Making Sense of Intraoral Radiographs

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Intraoral radiography has evolved a great deal over the past 10 years. Initially it was only available through dental specialists and people with a comprehensive interest in dentistry. Now it has become readily affordable for the average practitioner and is commonly available in practice. The indications for dental radiography are variable and many, but being able to understand and interpret the results are paramount to identifying pathology and recommending the appropriate treatment.

Indications for radiography

Missing, mobile, fractured, discolored teeth and teeth with periodontal pockets are all teeth that should undergo radiographic evaluation to determine treatment options. Teeth that are planned for extraction, for whatever reason, should be radiographed to aid in treatment planning, correct estimate creation and to appropriately counsel clients about potential complications. Some individuals even suggest that radiographs prior to and after a procedure may even serve as a protection against clients who may question the quality of a procedure.

Marketing radiography to clients

The information that intraoral radiography can provide is invaluable for correctly and accurately identifying abnormalities and recommending treatments that will improve the veterinary patient's quality of life. With ½ to 2/3 of the normally erupted tooth anatomically being located below the gum line, educating the client about the health of the subgingival periodontal attachment as well as the vitality of the endodontic system can only be impressed through the demonstration of a radiograph. The use of acrylic models or "smile" books displaying "normals" can be helpful at conveying to clients this valuable service.

Once radiographs have been taken, printing the radiograph images and including them with discharge instructions provide the client with something tangible which can help to validate the service, justify the charges and provides redundancy of the information in the medical record. In my experience, clients typically appreciate the images and discussing the treatment and its justification is more easily understood.

Media options: Film *vs.* digital

Similar to the evolution of photography from film to digital, digital radiography in veterinary practice started out in most practices as images captured on conventional radiographic film. Previously, if intraoral imaging had been offered, many practices utilized human intraoral dental film and chair side developers. Chair side developing of these small films allowed for quicker results than bootlegging dental film for processing in a standard automatic processor. The move to chair side developing not only improved efficiency of developing and reviewing films, but the chemicals used in such chair side development systems took advantage of films and chemicals that yielded images quicker than automatic processors could provide. Maintenance and disposal of chemicals, maintaining film and a somewhat temperamental developing process that took as long as several minutes created countless situations where film and supplies became discarded in a storage closet.

Advantages of digital intraoral radiography in today's practice lies both in the ubiquity of computers, ease of sharing for referral evaluation, and an improved learning curve with even quicker attainment of radiographic images. Digital radiographic mediums require significantly less radiation exposure, which makes them safer compared to traditional film when considering operator safety. Generally speaking, there are two technologies that make up digital dental radiography today. Both technologies provide radiographic images significantly faster than traditional film radiography and digital offers the ability to easily magnify and manipulate certain qualities of the image.

Direct digital radiography

This technology utilizes hardware capable of generating an image while being "directly" connected to the computer. The sensors of these units are only available as size 2 or size 0 (because these sizes are most frequently used in human dentistry) and these sensors are rigid and several millimeters thick. Direct digital units offer the advantage that their image creation and display on the computer screen is virtually instantaneous. With the instant gratification of image display, an incorrect radiographic positioning relationship can be corrected without disturbing sensor and generator tube head. Damage to the sensor results in being unable to continue to collect information without replacing the sensor as well as the sizable investment of the sensor which may cost an upwards of $8,000-10,000 or more.

Indirect digital radiography

Involves technology of exposing phosphor plates that are then fed into a device which scans the plates, erases the plates and sends the image data to the computer. An advantage of this system are that the plates are thin and flexible, so they may accommodate the mouths of patients more comfortably, and include a variety of sizes. Dental specific readers can accept plates as large as about 5" x 7" which may be helpful for imaging exotics. Larger tabletop scanners have the capacity to accept large films typically use with tabletop

radiograph units. Disadvantages of this setup includes the necessary step of removing the plate from the patient's mouth, which increase image acquisition time and makes modification of positioning to rectify improper images more challenging. Phosphor plates are somewhat fragile and shouldn't be folded, bent or scratched. In the event they need to be replaced, most cost less than $100.

Positioning

Before radiographic films can be properly interpreted, they need to be properly taken. The fundamental principal of the parallel positioning technique is exactly the same as radiographic exposure of other parts of the body- place the anatomy to be radiographed against a film so that both structures are parallel to each other and then aim the radiation source perpendicular to the structure and the film. This approach is only successful when dealing with the caudal mandible because of the flexibility afforded by the soft tissue structures of the intermandibular area.

The bisecting angle technique enables the operator to generate anatomically appropriate images without excessive artifacts such as foreshortening or elongation. The bisecting angle technique is necessary to properly radiograph the entire maxilla and the rostral mandible. This technique works best if the operator has a preconceived idea of what the proper film should look like. By visualizing the long axis of the tooth structure, and visualizing the long axis of the radiographic film, evenly splitting the angle in half provides us with the bisecting able. By positioning the generator tube head perpendicular to this bisecting angle, a representative image will be created.

The most common reasons for disposing of film or retaking films are 1) missing the area of interest, 2) foreshortening of the image or 3) elongating the image. Foreshortening or elongation can be easily remedied by altering the angle of the x-ray generator. When these difficulties are encountered using the bisecting angle technique, modifications to the x-ray generator can be made in a manner analogous to looking at a person's shadow when on the beach. When standing on the beach, the person represents the tooth and the sand represents the x-ray film. If the sun is in a position in the sky where the sun's rays are perpendicular the bisecting angle between the person and the sand, a 1:1 scale shadow is made. If the sun is too much towards the horizon, the shadow becomes elongated. If the sun is directly overhead, the shadow appears short and squatty (foreshortened). Thinking of the x-ray generator as the sun, and looking at an image that is either foreshortened or elongated, the operator should have an easier time reasoning through which direction the x-ray generator needs to be moved to acquire the desired image.

Radiographing the maxillary fourth premolar correctly is a common point of frustration for many people. To assess all three roots of this tooth, two views are needed. A lateral view will enable visualization of the distal root. In this view the mesial buccal and palatal roots will appear superimposed. To effectively separate these roots, the x-ray generator needs to be oriented in either a caudorostral or rostrocaudal direction. The "SLOB" rule has been coined to help decipher which root is represented in which location on the film/image. SLOB stands for Same Lingual Opposite Buccal. The same/opposite are in relation to the direction the x-ray generator moves. If the x-ray generator is swung rostrally to shoot in a rostrocaudal direction, the resultant two mesial roots will be able to be interpreted as follows: the root moving in the "Same" direction on the film as the x-ray generator (rostrally) is the Lingual root. The root moving in the "Opposite" direction of the x-ray generator (generator went rostrally, so the root moving caudally on the film) is the Buccal root. This technique takes practice and, in general, a hospital should decide how to position for these radiographs where the roots are separated and everyone use the same positioning, or the films must be labeled.

Normal anatomy

Enamel and dentin are comprised of a greater percentage of minerals than bone, so they appear more radiodense. The periodontal ligament is primarily comprised of collagen so it should show as a distinct radiolucent line. The periodontal ligament should be thin, well demarcated, and of consistent width throughout the outline of the tooth. The pulp chamber is located in the center of the tooth root and should be of uniform diameter throughout. Whenever a radiographic abnormality is suspected, radiographic comparison is recommended of the contralateral or comparable tooth. Remember that as the tooth matures, the pulp chamber narrows as secondary dentin is produced. If a widened pulp chamber is identified compared to neighboring or contralateral teeth, chronicity of the lesion is demonstrated. The younger the patient (the wider the pulp chamber) the more profound the difference will be in the amount of secondary dentin laid down in six months. Mature patients can have very little change in pulp chamber diameter from year to year.

Pathology

Bone loss

Loss of mineral opacity is typically seen in vertical or horizontal orientations. If there is regionalized horizontal bone loss, a chronic inflammatory condition likely exists in that are or there are multiple neighboring teeth severely affected by periodontal disease. Bone loss does not equal attachment loss, so if there is there is periodontal attachment at the level of the cementoenamel junction and signs of underlying vertical bone loss, those teeth are not as periodontally "sound" because of the quality of the soft tissue attachment holding the root. The connective tissue maintaining attachment to the tooth should be closely monitored for the development of periodontal disease. In the most extreme cases of bone loss involving mandibular teeth, dental radiographs can impress upon the client the risk of jaw fracture while performing the extraction.

Periapical radiolucency

Periapical radiolucencies are typically what practitioners are concerned with when looking for nonvital teeth. While correctly identifying lesions suggestive of tooth nonvitality are important when deciding to recommend treatment, radiographic assessment for the purpose of anticipating difficult or complicated extractions may be even more important. Widening of the periapical periodontal ligament space can be suggestive of pathology. Keep in mind that a 40% loss of mineral density is required for pathology to be noticeable on radiographs. Typically, secondary changes related to tooth nonvitality are found emanating from one, or all of the apices of the affected tooth. These lucencies can be of variable size but typically are clearly well demarcated within the bone because of the focal effect of the expanding lesion. Triangular shaped radiolucencies extending from the apices of canine teeth and mandibular first molar teeth are referred to as "chevron" signs. This can be a normal finding on these particular teeth and are not indicative of tooth nonvitality. If one is unsure about a radiographic finding, radiographing the contralateral tooth is recommended. Not every periapical radiolucency results from infection and represents a nonvital tooth. Differentials for these lesions include cemento-osseous dysplasia, sterile granuloma or an early stage cementoma. All of these lesions are thought to arise from pulpal inflammation and cannot be differentiated without histologic evaluation. Treatment for all these conditions would still involve root canal therapy or extraction- especially since our patients cannot definitively tell us what type of pain they are in.

Root pathology

Radiographic evaluation of tooth roots provide a tremendous insight into the difficulty or involvement of an extraction. Root fractures, extra roots and unusual root shapes (root dilacerations) are all conditions that directly influence the time and likely success of tooth extraction.

Root resorption/ankylosis

Presence of a periodontal ligament reassures the practitioner that a soft tissue separation exists between the tooth an alveolar bone which will serve as some "wiggle room" for placement and action of the dental elevator. There are many causes for root resorption with inflammation being the most common. Instances where resorption has occurred but a periodontal ligament remains visible may demonstrate the tooth is weakened and may fracture during elevation. Instances of root resorption with ankylosis (bony fusion between cementum and alveolar bone) should prepare the practitioner for a more complicated extraction that will likely take longer. Older dogs with a history of being heavy or aggressive chewers will frequently exhibit ankylosis in dental radiographs. Extraction of these teeth typically take longer and may involve additional steps necessary for creating space for elevator placement. A practitioner should feel comfortable estimating a greater cost to the client to extract teeth that will be difficult.

Post-procedural radiographs

There are many circumstances where dental radiographs following extraction are helpful and provide the practitioner with reassurance that the job is complete. My recommendation is that a radiograph should always be taken at ANY time a root is suspected to have fractured during extraction. Gaining confidence is gross appearance of root structures after extraction and being able to compare them to pre/post operative films helps to build confidence. Post extraction radiographs may also be beneficial for sharing with clients at discharge to help justify procedural cost and objectify the pathology and the treatment. Printed dental radiographs provide the client with tangible information that can sometimes soothe concerns over client-perceived feelings that "unneeded procedures" were performed (you know, those clients who say their animal's mouth isn't painful but your exam and radiographs show otherwise!)

Occasionally you may have patients who have received advanced dental procedures (root canal, vital pulp therapy/pulp capping, crown placement.) Dental radiographs should always be taken of these teeth out of convenience if the animal is not undergoing a prescribed anesthesia for the purpose of dental treatment monitoring. Comparing immediate post treatment radiographs to present day films are usually necessary to comment on the success of the procedure. Be sure to share these films with whoever performed the original procedure and ask to be shown how to evaluate success.

References

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Veterinary Dentistry: Principles and Practice. Robert Wiggs and Heidi Lobprise. 1997

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