandibular fractures in 6 horses treated by cerclage wire

Horse	Fracture configuration	Age (year)	Fixation method	Oral wound	Post-operative complication	Cerclage wire removal
1	Unilateral, open, oblique fracture of right rostral mandible	2	Cerclage wire	Yes	No	6 weeks
2	Unilateral, open, transverse fracture of left rostral mandible	4	Cerclage wire	Yes	No	6 weeks
3	Unilateral, open, displaced and comminuted fracture of interdental space and caudal part of right horizontal ramus	8	Cerclage wire	Yes	Malocclusion	6 weeks
4	Unilateral, closed, transverse fracture at mid of interdental space of right horizontal ramus	6	Cerclage wire	No	No	6 weeks
5	Unilateral, open, oblique fracture of right rostral mandible	10	Cerclage wire	Yes	Wire loosening	12 weeks
6	Unilateral, open, oblique fracture of left rostral mandible	3	Cerclage wire	Yes	No	6 weeks

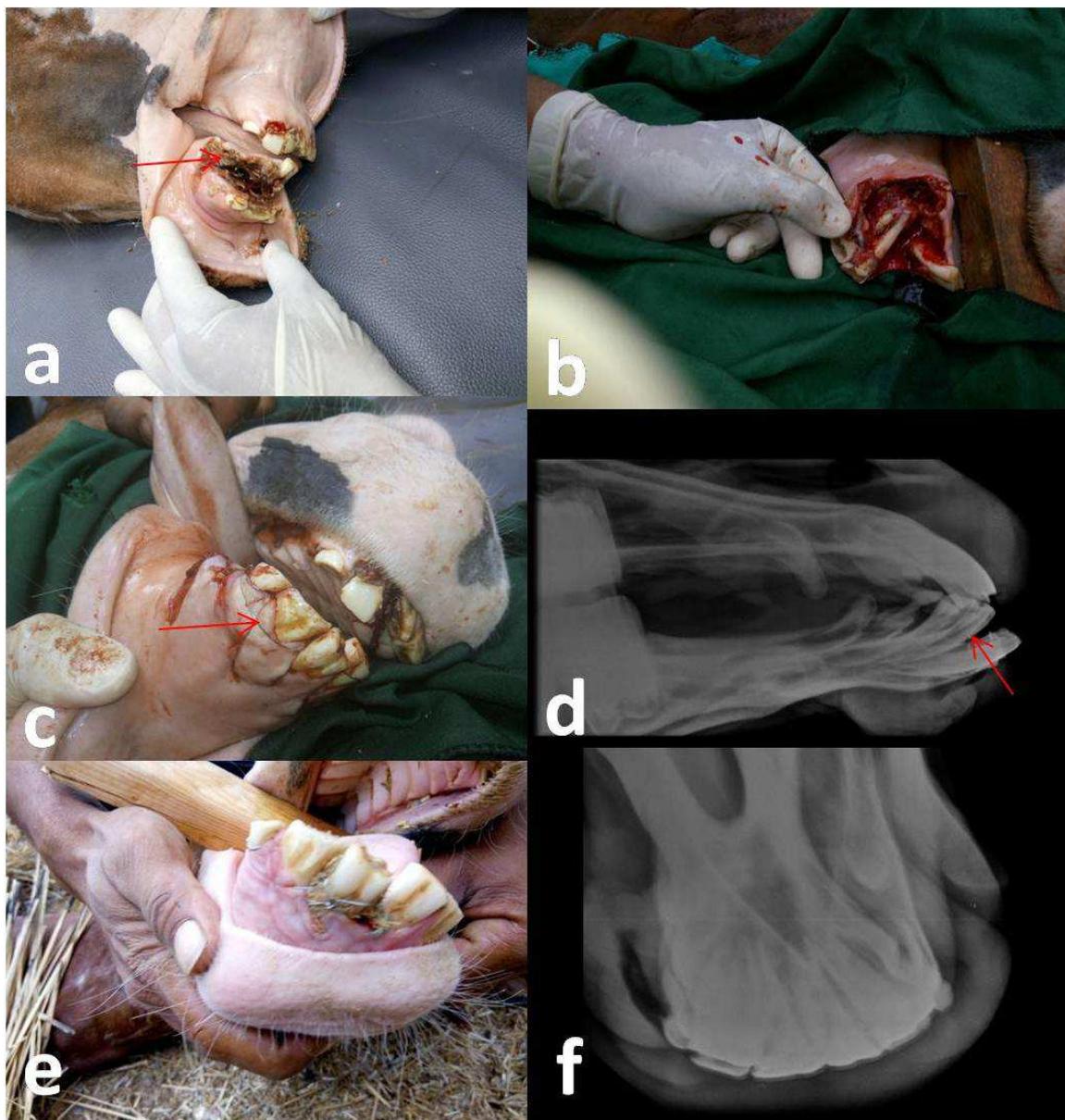


Fig. 1: Rostral mandibular fracture in a 2 year old horse (arrow; **a**), curettage of fractured part (**b**), after suturing of gingival wound and application of cerclage wire (arrow; **c**), lateral radiographic picture showing fracture line (arrow; **d**), two months after healing of the wound and fracture line (**e**), and dorso-ventral radiograph showing the healing of the rostral mandibular fracture in horse (**f**)

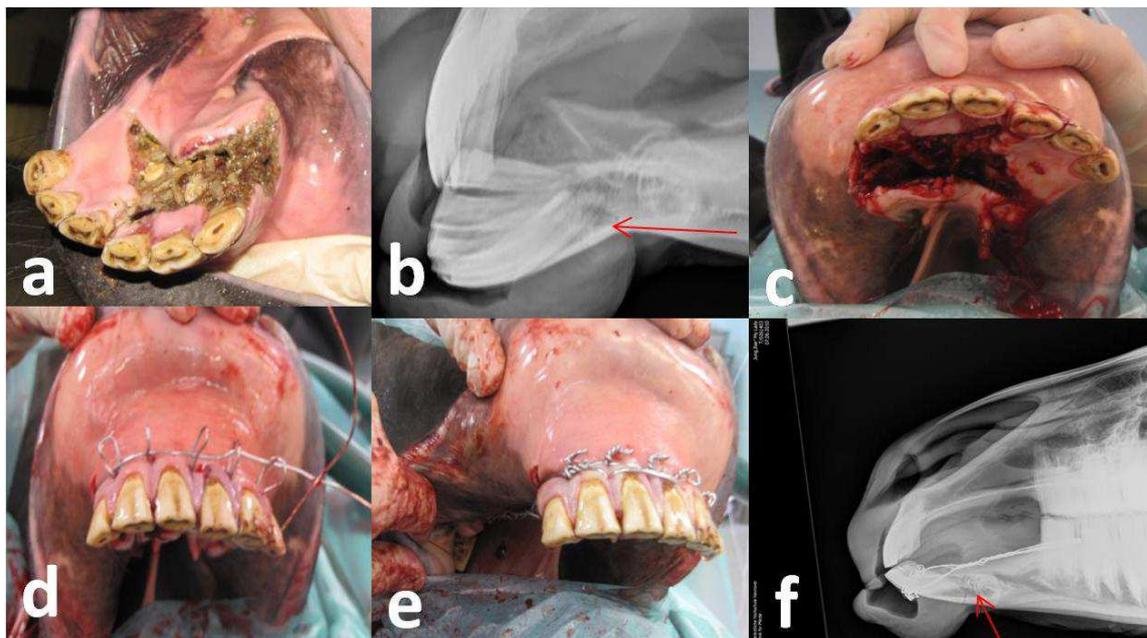


Fig. 2: Unilateral, open, oblique fracture of left rostral mandible in a 3 year old horse (a), lateral radiographic picture showing fracture-site (arrow; b); curettage of fractured-site (c), after application of cerclage wire (d), twisting of cerclage wire (e), and lateral radiograph showing the anchored cerclage wire and healing of the rostral mandibular fracture (arrow) in horse at one month post-operatively (f)

Radiographic images (lateral and dorso-ventral views) were taken preoperatively and post-operatively at one month intervals until bone healing.

Anesthesia and surgical repair techniques

Prior to surgery, horses were held off feed for 12 h, and were pre-medicated with intravenous injection of acepromazine (Vetranquil 1%, Libourne Cedex, France) at a dose of 0.05 mg/kg body weight (BW). Anesthesia was induced and maintained by infusion of a freshly prepared mixture of 500 mg xylazine HCl, 40 mg midazolam, and 2 g ketamine HCl dissolved in 1 L of 5% dextrose.

The oral cavity and the fractured bone ends were washed with sterile saline and curetted to remove debris, damaged bone and saliva (Fig. 1b; Fig. 2c). They were prepared for operation by washing with diluted povidone iodine.

Two holes were created in the fractured-site by 1.2 mm pin for passing of the cerclage wire. Furthermore, this desired pin was placed on the bone just ventral to the first and second incisors, and directed from the lateral to medial side of the rostral mandible including the rostral sublingual oral mucosa. When the first hole was created, the pin was removed and a 14 gauge needle was inserted from the lateral to medial side of the rostral mandible. The cerclage wire was then threaded through the 14 gauge needle from the medial to lateral side of the rostral mandible. Then, another hole was similarly created 2 cm caudal to the first one, and the cerclage wire was passed in the same method as the first (Fig. 1c; Fig. 2d). The wire ends were twisted at the ventral side of rostral mandible just below the mandibular incisive teeth for fracture reduction. The sharp ends of the wire knots were

bent (Fig. 2e).

Cerclage wire was anchored from the incisors to the ipsilateral premolar teeth for greater stability (Fig. 1c; Fig. 2e). The intraoral soft tissue lesions were sutured to cover the fracture line.

Post-operative management and follow-up

The oral cavity was lavaged 3 times daily with sterile saline and oral antiseptic. Antibiotic (penicillin-streptomycin [30,000 U/kg penicillin, 10 mg/kg streptomycin], Penstrep, Norbrook Laboratories, Corby, Northamptonshire, NN18 9EX, UK) was administered intramuscularly for 5 days and phenylbutazone (Phynelject, Adwia, Egypt; 4.4 mg/kg intravenously) was administered for 3 days post-operatively.

Clinical and radiographic follow-up examination was performed periodically for 6 to 12 weeks after surgery in all animals and the wire was removed after complete healing. Additionally, further follow-up information was obtained via telephone calls with the owners.

All treated horses were routinely inspected for identification of any evident cosmetic, masticatory, fracture healing-related (excessive callus formation or permanent fracture-site fistula) or tooth-related (tooth loosening, tooth deviation, feed impaction) problems.

Results

There were 6 horses (n=6) with unilateral mandibular fracture of the rostral horizontal rami (Table 1). Fracture-sites were rostral to the canines in one horse (n=1), rostral to the first premolar in 2 horses (n=2), caudal to the canines in one horse (n=1), and fracture of the incisive bone in 2 horses (n=2).

Saline lavage was achieved 3 times a day within the defects and the food particles were detached. An oral antiseptic was used to minimize the development of bone infection. Gingival wound healed completely by two weeks post-operatively in all cases. Moreover, animals became able to use their mandible normally during feeding by 4 weeks post-operatively.

Repairing of mandibular fracture by cerclage wiring achieved good fracture reduction and fixation in five horses and fair results in one horse (Fig. 2f). After 12 weeks, fracture healing was excellent practically and cosmetically in 5 horses (Fig. 1e). These horses resumed to their usual daily activities without any evident masticatory- or tooth-related problems, no obstinate fracture-site fistula or extreme callus formation.

Post-operative complications were observed in two cases; one horse displayed loosening of the cerclage wire and the wire was re-tightened under sedation. The owner confirmed that the animal started to use its mouth normally at 15 days post-surgery. In the second case, malocclusion was observed; however, that did not interfere with prehension and mastication of food.

Radiographically, cerclage wire achieved good fracture fixation and fracture gap closure were achieved after healing (Fig. 2f). Moreover, formation of uniting callus was noticed at 6-12 weeks post-surgery (Fig. 1f).

Discussion

In the present study, we aimed to evaluate the use of cerclage wire for the treatment of rostral mandibular fractures in horses. These fractures can be reduced and stabilized with interdental wiring (IDW). Interdental wiring is a simple, inexpensive, and quick technique. This technique was preferred because of the existing circumstances, and it achieved practical fracture healing (Çetinkaya and Demirutku, 2012).

In the present study, mandibular fractures in horses were mainly caused by trauma from kicks or collisions similar to a previous report (Auer, 2011). However, Ramadan (1994) reported that trauma from other animals or handlers were the second common cause of mandibular fracture in camels. Treatment by IDW achieved a satisfactory healing in most horses. Similar findings were previously reported (Ahmed, 2011).

In this study, we observed a rapid healing of the gingival wound that could be due to vascularization of the gingiva, which would speed up the healing process (Çetinkaya and Demirutku, 2012).

Most cases of rostral mandibular fractures in horses are oblique fractures (Auer, 2011). The use of hemicerclage wire compressed fracture fragments and prevented their sliding. These results agreed with previous reports (Henninger and Beard, 1997; Martens *et al.*, 1999; Auer, 2000; Beard, 2009). Interdental wiring has been shown to be efficient for the repair of stable and transverse fractures (Gahlot *et al.*, 1989). However, this technique is not suitable for all types of mandibular fracture and perfect reduction is difficult with oblique and multiple mandibular fractures (Murch, 1980).

Fractures were open in 5 of the 6 cases admitted for this study. All fractures were rostral to the cheek teeth (premolar 2 and molars 1-3). Similar rostral mandibular open fractures in the camel have been attributed to the presence of first premolar alveoli, the mandibular canal, and mental foramina (Siddiqui *et al.*, 2012). Open mandibular fractures heal well as abundant blood supply to the head and relatively stable nature of many fractures (Ramzan, 2008).

In the existing study, cerclage wire was used successfully in fixation of mandibular fractures in horses (interdentally and hemicerclage techniques). All treated cases had a satisfactory prognosis with good dental occlusion. However, some complications were observed such as wire loosening (1 of 6, 17%) and malocclusion (1 of 6, 17%). These complications were successfully managed with good results. These findings are opposite to previously reported ones (Gopinathan *et al.*, 2013; Naddaf *et al.*, 2015). Interdental wire loosening was observed in 22% of the horses (Gopinathan *et al.*, 2013; Naddaf *et al.*, 2015). In another report, tooth loss, malocclusion, osteomyelitis, sequestration, as well as chronic discharge were reported as complications (Çetinkaya and Demirutku, 2012).

The technique used in the present study was not efficient enough to prevent rostral mandibular malocclusion formation; however, that did not cause pain or interfere with feed intake. Similar complications were previously reported with these techniques (Henninger *et al.*, 1999; Peavey *et al.*, 2003; Beard, 2009).

The horse started to use the fractured jaw within 24 h after fixation (Çetinkaya and Demirutku, 2012). In the present study, the interfragment fixation of mandibular fracture using cerclage wire in horses did not have enough biomechanical efficiency; therefore, a rostral mandibular malocclusion occurred during mastication movements after surgery. Furthermore, the malocclusion did not worsen in the following days, and no excessive callus formation was formed (Beard, 2009; Çetinkaya and Demirutku, 2012).

Cerclage wires were left in place, as they got covered by mucosa and did not cause any irritation to the adjacent tissues (Çetinkaya and Demirutku, 2012; Jansson, 2016). In the present study, the sharp ends of wire knots were bent to minimize soft tissue irritation. However, it was reported that IDW induced intraoral ulceration as wires compressed the gingiva (Ahmed, 2011; Karrouf *et al.*, 2017).

Cerclage wires are the most frequently applied fixation devices for long oblique rostral mandibular fracture in horses as they are quite economic and do not require particular skills or materials. Despite some negligible complications, a functional fracture healing was achieved. All horses returned to their usual activities without any clinically apparent masticatory or healing-allied problems at the time of follow-up.

Conflict of interest

Authors declare no conflict of interest.

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