Therapeutic Decision Making and Planning in Veterinary Dentistry and Oral Surgery

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KEYWORDS

• Clinical decision making • Treatment planning • Evidence-based veterinary dentistry • Evidence-based practice • Evidence-based medicine

KEY POINTS

- There is no substitute for individual clinical expertise. Evidence-based veterinary dentistry aims to integrate individual clinical expertise with the best available external information about specific dental and maxillofacial conditions.
- To take advantage of one's own individual clinical expertise, one must be able to recall details of previous patients, procedures, and outcomes. This emphasizes the importance of a detailed dental record, well-archived dental radiography, and clear, retrievable photographs or video of prior procedures.
- The history and physical examination are of key importance in obtaining a correct diagnosis and assessing risks versus benefits of elective dental procedures.
- Performing "dry run" procedures on cadavers under the supervision of knowledgeable instructors may improve outcomes and relieve operator stress when done before clinical procedures.
- Patients with severe oral pathology may require decisions about prioritization and staging of procedures.
- Some dental procedures are elective in nature. Anesthetic and procedural risks sometimes outweigh the benefits of a procedure. It is important to accrue evidence in these cases to provide the clinician and the pet owner with as much information as possible regarding risks and benefits, so together they can decide on a course of action.

INTRODUCTION

A 13-year-old Yorkshire terrier is presented due to severe halitosis. The patient has no known concurrent medical conditions and was anesthetized only once previously at 6 months of age for ovariohysterectomy. An open-ended question of "What brings Guinevere to see us today?" reveals a worsening of her long-standing halitosis. Her

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appetite is good, although Guinevere does not chew on toys like she did in the past, and occasionally she approaches the food bowl to eat but then turns away, which is new for her. Guinevere has always sneezed and coughed occasionally, but both have increased recently.

The word "clinician" is derived from a Greek word meaning "bed." "Patient" is a term derived from the Latin "*pati,*" which means "to suffer." The clinician is the doctor at the bedside of the sufferer, accepting responsibility for the life entrusted to him or her and developing a plan for therapeutic care.[1] Although patient care is not usually envisioned as hard science, the truth is clinicians, knowingly or unknowingly, perform clinical experiments on patients every day. Well-designed therapeutic plans are created, performed, and appraised with the same intellectual approaches used in a well-designed scientific experiment.[1] This approach provides the opportunity to learn from every case, even if the therapeutic plan consists entirely of routine and accepted standards of care.

Therapeutic decision making is rarely taught didactically in veterinary school. Instead, skills in this arena are honed in the examination room during school and well beyond. This article discusses basic tenets of therapeutic decision making and highlights examples of therapeutic approaches to common oral conditions. Although algorithms are used in these examples, it is important to emphasize that algorithms are meant to be useful reminders of diagnostic and therapeutic considerations. Algorithms are not a replacement for the thought process required for each individual patient.

Therapeutics that work in the hands of one clinician may not work for every clinician, and therapeutics that are effective for one patient may not work for every patient. However, past clinical experiences and scientific studies provide the foundation for therapeutic decision making. The concept of evidence-based medicine, or perhaps more appropriately called evidence-based practice, integrates clinicians' individual expertise with currently available external information sources in an attempt to improve patient outcomes.[2]

Evidence-based practice is not a new concept: it was used in part by clinicians in ancient Greece.[3] Recent interest in evidence-based practice has arisen in part because of justification of the rising costs of human health care. Aside from human health management decisions, evidence-based practice reinforces the need for due diligence when justifying therapeutic decisions.

A hierarchy ranking of the types of evidence is shown in **Fig. 1**.[4] The strongest evidence for therapeutic interventions is almost universally considered to be systematic review of randomized, triple-blind, controlled trials of a homogeneous population with excellent follow-up. These studies are rare in veterinary dentistry. Client testimonials and expert opinion are considered the weakest form of evidence. Some argue that expert opinion should be viewed as a separate type of knowledge that does not fit well into evidence hierarchies.[5] Expert opinion and client testimonial can be more likely influenced by bias. However, expert opinion is often the only available evidence for uncommon veterinary oral conditions. Even when other sources of empiric evidence are available, expert opinion is an integral part of the knowledge required for therapeutic decision making.[5]

ANAMNESIS

Anamnesis is the medical case history of a patient. The history is the first important step to making appropriate diagnostic and therapeutic decisions. Some simple approaches to obtaining a history will increase chances of gaining helpful information. Use of open-ended questions allows a client to tell his or her full story and provides

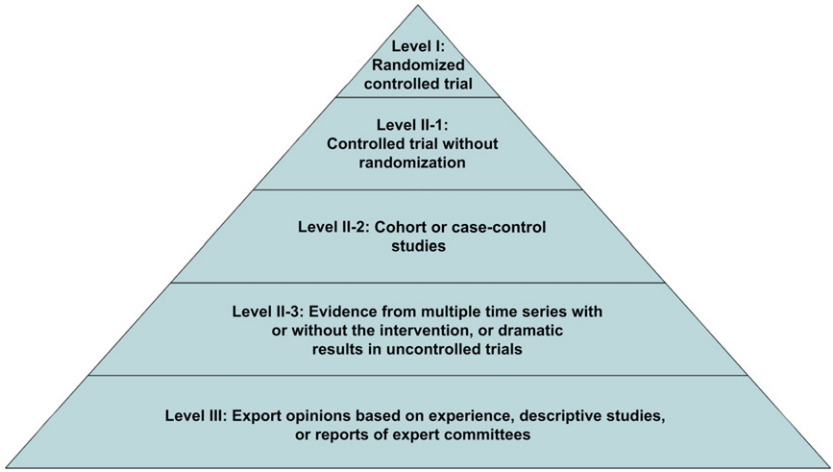

Fig. 1. An early proposed hierarchy of clinical evidence as stratified by the US Preventive Services Task Force. (*From* United States Prevention Services Task Force. Guide to clinical preventive services: report of the U.S. Preventive Services Task Force: United States Prevention Services Task Force; Washington, DC, 1989. p. 263; with permission.)

the clinician with a full understanding of the owner's perspective when coupled to attentive listening. Providing structure is necessary to redirect the conversation if open-ended questions result in tangential conversation. Pointed questions probe deeper in areas that seem important to explore. A good history taker allows the client to tell his or her story to obtain a complete understanding of what is occurring with the patient, and what is important to the client.

PHYSICAL EXAMINATION

The physical examination provides the foundation for decision making and brings the clinician one step closer to a therapeutic plan. A patient with the presenting complaint of halitosis leads us toward a diagnosis of periodontal disease even before we perform our physical examination, but it is important to thoroughly examine even the most straightforward of presenting complaints. Periodontal disease is the most common cause of halitosis, but any given case of halitosis may be caused by a necrotic tumor, endodontic disease, idiopathic osteomyelitis/osteonecrosis, stomatitis, lip fold dermatitis, uremic ulcers, or gastrointestinal disease. Ten to twenty percent of all cases of human halitosis are due to systemic causes, such as gastric, hepatic, pancreatic, and renal insufficiencies; trimethylaminuria; upper and lower respiratory tract infection; and medications.[6]

The physical examination provides information necessary to assess risk for elective procedures. Auscultation is performed in a quiet area to listen for cardiac murmurs or arrhythmias. The lungs are auscultated to listen for evidence of pulmonary pathology that may affect anesthetic plans. The trachea is palpated, especially in the proximal neck and thoracic inlet area of small-breed dogs, to check for a cough that may be indicative of collapsing trachea.

The head, neck, and oral examinations are done after the general examination, because the patient may be painful in these areas if presenting for an oral problem. The head and neck examination begins with extraoral observation of the head, face, eyes, ears, and neck using visual observation, palpation, and smell. Using

gloved hands to avoid transmission of disease between patients and caregivers, palpate each side of the face, head, and neck for symmetric comparison. Assess the temporal and masseter muscles for the presence of atrophy, enlargement, or pain. Palpate the ventral, lateral, and medial surface of the left and right mandibles for the presence of swelling that could be evidence of neoplasia, infection, or fracture.

Visually inspect the ears and note evidence of discharge, odor, or pain on palpation. Pain upon opening the mouth may be a result of severe middle ear disease (**Fig. 2**). The eyes are palpated using thumbs on the closed eyelids to gently push (retropulse) both eyes at the same time. Bilateral retropulsion allows for symmetric comparison of depth and firmness. If a space-occupying mass (as a result of neoplasia, inflammation, or infection) is present behind or beneath the eye, retropulsion may find a decreased ability of the globe to move caudally in the orbit on one side when compared with the opposite side. The normal ability to retropulse varies depending on facial conformation: brachycephalic dogs and cats have shallow orbits and less ability to retropulse. Observe for evidence of ocular discharge, which may be caused by blockage of the nasolacrimal duct by a pathologic process, such as a tooth root abscess or neoplasia. Evaluation of the neck includes palpation of the right and left mandibular salivary glands beneath the skin of the ventral neck. The mandibular salivary gland is the only easily palpable major salivary gland in dogs and cats. The 3 other major salivary glands are either too diffuse to palpate easily (parotid, sublingual glands) or are not superficial enough to palpate (zygomatic gland). The mandibular gland is easily distinguished from the mandibular lymph nodes because it is softer, larger than, and caudomedial to the mandibular lymph nodes. Once the salivary glands are located, the mandibular lymph nodes can be identified by moving the finger tips cranially. The mandibular lymph nodes are palpated bilaterally for symmetry and firmness. In the cat, mandibular lymph nodes are difficult to palpate unless they are enlarged. In the dog, mandibular lymph nodes are generally always palpable, ranging in size from 0.5 to 1.5 cm in diameter depending on the size and age of the patient. Other nodes that drain the head (retropharyngeal, parotid) are not normally

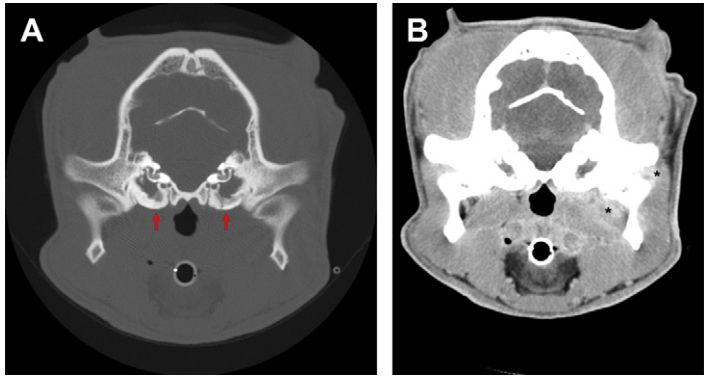

Fig. 2. A 2-year-old French bulldog with a history or prior ear infections was presented emergently for lethargy and pain on opening the mouth. (*A*) Computed tomography (CT) bone scan shows severe bilateral thickening of the cortices of the tympanic bullae (*arrows*) with a possible fissure through the ventral left bulla. (*B*) CT soft tissue scan after administration of intravenous contrast shows increased contrast uptake on each side of the left condylar process of the mandible, suggestive of peri-bullar cellulitis (*asterisks*). The close proximity of the temporomandibular joint to the bulla may result in pain on opening the mouth in patients with middle ear disease.

palpable. Nine percent of dogs have an additional lymph node that is palpable in the subcutaneous tissue dorsal to the maxillary third premolar tooth. This node is referred to as the facial or buccal lymph node and may be seen unilaterally or bilaterally.[7,8]

The occlusion should be evaluated before intubation by noting any teeth that are positioned incorrectly. Attention is paid to discrepancies of jaw length, the spatial relationship of the teeth as they erupt, and the relationship of the erupting teeth with the soft tissues and dental structures of the opposing jaw. Note any deciduous teeth that have not exfoliated by the time their permanent counterparts have erupted. Persistent deciduous teeth may create increased risk of periodontal disease (due to crowding and lack of normal gingival collar around the permanent tooth) and abnormal position of permanent tooth eruption.

The intraoral examination consists of evaluation of the soft tissues of the oral cavity, the dental structures, and the periodontium, a term that describes the supporting structures of the teeth. Some of this information can be obtained in the conscious patient, but assessment of the periodontium requires anesthesia. Begin by observing the skin and mucosa of the upper and lower lips. Some breeds are prone to lip fold dermatitis caudal to the mandibular canine tooth that can cause oral malodor unrelated to periodontal disease. Vestibular or labial mucosa refers to the mucosa that begins at the mucocutaneous junction and lines the cheeks and lips. Alveolar mucosa refers to the mucosa that lay against the bone of the upper or lower jaw, which meets with the gingiva at the mucogingival junction. The normal appearance of the mucosa may be pink or pigmented, and the mucosa should exhibit no lesions, ulcerations, or swellings. Mucosa that lay adjacent to periodontally diseased teeth may have painful mucosal ulcerations as a response to bacteria in the plaque, often referred to as contact stomatitis or mucositis. Observe the caudal cheek mucosa in the region of the carnassial and molar teeth. This mucosa frequently becomes pressed between the teeth during chewing, creating a condition known as “cheek-chewing lesions.” Similarly, mucosa beneath the tongue may also show signs of chewing lesions referred to as “tongue-chewing lesions,” which are usually bilateral (**Fig. 3**). These lesions usually do not require treatment unless the lesions are not bilaterally similar or if

Fig. 3. A sublingual chewing lesion (*arrow*) in a 13-year-old Chihuahua. The lesion (*arrow*) was removed and histopathological evaluation showed hyperplasia and granulation tissue.

the lesions are ulcerated. In these cases, the affected mucosa may be removed and submitted for histopathological evaluation.

Two raised bumps are found on the alveolar mucosa dorsal to the maxillary fourth premolar and first molar teeth. Salivary secretions from the parotid and zygomatic salivary glands travel through ducts leading to these duct openings. Two similar raised bumps can be found beneath the tongue just caudal to the mandibular symphysis, which are the caruncles of the mandibular and sublingual glands. Care should be taken to avoid trauma to these structures when possible to avoid development of sialoceles (**Fig. 4**).

Small-breed dogs with advanced periodontal disease may be affected by bone loss and pathologic fracture of the mandible, which may be found as an incidental finding in the examination room. If severe periodontal disease is suspected in a small-breed dog, care should be taken to avoid creating a pathologic fracture when opening the mouth during the conscious examination or during intubation.

The roof of the mouth is composed of the hard and soft palates. The hard palate is covered by palatal mucosa arranged in prominent ridges, called rugae. These rugae range from 8 to 10 in number. In brachycephalic dogs, the rugae are closely positioned, and hair and debris can accumulate in these rugal folds. On the midline of the hard palate, just caudal to the incisor teeth, the incisive papilla is a round, slightly raised structure. Lateral to the incisive papilla, a small bilateral communication with the incisive duct and vomeronasal organ exists. The vomeronasal organ is a paired sensory organ involved in detection of pheromones and other volatile compounds. Palpation of the area lateral and caudal to the incisive papilla may normally feel as if there is air trapped beneath the mucosa as a result of the communication between the mouth and these nasal structures. The soft palate consists of mucosa and muscle that separate the oropharynx and nasopharynx. Two prominent bony structures can be palpated just lateral to the midline of the soft palate that are the hamular processes of the bilateral pterygoid bones. If one or both hamular processes are difficult to palpate, this may be due to the presence of a nasopharyngeal mass.

The pharynx should be evaluated for evidence of inflammation or neoplasia. When the patient's mouth is open, bilateral folds of pharyngeal mucosa will be evident lateral to the tongue. These are the palatoglossal folds, and this area and the mucosa lateral to these folds may be inflamed in cats with caudal stomatitis.

Fig. 4. The left and right sublingual caruncles are seen in the raised, redundant mucosa lateral to the lingual frenulum. The mandibular and sublingual salivary ducts empty into the oral cavity at this site (*arrows*).

Gently hold the tip of the tongue to enable visual examination of the dorsal, ventral, and lateral surfaces. The firm, tubular structure palpable on the midline of the rostral tongue is called the lyssa, which helps to provided structure and coordinated movement of the rostral tongue. Lift the tongue to observe the mucosa of the floor of the mouth and the base of the tongue. In the conscious patient, the examiner's thumb may be used extraorally to push the tongue dorsally for better visualization of the ventral surface of the tongue. The dorsal surface of the tongue is covered by thousands of papillae, some of which contain taste buds. The large, distinctive papillae located at the caudal third of the tongue are the vallate papillae, which are spaced in a curved line separating the body from the root of the tongue. Depress the tongue to visualize the tonsils, noting any enlargement or change in color or texture. The color of a normal tonsil is typically more hyperemic than the color of the adjacent mucosa. Normal tonsils may be fully contained within the tonsillar crypt and may be difficult to visualize.

The next step in the intraoral examination is evaluation of the teeth and their supporting structures. First, determine the presence or absence of teeth in each quadrant. Missing teeth can be documented on the dental chart by darkening or circling the missing tooth. Radiographic evaluation of areas of missing teeth is imperative because dentigerous cysts can develop as a result of an unerupted tooth. A periodontal probe and dental explorer are used to evaluate the tooth and its attachment structures. These dental instruments are important clinical tools for obtaining data about the health status of each tooth. Consider the adult canine mouth as containing 42 patients and the adult feline mouth containing 30 patients, each patient requiring a thorough evaluation and treatment planning. The periodontal probe has a round or flat working end, which is marked in millimeter increments, ending in a blunt tip. The probe is used like a miniature intraoral ruler to measure attachment levels, sulcus and pocket depths, loss of bone in furcation areas, and size of oral lesions. It is also used to assess the mobility of teeth and the presence of gingival bleeding. Periodontal probes are available in an assortment of styles, with variations in thickness of the diameter of the working end and variations in increments of millimeter markings.

The dental explorer has a slender, wirelike working end that tapers to a sharp point. It is used to explore the topography of the tooth surface. When the explorer is held with a light modified pen grasp (**Fig. 5**), the examiner acquires a tactile sense to locate tooth surface irregularities, including caries, tooth resorption, calculus deposits, and pulp

Fig. 5. The modified pen grasp is used to hold an explorer while feeling for defects at the cervical portion of the left mandibular second premolar tooth.

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exposure. The explorer is also used to determine the completeness of treatment following calculus debridement and to ensure smooth transitions of dental restorations. Several designs of explorers are available. Varying degrees of flexibility contribute to the degrees of tactile sensitivity.

The assessment of the periodontium and teeth should begin at the midline of the mouth and systematically evaluate each tooth, one at a time, by using both visual observation and tactile use of the probe and explorer. Begin detecting excessive tooth mobility by placing the tip of the probe against the tip of the tooth and gently attempting to move the tooth in a buccolingual direction. Movement is estimated on a scale of 1, 2, or 3, based on the distance beyond normal physiologic mobility the tooth moves in one direction. A slight amount of movement is normal as a result of the periodontal ligament that connects the tooth to alveolar bone. The most severe mobility, a classification of 3, includes any tooth with vertical movement. As each tooth is approached to check for mobility, visually notice the characteristics of the gingiva for color, shape, texture, and consistency. Healthy gingival tissues are pink (except where normally pigmented), stippled (orange peel appearance), firm, tapered to a thin margin, and scalloped to follow the contour of the cementoenamel junction (CEJ) and underlying alveolar bone. Any area of the gingiva that deviates from these normal characteristics should be examined closer by use of the probe.

The probe is gently inserted into the sulcus (physiologic term) or pocket (pathologic term), ensuring that the probe is kept as close to parallel to the long axis of the root as possible, with the side of the probe tip in contact with the tooth. When physical resistance is felt at the base of the sulcus or pocket, note the marking level on the probe that is adjacent to the gingival margin. The probe is then "walked" around the tooth to assess the entire circumference of the tooth. Abnormal measurements (those greater than 3 mm in dogs, greater than 1 mm in cats) should be noted on the dental chart, along with the specific location of the pocket measurement (ie, MP for mesiopalatal). Probe measurements between millimeter markings are rounded up to the larger measurement. For accurate readings, it is essential to develop skills in consistent probing forces (between 10 to 20 g of pressure). This pressure amount can be practiced by pressing the probe tip into the pad of a thumb until the skin is depressed approximately 2 mm.

In areas where the height of the free gingival margin has migrated apically toward or beyond the CEJ, the probe is used to measure gingival recession. Recession is measured in millimeters from the CEJ to the level of the gingival margin. Attachment loss is a term that truly describes the periodontal state of a tooth because it accounts for both pocket depth and gingival recession. Gingival hyperplasia occurs when the free gingival margin migrates toward the crown of the tooth. An increased pocket depth may be due to hyperplasia or attachment loss, so clinical examination findings are necessary to determine if the increased probing depth is attributable to a true pocket or a pseudopocket.

When multirooted teeth are approached, the probe is used to assess loss of bone in the areas between and around the roots. A bifurcation is the furcation between 2-rooted teeth and should be assessed from the buccal and lingual-palatal surfaces. Trifurcations of 3-rooted teeth should be assessed between each of the 3 roots. The extent of bone loss determines the furcation classification.

During the periodontal evaluation of each tooth, also observe the hard structures of the tooth and use the dental explorer when noticing any chips, fractures, pulp exposure, or abnormal wear patterns of abrasion or attrition. Abrasion refers to tooth wear associated with aggressive chewing on external objects, such as toys, rocks, bones, and ice cubes. Attrition refers to 2 possible scenarios. Physiologic

attrition refers to the normal wear associated with tooth-to-tooth contact of a patient over time with normal mastication. Pathologic attrition is caused by a malocclusion resulting in abnormal wear of teeth as a result of contact with teeth of the opposing jaw.

Dental caries (commonly referred to by the lay term of "cavities") result from demineralization of the enamel and dentin from acids produced by certain oral bacteria. These lesions occur most commonly on occlusal (flat) surfaces of the molar teeth. Gently explore for pits and fissures of the occlusal surfaces of the maxillary first and second molars and the distal half of the mandibular first molar, feeling for areas of demineralization. Use the explorer to check for clinical signs of tooth resorption by dragging the sharp point horizontally across the cervical portion of each tooth. Sometimes it is challenging to determine whether a concavity in the area of a furcation is a resorptive lesion or merely mild furcation exposure. If tooth resorption is present, the explorer tip will "catch" on the edge of the concavity, whereas the explorer will freely move out of the concave area as easily as it fell into it when encountering mild furcation exposure. When tooth fractures are present, gently drag the sharp point of the explorer across the tooth surface, feeling for any openings into the pulp. Teeth with significant abrasion may have a brown or black spot in the center of the worn tooth. This can be a sign of either chronic pulp exposure or a reparative material produced by the tooth in response to chronic wear (tertiary dentin). Pulp exposure can be distinguished from tertiary dentin by use of an explorer. If a tooth has pulp exposure, the tip of the explorer will "fall into a hole," whereas a discolored area caused by tertiary dentin will feel smooth as glass when the explorer is run over this area. This is an important clinical distinction because treatment of pulp-exposed teeth is necessary, but worn teeth without pulp exposure often require no treatment if radiographically normal.[9]

CAPTURING THE CLINICAL EXPERIENCE IN A RETRIEVABLE FASHION

Record keeping during the physical examination is important not only because it provides legal documentation, but also because well-documented cases provide us the opportunity to learn from our patients by reviewing and comparing these cases to future similar cases. During the soft tissue examination, any tissue variations from normal should be described by recording the size, shape, color, surface texture, and consistency (eg, soft, firm, hard, or fluctuant). A dedicated area of the dental record may be created to allow for documentation of any abnormalities of intraoral or extraoral structures (**Fig. 6**). Paperless dental charting systems are commercially available. Copies of digital dental radiographs and digital records may be saved automatically via online backup programs or external hard drives. Conventional dental radiographs are saved in the dental record and may be digitized by photographing with a digital camera. Preoperative and postoperative photos and videos of procedures can be archived and doubly saved on an external hard drive in both chronologic and categorical folders for ease of searching.

EXAMPLES OF COMMON PRESENTATIONS

Case 1: 13-Year-Old Yorkshire Terrier with Severe Periodontal Disease

Physical examination of Guinevere, a 13-year-old spayed female Yorkshire terrier, whose history was mentioned in the introduction, reveals a grade III/VI holosystolic murmur over the left and right chest. A repeatable cough is elicited on tracheal palpation in the thoracic inlet area. Mandibular lymph nodes are bilaterally enlarged. The patient is reluctant to have a thorough conscious oral examination, but as the dog pants, it is apparent that the mucous membranes are slightly pale except at the

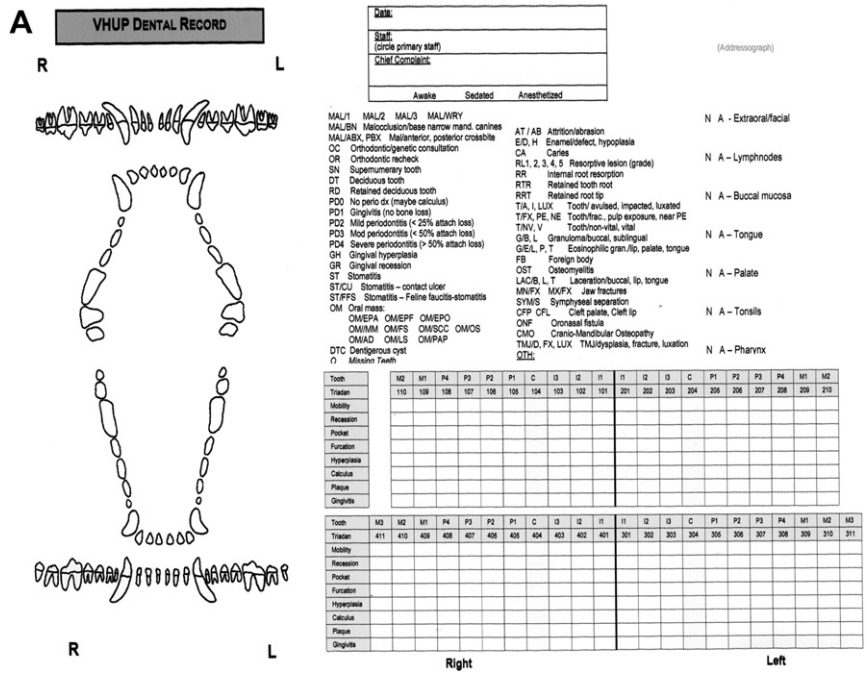

Fig. 6. An example of a canine dental record. (*A*) The front of the record contains diagnostic information.

gingival margin where gingivitis and gingival recession is seen around nearly all teeth. Severe calculus and plaque accumulation is present on the vestibular (buccal/labial) and palatal/lingual surfaces of all teeth. A gingival mass is seen arising from the gingiva of the left maxillary canine tooth (**Fig. 7**). A mild serous nasal discharge is present from the right nostril.

What did you prioritize as important information from the history and physical examination? Increased anesthetic risk is suggested by results of auscultation, tracheal palpation and mucus membrane color. Thoracic and cervical radiographs may be used to assess the trachea, heart, and lungs. Fluoroscopy may be used to assess dynamic changes of the trachea. Echocardiogram and electrocardiogram will provide further detail regarding cardiac abnormalities. Complete blood count and chemistry screen may elucidate a cause of mucus membrane pallor and will provide information on kidney and liver status.

The degree of overt periodontal disease in this patient and the lack of prior dental procedures suggest there are multiple hours of anesthesia necessary for this dog. Mortality rates associated with anesthetic procedures in veterinary patients have been documented to be between 0.17% and 5.00%, depending on the population studied and the study period.[10–12] Increasing American Society of Anesthesiologists (ASA) status was associated with an increased chance of anesthetic death in a recent study of 3546 dogs and cats.[11] ASA physical status classifications and examples are listed in **Table 1**.[13] **Fig. 8** shows an algorithm for potential decisions and outcomes regarding anesthetic risks in this patient.

If the decision is made to pursue treatment based on careful assessment of risk versus benefit, areas of the mouth causing the most morbidity should be prioritized,

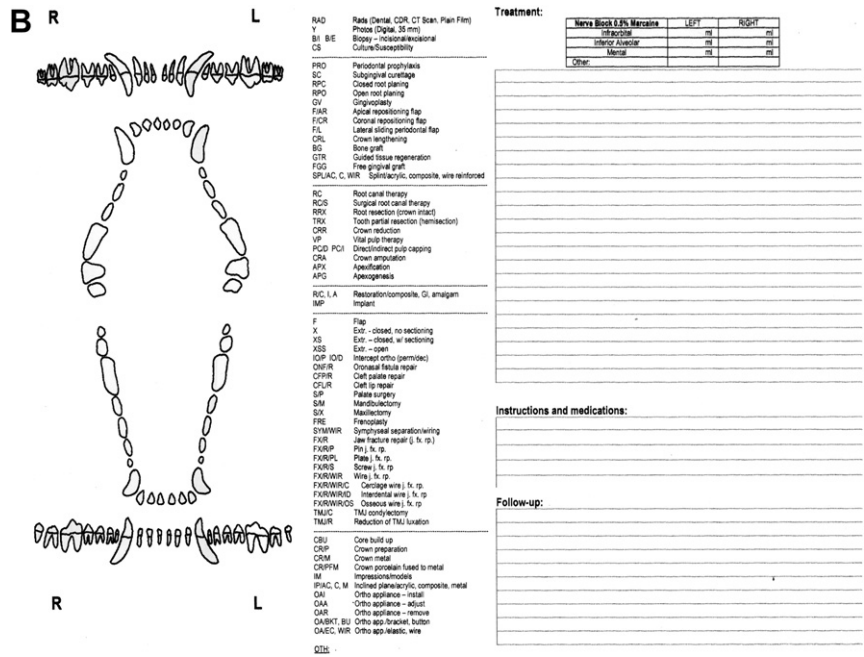

Fig. 6. (*B*) The back of the record contains treatment information.

as this procedure may require staging into more than one anesthetic episode. Assessment of how the patient eats may provide clues of which side is more painful. Plaque and calculus accumulation is often greater on the more painful side of the mouth, as less self-cleansing occurs because of less chewing on the painful side. **Fig. 9** shows

Fig. 7. Severe periodontal disease and gingival recession throughout the mouth of a 13-year-old Yorkshire terrier. Histopathology of the gingival mass over the left maxillary canine tooth revealed gingival hyperplasia and granulation tissue.

Table 1
American Society of Anesthesiologists physical status classification

Category	Physical Status	Example
I	Healthy patient	Removal of persistent deciduous teeth in a healthy young animal
II	Patient with mild systemic disease	Young healthy patient with a mandibular fracture due to dog fight
III	Patient with severe systemic disease	Cachexia, anorexia, and dehydration in a cat with severe stomatitis
IV	Patient with severe systemic disease that is a constant threat to life	Uremic, anorexic, anemic patient with bilateral pathologic mandibular fractures
V	A moribund patient not expected to survive 24 h with or without operation	Unresponsive patient with extreme shock, dehydration, active internal bleeding, pulmonary dysfunction, infection, and seizuring due to a terminal malignancy

Modified from Thurmon JC, Tranquilli WJ, Benson GJ, et al. Lumb & Jones' veterinary anesthesia. Baltimore (MD): Williams & Wilkins; 1996. p. 22.

an algorithm for treatment planning of periodontal disease in this patient. Decisions regarding how best to treat "borderline teeth" will depend on patient health status, the client's willingness to brush daily, and client interest level in saving teeth by performing regular professional dental cleanings in the future.

Case 2: 9-Month-Old Corgi Mixed Breed with a Fractured Tooth

A 9-month-old spayed female Corgi mixed breed is presented approximately 48 hours after fracturing its left maxillary canine tooth (tooth 204) while chewing on a deer antler (**Fig. 10**). The patient is otherwise healthy and was anesthetized 5 months earlier for ovariohysterectomy. Physical examination is nonremarkable except for a fractured cusp of tooth 204 with a red spot in the center of the cusp fracture indicative of pulp exposure. In this case, anesthetic risk, although always present at some level, is considered to be minimal and is outweighed by the benefit of treating the acutely fractured tooth. **Fig. 11** provides an algorithm regarding considerations for treatment of this patient. If the history was different, despite similar signalment (eg, motor vehicle trauma causing a fractured cusp of 204 in a 9-month-old dog), the anesthetic risk might be vastly different because of concerns for increased intracranial pressure, pulmonary contusions, blood loss, and internal bleeding.

Treatment options for a fractured tooth with pulp exposure include extraction, vital pulp therapy, or root canal therapy. An important consideration, when deciding if vital pulp therapy is appropriate, is elapsed time from onset of fracture until treatment. It has been shown that length of time of pulp exposure directly correlates with treatment outcome. A 36-month retrospective study compared the results of vital pulp therapy based on the duration of pulp exposure. Postoperative oral and radiographic examinations were performed at 3, 12, and 36 months following treatment. Based on the 36-month postoperative examinations 88.2%, 41.4%, and 23.5% of teeth were vital when treated within 48 hours, 1 week, and 3 weeks of pulp exposure, respectively. The conclusion from this study was that vital pulp therapy should be done as soon as possible after traumatic tooth fracture to improve outcome.[14] If vital pulp therapy does not provide the desired effect of keeping the tooth vital for the entire life of the

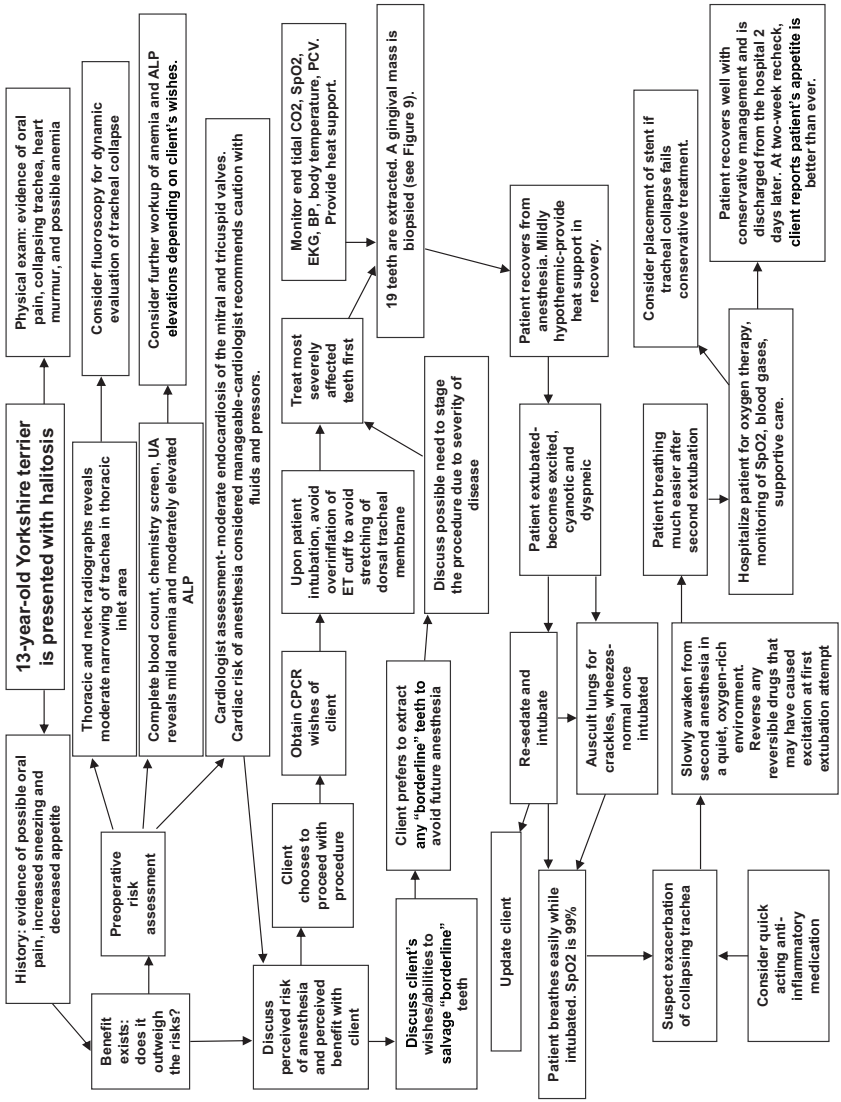

Fig. 8. An algorithm for possible considerations of anesthetic risks in a 13-year-old Yorkshire terrier.

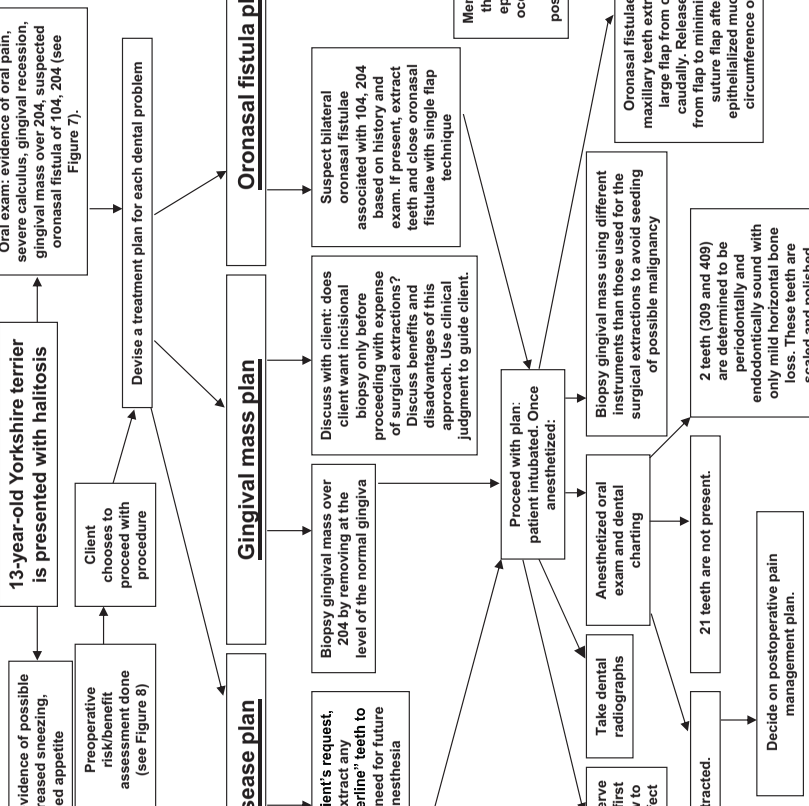

Fig. 9. An algorithm for decision making regarding periodontal treatment in a 13-year-old Yorkshire terrier.

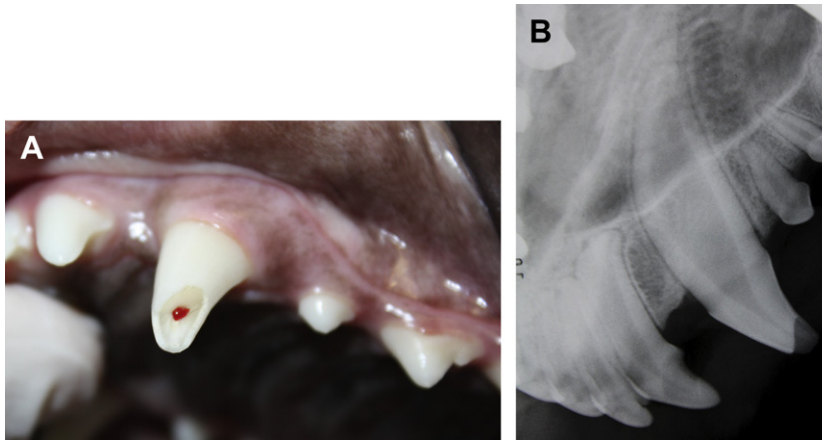

Fig. 10. A 9-month-old Corgi mix was presented with a fractured tooth approximately 48 hours after suspected trauma from chewing on a deer antler. (*A*) Photograph of tooth 204. (*B*) Dental radiograph of tooth 204.

patient, it may at least allow the tooth to mature enough that standard root canal therapy can be done once mature. Alternatively, if the pulp has been exposed for quite a while before treatment, root canal therapy may be considered if the root apex is developed enough to confine the root canal filling material, and if the maturing dentinal walls of the crown are thick enough to have a reasonable chance of avoiding future fracture.

FAILING TO PLAN = PLANNING TO FAIL

Planning of complicated dental or oral surgical procedures can be improved by using donated cadaveric material. The unwritten rule of the Dentistry and Oral Surgery residency program at the University of Pennsylvania is this: before performing a complex procedure on a living patient, this procedure is performed on a cadaver. Although no studies have evaluated the benefits of use of cadavers in veterinary dentistry and oral surgery, use of cadaveric material has been shown to improve outcomes and procedure times when teaching laparoscopy in human medicine.[15] Potential benefits for use of cadavers in veterinary dentistry and oral surgery include reaffirmation of anatomic knowledge, familiarity with instrumentation, and relief of operator stress during the actual procedure. For more involved maxillofacial procedures, computed tomography or magnetic resonance imaging may be performed and evaluated before the actual procedure date to allow for ample time to assess, plan, and perform cadaver procedures.

Another important planning aspect is review of instrumentation before anesthetizing the patient. Reviewing the surgical armamentarium before the procedure ensures all necessary equipment is ready for use and allows an opportunity to define roles when performing "4-handed dentistry" with an assistant. What is on my tray and what needs to be on my tray?

Planning for potential complications is also important. From our previous example, if our 13-year-old Yorkshire terrier awakes from anesthesia, and on extubation, becomes cyanotic and severely dyspneic, do we have the expertise, equipment, and staff to place a nitinol stent if indicated and if other treatment options fail? If not, what can we do as an alternative? Although no pet owner wants to think about what they would do if cardiac or respiratory arrest occurs, do we have a

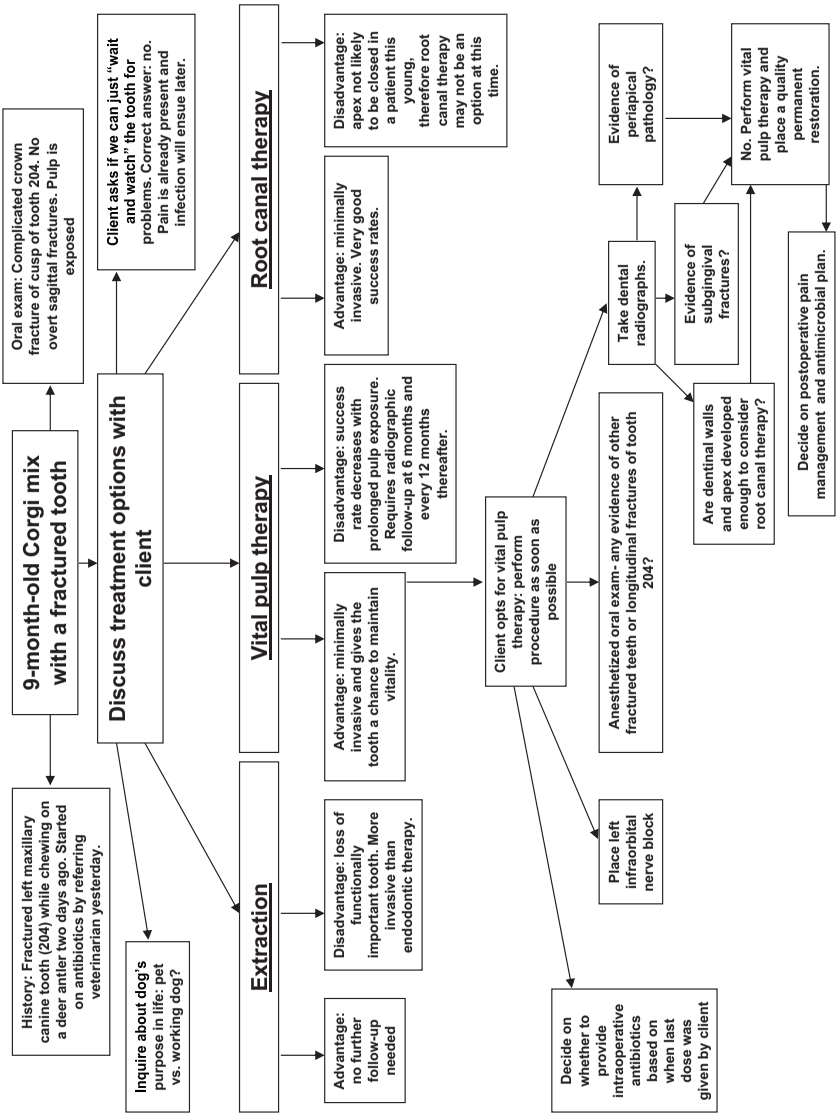

Fig. 11. An algorithm for decision making regarding treatment of a fractured tooth in a 9-month-old Corgi mix.

plan regarding whether the client would like cardiopulmonary cerebral resuscitation performed?

SUMMARY

Making successful therapeutic decisions involves an amalgamation of inputs, including history, physical examination, previous clinical experiences, and available literature. Although there is very little Level I evidence for veterinary dental conditions, the body of literature grows every day. If the details of the case are captured in memory or in dental records, even the most common case provides the opportunity to learn something new.

REFERENCES

1. Feinstein AR. Clinical judgment. Baltimore (MD): Williams & Wilkins; 1967.
2. Sackett DL, Rosenberg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. BMJ 1996;312(7023):71–2.
3. Woolf SH, George JN. Evidence-based medicine. Interpreting studies and setting policy. Hematol Oncol Clin North Am 2000;14(4):761–84.
4. United States Prevention Services Task Force. Guide to clinical preventive services: report of the U.S. Preventive Services Task Force; Preface by Robert S. Lawrence. Washington, DC: United States Prevention Services Task Force; 1989. p. 263.
5. Tonelli MR. In defense of expert opinion. Acad Med 1999;74(11):1187–92.
6. Feller L, Blignaut E. Halitosis: a review. SADJ 2005;60(1):17–9.
7. Casteleyn CR, van der Steen M, Declercq J, et al. The buccal lymph node (lymphonodus buccalis) in dogs: occurrence, anatomical location, histological characteristics and clinical implications. Vet J 2008;175(3):379–83.
8. Shelton ME, Forsythe WB. Buccal lymph node in the dog. Am J Vet Res 1979; 40(11):1638–9.
9. Bassert JM, McCurnin DM, McCurnin DM. McCurnin's clinical textbook for veterinary technicians. St Louis (MO): Saunders Elsevier; 2010.
10. Brodbelt D. Feline anesthetic deaths in veterinary practice. Top Companion Anim Med 2010;25(4):189–94.
11. Bille C, Auvigne V, Libermann S, et al. Risk of anaesthetic mortality in dogs and cats: an observational cohort study of 3546 cases. Vet Anaesth Analg 2012;39(1): 59–68.
12. Hosgood G, Scholl DT. Evaluation of age and American Society of Anesthesiologists (ASA) physical status as risk factors for perianesthetic morbidity and mortality in the cat. J Vet Emerg Crit Care 2002;12(1):9–15.
13. Thurmon JC, Tranquilli WJ, Benson GJ, et al. Lumb & Jones' veterinary anesthesia. Baltimore (MD): Williams & Wilkins; 1996. p. 22.
14. Clarke DE. Vital pulp therapy for complicated crown fracture of permanent canine teeth in dogs: a three-year retrospective study. J Vet Dent 2001;18(3):117–21.
15. Levine RL, Kives S, Cathey G, et al. The use of lightly embalmed (fresh tissue) cadavers for resident laparoscopic training. J Minim Invasive Gynecol 2006; 13(5):451–6.