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Case Report

Treatment of incisive bone fracture in a horse using an acrylic splint

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Summary

A ventrally displaced incisive bone fracture was diagnosed in a 3-year-old Andalusian stallion. Symptoms included swelling of the lips, dysphagia and ptyalism.

External manipulation revealed pain and crepitus in the gingival region of the rostral maxilla. An intraoral examination revealed upper gingival haematomas, misalignment and malocclusion of the incisors (prognathism). A radiograph of the rostral maxilla confirmed ventrally displaced bilateral fractures of the incisive portion of the maxilla rostral to the canine teeth (Triadan 104/204).

The fracture was reduced under general anaesthesia. A methylmethacrylate intraoral splint was used to stabilise the fracture. Post operative radiographs confirmed the fracture reduction. Post operative clinical control confirmed the correct position of the splint. No complications were encountered in the post operative period and good stabilisation was obtained. The splint was removed 60 days post operatively.

The use of an acrylic intraoral splint successfully stabilised a bilateral, ventrally displaced incisive bone fracture. Normal occlusion was obtained.

The use of an acrylic splint may represent a relatively simple, inexpensive and noninvasive technique for the repair of incisive bone fractures rostral to canine teeth in horses.

Introduction

Premaxillary, maxillary and mandibular fractures occurring rostral to the cheek teeth or molar arcades, are common sequelae to equine head trauma (Sullins and Turner 1982; Henninger and Beard 1997; Crabill and Honnas 1999; Belsito and Fischer 2001). These injuries often occur as a result of a kick from another horse or of a fall leading to direct impact with the ground or solid objects nearby (Sullins and Turner 1982; Henninger and Beard 1997; Beard 1999; Belsito and Fischer 2001).

Clinical signs vary according to the severity, time elapsed since injury and the structures involved (Henninger *et al.* 1999). Horses with stable fractures of the incisive bone often show swelling of the lips and surrounding soft tissues together with haemorrhage, ptyalism, dysphagia and pain on palpation (Henninger *et al.* 1999). In the case of a displaced fracture, the aforementioned signs will be seen together with crepitation and an obvious misalignment of the upper incisor arcade (Beard 1999; Henninger *et al.* 1999; Belsito and Fischer 2001). Often food and debris impacted at or around the fracture site, together with bacterial contamination, will lead to halitosis (Beard 1999; Henninger *et al.* 1999). Oral examination alone is often sufficient to diagnose a rostral fracture of the maxilla (Henninger *et al.* 1999) but radiographic examination is essential in providing information concerning the fracture configuration and the presence, if any, of tooth and alveolar involvement (Sullins and Turner 1982; Henninger *et al.* 1999). This will be a necessary aid in the decision process regarding the optimal method and technique for treatment (Wiggs and Lobprise 1977).

In the case of a displaced unstable fracture, regardless of whether it is open or not (Belsito and Fischer 2001), surgical stabilisation is indicated (Beard 1999; Henninger *et al.* 1999).

In horses, delay or failure to repair these fractures may result in malocclusion, tooth loss, a poor cosmetic effect and, more seriously, osteomyelitis and loss of function (Henninger and Beard 1997; Henninger *et al.* 1999).

The desired surgical objective in premaxillary, maxillary and mandibular fractures is to re-stabilise correct dental occlusion with the return of normal mastication. Closed reduction is the best choice, when possible, to preserve

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the blood supply and minimise soft tissue trauma during the fracture repair (Wiggs and Lobprise 1977; Henninger and Beard 1997; Beard 1999; Henninger *et al.* 1999; Belsito and Fischer 2001).

There have been several methods of repairing equine premaxilla displaced fractures documented in the literature. The use of wires and tension band wires (Sullins and Turner 1982; Henninger and Beard 1997; Beard 1999; Crabill and Honnas 1999; Henninger *et al.* 1999; Tremaine 2004; Gupta and Singh 2005) intramedullary pins (Sullins and Turner 1982), lag screws (Sullins and Turner 1982), U–bar technique (Krahwinkel and Heffernan 1969; Sullins and Turner 1982; Henninger *et al.* 1999), Kirschner apparatus (Garner and Thurmon 1968; Sullins and Turner 1982) and intraoral acrylic splints (Colahan and Pascoe 1983; Beard 1999; Tremaine 2004) are a few. Most of these techniques have been utilised in cases involving maxillary-incisive bone fractures occurring in the interdental space (Garner and Thurmon 1968; Krakwinkel 1969; Colahan and Pascoe 1983; Dart and Pascoe 1987; Beard 1999; Greet 1999). In the case of fractures located in the region of the incisors, rostral to the canine teeth, and involving only the incisive bone body, the limited space available to stabilise these fractures renders most of these techniques difficult or inadequate (Colahan and Pascoe 1983; Dart and Pascoe 1987). The possibility of damage that has occurred to the permanent tooth buds or roots can further complicate the use of orthopaedic implants (Colahan and Pascoe 1983; Dart and Pascoe 1987). In the case of equine premaxillary fractures the primary objectives of surgical intervention are to restore the horses's ability to eat in the immediate post operative period, and to create a strong and fast fracture repair (Belsito and Fischer 2001).

Case details

History

A 3-year-old Andalusian stallion weighing 420 kg was admitted to the Department of Veterinary Clinical Science at the University of Padua 5 h after a fall that occurred while loading the horse onto a trailer.

Clinical findings

Clinical signs included swelling of the lips and surrounding area, dysphagia, ptyalism and pain on palpation.

No other abnormalities were found on a general physical examination. A complete blood count and serum biochemistry profile showed no abnormalities. Body temperature, mucous membranes and capillary refill time were all within normal parameters. Bilateral nasal obstruction was found, yet there was no evidence of nasal discharge. Delicate external manipulation revealed pain and crepitus in the upper gingival region of the rostral maxilla. An intraoral examination revealed various small lingual lesions, including a large tongue ulcer, that did not appear related to the fall. Upper gingival haematomas, misalignment and malocclusion of the incisors with prognathism were observed (**Fig 1**).

Diagnosis

Radiography of the rostral maxilla confirmed ventrally displaced bilateral fractures of the incisive portion of the maxilla rostral to the canines with no evident incisor alveolar involvement (**Fig 2**). Radiographs were taken of the temporomandibular joints in order to exclude other fractures or possible luxations in that area. There was no evidence of trauma found in these joints. The function and integrity of the tongue, apart from the visible ulcer, was normal, thus excluding temporary or permanent glossal paralysis.

Treatment

Tetanus antitoxin[1] (5000 iu) and benzylpenicillin-dihydrostreptomycin[2] (9000 iu/kg bwt and 11.25 mg/kg bwt, respectively) were administered i.m. preoperatively.

The horse was premedicated with acepromazine[3] (0.02 mg/kg bwt i.v.) followed by xylazine[4] (0.5 mg/kg bwt i.v.) and butorphanol[5] (0.02 mg/kg bwt i.v.). General anaesthesia was induced with ketamine[1] (2.2 mg/kg bwt i.v.) and diazepam[5] (0.05 mg/kg bwt i.v.).

A 28 mm silicon-cuffed endotracheal tube was passed and the horse placed in dorsal recumbency. Surgical anaesthesia was maintained with a gas mixture of isofluorane[6] (1.2–2%) and oxygen (8 l/min). Lactated Ringer's solution[7], together with saline solution was infused using a 14 gauge jugular catheter at a rate of 10 ml/kg bwt/h. Heart rate, respiratory rate, pulse-oximetry, end-tidal carbon dioxide, end-tidal isofluorane, body temperature and direct blood pressure were monitored and recorded every 5 min.

Any remaining debris was removed from the oral cavity, which was then surgically prepared with povidone iodine solution. No palatal lacerations were found. The fracture was manually reduced, carefully avoiding any mucosal-gingival trauma. Correct fracture reduction was assessed using intraoperative fluoroscopy and by verifying the occlusion of both molars and incisors. A cold methylmethacrylate (Palacos R)[8] mixture was moulded onto the palatal surface in the interdental space between the lingual surface of the incisors and the 2nd premolars (Triadan 106/206). The first premolars, or wolf teeth, were not present. A thin cellophane type film was placed between the palate and the acrylic splint during the exothermic reaction so as to avoid thermal damage to the mucosa, as well as possible adhesions between the surfaces. After hardening, the splint was removed from the mouth together with the film. Any sharp edges and excess resin were rasped away to allow normal occlusion between the upper and lower arcades. The splint was then correctly positioned against the hard palate (**Fig 3**).

Fig 1: Photo of a 3-year-old Andalusian stallion showing an upper gingival haematoma, with evident prognathism, misalignment and malocclusion of the upper incisors.

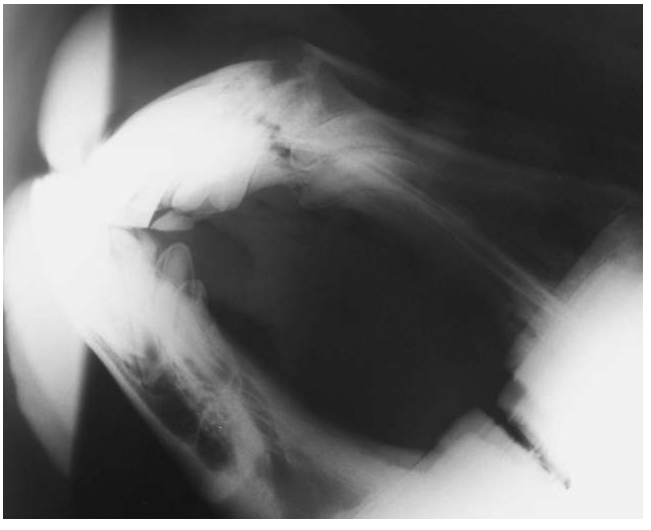
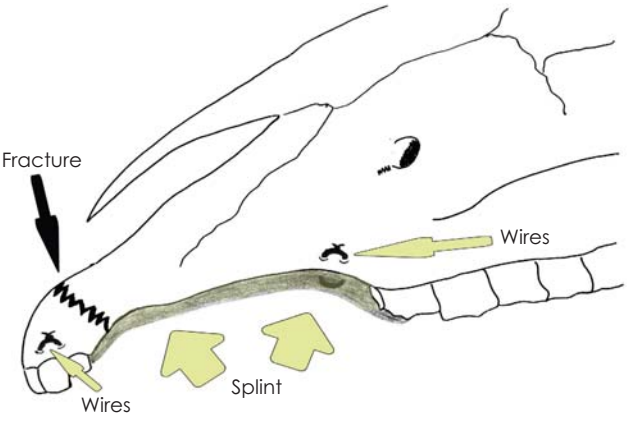


Fig 2: Lateral radiographic view of the same subject showing a ventrally displaced bilateral fracture of the incisive bone. As can be seen in the image, the fracture point is located rostral to the canine teeth (Triadan 104/204).

Fig 3: Photo showing the correct temporary positioning of the intraoral splint against the hard palate. A large tongue lesion is also visible (black arrow).



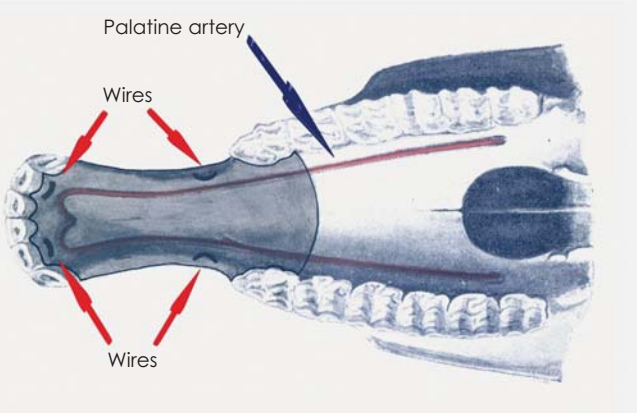


Fig 4: Diagrams depicting the location of the fracture, the course of the palatine artery and the anchoring of the splint with the stainless steel wires.

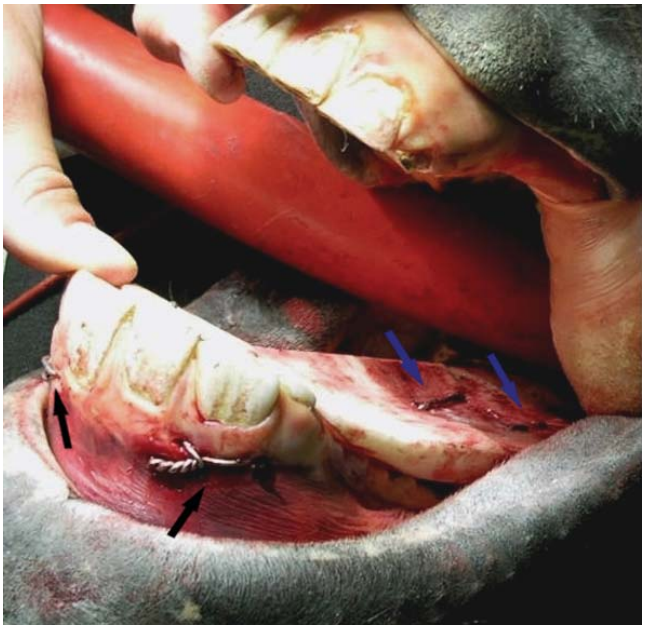


Fig 5: In this photograph, the final anchoring of the splint with the steel wire can be seen while the horse is in dorsal recumbency. In the rostral area, 2 wires were passed around both the number 2 upper incisors (Triadan 102/202, black arrows). The other 2 wires were passed rostral to the 2nd premolars on both sides of the palate (Triadan 106/206, blue arrows).

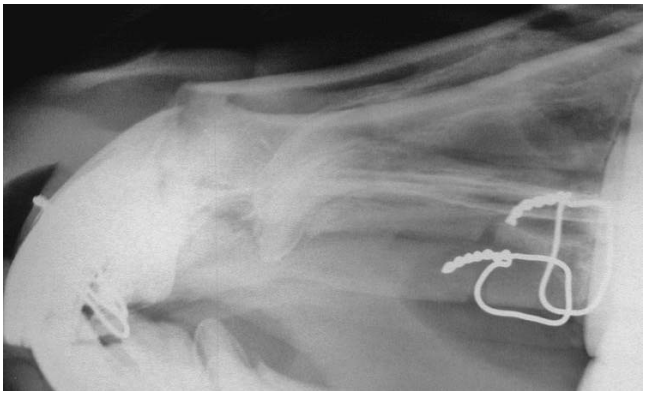


Fig 6: Post operative lateral view showing both the position and the anchorage of the stainless steel wires together with the splint, which is fixed against the hard palate. In this view all 4 stainless steel wires are visible.

Fig 7: Post operative dorso-ventral intraoral view of the rostral maxilla showing fracture reduction and the interdental passage of the stainless steel wires around the 2nd upper incisors (Triadan 102/202) on both sides of the arcade.

Fig 8: Photograph taken 2 weeks post surgery. As can be seen, the splint is still in the original position and there are no visible soft tissue lesions.

Fig 9: Lateral photograph taken 60 days after surgical treatment and immediately before the removal of the splint. The splint was still in correct position. Good alignment between the mandible and maxilla has been obtained.

Fig 10: Lateral radiographic view of the rostral maxilla 60 days post operatively. Normal healing with good callus formation of the fracture site can be seen.

Fig 11: Photograph of 5-year-old Andalusian stallion. This was taken during an examination 2 years post operatively. As can be seen there is a good anatomical relationship between upper and lower arcade. The 3rd left upper incisor (Triadan 103/203) has erupted normally. Although the mouth is open, the restoration of normal occlusion with optimal cosmesis were obtained.

To anchor the splint to the hard palate, 2 holes were drilled between the 1st and 2nd (Triadan 101/102 and 201/202), and 2nd and 3rd (Triadan 102/103 and 202/203) upper incisor reserve crowns. This procedure was done bilaterally on the upper incisor arcade, approximately 1 cm from the gum line, and also through the splint itself using a 3.2 mm drill bit. Care was taken to avoid penetrating the tooth surface, as well as avoiding perforating the pulp cavity. To anchor the caudal part of the splint, the labial commissure was retracted and 2 holes were drilled, bilaterally, in the palate across soft tissue and bone together with the splint, which was simultaneously held in the correct position. The holes were made in the hard palate rostral to the upper 2nd premolars (Triadan 106/206) approximately 1 and 2 cm, and 1 cm above the gum line. The drill bit was inserted in an oblique direction from the dorso-lateral to the ventro-medial side, using a drill guide to protect the soft tissue. Due to the risk of damage to the palatine artery, which runs in proximity to the perforation site (**Fig 4**), the drilling procedure of the hard palate was carried out in a slow and carefully monitored process. Subsequently, a 1.2 mm stainless steel wire was passed through the above mentioned holes and twisted tightly on the labial side of the incisors and on the labial and buccal side of the interdental space of the upper arcade. Any excess wire was removed and the remaining portion was twisted and bent back so as to lie flat against the gum (**Fig 5**). Post operative radiographs were taken to confirm both fracture reduction and the correct position of the splint (**Figs 6** and **7**).

As can be seen in **Figure 7** no trauma was evident of either pulp cavity or roots of the permanent incisors.

Benzylpenicillin-dihydrostreptomycin, at the above doses, was administered i.m. for 7 days. Phenylbutazone (3 mg/kg bwt i.v.; Bute Iniettabile)[9] was administered after surgery and was continued for 3 days.

The horse was able to eat and drink without assistance from the first day after surgery. He was put on a diet of pellets for a week post operatively, and fed at ground level so as to facilitate prehension and mastication. Healing was uncomplicated and the cosmetic results were good.

Outcome

Two weeks post operatively the splint was in the correct position with no evidence of a soft tissue lesion or necrosis (**Fig 8**). A clinical examination was performed 60 days after surgery. The owner reported that the horse was well and eating normally. Good maxillary-mandibular alignment was seen (**Fig 9**) and it was thus decided to remove the wires and splint. This was done under standing sedation with xylazine[4] (1 mg/kg bwt i.v.). A manual examination demonstrated complete stabilisation of the premaxilla. A subsequent radiograph was taken and confirmed the presence of good callus formation (**Fig 10**). Based on these examinations, it can be concluded that the healing process was successful and a good anatomical relationship was obtained.

The horse was examined 2 years after surgery and appeared completely normal as confirmed by his owner. The maxillary alignment appears physiological with an optimum cosmetic effect (**Fig 11**).

Discussion

In the present case, the limited space on the rostral fracture fragment together with the risk of incisive root damage, made the use of orthopaedic implants or external braces impractical treatment options. Due to the ventral displacement of the rostral fragment, with the incisors positioned caudally, the use of intraoral wiring alone as well as the use of tension band wires was considered unsuitable for this case. The use of these techniques in our case would in fact cause collapse of the fracture site as the wires are tightened and consequently cause a subsequent caudal rotation of the reduced fracture. In addition, the stallion was 3 years old at the time of the surgery and the canines were unerupted, as can be seen in **Figure 2**.

The application of an acrylic intraoral splint, anchored with stainless steel wires was chosen to maintain the correct length and alignment of the premaxilla bone and was considered the best choice of treatment in this case. The treatment of upper interdental space fractures using an oral acrylic splint has been described (Colahan and Pascoe 1983; Beard 1999; Crabill and Honnas 1999; Tremaine 2004). However, its application in incisive fractures, rostral to canine teeth, has, to our knowledge, never been previously documented.

The decision to anchor the caudal part of the splint in the incisive bone, instead of around 106/206, was made in light of the fact that the fracture was located so far rostrally, therefore the hard palate was considered an alternative and possibly more stable site for anchoring the splint with intraoral wires. It was thought that following fracture reduction, anchorage of the wires in the dorsally located incisive bone, and thus closer to the fracture line, would allow ventro-dorsal traction on the splint against the hard palate. Consequently, this technique could provide an improved support in the rostral fractured zone while simultaneously contributing to better stabilisation of the fracture site.

The exothermic reaction that occurred during the methylmethacrylate polymerisation phase did not cause any evident thermal damage or necrosis to the palatal tissue. Fluoroscopy was used during surgery to evaluate the correct fracture reduction and to avoid damaging the incisor roots. To anchor the caudal part of the splint, simple manual retraction of the labial commissure was used to allow visibility of the interdental space during fixation of the splint. A stab incision to allow additional access to the fixation zone, as described by some authors (Colahan and Pascoe 1983; Dart and Pascoe 1987), in this case was not found to be necessary.

Due to the risk involved with drilling holes in proximity to the palatine artery, extreme care was used. Considering this risk, general anaesthesia, with the horse in dorsal recumbency, was considered necessary since it not only allowed maximum visibility of the site, but also permitted the perforation of the hard palate to be carried out in a slow and carefully monitored procedure.

The splint was well tolerated by the horse and it was able to eat and drink one day after surgery. Although other authors have noted loosening of the surgical wires and/or breakage of the splint (Colahan and Pascoe 1983; Henninger *et al.* 1999), this did not occur in the present case. There were no resulting tongue irritations or ulcers observed in the post operative period. Normal occlusion of the incisors arcade with an optimum cosmetic aspect was obtained.

In our case, the use of an acrylic intraoral splint proved an excellent choice in stabilising a bilateral, ventrally displaced incisive bone fracture. Good stabilisation was achieved with minimal surgical invasion, thereby avoiding any further damage that may have been caused by the use of other orthopaedic implants.

As has been well described in small animals (Wiggs and Lobprise 1977; Harvey and Emily 1993), the use of an oral acrylic splint may represent a relatively simple, inexpensive and noninvasive technique for the repair of incisive bone fractures in large animals. When moulded and positioned correctly, this technique will ensure adequate stabilisation and healing without the necessity of extensive surgical intervention, intensive post operative care or post operative complications (Dart and Pascoe 1987).

Manufacturers' addresses

[1]Gellini International, Milan, Italy.
[2]Pfizer, Latina, Italy.
[3]ATI, Bologna, Italy.
[4]Bayer, Milan, Italy.
[5]Intervet Italia, Milan, Italy.
[6]Schering-Plough S.p.A., Milan, Italy.
[7]B. Braun, Milano, Italy.
[8]Heraeus Kulzer GmbH, Wehrheim, Germany.
[9]Acme, Reggio Emilia, Italy.

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