



## **Dental Investigation & Xray Mini Series**

### **Session 3: Treatment planning – interpreting the information**

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## Image Interpretation

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In order to ensure the diagnostic quality of images produced, attention must be paid to each step of both radiography and processing. Common faults include inaccurate positioning technique and incorrect handling of films during processing.

### Radiographic Technique Faults

#### INACCURATE FILM/ PLATE/ SENSOR POSITIONING:

The most frequent error is allowing insufficient film area for the dentition in question, leading to areas of missed anatomy, often the periapical area. It is vital to have all the information present to enable diagnostic interpretation. The periapical area is most important and should include 3-5mm of surrounding bone. This is achieved by careful placement of appropriately sized film.

#### INCORRECT BISECTING ANGLE TECHNIQUE:

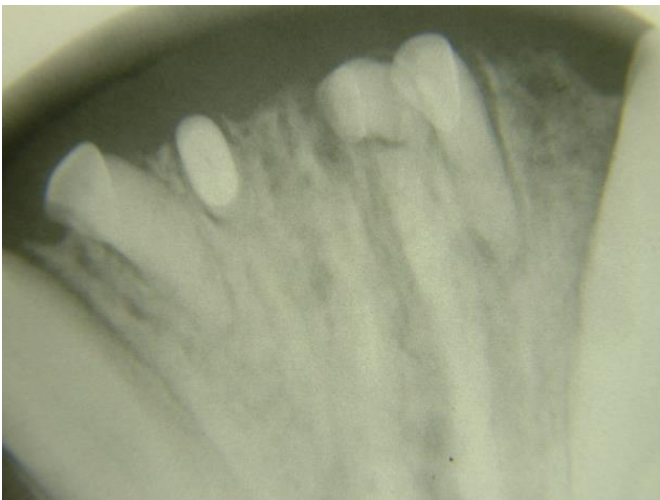
##### A) INCORRECT VERTICAL ANGULATION

**Elongated, thin image** - Xray beam angle too shallow onto object

- false positive periapical lucencies, pulp falsely narrow

**Short, fat image** – Xray beam too steep onto object

- periapical pathology hidden, pulp appears wide



Fore-shortening of incisors

##### B) INCORRECT HORIZONTAL ANGULATION

Superimposition – failure to align the beam in such a way that the image is 'thrown away' from adjacent anatomy (eg neighbouring dentition).

#### FILM/ PLATE FLEXION:

Distortion should be avoided by keeping films flat, through careful use of paper or sponge when positioning.

## **INCORRECT XRAY MACHINE SETTING:**

Pale, indistinct image- underexposure

Dark, indistinct image- overexposure

Digital systems required a shorter exposure time than none digital. Ensure your system sensor and xray machine are compatible (this is usually the case where the timer can be reduced to 0.06s or below).

## **Normal Radiographic Anatomy**

**ENAMEL**- the densest tissue in the body, it is high radio-opaque, however it is also very thin. It is thus seen most obviously as a white opacity over the crown when edge-on.

**DENTINE** - this forms the bulk of the tooth, the walls of both crown and root. It is a hard, porous material with density greater than bone but inferior to enamel. Dentine is produced by the pulp as the animal ages, thereby thickening the walls and reducing pulp cavity width. This fact can be used to estimate both age and pulp vitality of a tooth.

**PULP**-the living centre of each tooth, this complex soft tissue organ contains vascular, nervous, lymphatic and connective tissues. It produces dentine, primarily at the outer extremity, thus laying down the thickening dentinal walls. The radiographic pulp chamber and root canal thus becomes thinner as the animal ages.

**CEMENTUM** – coats the outside of the root but is relatively low density and normally too thin to be identified radiographically.

**PERIODONTAL LIGAMENT**- this fibrous attachment suspends the root within the socket. The fibres provide support by traversing the periodontal ligament space between root cementum and alveolar bone. The space and soft tissue density results in a thin, radiolucent line describing the extremity of the roots and the socket shape. Radiolucent apical widening represents the area in which the neurovascular supply enters each root via the 'apical delta'.

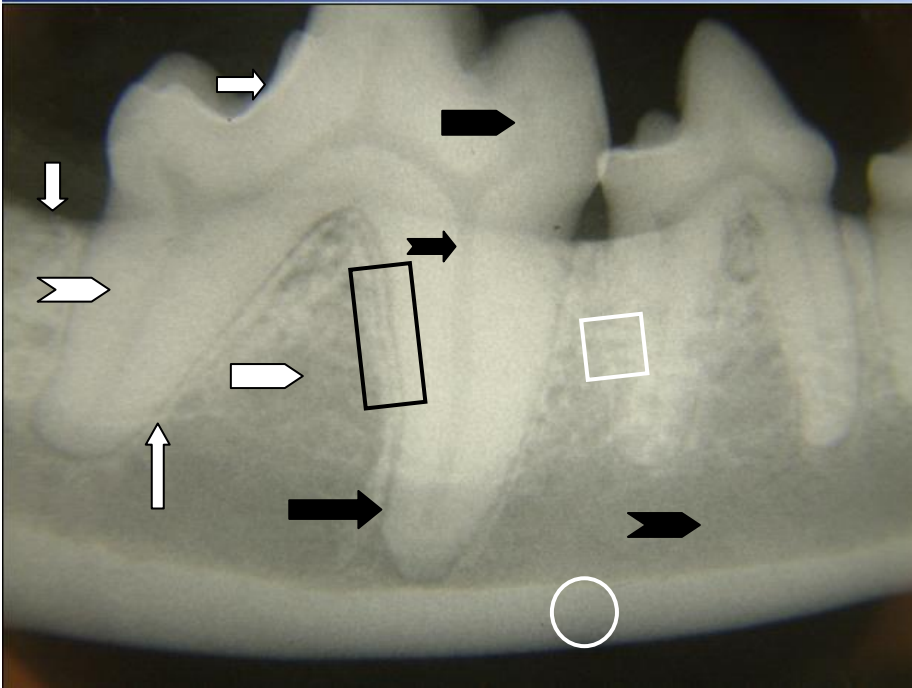
**ALVEOLAR BONE**- bone forming the tooth socket; extremities are delineated as:

- **Alveolar crest:** most cervical, normally matches root height ie cemento-enamel junction.
- **Lamina dura:** white line (viewed as edge-on, dense bone) describing the socket edges. Normally this shape closely matches root anatomy.

**NUTRIENT CANALS**-running through bone of the maxilla and mandibles, these house and protect neurovascular bundles supplying the adjacent dentition and soft tissues. The soft tissue contained results in linear, radiolucent, radiographic signs (see below).

**Maxilla:** infraorbital canal

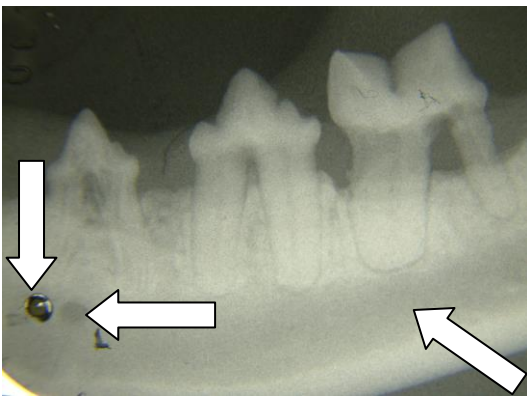
**Mandible:** mandibular canal



**Radiographic dental anatomy:**

Radiodensities (white) - enamel of crown (top arrow), alveolar bone (downward arrow), dentine (chevron), lamina dura (upward arrow), alveolar bone – open-weave, trabecular (block arrow), cortical bone (circle), area of ankylosis ie loss of periodontal ligament space (square)

Radiolucencies (black) - pulp cavity (notched arrow), pulp horn of pulp chamber (block arrow), periodontal ligament space (horizontal arrow), developmental groove (rectangle), mandibular canal containing neurovascular bundle (chevron)



arrows: vertical=clip site, horizontal=mental foramen,  
oblique=mandibular canal

**FORAMINA-** typically well-demarcated radiolucent circles, marking the extremities of nutrient canals. They may be close to dentition – take care not to interpret their presence as pathology.

**Maxilla:** infraorbital foramina lie dorsal to the distal root of the third premolar and just rostral to the mesial roots of the fourth premolar ('carnassials').

**Mandible:** mental foramina should be noted, positioned directly ventral to the mesial root of the second premolar and therefore adjacent to the apex of the lower canines.

## STAGES OF DENTITION

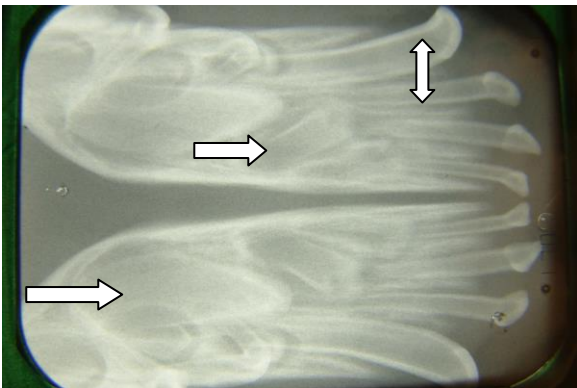
### Immature:

#### Deciduous Dentition

The roots are narrow and fragile but undergo resorption to enable their atraumatic loss (exfoliation) as permanent dentition approaches the stage of eruption.

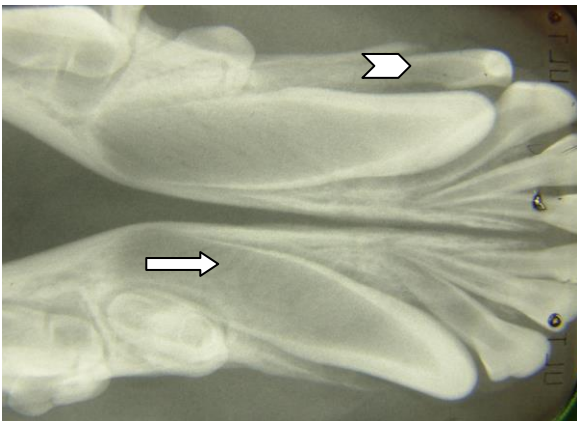
#### Permanent Dentition

Unerupted permanent dentition is observed in the juvenile animal, most notably as tooth buds closely apposed to the overlying deciduous dentition.



deciduous dentition (double arrow) and underlying tooth buds (single arrows) of unerupted, permanent dentition

Prior to adulthood, permanent teeth have an open apex and thin dentinal walls; the bulk of the tooth anatomy is pulp at this stage. Apexogenesis, the gradual process of root lengthening and apex closure, ensues.



immature, erupting permanent canine (arrow) and persistent deciduous canine (chevron)

### Mature Dentition:

Apexogenesis to form a closed apex is achieved at approximately 18 months of age (appears closed radiographically from around 12 months of age) and dentinal walls gradually thicken.

## PATHOLOGICAL CHANGES

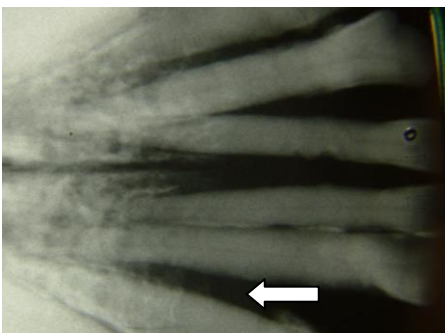
### PERIODONTITIS:

Periodontal ligament space widening, generally or in specific sites, is an early sign. All treatment options except extraction rely on effective daily plaque removal, ie tooth-brushing.

### Bone Loss

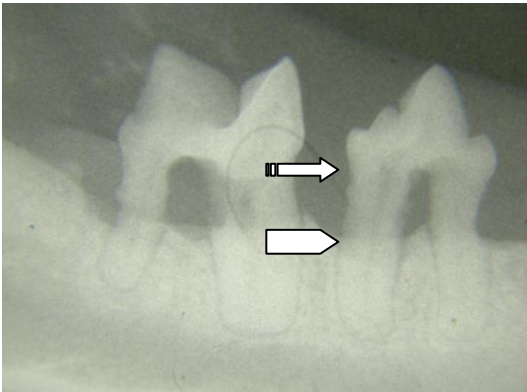
Initially the alveolar crest between teeth develops concavity. This may progress in a vertical or horizontal manner.

Vertical - pocket formation; V shaped areas of radiolucency migrating apically between the root and alveolar bone.



vertical bone loss

Horizontal - lowered alveolar crestal height resulting in exposed areas of root and radiolucency between roots (furcation).



Horizontal bone loss - top arrow indicates normal height. Note also film stain

Lateral Wall Abscessation- localised alveolar wall destruction; lucency, may be produced by lysis secondary to infection 'trapped' between root and socket.

### TRAUMA:

**Bone Fracture** - traumatic pathology may be identified with high resolution while avoiding much superimposition by the use of dental film/ plate or sensor and intra-oral technique.

**Tooth Fracture** - where pulp exposure is present (ie 'complicated fractures') a continuum will be produced between pulp and radiolucency of the oral cavity. Uncomplicated fractures show a layer of dentine separating the pulp from the oral cavity. This may however be hidden where dentine is very thin. Periapical pathology is a frequent feature of both situations. Treatment is extraction or endodontic treatment (root canal treatment or, in some cases, pulp capping).

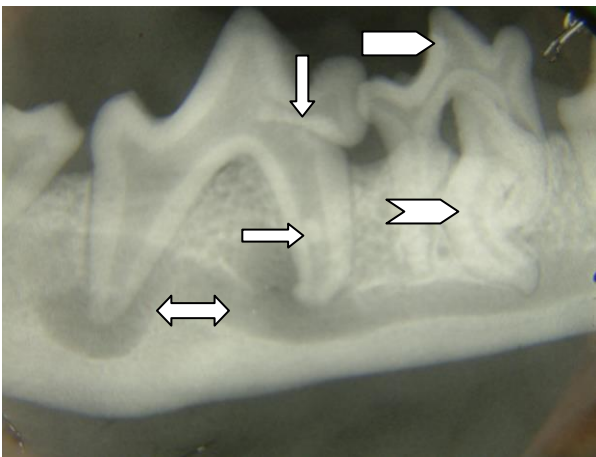
**PULPAL PATHOLOGY:**

**Pulp Necrosis** - the loss of pulp vitality results in cessation of dentine production and therefore wall thickening is arrested. Where devitalisation is permanent, a disparity will be produced, over time, between wall thickness/ pulp cavity width of the non-vital tooth and its live/ vital, contralateral counterpart. Non-vital teeth with long-standing pulp necrosis have a relatively wide pulp and narrow walls. Treatment is extraction or root-canal therapy to treat or prevent infection.



Lower left canine is non-vital ie has pulp necrosis.

**Pulp Stones** - focal mineralisations of the pulp due to pulpal inflammation.



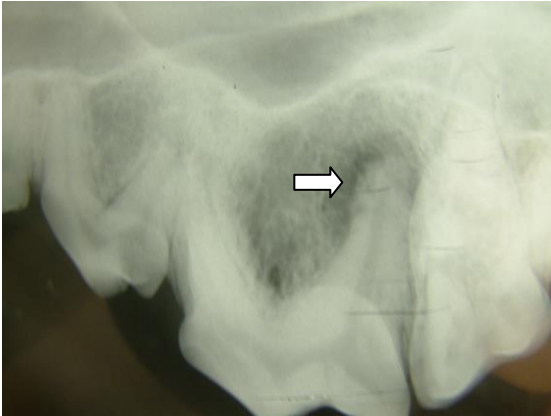
Invagination (vertical arrow), periapical lucency (double arrow), and pulp stone (horizontal arrow) in mandibular first molar. This is a result of obstruction to eruption of permanent dentition, due to retention of deciduous dentition (impaction). Note wide pulp cavity of the non-vital molar compared to the fourth premolar (chevron), and overlying, retained deciduous tooth (block arrow).

**Invaginations** - infolding of dentine and enamel may occur as a result of difficulty in eruption and trauma. Dilaceration refers to abnormal root-crown angle.

**Stenosis** - narrowing of the pulp cavity.

**PERIAPICAL PATHOLOGY:**

This area signals infection of the pulp. Inflammatory factors released by bacteria result in bone destruction just beyond the apex. A typical periapical lucency or 'rarefaction' is due to bone lysis and presents as a circular, radiolucent 'halo'. It may be due to abscessation, cyst formation or granulation tissue production. Biopsy and histopathology differentiate pathological types. The origin may be pulpal or periodontal. Treatment is extraction or, where periodontally sound, root canal treatment

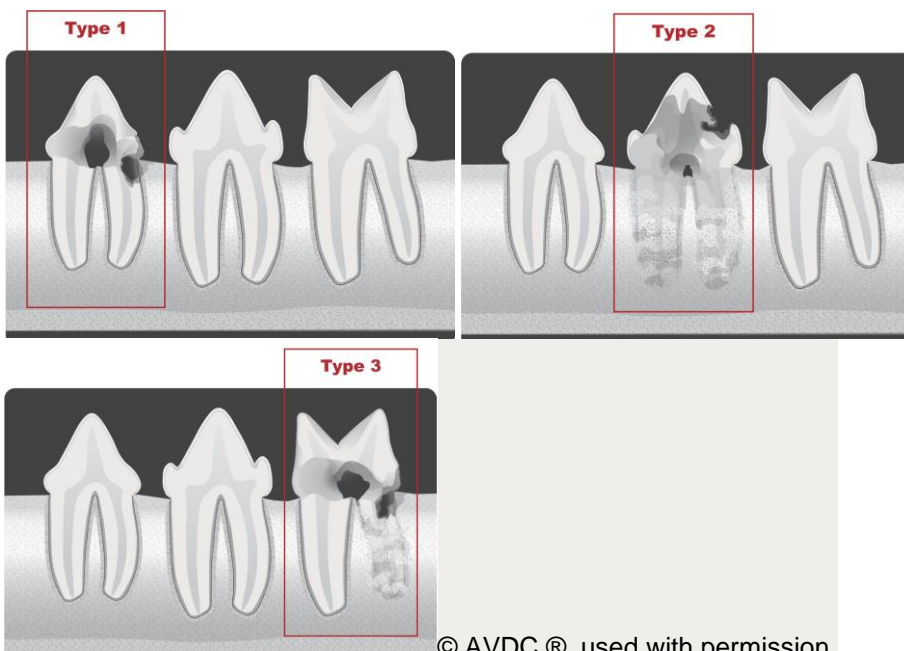


periapical lucency at distal root of PM4(carnassial)

**TOOTH RESORPTION:**

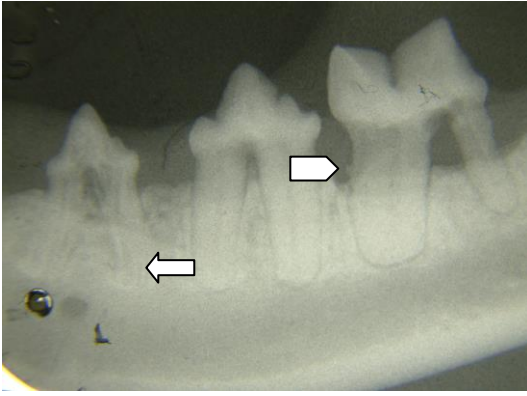
**Internal** - destruction of the dentine lining the pulp cavity secondary to pulpitis eg fractured tooth.

**External** - destruction of the cementum and dentine, commonly in roots of feline teeth, due to inflammatory or idiopathic causes. Tooth resorption ('TR' formerly known as resorptive lesions 'RL', feline odontoclastic resorption 'FORL') may be Type 1, Type 2 or Type 3 (both Type 1 & 2 on the same tooth). Treatment is extraction or, for Type 2 stage 4c, coronal amputation ('coronectomy').



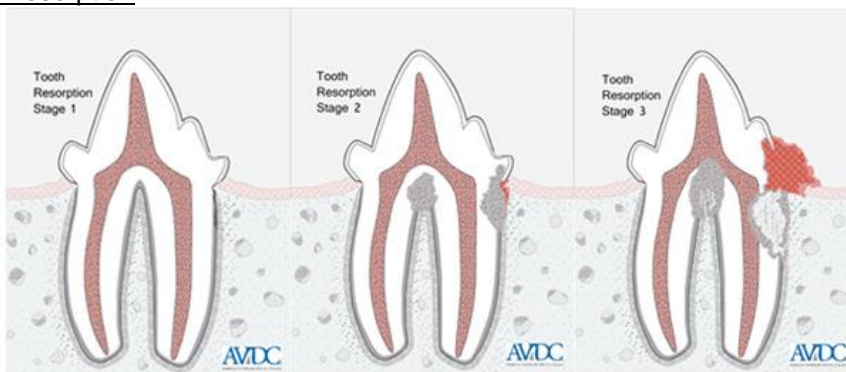
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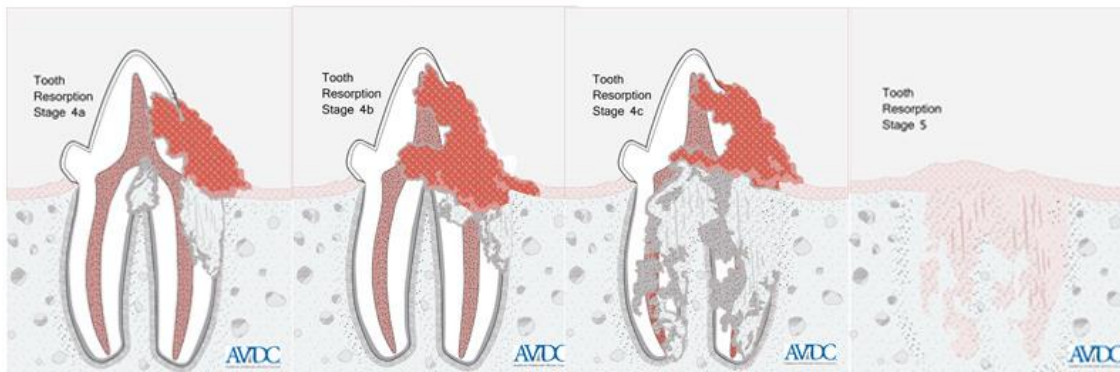


Type 1 external resorption damage secondary to periodontal inflammation (arrow head); Type 2 idiopathic replacement resorption, with periodontal ligament space loss and advanced root replacement by bone 'ghosting' (arrow).

### Stages of Resorption



Tooth Resorption - AVDC Classification of Clinical Stages



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- 1 = mild hard tissue loss. In cementum +/- enamel only (not dentine).
- 2 = moderate hard tissue loss. In dentine, not extending to pulp.
- 3 = deep hard tissue loss. In dentine to pulp, tooth retains most of integrity.
- 4 = extensive hard tissue loss. In dentine to pulp, with loss of most of integrity.  
(4a=root>crown, 4b=crown>root, 4c=equal root & crown)

**CARIES:**

Crown destruction (usually in flat-surfaced teeth) is evident as areas of relative radiolucency. This loss of tooth material is distinct from resorption and is found in dogs, most notably affecting pits and fissures of molar teeth. Teeth may be restored by fillings or root-canal treatment where appropriate or extracted (advised where teeth are broken down) and the owner must prevent further lesion progression by avoiding simple sugars.



Caries in a maxillary molar

**MISSING DENTITION:**

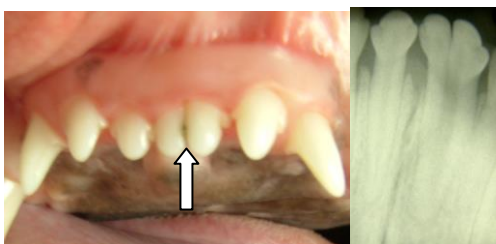
Distinction between teeth which are missing or have failed to erupt is made simple by intraoral radiography. Impacted teeth are frequently found in brachycephalic breeds where physical space for teeth is limited. Unerupted dentition may result in cyst formation with associated bone destruction. Fusion of adjacent teeth occasionally gives the appearance of a reduced dental count. Hairless or partially haired breeds are expected to have multiple missing teeth (though could also have impacted teeth too).



LARGE MANDIBULAR DENTIGEROUS CYST. IMPACTED 405, LYTIC ROOTS, CLEAR MARGIN. CYSTS REQUIRE ENUCLEATION. LARGE CYSTS ARE BEST REFERRED.

**EXTRA TEETH:**

Extra teeth may be of abnormal morphology. Most arise from an additional tooth bud, however in gemination a duplicate tooth forms from a single bud.

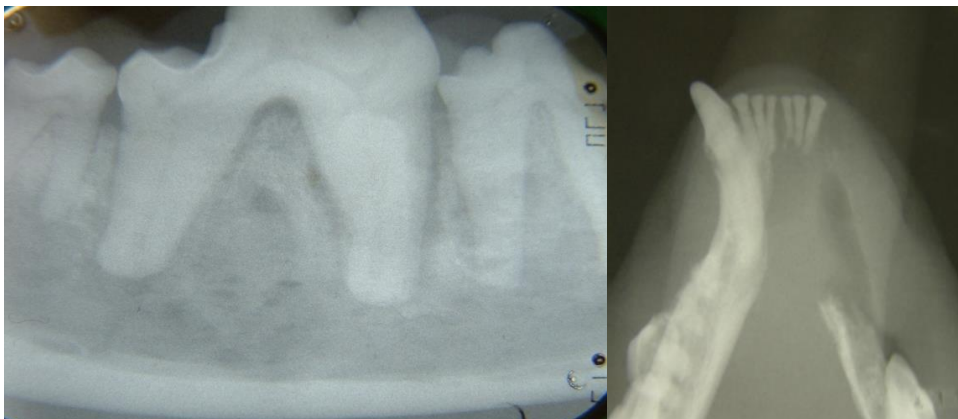


gemination; single rooted, double crowned tooth

## NEOPLASIA:

Intraoral imaging is an essential adjunct to biopsy in tumour identification and surgical planning. These investigatory modalities should be considered mandatory when any oral mass is apparent or suspected. Soft tissue masses may protrude into cavities or disrupt tooth position. Bone destruction is often associated with aggressive tumours and 'floating' teeth indicate poor prognosis. Parallel radiographic technique is utilised primarily. For maxillary masses CT is optimal.

Biopsy should include affected bone where present and follow standard oncological rules to avoid margin contamination.



Moth-eaten alveolar bone around 409 in a dog and floating incisors (aggressive bone loss) in a cat.

## SUMMARY

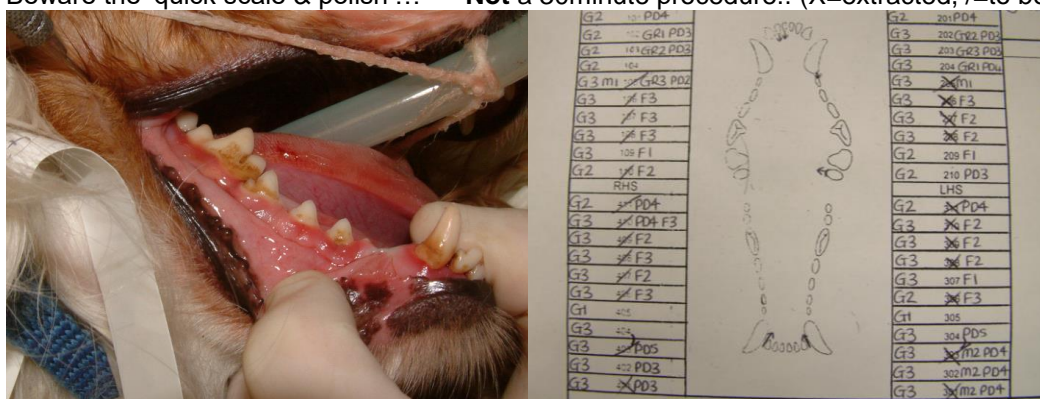
The information gleaned by intra oral radiography is essential in the investigation of dental, oral and maxillofacial trauma and disease. Elimination of guesswork enables avoidance of many potential surgical complications. Intraoral radiology should be regarded as a vital, daily tool for the formulation of an accurate diagnosis and appropriate treatment plan.

## Treatment Planning

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With a conscious examination of the mouth we see very little. In viewing the crowns we observe only around 30-40% of each tooth, the vast majority – the root- is hidden by bone & soft tissue. At this stage only 'the tip of the iceberg' is visible; it is inevitable that huge amounts of pathology will be missed, even in compliant animals. This creates a problem as a disparity exists between what we think is a problem/needs treatment/ treatment type and what thorough oral investigation under GA reveals. The true picture will only be known following GA and thorough investigation ie probe, chart, dental radiography and any other necessary further tests.

Beware the 'quick scale & polish'... **Not** a 30minute procedure!! (X=extracted, /=to be extracted)



## Anticipated Problems

The key to success in client, self and practice management is education. As clinicians, if we ourselves are unfamiliar with pathologies and treatments, explanation and education of our clients and colleagues is impossible.

Estimating treatment types, times and costs is fraught with difficulty. Commonly, for every lesion noted in the conscious patient another 5 or more may be found. Typically there is a far greater number and variety of pathologies than anticipated, thus altering treatment options, time, cost, technicality and optimal approach. The temptation to tackle everything at once is to be resisted! This will usually end in the following scenario:

- Stress to operator due to pressure of time, technicality & equipment required
- Fatigue to operator & reduced ability
- Longer GA and potential implications
- Poorer quality treatment due to rushing
- Increased complications due to rushing
- Increased cost to owner (often despite 'capping' of the price)
- Reduced revenue for the clinic – many operations running at a loss
- Client complaint due to increased cost
- Client complaint due to number of teeth extracted

- Issues re consent
- Client complaint as 'wanted him to keep his teeth' / friend from dog club had a 'filling' for their dog's tooth etc
- Stress to nursing or reception staff if they do the discharge/ take payment
- Split developing within the practice as operator tries to do increasingly thorough job but other staff just see long/expensive ops and difficulties with owners
- General stress, frustration & depression.

### ***Preventing Problems – Pre-emptive Client Management & Education***

The following **5-point protocol** is advised to prevent and control potential problems:

1. Identify what you can (if safe to do so) on conscious examination and inform the owner.
2. Advise on pathology, treatment options & complications in general terms.
3. Manage expectations –
  - Advise that it is not possible to fully assess the mouth/ teeth when conscious (tooth crown/ 'tip of iceberg' analogy is useful)
  - Warn that a full assessment requires GA with probing & xrays
  - Warn of the likelihood of identifying further lesions at this point
4. Advise that treatment after investigation focuses on the most urgent (ie often painful) problem.
5. Give an estimate based on the above (and add a £50 margin OR give a range of eg £100 if in doubt!). This would commonly be based on a maximum limit of 1-1.5hours work (based on initial investigation taking approx. 30mins & avoiding excessive operator fatigue) incorporating:
  - Any pre-GA testing, medications, fluids etc
  - GA for max 1.5hr
  - Gross calculus removal to facilitate observation, probing & radiography
  - Chlorhexidine gluconate prep
  - Probe & chart
  - Dental radiography
  - Treatment plan – triage chart
  - Local analgesia
  - Surgical preparation – scaling (+/- polish) is the oral equivalent to pre-op 'clip & prep'.
  - Treatment of most painful/urgent pathology eg abscess treatment, mobile tooth removal
  - Discharge with homecare advice & discussion of findings
  - Revisit with VN or Vet as appropriate eg in 5days

Ensure you tell them what is wrong & what is to be done to remedy this. **Do NOT use the non-descriptive term a 'dental'**; this tells us nothing about diagnosis or treatment, gives an impression of ignorance and thus conveys no gravitas or worth. Would one equally say 'an orthopaedic' instead of specifics? A cast on a toe fracture or external fixator on a femur would both fall under the term but be very different in technicality, anticipated cost and the message conveyed to colleagues and clients.

### ***Preventing Problems – Case / Patient Management: Triage***

Gross calculus should be removed (using a hand scaler) to enable the teeth to be seen, allow accuracy of probing and avoid misinterpretation of radiographs via calculus superimposition. Scaling prior to any surgery may be optimal in order to have a clean operative site and reduce the risk of calculus debris contaminating extraction sites. However, teeth to be extracted would not receive detailed scale – the aims are:

- 1) visualise the tooth
- 2) avoid calculus debris entering surgical sites
- 3) reduce biofilm contaminating the area (thus reduce bacteraemic load)

Where multiple painful pathologies have been identified it is more important to deal with these (and therefore spend the client's money most appropriately) than run out of time / estimated cost by having first perfected the cleaning. This approach would also be appropriate where funds and/or client compliance with homecare are minimal.

Perform the most vital treatment first and avoid embarking upon further work than is necessary. Straying onto the next tooth 'because there's 10mins left' is often fated to complications such as root fracture with the 10mins escalating into an hour! While telephone updates on treatment and thus estimate should be avoided except in specific situations for essential, urgent treatment only. Unfortunately explanation over the telephone is limited, clients often fail to fully appreciate the situation and cost implications but feel pressurised into making a decision. Alternatively they want you to stall mid-surgery while they phone relatives and friends to ask advice! The chances of maintaining a satisfied client drops.

### ***Preventing Problems – Post-op Client Management & Education***

#### **Discharge Explanation**

The discussion at discharge is critical. Where client expectations have been met – both financial and outcome for the most problematic of their pet's dental pathologies – owner satisfaction is high. If any change to the estimated cost has occurred it is critical that the operator performs the discharge in order to positively explain the cause. Always do this **before** payment is taken.

Dental charts and radiographs are powerful tools to educate clients on their pet's issues and the work involved and thereby perceived worth. Failure to do this makes owners focus only on cost rather than value and they will simply compare their 'dental' (do **not** use this term!!!) with their friend's dog's (cheaper) 'dental'.

## Prognosis & Planning

At this point describe what issues remain, the prognosis, timescale/ progression and plan for further treatment. Discuss pathology (eg caries, fractured tooth) which may have various potential treatments or require further investigation and referral. Discussing in advance allows owners time to consider the options and feel comfortable with their choice. This applies where complications may have arisen eg jaw fracture, root remnants. Detail is not required or expected of the GVP; the referral surgeon should provide this during a consultation.

Advanced treatments offer advantages, often in preserving teeth. Referral is not necessarily a more expensive route. It is strongly recommended, especially with clients' increasing use of internet searches, that all owners are offered the options available. Owners can then make an **informed choice**, which helps avoid dissatisfaction, complaints and litigation. Ensure this is extended to **all** clients; many motivated owners wanting optimal treatment may not opt for insurance (and some work in the human dental and maxillofacial fields – ignore at your peril!).

## Revisits & Oral Hygiene Clinics

Timing between revisits depends on treatment performed, pathology type and severity and individual factors.

The following is a guide:

- Minor extractions – 5days then every 3-6months
- Major extractions – 5days, 14-21days then every 3-6months
  
- Tooth Resorption - every 3months
- Caries - every 3months
- Periodontal disease – 4-6weeks then every 3-6months
- Malocclusion identification - check of all 4-5month old puppies & kittens  
(in addition to checks at 1<sup>st</sup> purchase & vaccinations)
- Malocclusion monitor – every 2weeks during head growth & tooth eruption.
- Stomatitis – 5days then every 1-2weeks until resolution.  
May require suture removal.

Without homecare the long-term prognosis for oral health is diminished. Daily tooth brushing remains the gold standard for periodontal disease prevention and control. Owner compliance and motivation must be encouraged and monitored as well as the animal! Ensure that the owners understand why and how to do this and that they can perform required procedures. Demonstrations, information sheets, referring back to charts and radiographs and use of plaque disclosing solution can all be used to assist this. NB CARE! Disclosing solution also stains clothes!

**A routine dental check every 3-6months is recommended.**

## **Preventing Problems –**

### **Practice Management**

In carefully managing our clients and cases we automatically prevent discord within the practice. Avoiding excessive operating time and dissatisfied or angry clients at discharge or reception reduces stress levels among nursing and reception staff and blame of the operator. This therefore also provides self-management, reducing stress, frustration, fatigue, injury (back ache and RSI), burn-out and declining relations within the practice team for the operator. While the ultimate cost of finalising all treatment aspects may be higher by staging procedures and inherent multiple visits, the perception is often the opposite:

- Clients have time to save or check if/ which conditions are covered by insurance (ie stage their finances).
- Reception staff observe smaller invoices produced per time, which they may be more comfortable with in general practice.

Further, staging can reduce costs by avoidance of over-treatment - for example radical extractions performed in a dog where an owner can provide daily toothbrushing, thus a more conservative approach is appropriate.

Ethically one must equally avoid excessive staging due to the small, but present, risk general anaesthesia poses, in addition to financial aspects.

### **Practice Education**

Practice cohesion regarding the dentistry service is critical. In creating a better service by more thorough investigation and improved treatment methods, potentially using new equipment, the type and cost of dentistry and oral surgery procedures is likely to rise. It is **essential** that the **entire practice team** understands and embraces the changes. Education of the practice team as a whole – vets, veterinary nurses, reception staff, managers etc - is absolutely fundamental to success. Without this, the risk is that the service is undermined from within.

The table below contrasts the situations:

<b>Educated, Cohesive Team</b>	<b>Variably Educated Team</b>
<ul style="list-style-type: none"><li>• Unified understanding</li><li>• Consistency in advice</li><li>• Ability to explain disease</li><li>• Working together as team</li><li>• Enhanced service quality</li><li>• Supportive team relationships</li></ul>	<ul style="list-style-type: none"><li>• Disparate interpretations</li><li>• Client given differing advice</li><li>• Incorrect/ inconsistent explanation</li><li>• Team rifts, divisions &amp; corrosion</li><li>• Vastly variable service quality</li><li>• Deteriorating relationships</li></ul>



It is easy to see the net effect of this. Variable education levels, especially where the educated party is a lone assistant veterinary surgeon or veterinary nurse, may lead to internal corrosion and failure of the improved service. This cost is both financial and personal; the educated team member often feeling isolated, frustrated and disempowered. The natural succession is deteriorating working relationships and crushed enthusiasm and motivation for the individual. This may not be the case in every practice but is all too common. One should not underestimate the destructive power of a comment on price at reception! The sceptic who does not understand why prices have increased to include radiographs can affect all the clients in the waiting room...and the people at dog club etc! 'If someone in the practice thinks it's expensive it must be a rip off'. The client may in fact have received excellent value for money.

The cohesive team forms a supportive, motivated unit with all staff working together. It is optimal to utilise the individuals most drawn to the discipline as the primary operators of the dentistry service within a supportive practice environment. While there may still be an occasional sceptic, they are now both more educated and outnumbered by enlightened colleagues, diminishing their negative effect. The practice strives to improve the service and thereby increases turn-over as well as patient and client welfare.

Cost may be the primary issue for some, but once clients understand what you are advising and why, they appreciate the value of, and often request, radiographs etc. Their choice and treatment suitability is consolidated by all team members they meet – and the waiting room clients absorb this too. If people feel they and their pets have received good service, treatment and value for money, this is the message they pass to friends.

To make the new service work a team approach is critical. All members should receive appropriate CPD, with updates for new members, further skills and refreshers over time.