Perioperative complications in dental patients
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Complications related to surgical procedure

Root fracture
The most common complications are related to dental extractions, with root fracture probably being the most common complication, especially when extracting feline teeth. A retained root tip may cause persistent infection, draining tract formation and/or chronic nasal discharge. Therefore, a root tip is carefully inspected following the extraction and a post-extraction dental radiograph should be obtained. If a retained root fragment is noted, it needs to be carefully removed. Blind attempts to remove the root tip and “pulverisation” of the root tip are strongly discouraged, as this may result in an incomplete removal of dental tissues, significant trauma to the surrounding tissues and/or dislodgement of the root tip into the mandibular or infraorbital canal, nasal cavity, or maxillary recess, the structures located in the immediate vicinity of the root tips. Rather, upon careful examination, supported by dental radiography, surgical extraction of the root tip is planned (mucoperiosteal flap is created if it has not been performed previously), with following gentle alveolectomy and special root tip elevators/root tip teasers and root tip forceps are used to remove the root tip remnants. Upon removal of the retained root tips, another dental radiograph should be obtained to confirm vacated alveoli. If a root tip is accidentally displaced into the mandibular canal, infraorbital canal or nasal cavity, removal should be carefully planned to avoid further significant trauma, or the client informed about the complication and the surgical site monitored periodically (clinically and radiographically), or the animal referred to a specialist.

Hemorrhage
Hemorrhage may be a problem in patients with impaired hemostasis or where significant blood loss is expected. Therefore, before any procedure, where severe bleeding is expected (e.g. maxillectomy/mandibulectomy, palatal surgery, full-mouth extractions), appropriate pre-operative laboratory tests should be performed and blood (products) readily available. Most of mucosal bleeding can be well-controlled with a digital pressure over a wet gauze. If severe bleeding is encountered due to the damage of the infraorbital, major palatine or inferior alveolar artery, the vessel(s) should be identified and ligated and blood loss estimated in order to act further appropriately. Iatrogenic damage to blood vessel(s) is avoidable with careful extraction techniques and the knowledge of anatomy.

Soft tissue trauma
Orbital penetration with a dental elevator with subsequent ocular and/or brain trauma during dental extractions has been reported for cats and dogs. The consequences may be fatal. The complication can be avoided with proper and gentle extraction technique. Nasolacrimal duct, which in cats runs just dorsal or dorsomedial to the maxillary canine tooth root (and is separated from it only by the thin alveolar bone), may be obstructed as a result of an aggressive extraction of the maxillary canine tooth or as a result of a fractured maxillary canine tooth with periapical disease. Other soft tissue injuries are related to flap tear during flap elevation, lip and cheek trauma, or trauma to the salivary ducts with rotary instruments, and puncture wounds due to instrument slippage. Soft tissue injuries to the floor of the mouth may result in significant sublingual edema, that would require medical treatment if interfering with breathing, or sublingual sialocele, if salivary ducts are damaged.

Jaw fracture
Fracture of the alveolar process may occur with an aggressive extraction technique. This is mostly a minor complication, unless the alveolar fracture extends to a jaw fracture (e.g., during extraction of a mandibular canine tooth). In cats and small dogs, use of small instruments (e.g., 1 mm luxators) or a piezotome and gentle extraction technique can prevent this complication.
Blindness
Central neurological deficits, including temporary or permanent blindness, may be a sequel of keeping the mouth of a cat open widely with a mouth gag for extended periods of time, which reduces the maxillary artery blood flow. It is therefore recommended to avoid especially spring-loaded mouth gags and use smaller (up to 30 mm) plastic mouth gags, or try to avoid using mouth gags at all. Post-anaesthetic blindness may also be related to anaesthesia procedure (e.g., hypotension, hypoxemia).

Air embolism and emphysema
Air-powered systems (e.g., high-speed handpiece) are commonly used in dental extractions (sectioning of multi-rooted teeth, alveolectomy, alveoloplasty) and associated complications are rare. However, fatal venous air embolism was reported in a cat following such a procedure, but the case raised some concerns as to what the real cause of the cardiac arrest was and the case remains debatable. Emphysema is also possible, mostly related to the use of the three-way syringe. Although emphysema usually resolves spontaneously in a few days, the use of a three-way syringe in open wounds is discouraged.

Postoperative complications related to surgical technique
Inappropriate/aggressive surgical technique is also the most common reason for postoperative complications. Poor surgical planning (e.g. not performing a CT prior to palatal defect repair), aggressive extraction technique, absence of aseptic technique and poor pain management are related to postoperative swelling, pain, infection, delayed wound healing or wound dehiscence, systemic complications, occlusal trauma (e.g., maxillary lip entrapment following extraction of maxillary canine teeth, mandibular drift post segmental or total mandibulectomy), glossoptosis (e.g., following extraction of mandibular canine tooth), oronasal fistula formation (especially if pre-existing), alveolar margin recession and weakening of the mandible. Dental extractions were also reported to be associated with post-operative development of endophtalmitis caused by Actinomyces species in a cat.

Complications related to local anaesthesia
Nerve blocks are commonly used in animals undergoing oral/dental procedures as a part of multimodal approach to analgesia/anaesthesia. Administration of nerve blocks has been shown to help reduce the amount of general anaesthetic used and the postoperative pain. Careful (aseptic) technique and appropriate maximum dosage/volume of the local anaesthetic used are of the utmost importance to avoid complications.
Nerve blocks may be associated with systemic toxicity of the local anaesthetic, including life-threatening neurotoxicity and cardiotoxicity. Accidental direct intravascular injection and/or excessive dose of local anaesthetic is the most common mechanism for production of excess plasma concentrations of local anaesthetics and their adverse effects. Hence maximum total dose (in milligrams) must be calculated and aspiration must be performed prior to injection. Local anaesthetics can also be locally toxic causing nerve damage if injected intrafascicularly or deposited within the nerve as the needle is withdrawn. Application of local anaesthetics can affect mechanoreception, thermoreception and nociception, taste sensation may also be altered long-term or irreversibly in humans, but the exact mechanism of injury is still a subject of debate (e.g., neurotoxicity, direct trauma from the injection needle, intraneural hematoma formation) and little is known about these adverse effects in veterinary medicine.
As nerve damage may possibly be related to mechanical trauma of the needle, gentle technique and use of fine needles (27G) with short bevel, which is oriented in the same direction as the nerve fibers, is recommended. Local anaesthetic should not be injected if resistance to injection is encountered, which likely indicates nerve penetration - in such case, gentle repositioning of the needle, aspiration and application should be performed. If hematoma occurs at the site of injection, it usually resolves without complications.
Infections associated with nerve blocks appear to be extremely rare, however, aseptic technique is recommended especially when using extraoral approaches, and disinfection of the oral cavity (with e.g., 0.12 % chlorhexidine) is recommended prior to application.
With inferior alveolar nerve block one needs to be aware of the possibility to block the lingual and mylohyoid nerves, if the local anaesthetic is deposited too far away from the mandibular foramen, which may result in (temporary) desensitization of the tongue and related tongue chewing post-operatively.

Maxillary nerve block was associated with a globe penetration and subsequent need for eye enucleation in cats, hence the knowledge of the anatomy of the feline maxilla and careful nerve block technique (infraorbital nerve block is considered preferable) are of an utmost importance.

**Complications related to general anaesthesia**

General anaesthesia is required for all dental procedures. It has been reported, that, overall, cats have a higher risk of complications from anaesthesia compared to dogs. Reported risk factors included higher ASA grade, old age, extremes of body weight, urgency of procedure, endotracheal intubation and intravenous fluid therapy. The risks can be significantly reduced with meticulous pre-anesthetic examination and preparation of the patient, good anaesthesia planning, aggressive monitoring of the life functions during anaesthesia (ideally with an experienced anaesthetist and involving monitoring of at least body temperature, blood pressure, capnography, pulse oximetry), and close observation of the patient during the recovery period.

**Hypothermia**

Hypothermia is a common problem during anaesthesia of cats, especially with long dental procedures. It is expected even more so in geriatric patients with underlying diseases. Hypothermia can affect function of several body systems and hence impair anaesthesia and general recovery, or even lead to peri- and post-operative complications. In dental patients, body heat is dissipated with evaporation, conduction, convection and radiation – most important ways are through the anaesthetic system (especially non-rebreathing systems) and cold anaesthetic gases, by large amounts of water used in the oral cavity and cool surgical tables/rooms. Therefore, it is very important to prevent hypothermia from occurring as much as possible by close monitoring of the patient’s body temperature throughout the procedure (every 5 minutes) and after the procedure until the patient is normothermic, and provide adequate thermoregulatory support. To avoid any long-term detrimental effects, body temperature should be maintained above 35.5°C.

**Aspiration**

Aspiration of liquids from the oral cavity is possible, especially if animals are placed in dorsal recumbency. Hence, airway protection is needed and the animals should be endotracheally intubated, pharynx gently packed with absorbent pack (e.g., gauzes) that is changed during the procedure when saturated with fluid (and removed at the end of the procedure!), and aspiration used at all times. Note that sublingual edema may result from pharyngeal pack packed too tightly.

**Tracheal rupture**

Tracheal rupture has been reported to occur in cats during anaesthesia, commonly related to dental procedures, although the cause has remained undetermined. To prevent tracheal damage, head and neck should be carefully manipulated during dental procedure and endotracheal tube disconnected from the breathing system any time when changing patient’s or tube’s position. If using the stylet during intubation, special care should be employed. Endotracheal tube cuff must be carefully inflated, as its’ overinflation has been considered the most likely cause of tracheal rupture with ruptures being of a greater length when high-volume low-pressure cuff was used. The cuff should be carefully inflated also to avoid pressure on the mucosal blood flow in the trachea, and always deflated before extubation.

**Corneal damage**

Eyes should be lubricated every 30 minutes in all patients undergoing general anaesthesia and the eyes protected from the physical trauma in order to avoid corneal damage and ulceration.
References available upon request/during the live lecture.