A Review of Diagnosis, Treatment, and Sequelae of Incisor-Luxation Fractures in Horses (From a Dentist’s Viewpoint)

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From a dental viewpoint, incisor-luxation fractures in horses are fraught with complexities. Luxation fractures are defined as the dislocation of a tooth out of its alveolus without being totally avulsed from the mouth.\(^1\) These are dental emergencies with far-reaching implications. The periodontal and endodontic survival of the involved teeth depends on how these cases are handled. Owners should be made aware of the chronic nature of problems associated with these fractures, especially in young horses with unerupted permanent incisors. Author’s address: Silverton Equine Veterinary Services, PO Box 507, Silverton, OR 97381; e-mail: LAC4492@aol.com. © 2006 AAEP.

1. Introduction

Horses are grazing animals. When kept in confinement, especially in times when they are without hay, they frequently place their incisors on objects and pull, mimicking grazing behavior. Unfortunately, the objects on which they are approximating their grazing behavior are often not as forgiving as blades of grass. This may result in luxation of one or more incisors from their alveoli in either the maxilla or mandible (Fig. 1).

Surgical repair of incisor luxation fractures has been previously described, and the results tend to be very successful. The apparent outward success of the surgical repair of these fractures is very high, mostly because of the copious blood supply of the mouth; however, true success revolves around the treatment and follow-up care afforded to the teeth. As described by Moll\(^2\) and Baker and Easley,\(^3\) these fractures are easily repaired in a standing horse; however, consideration must be given to the health and vitality of the teeth and their prognosis for survival. Root or pulp exposure and subsequent avascular necrosis of the avulsed teeth can lead to periapical (the area around the root tip) abscessation that will necessitate future endodontic therapy or exodontia (extraction).

The incisors of a horse are like one leg of a three-legged stool. They are part of the balance of the horse’s skull along with paired temporomandibular joints. Missing or damaged incisors will directly affect the balance of the teeth in the rest of the mouth, as well as affect how a horse prehends and masticates food, uses his food, and uses the bridle. Therefore, if the incisors can be salvaged, all attempts to do so should be employed. To this end, the dental-eruption schedule of equids is important core knowledge. Knowledge of the eruption schedule facilitates prognosis of the likelihood of events after an incisor luxation. This paper presents the concepts necessary to give teeth the best shot at survival and the veterinarian and horse owner the
and the owners should be made aware of this. Benign evidence of previous deciduous incisor trauma can be seen in affected permanent teeth after eruption, but much more serious developmental problems can occur, such as malformation, impaction, or loss of the developing tooth altogether.

Incisor luxation fractures are a dental emergency. The blood supply of the teeth is compromised when the tooth becomes displaced from its alveolus. Swelling of the pulp subjects it to the tamponade effect of the rigid walls that enclose it. Non-steroidal anti-inflammatory drugs (NSAIDS) in appropriate therapeutic doses are immediately indicated and are part of basic emergency therapy. These fractures are heavily contaminated and are very painful to the horse, making examination and diagnostics very difficult. Regional and local nerve blocks have been described to anesthetize the mental and infraorbital branches of the mandibular and maxillary nerves using lidocaine or mepivacaine. However, in the presence of inflammation and infection, afferent pain pathways are five times more resistant to the anesthetic effects of lidocaine. Bupivacaine is much more effective in these circumstances, and the surgeon should be aware of its delayed onset of action as well as its prolonged duration of action compared with lidocaine or mepivacaine.

A mixture of 1:4 lidocaine to bupivacaine may be used to facilitate more rapid onset of perineural or local anesthesia that does not need to be repeated frequently. Fractures of any sort tend to be excruciatingly painful, and therefore, a certain amount of allosthesia (pain resulting from a non-painful stimulus) should be anticipated. Acepromazine is helpful as a neuroleptic agent at a dose of 0.02 mg/kg IV in combination with alpha adrenergic agonists such as xylazine at 0.6 mg/kg IV and butorphanol at 0.01 mg/kg IV to facilitate examination and institution of treatment.

If the pain is subjectively insurmountable, general anesthesia with nasotracheal intubation may be indicated to achieve the optimal therapeutic outcome.

Incisor luxation fractures are heavily contaminated and many times they are presented days after they happen. The horse may even be presented for a fever of unknown origin. The fracture line is exposed to the plethora of bacteria in the normal mouth of horses in addition to the anaerobes and spirochetes that proliferate in the presence of inflammation. Broad-spectrum antibiotic therapy is mandatory and should be initiated immediately on presentation. This is because a bacteremia may lead to what is called an “anachoretic pulpitis” (exposure to bacteria through a hematogenous route) of involved and adjacent teeth or seeding of infection in areas of increased metabolic activity such as the physes of the long bones in juvenile horses.

Radiographs are absolutely essential to the diagnostic work-up, and no further manipulation of the fracture should take place before a diagnostic intraoral film is obtained. Intra-oral radiographs will help to identify tooth root or crown fractures, bone fragments, and degree of displacement of the teeth.
from their normal anatomic position. Lateral extra-oral films are also indicated, and both radiographs are easily produced with standard radiograph equipment. Extraction of very loose teeth or those with deep-root or compound fractures are immediately indicated; these teeth will not add to the stability of the fracture fragment, and extraction will prevent the infection from progressing to a periapical abscess.\textsuperscript{11,12}

When the horse is adequately sedated, anesthetized, and administered with anti-inflammatory and antibiotics, examination and diagnostics can commence. The entire oral cavity should be rinsed clean before manipulation of the fracture. A solution of \( <0.12\% \) chlorhexidine digluconate\textsuperscript{b} (CHX) is the antiseptic of choice for rinsing the oral cavity, because CHX adheres to the cells of the pellicle and salivary glycoproteins that coat the entire oral cavity for \( \lesssim72\) h. Concentrations \( >0.2\% \) should not be used, especially in the case of bone exposure, because CHX at higher concentrations may cause disturbed healing, which is characterized by fibrosis and lack of epithelialization.\textsuperscript{13} The wound should be gently debrided without traction on the teeth, and the fracture line should be carefully cleaned of all debris and non-vital tissue. No curettage of the alveolus or tooth roots should take place because further damage or removal of periodontal ligament (PDL) cells would prevent their reestablishment and reattachment to the tooth. The fracture line itself should be gently but copiously lavaged after careful debridement with warm sterile saline with or without dilute doxycycline in solution. Along with other beneficial actions, doxycycline has been shown to inhibit collagenase and enhance reattachment of the PDL.\textsuperscript{14}

Previous descriptions of incisor-luxation fracture repair have recommended the use of dilute povidone iodine as an antiseptic in the fracture line;\textsuperscript{2,3,15–17} however, the effects of povidone iodine on cells of the PDL is unknown. CHX should not be applied directly to exposed roots, because the use of CHX is contraindicated in the case of root or periodontal ligament exposure at any concentration. Specifically, CHX at even the minutest dilutions inhibits the growth of PDL cells, and at strengths \( >0.12\% \), attachment of PDL cells to the surface of the root is hindered.\textsuperscript{14} Unfortunately, there is no research in the equine species on the toxicity of CHX or povidone iodine on cells of the PDL. Nevertheless, it is prudent to avoid direct contact of povidone iodine or CHX at any strength with cells of the PDL until more research is completed.

The fracture is reduced using the least amount of traction on the fracture fragment, which minimizes further trauma to the apical blood supply. Fixation can be accomplished by wiring the crowns of the teeth to other teeth as anchors. The intra-oral wiring technique has been previously described by several sources and is the technique used by the author. However, most of these techniques use holes bored by Steinmann pins or a drill bit into the bone of the mandible or maxilla to achieve stabilization of the fracture site.\textsuperscript{2,3,15–17} Review of small-animal mandibular and maxillary fracture repair techniques clearly show that the use of intra-osseous fixation devices are contraindicated in many cases and may cause further irreversible damage to the very structures one is desirous of saving.\textsuperscript{18,19} Denervation by traumatization of the mental or infraorbital nerve may lead to denervation necrosis of the teeth, because odontocyte processes only extend into the dentinal tubules in the presence of nerves.\textsuperscript{7,17} Therefore, wiring should be limited to the use of the crowns of the teeth for stabilization if at all possible (Fig. 2).

Small notches in the enamel of the corner incisors made with a diamond wheel will provide a “seat” for the wire,\textsuperscript{11} and if further stabilization is required, the use of compactable composite resin bonded to the teeth or intra-oral splints built from acrylic is highly recommended\textsuperscript{c} (Fig. 3). The application of either of these materials requires preparation of the teeth by removal of the coronal cementum, acid etch, and light-cured bonding agents,\textsuperscript{d,e} as well as a familiarity with the use of these agents. If more room is required to pass the stainless-steel wire through the...
interproximal spaces (IP; spaces between adjacent teeth), careful odontoplasty may be performed to widen the IP spaces, using a diamond wheel to avoid further trauma to the periodontium of the teeth used as anchors by forcing needles or pins through their periodontia.

Acute pulp exposure of any tooth should be treated immediately with a direct pulp capping procedure. If the tooth with a pulp exposure for <48 h is to be saved, the pulp must be addressed with this technique. Pulp exposure is obvious in the case of crown fracture, because it appears as a bleeding spot in the fracture line of the tooth. If the exposure is >48 h, then vital pulpotomy or root canal therapy is indicated for permanent incisors; however, formal endodontic therapy may be performed at a later date when the larger fracture is fully healed. If the structure of the tooth can be saved and the periodontium repaired, even for a non-vital tooth, it will still contribute to the balance of the mouth and skull of the horse. There is ample evidence in humans and companion animals that non-vital teeth can maintain a healthy periodontium, and in the horse, it may even be able to erupt and suffer attrition of normal occlusal wear. However, during the healing phase, the teeth involved in the fracture fragment should be taken out of occlusion with a sharp bur after wire stabilization to avoid normal occlusal forces and movement of the fracture line.

After the intra-oral fixation device is applied, care is taken to avoid trauma to the soft tissues of the mouth. Wire knots are carefully bent, tucked, and covered with a coating material that will avoid severe irritation to the mucosal surface of the lips. Vinyl polysiloxane impression material is very useful for this application, cost effective, and easy to apply (Fig. 4). It is this author’s experience that it stays in place remarkably well.

Trapping of food in, around, and under the device contributes to the oral flora change common to periodontal disease. The owners should be advised to rinse the mouth multiple times daily with a warm salt solution to ameliorate the trapping effects of the fixation device for the duration of the fixation and not just until the mucosa has healed. Antibiotic therapy is indicated for at least 2 wk, and anti-inflammatories should be used for at least 1 wk to reduce swelling in the pulp chambers of involved teeth. The owners should check the device daily for failure so that it may be replaced as needed. Frequent rechecks should be encouraged during the convalescent period to monitor the condition of the repair. The fixation device should be left in place for 6–8 wk and then removed. Removal of the wires should be followed by an occlusal equilibration to ensure the best balance of the entire mouth, but this work should be delayed for at least 2–3 mo after wire removal to achieve the highest degree of wound strength, particularly in light of the fact that the incisors will be placed in a full-mouth speculum for that procedure.

Six months after the initial fracture, a thorough extra- and intra-oral recheck examination should be performed. At this time, any swollen lymph nodes, asymmetries, or draining tracts in the skin should be identified. A complete intra-oral exam should be
performed with an excellent light source and periodontal probe. A diagnostic intra-oral radiograph of the involved teeth should be taken to assess periodontic and endodontic status. Endodontic or periradicular pathology are rarely outwardly obvious, but sinus tracts from periradicular abscesses may be evident as a small blister-like area on the attached gingiva on either the labial or palatal/lingual surfaces of the incisive area that had been fractured. These may be seen several months later and should be traced radiographically with a long gutta percha point or silver point to identify the tooth that is the source of the infection (Fig. 5).

In juvenile horses, the follow-up radiograph is imperative to assess the condition of or lack of developing permanent teeth or persistence of developmental tissue that may present as a cystic structure later (Fig. 6). In small animals, it is known that internal staining of the involved teeth is a poor prognostic indicator because it signifies previous pulp hemorrhage and probable pulp necrosis that necessitates endodontic therapy. Despite the outward appearances of successful fracture repair, the need for exodontia or additional surgeries may still exist to provide for the optimum outcome. Should exodontia be indicated, the owner should be advised that frequent equilibration of the mouth will be required to maintain balance and prevent overgrowth problems. As the primary dentition involved in the fracture exfoliates, the permanent dentition may erupt with developmental problems, be malformed or impacted, or simply have excess cementum on the crown.

3. Discussion

The repair of incisor avulsion fractures is outwardly very rewarding to the surgeon, but the assessment of success of these fractures based on external signs of healing may be very misleading to the practitioner and horse owner. The general practitioner is capable of handling the immediate treatment of these fractures in the field if they are uncomplicated. However, familiarity with potential complications, especially of juvenile horse dentition, suggests that it may be prudent for the general practitioner to consult with an equine dental specialist. Knowledge of these potential dental complications will allow for the best treatment planning and management strategies for the owner and the unfortunate horse that suffers this trauma.

References and Footnotes


*aMarcaine, Abbott Laboratories, North Chicago, IL 60064.
*Nolvasan antimicrobial solution, Fort Dodge Animal Health, Fort Dodge, IA 50501.
*Jet Denture Repair, Lang Dental Manufacturing Co. Inc., Wheeling, IL 60090.
*Acid Etch 35% Phosphoric Acid Gel, Bosworth Co. Skokie, IL 60076.
*Acid Etch 35% Phosphoric Acid Gel, Optibond Solo Plus Kerr Mfg., Orange, CA 92867.
*Splash! Half-Time, Discus Dental, Inc., Culver City, CA 90232.