How to Stabilize Mandibular and Maxillary Fractures Using Trans-Dental Dynamic Compression-Plate Fixation

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1. Introduction

Fractures of the incisive bone and the rostral mandible are common fractures of the horse's head. These are frequently repaired with orthopedic wires placed as tension bands near the gingival margin. Other methods such as lag-screw fixation, intramedullary pinning, and intraoral splints are rarely necessary.

Mandibular fractures of the interdental space are, however, surgically more demanding because they are often bilateral, unstable, and heavily contaminated (Fig. 1).[1]

In most cases, tension-band wiring will not give adequate stabilization.[2] Internal fixation is not a viable option in most cases because of the excessive contamination of the fracture site with food material and saliva. Complications include osteomyelitis and implant failure.

Other methods include external fixation with a Kirschner-Ehmer device, intraoral acrylic splints, intramedullary pinning, intraoral U-bar placement, or a combination of these techniques.[3,4] Complications of these methods include breaking of pins or wires, sequestration, superficial osteitis, septic alveolar periostitis, chronic draining fistulae, malocclusion, and chronic mandibular joint arthrosis caused by unsatisfactory stabilization.

The technique described here stabilizes the fracture using a dynamic compression plate (DCP) that is fitted to two incisor crowns and anchored caudally to the premolars with 4.5-mm cortical screws to bridge the fracture. This method avoids most of the above listed problems; it is minimally invasive, and the tooth crowns provide safe and rigid anchor points.

2. Materials and Methods

Between 1988 and 2005, 18 mandibular and 3 maxillary fractures were repaired at Somerton Equine Hospital in Ireland and Tierklinik in Telgte, Germany. This technique proved to be successful with minimal complications.

In affected horses, clinical signs may be subtle, and the injury may go undetected for several days when halitosis and excessive salivation caused by pain, osteomyelitis, or alveolar periostitis become apparent. Clinical examination is performed under standing sedation (detomidine, 6 μg/kg body

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Fig. 1. Unstable mandibular fracture in an adult horse.

Fig. 2. Temporary stabilization of the mandibular fracture by wiring the upper and lower incisors closed.

weight, IV and butorphanol, 0.05 μg/kg body weight, IV), which allows assessment of the extent of the oral gingival laceration, loose bone fragments, involvement of teeth, and other associated injuries. Radiographic examination should include lateral-medial, dorso-ventral, and oblique projections of the complete mandible, maxilla, and temporomandibular joint to accurately assess the fracture configuration.

Other intraoral radiographs like ventral-dorsal (mandibular) and dorsal-ventral (maxilla) projections may be obtained under general anesthesia (GA) before surgery.

3. Surgical Technique

Surgery is performed with the horse in dorsal or lateral recumbency, as preferred, under GA. The endotracheal (ET) tube is passed through the nasal passage. In one horse with maxillary fracture, the ET tube was passed through a tracheostomy because of extensive swelling at the nostrils. The technique is performed in two parts.

Part 1. Non-sterile: Cleaning and debridment of the fracture site followed by temporary stabilization of the fracture and adaptation of the trans-dental DCP.

Part 2. Sterile: Lavage and suture of the gingival laceration. Screw fixation of the DCP through buccotomy incisions.

Part 1

The fracture site is thoroughly cleaned and debrided to remove debris and any loose bone fragments. The mouth is temporarily wired closed at the incisors. A 14-gauge needle can be used to pass the wire between the teeth of young horses, but a 3-mm drill may be necessary in older horses. The wire is passed through the inter-dental space of the upper and lower incisors and tightened (Fig. 2). Where possible, the fracture should be further immobilized with a large-pointed reduction forceps to span the fracture line.

A narrow DCP (10–14 hole) that extends from the premolar 3 (PM3) to the first or second incisor is adapted to fit the individual and will vary depending on the age of the horse and the orientation of the incisors. Plate bending may be carried out using specialized American Society of Internal Fixation (ASIF) instruments (plate bender) or general purpose tools. Plates that have been used previously for orthopedic internal fixation may be used for this procedure. The plates can be pre-bent so that only minor adjustments need be made during the surgery. In recent cases, polymethyl methacrylate[a] was used for plate luting when adaptation at the incisors was difficult.

Part 2

The buccal area is clipped, and the entire surgical site is aseptically prepared. A 3–4 cm buccotomy (Fig. 3) over premolar 2 (PM2) and PM3 is performed through a skin incision, and the muscle and

Fig. 3. Buccotomy incision over the PM2 and PM3 with screws and DCP in place.

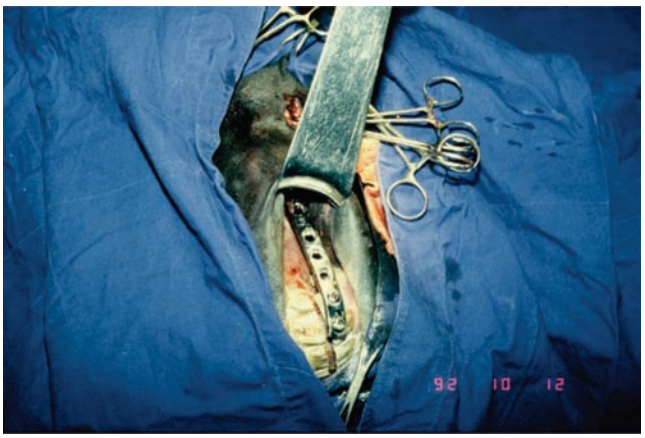

Fig. 4. DCP fitted to the incisor 2 and incisor 3.

mucosa layers are bluntly dissected. A wound retractor enables good visualization of this area. A hole is created in the crown of the tooth using a sharp 3.5-mm drill bit from a conventional tool kit. (A 3.2-mm hole would increase the risk of breaking the tap). Two tooth crowns of the premolars and two incisors are drilled centrally (3.5 mm) and tapped (4.5 mm). Care must be taken with the latter to avoid breaking the tap because of the hardness of the enamel of the tooth crowns. The drilling can be done using an air-powered drill from ASIF instrumentation with a Jacobs chuck to fit a 3.5-mm drill bit or using a dremel drill with a sterile cover; 4.5-mm cortical screws (length between 18–24 mm) are inserted, and the plate is then tightened to the teeth crowns (Fig. 4). The buccotomy is closed in three layers using absorbable suture material (3.5 metric) in the deep layers and non-absorbable in the skin (3 metric). The procedure is carried out similarly on the contralateral side (Fig. 5). At the end of the surgery, the reduction forceps and wire at the incisors are removed, and the horse is recovered.

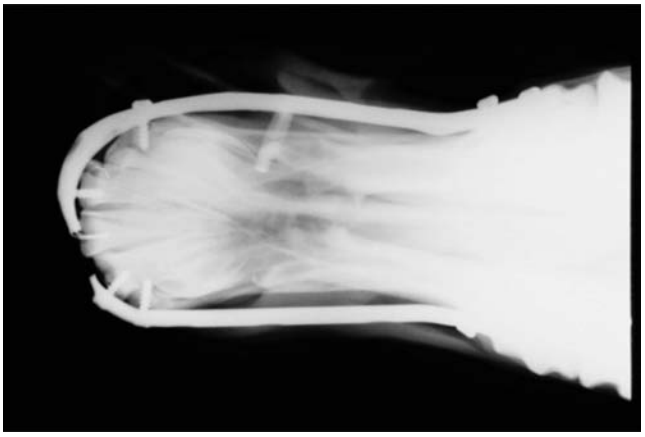

Fig. 5. Radiograph of bilateral trans-dental DCPs.

Antibiotic therapy includes 7 days of procaine penicillin (20 mg/kg body weight, IM), gentamicin (6.6 mg/kg body weight, IV), and anti-inflammatory treatment of phenylbutazone (4.4 mg/kg body weight, IV).

In cases where the gingiva of the intraoral laceration could not be closed completely, the horse was fed by nasogastric tube twice daily and muzzled for 1 wk, depending on progress. A distal drainage tract was created in these cases and flushed with a 5% povodine-iodine solution twice daily until the intraoral wound was closed.

Horses were discharged from the hospital between 1 and 3 wk after the surgery. The aftercare included 3 wk box rest before turnout. Diet consisted of grass, soft feed, and hay. These cases were reassessed after 3 mo, and implants were removed between 3 and 6 mo after the surgery.

The implant removal was carried out under GA with the horse in dorsal recumbency. In the majority of cases, it was not necessary to create stab incisions to remove the screws from PM2 and PM3. After removal of the screws, the defects were cleaned with surgical spirit and plugged with polymethyl methacrylate. There was no evidence of screw penetration into the pulp cavity that could result in a potential pulpitis and tooth decay.

4. Results

Between 1988 and 2005, 21 mandibular (n = 18) and maxillary (n = 3) open, unstable fractures in the interdental space of the mandible and maxilla were repaired. Four of the mandibular fractures were unilateral, and the remaining (n = 14) were bilateral. All individuals had excessive gingival defects and marked displacement with contamination of the fracture site. The age at presentation varied between 1.5 and 16 yr. Six horses received one unilateral dental plate (all 4 unilateral mandibular fractures and 1 maxillary fracture); the remaining horses were repaired using two plates. Eight horses had repeated curettage at the ventral draining tract and medical treatment (antibiotics and anti-inflammatories) for between 2 and 4 wk after initial surgery.

Fracture healing was satisfactory in 20 horses. All of these individuals resumed their previous activity without complication. Implants were removed between 3 and 6 mo after surgery. One horse was euthanized before implant removal for an unrelated reason. At the time of removal, all implants were stable. There were no reports of short- or long-term problems associated with the drill holes in the tooth crowns.

5. Discussion

Open, dislocated, contaminated fractures of the inter-dental space of the mandibles and maxillae are often self-inflicted, frequently when the teeth are caught in a stationary object. The majority of these

fractures are bilateral. The fractures described in this study pose a significant surgical challenge.

Different methods have been described to repair these fractures with variable success (e.g., intraoral acrylic splints, intramedullary splints with tension band wires, internal fixation, and external fixation with a Kirschner-Ehmer device).[5] Potential complications of these methods include breaking of the tension band wires, lack of sufficient stability, and proximity of the implant to the contaminated fracture site or implant crossing the fracture (increases the likelihood of implant failure and infection). Because the screws and plates are positioned in the upper 8 mm of the tooth crowns, the screws are, therefore, unlikely to penetrate the sensitive pulp cavity. However, it is not known whether the pulp cavity was penetrated inadvertently in some cases, but no complications were encountered in these individuals.

For external fixation, the placement of at least four centrally threaded pins makes avoiding the tooth roots, facial vein and artery, parotid duct, and sublingual salivary glands difficult, and there is the constant risk of entanglement of the external device during convalescence.

The trans-dental plating technique avoids these potential pitfalls. Only four screws are placed into the crowns of two incisors and two premolars to anchor the DCP.

The availability of used DCPs makes this technique cost effective. A single DCP was used for one orthopaedic and two mandibular surgeries without implant failure. Pre-adapted 10- to 14-hole plates reduces the surgical time.

The limiting factor of this procedure is the need for four (two incisor and two mandibular) viable tooth crowns to anchor the plate. Viable tooth crowns provide rigid anchors for screws and plates. There is no risk of infection or loosening of implants. The plates are well tolerated, and most animals can be turned out to grass 3 wk post-surgery.

References and Footnote

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[a]Technovit, WDT, Hannover, Germany 3500.