INTRODUCTION
Oral emergencies frequently occur to both the hard and soft tissues in dogs and cats in small animal veterinary practice. Hard tissue trauma involve fractures of the teeth and jaws; alveolar osteitis; oral foreign body; and traumatic malocclusions such as luxation and avulsion. Soft tissue injuries include lacerations and abrasions of the gingiva and tongue. Oral emergencies have their own unique set of potential problems, and failure to treat them properly may lead to detrimental effects on the teeth, oral environment and the animal’s systemic health.

DECIDUOUS TEETH
In humans, several clinical studies have related the specific type of injury to the deciduous tooth to disturbances in the permanent dentition. Some of these disturbances include crown dilaceration and dysplasia (Fig 1), root dysplasia (Fig 2), retained deciduous teeth (Fig 3), yellow-brown enamel discolouration or hypomineralisation (Fig 4), premature or delayed eruption (Figs 5 & 6), or impaction of the permanent tooth (Fig 7) (Ravn 1968, Selliseth 1970, Andreasen et al 1970, Andreasen & Ravn 1970, Ravn 1975, Ravn 1976). Although injuries to the deciduous dentition and developing permanent tooth have not been studied in detail in dogs and cats, the author has noticed a relationship between enamel hypomineralisation of permanent canine teeth following traumatic extraction of their deciduous predecessor (Clarke 1999 unpublished data).

Fractures of the deciduous teeth
The deciduous teeth have very thin walls and may easily be fractured during play or trauma (Fig 8). Infection may gain access through an open pulp canal and be a potential source of pathology to developing permanent teeth and alveolar bone. Fractured deciduous teeth should therefore be extracted (Clarke & Lobprise 1994).

Malocclusion of the deciduous teeth (dental interlock)*
A puppy with a normal scissor bite should have 28 deciduous teeth with the lower canine tooth positioned midway between the upper third incisor and upper canine teeth (Fig 9). Growth of each jaw quadrant (upper and lower mandibles and maxillae) are relatively independent of one another, so slight variations in length may cause an interlock of the deciduous canine teeth. Clinically, this means the lower canine tooth will be positioned behind the upper canine tooth, physically impeding further mandibular growth (Fig 10).

If a dental interlock occurs, the lower deciduous canine teeth should be extracted. This is ideally performed between six to eight weeks of age (Emily 1991, Clarke & Lobprise 1994). Retention of these teeth usually causes hard palate ulceration (Fig 11), interferes with mandibular jaw growth, and also influences their permanent counterparts to erupt even further lingually. Selective extraction of canine teeth to relieve dental interlocks and allow normal mandibular growth will not be effective if the malocclusion is of genetic origin (Wiggs & Lobprise 1997).

*Included as it is an owner perceived “urgency”
FIGURE 1: Canine tooth showing crown dysplasia.

FIGURE 2: Upper fourth premolar tooth showing severe root dysplasia, with twisting and convolution of the distal and mesio-buccal roots and shortening of the palatal root.

FIGURE 3: Retained upper and lower canine teeth in a Terrier.

FIGURE 4: Enamel hypomineralisation of the upper canine tooth in an Akita.

FIGURE 5: Delayed eruption of the lateral incisor tooth in a Beagle.

FIGURE 6: Radiograph showing the delayed eruption of the incisor tooth from Figure 5.

FIGURE 7: Bony impaction of the upper second and third premolar teeth in an eight-month-old Bassett Hound.

FIGURE 8: Fractured deciduous canine tooth.
FIGURE 9: Normal scissor bite of a puppy.

FIGURE 10: Dental interlock malocclusion in a puppy.

FIGURE 11: Hard palate ulceration resulting from a lingually positioned deciduous canine tooth.

FIGURE 12: Fractured lower first molar tooth showing enamel-dentine fracture.

FIGURE 13: Fractured upper canine tooth with pulp exposure in a Siamese.

FIGURE 14: Fractured upper fourth premolar tooth with pulp exposure.

FIGURE 15: Diagrammatic figure showing apexogenesis. (Used with permission, Aust Vet J 1999.)

FIGURE 16: Diagrammatic figure showing apexification. (Used with permission, Aust Vet J 1999.)
Extraction of deciduous teeth

Exodontia should be performed using gentle elevation to prevent fracture of the delicate root and to minimise damage of the developing permanent tooth. Infiltration of a local anaesthetic containing adrenaline is recommended to decrease local discomfort and haemorrhage, as blood pigments may discoulour the forming enamel (Wiggs & Lobprise 1997). Antibiotics should also be given if signs of infection are present. If the crown fractures during extraction, attempts should be made to retrieve the remaining root, utilising a moderate gingival flap and alveoplasty to expose the root tip, as the root can still deflect the permanent tooth’s eruption (Wiggs & Lobprise 1997), and the retained root may act as a foreign body by the patient causing significant inflammation (Eisenmenger & Zetner 1985).

Whenever attempting deciduous extractions, the owner should be notified that while all reasonable precautions will be taken to minimise damage to the developing permanent tooth, problems may still occur (Wiggs & Lobprise 1997). These changes may range from very mild enamel pitting, to more severe enamel dysplasia (Fig 1), root dysplasia (Fig 2), and even malposition or unerupted teeth (Fig 7) (Andreasen et al 1970).

**ADULT TEETH**

The most common traumatic condition seen in adult dogs and cats involves fracture of an individual tooth, with the canine and carnassial (upper fourth premolar) teeth the most commonly affected (Spodnick 1992). While most human dental trauma is caused by trivial and probably unpreventable means, such as falls and collisions (Andreasen & Hjorting-Hansen 1966, Ravn 1974), tooth fracture in dogs and cats can usually be prevented. In dogs in Australia, trauma from chewing raw bones accounts for 83.7% of carnassial tooth slab fractures, while of all tooth fractures, raw bones account for 65.0%; chewing on rocks, sticks and bricks (12.8%); general trauma (hit by inanimate objects such as a cricket bat) (10.2%); dog fights (7.5%) and car accidents (4.4%) (Clarke 1999 unpublished data).

**Enamel fracture**

One frequent sequela of oral trauma includes fracture of the tooth crown involving only the enamel (Stalhanet & Hedegard 1975, Ravn 1981a, b). To avoid cuts and lacerations of the surrounding soft tissues the tooth may require smoothing with a water-cooled high speed diamond burr or polishing discs. The few human studies on the prognosis of crown fractures, without periodontal ligament damage, indicate that very few complications can be expected, with one study reporting pulp necrosis in only 1% of 2862 teeth (Ravn 1981a).

**Enamel-dentine fractures**

Fractures confined to the enamel and dentine, without pulpal involvement, require treatment to protect the underlying pulp (Fig 12). Deep fractures may leave only a thin protective layer of dentine covering the pulp, which in turn may lead to sensitivity from various stimuli, such as chewing, while the rough dentine surface may increase plaque build up over this area. More importantly though, bacterial invasion of the pulp may occur via exposed dentinal tubules (Bramstrom 1962, Olgart et al 1974).

The number of cases that result in inflammatory pulpitis is presently unknown, but in one human study comprising 3044 teeth, 3.2% underwent pulp necrosis following enamel-dentine fracture (Ravn 1981c). Recommended treatment is indirect pulp capping, by placing a Ca(OH)$_2$ protective barrier over the exposed dentine followed by a composite or glass ionomer restorative.

**Crown fractures with pulp exposure**

Whenever the pulp is exposed (Figs 13 & 14), treatment success depends on the size and time of the exposure, the age of the animal and the healing potential of the pulp (Duell 1995). Following pulp exposure, the degree of pulpal infection and inflammation is difficult to determine, as it depends on the intensity of the traumatic insult, the amount of bacterial contamination, and the duration of time from exposure to treatment (Wiggs & Lobprise 1997).

Ideally, tooth fracture with pulp exposure should be treated by vital pulpotomy (direct pulp capping) as soon after the trauma as practical. While numerous studies indicate that the depth of pulpal inflammation does not exceed 2-3mm from the exposed surface for up to seven days following traumatic exposures (Cvek 1982, Heide 1908, Heide & Kerekes 1986, Watts & Paterson 1982), there are no hard and fast rules regarding vital pulpotomy treatment and pulp exposure in veterinary dentistry. Therefore, treatment by direct pulp capping may still be successful when performed days or weeks post trauma (Heide & Kerekes 1987). Antibiotics and nonsteroidal anti-inflammatory drugs are recommended to decrease infection and inflammation respectively. The author’s choice is clindamycin$^1$ given at 11mg/kg twice daily for six days, as clindamycin has both excellent aerobic and anaerobic coverage (Gordon & Walker 1993).

Immature teeth with a vital pulp and an open apex may be treated by apexogenesis (direct pulp capping of an immature tooth). Apexogenesis is defined as the treatment of a vital pulp in order to permit continued closure of the open apex and development of the root (Fig 15) (Webber 1984). Apexogenesis using Ca(OH)$_2$ may be attempted, as direct pulp capping was found to be successful (including formation of a hard tissue barrier and vital pulp reaction) in 90.5% of 84 human teeth treated (Ravn 1982). In another human study analysing 60 teeth, a 96% success rate was seen after partial pulpotomy, where the pulp was amputated about 2mm below the exposure site and covered with Ca(OH)$_2$ (Cvek 1978). Immature teeth with an open apex and necrotic pulp require apexification (Schumacher & Rutledge 1993, Harbert 1996). Apexification involves the removal of the necrotic pulp and intra-canal placement of Ca(OH)$_2$ to induce an apical hard tissue barrier (Fig 16) (Heide & Kerekes 1987, Parashos 1997). Mature teeth with a closed root apex may successfully be treated by pulp capping up to three weeks after pulp exposure (Clarke 1999 unpublished data). Mature teeth with long standing pulp exposure or necrotic pulp tissue should be treated by standard root canal therapy (Fig 17).

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$^1$Antirobe, Pharmacia & Upjohn
When owners do not wish to save a fractured tooth with pulp exposure, extraction should be considered. Performing no treatment is not an option, and could be regarded as being negligent, as all fractured teeth with an exposed vital pulp are painful, and will eventually undergo irreversible pulpitis leading to periapical abscessation and osteomyelitis (Fig 18).

Crown-root fracture
Crown-root fractures can occur with or without pulpal involvement (Fig 19). Treatment depends on the extent of tooth loss and the degree of pulpal involvement. Options include direct or indirect pulp capping, restoration and extraction.

Root fracture
Root fractures involve the dentine, cementum, pulp and periodontium. In veterinary dentistry, root fractures often lead to instability of the crown, resulting in crown separation and root exposure to the oral cavity. The long term prognosis of treated teeth with root fractures in dogs and cats has not been studied, but the rate of pulp necrosis following treatment in humans has been found to vary from 20% to 44% (Andreasen & Hjorting-Haven 1967, Jacobsen & Zachrisson 1975, Zachrisson & Jacobsen 1975).

Pulpal haemorrhage
Trauma to the tooth may result in pulpal haemorrhage with either reversible pulps or pulp necrosis. Following haemorrhage and odontoblast cell death, the erythrocytes may travel into the dentinal tubule and break down into heme and iron components. As this process continues, a colour change may be seen within the tooth, from purple to grey and black (Fig 20). Radiographs should be taken following pulpal haemorrhage to identify concurrent root or alveolar bone damage, but pulp vitality cannot be conclusively tested by any extra-pulpal method in the canine or feline tooth at this stage. If a radiograph is taken at the time of trauma and again three months later, by comparing the width of the pulp chamber, an indication of pulpal vitality can be obtained. If the pulp remains vital, it can be assumed the width of the pulp canal will decrease, whereas if the pulp is necrotic, the width of the pulp canal will remain the same as at the time of trauma. If the pulp is vital, no treatment is necessary, whereas if the pulp is necrotic, a standard root canal (Fig 17) is required to avoid future periapical abscessation (Fig 18).

Oral foreign body
A common problem in Australian dogs and cats that consume raw meaty bones is oral foreign body. A rib bone may get caught over the hard palate wedged between the maxillary teeth (Fig 21). The animal may present to the Veterinarian pawing at its mouth, hypersalivating and in distress as if it had been poisoned. Diagnosis is confirmed by visualising the offending item. Treatment involves removal with dental forceps or pliers; sedation or anaesthesia may be necessary.

Subluxation
Subluxation is the incomplete displacement of a tooth from its socket (Fig 22) and is usually caused by trauma to the tooth and because of socket anatomy, may be accompanied by fracture of the socket wall, periodontal ligament haemorrhage and pulpal oedema. As injury to both the pulp and periodontium is common, a variety of healing complications may arise, such as pulp necrosis, pulp canal obliteration, root resorption and loss of marginal attachment (Andreasen 1985). Time is an important factor for successful treatment, as the likelihood of survival of the periodontal ligament and pulp tissue decreases the longer the tooth root is exposed to the oral environment. Treatment involves placing the injured tooth back into its normal anatomical position under general anaesthesia, suturing the gingiva and splinting the tooth (Fig 23). As there is a chance of pulp necrosis and root resorption the animal should be placed on antibiotics to prevent infection, and non-steroidal anti-inflammatory drugs to decrease inflammation and pain. There is no study to date that has described the long-term prognosis of this injury in dogs and cats.

Avulsion
Avulsion is the complete displacement of a tooth from its socket. Successful treatment depends on the stage of root development, the storage medium of the tooth whilst out of its socket and the time the tooth is out of the mouth (Andreasen 1981a, Kristeron & Andreasen 1984). Teeth replaced within 30 minutes have a greater than 90% success rate (Spodnick 1992, Dumsha 1992), whereas teeth out of the mouth for more than two hours have a 95% likelihood of suffering extensive root resorption (Hammarstrom 1986a).

Extra-oral tooth storage is of vital importance to successful replantation, because if the periodontal ligament remains viable, it will reattach the tooth to the dental alveolus within three to four weeks of replantation (Sculman & Kalis 1970). Dry storage inflicts irreversible damage to the periodontal ligament and may result in a fusion (ankylosis) between the alveolar bone and cementum of the root once the tooth is replanted (Hammerstrom 1986a). While a specialised tooth storage medium is available2 (Kraser 1990), the owner usually only has access to either tap water or milk. Tap water should be avoided because the pH and osmolality differences reduce viability of the periodontal ligament fibres (Lindskog & Blomlof 1982). Therefore, the avulsed tooth should be transported to the surgery in milk.

On arrival at the surgery, the animal should be anaesthetised and the entire tooth root surface rinsed in normal saline or chlorhexidine to remove dirt and debris. However, chlorhexidine irrigation is still controversial due to potential periodontal ligament fibre irritation (Gracis & Orsini 1998). The tooth should be placed gently back into the socket and stabilised using a wire and composite splint (Gorrel et al 1993). Generally, splinting should be used for no longer than 4-6 weeks (Kehoe 1986). Young permanent teeth with open apices may revascularise after avulsion, but as a general rule revascularisation of the pulp seldom occurs (Hammarstrom 1986a). Endodontic treatment of the avulsed tooth is recommended within 14 days of the replantation (Andreasen 1981b).

2Emergency Tooth Preserving System, Biological Rescue Producers Inc., Pottstown, PA, USA
EMERGENCY DENTISTRY

FIGURE 17: Endodontic files in the root canals of an upper fourth premolar tooth in a Bull Terrier.

FIGURE 18: Sub-orbital draining sinus from periapical abscessation/osteomyelitis following a fractured upper fourth premolar tooth in a Maltese.

FIGURE 19: Vertical crown-root fracture of the lower left canine tooth in a Sumatran tiger.

FIGURE 20: Pulpal haemorrhage in the upper first incisor tooth.

FIGURE 21: Rib bone caught over the hard palate.

FIGURE 22: Caudal sub-luxation of the upper incisor teeth.

FIGURE 23: Stabilisation of the sub-luxated teeth from Figure 22.

FIGURE 24: The correct technique to hold a dental elevator.
Whilst out of the socket, the tooth may be contaminated by bacteria entering the pulp tissue apically or via exposed dentinal tubules. Pulpal infection results in toxic bacterial by-products, which on tooth replacement may spread to the periodontal ligament stimulating inflammatory root resorption (Andreasen 1981b). The animal should be given tetanus coverage, antibiotics and non-steroidal anti-inflammatory drugs for two weeks. Early recommendations by the American Association of Endodontists suggested no antibiotic treatment unless indicated for other medical reasons (Dumsha 1992). However, studies conducted on dogs have shown that systemic antibiotic therapy started immediately post-replantation prevents bacterial invasion of the pulp and inflammatory root resorption (Hammarstrom 1986b). It is now recommended that systemic antibiotic therapy be instituted immediately following replantation (Hammarstrom 1986b). Clindamycin is given at 11mg/kg twice daily (Gordon & Walker 1993).

**Alveolar osteitis (dry sockets)**
Alveolar osteitis occurs when the intrabony blood clot degrades by bacterial invasion and endogenous fibrolytic mechanisms approximately 48-72 hours post extraction (Swanson 1990). Alveolar osteitis in humans is claimed to be very painful and has an incidence of between 1% and 3% in simple extractions and up to 20% in surgical removal of teeth (Larsen 1991, Betts & Markowsky 1995). Although the condition is rarely reported in small animal dentistry, veterinarians should be aware of it as a possible complication (Van Cauwelaert de Wyels 1998).

When performing extractions, procedures to reduce post-operative complications, promote faster healing of the sulcus gingiva and enable the animal to resume normal eating should be encouraged (Julius et al 1982). These include gentle tissue handling, packing of the tooth sulcus with an extraction mixture such as Consil, Gelfoam, Kaltostat, or Kalzinol, suturing the gingiva over the sulcus, and prescribing antibiotics and nonsteroidal anti-inflammatory drugs.

**Soft Tissue Injury**
The most common soft tissue injury is a laceration of the gingiva or tongue from a hard or sharp object. Soft tissue trauma may also occur iatrogenically during oral surgery, when a scalpel blade or dental elevator slips cutting the tongue or gingival tissue. Care should be taken when using a high speed burr to section teeth or remove bone as the rotating burr may abrade the lips, gingiva or tongue. A retractor may be used to protect soft tissues from burrs, scalpels and periodontal elevators. When elevating a tooth, the index finger should extend along the shaft of the instrument to prevent it from penetrating the tissue should it slip (Fig 24). Proper visualisation of the surgical field and good lighting is necessary to avoid injury. Lacerations may require suturing, whereas, abrasions or ulcerations may only require topical anaesthesia.

**Post-operative haemorrhage**
The oral cavity is a blood rich area and therefore has both the potential for excellent healing as well as post-operative haemorrhage. A thorough history should be taken before surgery including: breed type for possible clotting problems (e.g. von Willebrands disease), access to non-steroidal anti-inflammatory drugs and anti-coagulant type products. Good surgical technique, anatomical knowledge, avoiding tension on any sutures and surgical wounds, ensuring gentle tissue handling, and packing and suturing the post extraction tooth socket will aid in decreasing post-op haemorrhage.

**Jaw fractures**
Jaw fractures may result from motor car accidents, falls from heights, dog fights, pathological fracture secondary to periodontal disease or iatrogenically during tooth extraction. Whereas most mandibular fractures require surgical stabilisation, many maxillary fractures do not. A variety of techniques have been used to stabilise fractures, including tape muzzles, intraoral splinting, interdental or interfragmentary wiring, plates, screws, pins and wires (Dulisch 1985). Intramедullary pins, plates and screws are best avoided in mandibular fractures, as it is virtually impossible to avoid damaging the tooth roots, which results in pulp necrosis and root resorption (Wiggs & Lobprise 1997). Tape muzzles, interdental wiring or interfragmentary fixation, dental acrylic or Protemp Garant may be used with greater success (Harvey & Emily 1993).

Reduction of mandibular and maxillary fractures and restoration of proper dental occlusion can be most accurately assessed with the mouth closed. Following general anaesthesia, the endotracheal tube should bypass the oral cavity via a pharyngotomy, unless a tracheotomy has been performed. Surgery involving the mandible and maxilla should be sterile, therefore, the oral cavity should be flushed using a dilute antiseptic such as povidone-iodine, and the skin in the surrounding area should be prepared and draped as for standard invasive surgery. Because most mandibular fractures are open to the oral cavity they should be treated as contaminated wounds. Antibiotic cover (e.g. clindamycin 11mg/kg twice daily) is mandatory. Teeth that are damaged or diseased, such as those in a fracture line, should be removed unless they are important for reduction (Schloss & Manfra Marretta 1990). To achieve normal occlusion the mandibular canine tooth should be positioned midway between the maxillary lateral incisor and canine tooth in a dog or cat with a scissor bite (Fig 9).

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We’ve changed our focus from the ears to the eyes. We are overly concerned with how people look and not what they say. This paralysis of the imagination is a potential danger because it changes us from being an audience to being spectators – people who see but don’t necessarily listen.

— Richard Olivier, theatre director (son of Sir Laurence Olivier)