General Concepts of Facial Fractures

Mandibular and maxillary fractures represent 3% to 6% and 0.7% to 2.1%, respectively, of all fractures in the dog. In the cat, 15% of all fractures occur in the mandibular symphysis. The most common location for mandibular fractures in the dog is PM-1 and M-2. The majority of fractures occur secondary to trauma. As with any trauma patient, full assessment is necessary before complete evaluation and definitive repair of a facial fracture. This includes recognition and treatment of: shock, neurologic injury, compromise of the airway including pneumothorax and diaphragmatic hernia, and cardiac arrhythmias secondary to traumatic myocarditis. Other soft tissue and orthopedic injuries need initial and definitive treatment at the appropriate time. During management of other injuries, mandibular fractures can be initially supported by a loose fitting muzzle. If both maxillary and mandibular fractures are present, a muzzle should not be used.

Diagnosis of Facial Fractures

Facial asymmetry and inability to completely close the mouth are common findings. In addition to radiographs, computed tomography is helpful for detection of caudal fractures of the mandible where radiographic interpretation may be difficult.

Principles of Facial Fracture Repair Include:

- Restoration of occlusion and anatomic reduction
  Achieving occlusion is essential to return of normal oral function, however, this may be difficult in severely comminuted fractures. Fractures will often heal in the presence of fracture gaps and minor instability provided the blood supply is protected, and infection prevented. Therefore, anatomic reduction and rigid fixation may be sacrificed to achieve occlusion. Malocclusion has been reported in 18% of dog and 11% of cat mandibular fractures. It is necessary to maintain occlusal alignment while applying the fixation device and during the healing period. Sequelae to malocclusion include cosmetic deformity, masticatory difficulty, periodontal changes and temporomandibular joint arthritis.
- Stable fixation to neutralize detrimental forces on the fracture line(s)—
  The selected method of repair should provide occlusion and, ideally, rigid stability of all major fragments. The device should allow immediate return to oral function, be light-weight, economical, and not cumbersome for the patient.
- Preservation of blood supply
  Soft tissue attachment to bone fragments must be preserved by gentle tissue manipulation and minimal tissue elevation.
- Avoidance of iatrogenic dental trauma. Do not injure the tooth roots.
- Extraction of diseased teeth at the fracture line(s).
Patient management

The patient is medically stabilized and hydrated before fracture repair. A temporary tape muzzle may be applied to “cradle” the mandible. This may not be feasible in cats or brachycephalic breeds. Patient nutrition must be considered and any delay in fracture repair may require installation of a percutaneous gastrostomy or esophagostomy tube.

Management of Involved Teeth

Teeth aid both occlusal alignment and stability and should be retained when possible. Periodontally involved teeth with secondary bone loss, or teeth that are mobile from periodontal disease or the trauma can impair fracture healing and should be extracted and all accompanying debris removed. Teeth at fracture lines can act as foreign bodies and make it difficult for granulation tissue to bridge a fracture gap. A specific tooth at a fracture line that is stable, adds to the fixation stability and is not diseased should be retained. Devitalization of this tooth secondary to the trauma may occur and will result in pulp necrosis and the possible need for later extraction or endodontic treatment. Serial radiographic assessment of fracture healing may indicate delayed healing at the site of a tooth in a fracture line. This tooth should then be extracted. Extraction of teeth at the time of fracture repair may increase complications by iatrogenic trauma to adjacent tissues and blood supply, further displacement of fracture fragments, remove occlusal landmarks and areas for repair device fixation. Fractured teeth, after evaluation, are extracted or treated endodontically at the time of fracture repair. They are usually extracted if not essential to aid in fracture repair. Stable teeth in the presence of an alveolar fracture are maintained. Avulsed teeth with associated bone fragments are maintained as an aid to fracture repair. The presence of dental calculus and periodontal disease requires dental cleaning, including periodontal pocket debridement, at the time of fracture repair.

Tissue management, antibiotic therapy

Most oral fractures are open. Nonviable soft tissue and bone is removed. Small fragments of loose bone are discarded. All debris is removed and the fracture site copiously lavaged with sterile saline. Mucosal defects are closed after fracture repair. Cefazolin or ampicillin may be initially administered and changed depending on culture and sensitivity results. Clindamycin or amoxicillin with clavulanic acid is initially administered if periodontal disease is present.

Adequate visualization for alignment of occlusion

Occlusion can be restored in simple fractures by achieving anatomic fracture fragment alignment and checking the occlusion by closing the mouth at endotracheal extubation. However, many fractures are complex and require periodic occlusion checks during the fixation surgery. For short duration surgeries (ex. some intraoral acrylic splints) anesthesia may be maintained on a propofol drip and the patient carefully monitored including pulse oximetry. However, the safest way to maintain a patient and be able to accurately check occlusion is with endotracheal intubation via a pharyngostomy incision or temporary tracheostomy. Remember that a patient may not have had normal occlusion before the fracture. The teeth are examined for wear patterns that suggest abnormal occlusion at the time of fracture repair. Severe comminution may make return of normal occlusion very difficult. In this case, once the fracture repair has been made, various odontoplasties (reshaping of teeth) may be needed. In
addition, possible extraction or dental crown height reduction and vital pulp therapy may be needed for selected teeth in order to provided pain free oral function.

Temporary muzzle
These are for primary repair of caudal mandibular body and coronoid process fractures that are relatively stable and aligned. They can be used as an adjunct with other fixation methods. The normal occlusal relationship of the caudal maxillary and mandibular teeth help to maintain alignment. The muzzle is loose fitting to allow the mouth to open a small amount for drinking and eating a soft to gruel consistency food. Complications include dermatitis, malocclusion, aspiration secondary to vomiting, and hyperthermia secondary to reduced panting. Nylon muzzles are easy to clean. Two nylon muzzles can be dispensed and can be changed so that a clean muzzle is always in place.

Interarcade wiring
This is a minimally invasive method to form an “internal” muzzle. Holes are drilled at the dental furcation across the alveolar ridge and the mandibular and maxillary arcade are wired together leaving a small gap, as with the tape muzzle, to allow eating and drinking. Except for dermatitis, complications are the same as those for a temporary muzzle.

Interdental wiring
This technique is rarely used by itself in animal patients as it does not provide enough stability to the fracture site. It can be used with interosseous wiring or with intraoral composite splints. Fine gauge orthopedic wire (24, 26 gauge depending on patient size) is placed around the cervical region of the teeth adjacent to the fracture line. A minimum of two teeth on each side of the fracture are incorporated in the wire. Teeth at the fracture site must be healthy and stable for interdental wire to be used. Several wiring techniques have been described; however, the Ivy loop and Stout techniques are most commonly used. In order to place the wire properly around the teeth, the wire is passed through the gingiva just below the gingival margin. Therefore, the “enamel bulge” configuration at the apical end of each crown will help prevent slipping. This bulge area is minimally developed in the dog and wire slipping can occur. The wire is tightened just enough to maintain apposition of the fracture fragments. The wire is placed on the occlusal side of the mandible or maxilla. Over tightening the wire may distract the fracture fragments into abnormal occlusion. For example, over tightening the wire will distract the ventral mandibular border and contribute to malocclusion primarily at the rostral mandible due to dorsal and caudal displacement of the rostral mandibular teeth.

Intraoral splints
These techniques are very versatile and relatively easy to perform. Cold cure bis-acryl composite materials are most commonly used. The teeth are the fixation points for the composite and contact with the gingiva can be minimized. Composite can be used alone or in combination with interdental wiring. Composite is stronger than the fine interdental wire and the combination of composite and wire is stronger than either. At least 2 teeth on each side of the fracture line should be incorporated into the splint. In preparation for fracture repair, pharyngostomy or temporary tracheostomy endotracheal intubation is performed. A routine complete dental cleaning is performed and the teeth are polished with pumice. Care is taken to not allow pieces of dental calculus or pumice from entering open fracture sites. In open fractures, soft tissues are
débrided, and wounds irrigated then closed after general alignment of the fracture fragments. Interdental wire is then placed.

The teeth that will act as fixation points are acid etched with phosphoric acid then rinsed. The etching results in enamel defects of 20-50 microns in depth. A bonding agent is then applied and light cured. The composite splint material is then placed. It will chemically adhere to the cured bonding agent. The composite sticks to itself and can be layered thicker if needed. It produces no heat during curing. The composite is self curing and may be shaped with a bur if needed. Occlusion can be continuously checked during application of the intraoral splint. The teeth of the opposing arcade are coated with a thin layer of petroleum jelly to prevent sticking to the splint material. The mouth can be opened and closed to check occlusion and to allow the opposite dental arcade to help in shaping the splint. If properly applied, intraoral splints may last for 6 to 8 weeks.

Home care consists of feeding soft food (canned food consistency) and, preferably, twice daily irrigation of the splint with chlorhexidine solution to remove food debris. Gingivitis occurs under all splints. Gingivitis quickly heals when the splints are removed. Bone healing is followed by making serial radiographs. When the fractures are healed the splint is removed. For removal, the splint can be scored with a bur and gently cracked off. Care must be taken to not damage or fracture teeth. Routine dental cleaning is performed.

**Dental bonding**

This technique applies the bis-acryl composite to temporarily bond the left and right mandibular and maxillary canines together. This is another method of creating an “internal muzzle” for stabilization of caudal mandibular fractures. A gap is left for eating and drinking. When healed, the composite is gently removed and the teeth cleaned.

**Internal fixation**

These techniques involve application of bone plates or interfragmentary wires. Internal fracture fixation principles are detailed elsewhere and will not be extensively reviewed. Internal fixation must provide rigid fracture stabilization, avoid tooth roots and vascular canals (mandibular and infraorbital canals). Bone plate size and wire gauge are selected based on patient size and anticipated forces applied to the repair. Internal fixation can be supplemented with temporary muzzles or intraoral composite splints.

**Fracture fixation in the immature animal**

Repair of mandibular and maxillary fractures in dogs and cats under 6 months of age can be challenging due to the presence of developing permanent tooth buds. Whenever possible conservative methods are used for fracture stabilization so as not to injure the developing teeth. Examples include interdental wires around deciduous teeth combined with a temporary muzzle; or intraoral splints applied to the deciduous teeth.

**Salvage procedures**

In selected patients fractures are not repaired. This most often involves injuries to the mandible. Partial mandibulectomy may be performed for severe fracture comminution; bone loss due to the original trauma or concurrent severe periodontal disease; and economic limitations for treatment.
In smaller breeds, severe periodontal disease may weaken the bone and fractures can occur in these areas. Bone loss may be so extensive that anatomic reconstruction is not possible. Extraction of adjacent teeth and segmental mandibulectomy can be performed. Another technique is extraction of adjacent teeth and alignment of fracture fragments using heavy gauge PDS and the application of bioglass to this area. The result is a fibro-osseous union that is stable, functional, pain free and avoids the mandibular shift and malocclusion seen with segmental mandibulectomy.

Nonunion mandibular fractures in smaller breeds result in mandibular bone atrophy and resorption. These patients have lost the function of the mandible and the mandible “hangs” ventrally. Prehension and drinking is only by the tongue and the patients usually maintain adequate hydration and nutrition. Open fracture sites are débrided and closed. Samples are obtained for culture and antimicrobial sensitivity. The labial commissures are bilaterally advanced to the level of the second mandibular premolar. This provides a more normal size ostium for more normal oral function and improved cosmetics. The rostral aspect of the mandible does not move and the mouth can not be completely closed.

Selected References