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Standing oral surgery for the management of mandible and maxilla fractures in horses: a case series of 15 horses

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ABSTRACT

Fractures of the mandible and maxilla are common in horses. The present study was conducted on fifteen horses referred for the management of mandible or maxilla fractures. Fixation methods were used to repair the fractures in these horses, including tension band and cerclage wires, dynamic compression plates, and lag screw fixation. All procedures were performed under chemical restraint and regional nerve block anesthesia in the standing position. According to the results, the long term follow-up of the horses was satisfactory, and no severe complications were observed. Jaw fractures are most successfully treated by early diagnosis and fracture fixation. The surgical management of most oral region injuries may be readily performed in the standing position, to avoid the risks associated with general anesthesia in horses.

Key words: horse; mandible fractures; standing surgery

Introduction

Traumatic injuries to the oral cavity are prevalent in horses, and include fractures of the teeth, mandible and maxilla, as well as the loss of related surrounding soft tissues (HAGUE and HONNAS, 1998). The mandible is the bone most commonly affected by fractures in the equine head. These fractures are often caused by a kick from another horse, or occur when a horse abruptly pulls back its head or attempts to escape while the incisors or mandible are trapped on a fixed object. Mandibular fractures may occur at any site along the mandible, and affect the incisive area, interdental space and the vertical or horizontal ramus through the cheek teeth (BELSITO and FISCHER, 2001). However, the incisive and interdental regions are frequently affected by fractures, since the forces needed to

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cause fractures in these areas are significantly less potent than other regions (MONCK et al., 2020). Mandibular fractures are classified on the basis of their cause, anatomical location, fracture type, degree of stability, and the involvement of other structures (BELSITO and FISCHER, 2001; PEAVEY et al., 2003). Tension band wiring, external skeletal fixators (ESFs), threaded intramedullary pins, a lag screw and compression plate, or a combination of these techniques may be utilized for fixation of jaw fractures in horses, depending on the fracture configuration (BELSITO and FISCHER, 2001; MONCK et al., 2020; PEAVEY et al., 2003; BEARD, 2009; WILSON, 2011; NELSON et al., 2021). With adequate stability, mandibular and maxillary fractures heal very quickly owing to the high blood supply (MONCK et al., 2020, PEAVEY et al., 2003). In order to reduce the risks associated with general anesthesia in horses, it is recommended that oral procedures be performed in horses by using appropriate sedative combinations and regional perineural anesthesia in the standing position (MENZIES and EASLEY, 2014).

This case series aims to report a selection of cases with mandibular and maxillary bone fractures treated using different techniques in horses undergoing standing oral surgery, with chemical restraint and regional nerve block anesthesia.

Case presentation

The medical records of the horses referred for the surgical management of mandibular or maxillary bone fractures due to trauma were reviewed in this study. Data were collected on fracture classification, surgical methods of repair, and complications in the animals.

Surgical procedure. In all the cases, a complete history was obtained, and clinical and oral examinations were performed prior to the surgical management. In addition, appropriate radiographic images of the head were obtained, based on the oral examination findings.

The surgical procedure was performed with the horse sedated in the standing position. For this purpose, the horse was restrained in stocks in a quiet area. An intravenous catheter was placed for the safe administration of the intravenous analgesic drug and rapid venous access in an emergency. Deep sedation and analgesia were attained using detomidine (20 µg/kg, IV) combined with morphine (0.1 mg/kg, IV). In addition, an antibiotic (cefazolin (10 mg/kg, IV) and also flunixin meglumine (1.1 mg/kg, IV) were administrated prior to the surgery. An appropriate regional anesthesia method was also employed, using 2% lidocaine, depending on the fracture site and the surgical technique. Oral cavity lavage was performed using 0.9% saline and a chlorhexidine gluconate solution prior to the procedure, to reduce the number of oral bacteria.

Mandibular symphyseal transverse fracture (4 horses, Fig. 1). A bilateral mandibular nerve block was performed at the level of the mandibular foramen on the medial aspect of the mandibular ramus to anesthetize the mandibular structures, including the lower teeth and mandible (DUGDALE, 2010). After debridement of the fracture site, bilateral interdental tension band wiring was used for management of these cases. For this purpose, the fractured segments were reduced, then 16-18 cerclage wires were inserted interdentally using 14-16 gauge needles inserted between the teeth at the level of the incisors, and anchored caudally around the canine or premolar 2.

Fig. 1. A transverse fracture through the mandibular symphysis

Avulsion fracture of the incisive bone (7 horses, Fig. 2). In these cases, anesthetizing the rostral parts of the mouth was indicated. For this purpose, in the horses with a fracture of the incisive part of the mandible, a mental nerve block was performed through the mental foramen of the lateral mandible, rostral to the first cheek tooth. In the horses with a fracture in the incisive segment of the maxilla, the infraorbital nerve was desensitized via the infraorbital foramen, between the rostral facial crest and the nasoincisive notch (DUGDALE, 2010). The avulsion fractures of the incisive bone were repaired using a combination tension band and cerclage wiring (Fig. 3). Initial debridement and irrigation of the fracture sites were also performed. To this end, 16-18 gauge wires were passed through 14-16 gauge needles and inserted between the incisor teeth at the level of the gingiva, then tightly twisted to reduce and attach the avulsion segments and unstable teeth (Fig. 3). For augmenting the strength of fixation and prevention of oral irritation, the wires were embedded in polymethylmethacrylate (PMMA), (Fig. 4).

Fig. 2. An avulsion fracture of the mandible bone including the intermediate and corner incisors

Fig. 3. Tension band wiring to repair a rostral mandibular fracture involving the incisors

Fig. 4. Wire coated with Polymethylmethacrylate

Unilateral and bilateral fractures of the horizontal ramus (3 horses: one unilaterally, Fig. 5, 6, 7, two bilaterally). Since these fractures were unstable and had a rigid cortex, on the basis of radiographic evaluation, plate fixation was

Fig. 5. A long oblique fracture through the horizontal ramus of the mandible

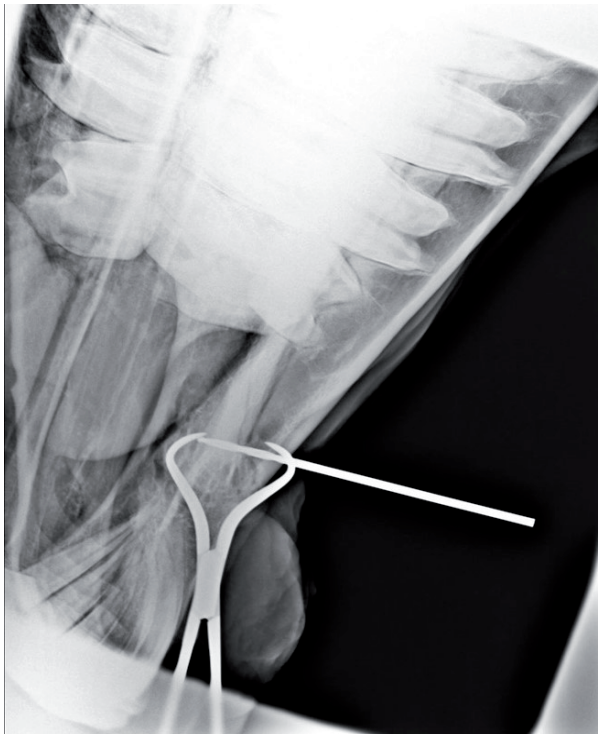

Fig. 6. Intraoperative radiograph to confirm anatomical reduction of the fracture

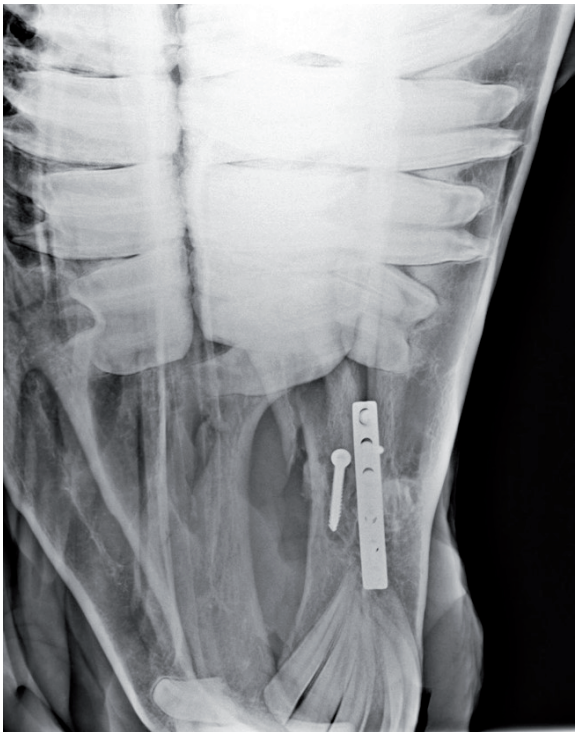

Fig. 7. A horizontal ramus fracture of the mandible repaired with a dynamic compression plate and a lag screw

selected for their management. In the standing position with sedation, the mandibular region was clipped. Following this, a mandibular nerve block was provided to anesthetize the lower arcade, mandible, and lower lips. After preparing the surgical site aseptically, a longitudinal incision was made through the skin on the ventrolateral aspect of the mandible, over the affected area of bone. The fracture was reduced using pointed reduction forceps and checked radiographically (Fig. 6). It was then stabilized by a dynamic compression plate (DCP) combined with one or two lag screws. For this purpose, 3.5 mm or 4.5 mm DCP was applied along the interdental horizontal ramus of the mandible on the lateral or ventral aspect of the fractured bone. Depending on the fracture configuration, a cortex screw was applied in lag fashion to provide compression and rigid fixation at the fracture site. Postoperative radiographs were taken to confirm stabilization (Fig. 7). Finally, the incision was closed routinely.

Systemic antibiotic therapy using cefazolin and gentamicin, and non-steroidal anti-inflammatory therapy using flunixin meglumine were administrated intravenously, postoperatively. The duration of administration was determined by the severity of the contamination in each case. Moreover, feeding with soft foods and oral cavity lavage with oral antiseptic (0.2% chlorhexidine gluconate) were recommended, followed by meat. Vertical ramus fracture of the mandible with disruption to the temporomandibular joint (1 horse): The horse was euthanized.

Results

In total, fifteen horses of various breeds were studied with mandibular or maxillary bone fractures due to trauma. These horses were referred for treatment within a short time after the occurrence of the fracture, so no serious complications associated with time delay were identified before surgery. However, excessive salivation, trapped food particles between the fracture lines in the oral lesions, and swelling around the fracture site were observed. Of these fifteen horses presented, seven cases had an avulsion fracture of the incisive bones (six mandibular and one maxillary fractures), four

horses had a mandibular symphyseal transverse fracture, three cases had a horizontal ramus fracture in the mandible, and one horse had a vertical ramus fracture with disruption of the temporomandibular joint (Table 1). None of the horses required hospitalization or a nasogastric tube for feeding, and post-operative examinations were performed on all the horses. In the early postoperative follow up, food particles were trapped in the oral lesions in some horses, and it was recommended that food particles be removed after feeding by regular vigorous oral lavage. Drainage from the fractures site was observed in some horses, and managed with antibiotic therapy and lavage. All the horses began to use their jaw functionally within a few days after the surgery. The horses returned to a normal diet within 1-2 weeks after the surgery. Clinical and radiographic follow-up (Fig. 8) was performed periodically to assess the healing process, as well as for evaluation of surgical site infection or implant failures. The healing of the oral wounds and fractures was accomplished in all the horses without any serious complications associated with fracture healing.

Table 1. Clinical summaries of horses with jaws treated by various techniques

Classification of fractures	Method of repair	Number of horse (15 horses)
Avulsion fracture of the incisive bone of the mandible	Tension band and cerclage wiring	6
Avulsion fracture of the incisive bone of the maxilla	Tension band and cerclage wiring	1
Mandibular symphyseal transverse fracture	Interdental tension band wiring	4
Unilateral fracture of the horizontal ramus of the mandible	Dynamic compression plate with the lag screw	2
Bilateral fracture of the horizontal ramus of the mandible	Dynamic compression plate with the lag screw	1
Vertical ramus fracture of the mandible	-	1

Fig. 8. A radiograph taken 2 months postoperatively, demonstrating advanced remodeling, indicating progressive healing

Discussion

In the past, some diagnostic and surgical dental procedures in horses were carried out under general anesthesia. With the improved understanding of general equine anesthetic-related risks, the availability of more effective sedative agents, as well as advancements in surgical equipment and techniques, many oral surgeries are being performed in standing sedated horses (MENZIES and EASLEY, 2014; TANNER and HUBBEL, 2019; PEARCE, 2020). Unlike some similar reports published recently, which have focused on the treatment of equine jaw fractures under general anesthesia, in the present study the surgical reconstruction of the fractures were carried out entirely in standing horses under sedation using regional anesthesia. This avoids the risks associated with general anesthesia in horses, and

provides better access to the jaw structures because the head is in an anatomical position under these circumstances (MENZIES and EASLEY, 2014).

Mandibular fractures are common orthodontic injuries in horses. Among the fifteen horses studied, thirteen horses had a mandible fracture, and one horse had a maxilla fracture. Avulsion fractures of the mandibular incisive bone had the highest prevalence (n=6) followed by mandibular symphyseal (n=4), mandibular horizontal ramus (n=3), and mandibular vertical ramus (n=1) fractures, respectively. Moreover, one horse had an avulsion fracture of the maxillary incisive bone.

Multiple techniques are used for the repair of these fractures (PEAVEY et al., 2003; BEARD, 2009; WILSON, 2011; MONCK et al., 2020). In the present study, in line with the anatomical region of the fracture site and configuration, various methods were employed. A dynamic compression plate with a lag screw was preferred to repair unilateral and bilateral fractures of the horizontal ramus, under chemical restraint and regional nerve block anesthesia. Although other techniques are used for reconstruction of horizontal ramus fractures, plate fixation provides the most stable construction, especially for unstable fractures (BEARD, 2009; KUEMMERLE et al., 2009). Application of a plate for fixation of the equine mandibular fractures represents a challenge for veterinary surgeons for several reasons, including interference of the screw with the dental root, limiting the length of the screw and the need for expertise. Since the tension side of the mandible is the occlusal surface, applying a plate to this side is also difficult. Therefore, the plate is commonly placed on the ventral or lateral aspect of the mandible, depending on the characteristics of the fracture, which may lead to reduction of the fracture's biomechanical stability (AUER, 1998; KUEMMERLE et al., 2009; CALDWELL and DAVIS, 2012; MONCK et al., 2020; BOORMAN et al., 2020). To date, no analytical studies have investigated the biomechanical effects of lateral versus ventral plate positioning (KUEMMERLE et al., 2009). Nevertheless, a few reports are available in the current literature regarding plate fixation for equine mandibular fractures. In their study, Caldwell and Davis successfully used DCPs to stabilize bilateral mandibular fractures in one horse under general anesthesia (CALDWELL and DAVIS, 2012).

In the study presented here, complete fracture healing and good functionality were achieved in three horses with a horizontal fracture of the mandibular ramus, using a DCP and lag screw. It seems that this technique is a reliable method for management of horizontal ramus fractures of the mandible. However, further studies are required on a larger group of horses to confirm this finding. A locking compression plate (LCP) is a new fixation concept in the field of equine orthopedic surgery. In a study conducted by KUEMMERLE et al., a LCP plate was successfully applied for osteosynthesis of complicated mandibular fractures in six horses under general anesthesia (KUEMMERLE et al., 2009). According to the results obtained, the LCP provided the greatest biomechanical stability in the equine cadaver mandibular fracture model (MONCK et al., 2020).

Given the higher cost of LCPs compared to DCPs, the LCP system is more suitable for management of complicated equine mandibular fractures. Seroma formation, breakage/ loosening of the screws and implant are among the complications that may occur due to plate osteosynthesis. However, infection is reported to be the main complication in this regard, particularly in open fractures (KUEMMERLE et al., 2009). In our cases, DCP osteosynthesis was observed to be an effective method, providing adequate stability in fracture healing.

According to the current study, avulsion fractures of the rostral mandible were common fractures (n=6). Cerclage and tension band wires were used for management of these horses, as well as for one horse with an incisive maxilla fracture, and four horses with a transverse fracture of the mandible. Notably, these procedures were performed on the horses in the standing position, with sedation and regional local anesthesia.

After wire application, complications, such as wire loosening, subsequent fracture instability, and soft tissue ulceration, may occur (PEAVEY et al., 2003; DIXON et al., 2008). In order to prevent these complication, PMMA was used on the wires applied in the horses presented here.

Wire application is the most commonly used fixation implant for reconstruction of the avulsion fractures of the incisor and mandibular symphysis in horses (BEARD, 2009; MENZIES and EASLEY, 2014). This implant is economic, with minimal invasiveness and its placement technique is also convenient, requiring no special skills (ÇETINKAYA and DEMIRUTKU, 2012; PEAVEY et al., 2003; RIZK and HAMED, 2018). Despite recent similar reports under general anesthesia (ÇETINKAYA and DEMIRUTKU, 2012; RIZK and HAMED, 2018), application of this method was fairly simple with the horses in the standing position in the present study.

External skeletal fixators (ESFs) are another alternative for the repair of mandibular fractures. Various ESF techniques are employed for management of mandibular fractures (BELSITO and FISCHER, 2001; NELSON et al., 2021). It is generally recommended that this type of fixation be combined with other implants, such as tension band wire, intraoral splints, pedicle screws, and even a bone plate (PEAVEY et al., 2003, ÇETINKAYA and DEMIRUTKU, 2012). Some of the potential complications of ESFs in horses are discomfort, difficult management, and entanglement in external objects (BELSITO and FISCHER, 2001; PEAVEY et al., 2003).

To date, only a few experimental studies have compared the implants used for reconstruction of jaw fractures in horses. In an experimental study in this regard, a DCP was reported to create the most stable fixation for mandibular interdental space fractures in comparison with other fixation methods, such as ESF, ESF with interdental wires, and interdental wires with an intraoral splint (PEAVEY et al., 2003). In another experimental study of the mandible model in horses, a LCP provided a more stable biomechanical construct compared to an external fixation pedicle screw with wires (MONCK et al., 2020).

Fractures of the vertical ramus of the mandible in horses are rare. Unstable vertical ramus fractures require external or internal fixation. Due to the anatomical features of this area, the placement of the plate may be difficult (BOORMAN et al., 2020; FUERST and AUER, 2020). In the present study, one horse presented with a vertical ramus fracture of the mandible. After thorough examinations, the animal was euthanized due to the disruption of the temporomandibular joint, which reduced the prognosis, and the decision of the owner of the horse.

Various potential risks have been attributed to jaw fracture repair in horses, including implant loosening, infection, bone sequestration, fracture instability, drainage, difficult mastication, gingival ulceration, and brachygnathism (PEAVEY et al., 2003; KUEMMERLE et al., 2009; WILSON, 2011; DIXON et al., 2008; RIZK and HAMED, 2018; NELSON et al., 2021). In the current study, the entrapment of food particles around the implant was a common complication in the horses, and was most prevalent in the horses treated by the wire fixation method. Therefore, the owners were asked to remove and rinse any accumulated food regularly. Furthermore, drainage from the fracture site was another common complication observed in the horses presented here, and it was successfully managed by prolonged antibiotic therapy and lavage. This condition may occur due to the contaminated nature of the fractures in the maxillary and mandibular regions. In this study, oral wound and fracture healing were achieved in all the horses. The implants were removed two to four months after the surgery. At the long-term follow up of the horses, the outcomes of the surgical treatment were satisfactory in all the horses, with no serious complications.

Conclusion

The primary goals of the surgical management of equine jaw fractures are rigid reconstruction and reestablishment of occlusion, with minimal complications. Various fixation techniques are used to repair these fractures. Each method has clinical advantages and disadvantages that should be considered in the treatment plan. Notably, these surgical techniques can be performed in the standing position under general sedation, by providing good analgesia and using regional anesthesia techniques, to avoid the risks associated with general anesthesia in horses.

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GHASEMI, S., K. SARDARI, E. LAJMIRI, E. MANSOURINEZHAD, A. HOSSEINI, Y. MEHRANI, H. ALEMI: Oralno kirurško liječenje fraktura mandibule i maksile u konja u stojećem stavu: slučajevi 15 konja. Vet. arhiv 92, 531-539, 2022.

SAŽETAK

Frakture mandibule i maksile česte su u konja. Ovo je istraživanje provedeno na 15 konja u kojih je učinjen kirurški zahvat zbog frakture mandibule ili maksile. Primijenjene su se metode fiksiranja, uključujući zatezne trake i serklažne žice, dinamičke kompresijske pločice i "lag" fiksacijske vijke. Svi su postupci izvedeni u stojećem stavu konja, uz smirivanje kemijskim sredstvima i regionalnu anesteziju bloka živca. Prema rezultatima, dugoročno praćenje konja bilo je zadovoljavajuće i nisu uočene veće komplikacije. Prijelomi čeljusti najuspješnije se liječe ranom dijagnozom i fiksiranjem. Kiruško liječenje većine ozljeda u području čeljusti može se izvesti odmah i u stojećem stavu konja kako bi se izbjegli rizici povezani s općom anestezijom.

Ključne riječi: konj; frakture mandibule; kirurški zahvat u stojećem stavu