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Dental Investigation & Xray Mini Series

Session 2: Dental Xray Imaging – indications, equipment & technique

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Dental X-Ray Imaging

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Indications for Dental Xray Imaging

The high prevalence of dental pathology is well accepted. The significance of this to our patients can be marked, thus choosing appropriate treatment is essential. To effectively identify pathology type, severity and location, thorough oral investigation is required. Minimal investment in equipment, man-power and time is needed to vastly improve diagnostic work-up; dental radiology is an essential part of this.

The components of investigation:

1. History
2. Clinical examination (full, conscious)
    a) Extra-oral (head and neck)
        i. General shape & symmetry
        ii. Lymph nodes & salivary glands
        iii. Globe retropulsion (gentle!)
    b) Intra-oral (where patient compliant – often a 'general oral/ dental view' only; anticipate and warn of likely additional pathology identification once fully assessed under GA)
        i. Occlusion
        ii. Mucous membranes ; including colour & CRT
3. Pre-operative testing
4. Examination under GA
    a) Occlusion (after induction and prior to intubation)
    b) Soft tissues - mucous membranes of cheeks, lips, palate, tongue and floor of mouth
    c) Probe & chart - gingivae & teeth (colour, shape, missing teeth, abnormalities)
5. Special tests
    a) Intra-oral radiography
        i. Specific - all pathology and abnormalities other than soft tissue-only (eg gingivitis)
        ii. Full-mouth series
    b) Biopsy
    c) CT imaging
    d) Other

NOTE: Proceed with caution in animals of uncertain nature!
Conscious oral assessment is always compromised and may be both useless and dangerous in a fractious animal. Ensure safe, thorough investigation by advising anaesthesia if in doubt.

The results should be analysed both as a general view of the animal's oral status and on an individual tooth-by-tooth basis. The findings for a mouth, and the dentition within, will commonly span several pathologies and potential treatments. Assessing each tooth as an individual patient is useful, whilst also integrating within a holistic approach - balancing client expectations, compliance and patient factors - to guide treatment.

Intra-Oral Dental Radiology

Intra-oral x-radiography (method of obtaining images) is an essential and standard technique for imaging the oral cavity. Intra-oral x-radiology (obtaining and interpreting the images) is relied upon for dentistry, oral surgery and maxillofacial surgery cases including trauma and oncology. This investigatory method provides information critical for a full diagnostic examination and thus formation of a treatment plan.

It is essential due to the factors:

1. Roots form the major portion of each tooth.
2. Most pathology affects the periodontium and/ or pulp.
3. Periodontitis, pulp and many other pathologies are primarily identified by changes in bone around roots.
4. Other pathologies are typically within the tooth or affect the roots and/ or bone.
5. Roots are normally, by definition, subgingival and thus invisible without imaging.
6. Internal tooth structure and bone is only visible with imaging.
7. Optimal treatment planning is not possible without an accurate diagnosis.

Parallel with other veterinary disciplines, imaging is a critical element of case investigation. Omission of radiography will result in the operator missing enormous amounts of pathology, as it remains hidden. Clearly this is detrimental to patient, client and practice alike.

Alternative Imaging Methods

Whilst alternative imaging modalities such as CT are available, dental x-ray imaging remains gold-standard. CT offers advantages in some cases, most notably maxillofacial trauma and oncology, however xray imaging is still shown to be optimal for dental and mandibular trauma. CT and CBCT can identify some additional elements of dental pathology due to their 3D imaging versus the 2D of xray, but interpretation and resolution (latter dependent upon equipment and settings, especially for CBCT) can be limiting. The ideal is access to both CT and dental x-ray imaging.

Equipment necessary for intra-oral radiography represents a modest financial investment in order to reap the rewards of greatly enhanced diagnostic capability. Parallel and bisecting angle techniques are required and should be understood. With practical tuition and practice these techniques can be used on a daily basis with little increase in operative time. Whilst simplifying aids can be used, reliance upon them without deeper knowledge precludes improvement and correction. Dental radiography can be employed by both veterinary and nursing staff; the creation of a 'dental team' is encouraged to build expertise and efficiency.

Equipment Required:

- Dental x-ray generator
- Dental x-ray film, phosphor plates (PSPs) or sensor
- Dental x-ray processor
- Towels and tissue for positioning patients' heads and sensors/ PSPs

A wide variety of dental xray generators and processing systems are available, each with relative drawbacks and merits.

Indications for Intra-Oral Dental Radiography

All pathology and abnormalities other than soft tissue-only (eg gingivitis)

Specific

- Periodontitis
- Missing teeth
- Trauma (fracture, luxation, discoloured)
- Abscess & tracts
- Tooth resorption ('TR' aka resorptive lesion/s 'RL', 'FORL', 'neck lesions')
- Caries
- Oral masses/ lesions
- Where treatment complication arises (eg root fracture)
- Pre & Post Tx eg extraction (pre-op diagnosis, post-op proof of end result)
- Monitoring

Full-Mouth Series

- Where specific radiographs have indicated potential for widespread abnormality
- Where a screen is positive (eg 307, 407 for tooth resorption in cats)
- Routine – cost, exposure and time justification?
    - In a proportion of cases abnormalities are identified
    - In a proportion of these patients, findings may alter treatment
    - Larger films/ PSPs enable more rapid imaging - but reduced detail per tooth?

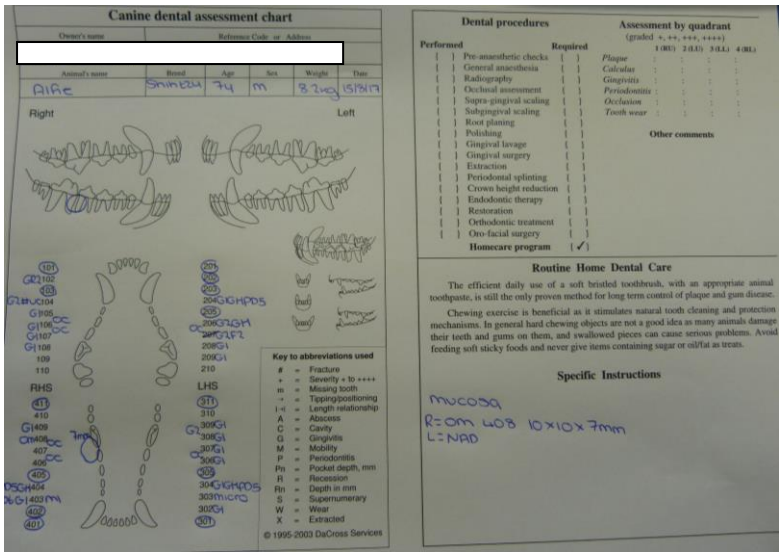


Fig1. Chart – information guides which areas justify xray investigation.

Benefits of Imaging

1. Diagnosis
2. Identify treatment options
3. Treatment planning
4. Complication avoidance
5. Save time
6. Reduce frustration
7. Increase work satisfaction
8. Improve outcomes - patient and client
9. Monitoring
10. Educational tool – colleagues and clients, self (referral, teleradiology)
11. Medicolegal

Barriers to Imaging	**Countered by**
Cost of equipment	Low relative cost; quickly recouped with use
Additional cost to clients	Avoid unnecessary surgical time, thus cost Low cost (typically £5-15/ diagnostic image)
Movement of animal for imaging • Xray room • Patient head (ET tube, safety, convenience)	Wall-mounted or mobile (hand-held) dental xray generator in dental theatre Dental xray generator head mobility minimises patient head movements required
Additional time imaging & interpreting	Teleradiography Fast-track efficiency by expert wet-lab tutoring

X-Ray Generator

Efficient intra-oral imaging requires a specific dental Xray generator. Their manoeuvrability enables the head of the Xray generator to be rotated and tilted to align the beam rather than moving the patient's head. With a standard vertical-beam Xray machine repeated positioning of the animal's head is required; this has potential hazard for endotracheal tube movement (trachea damage and/ or gas flow compromise). Further, the xray generator is commonly in a different room to that where dentistry is performed, thus requiring transport of anaesthetised animals throughout the practice. These factors create delay and difficulty; barriers to efficient and good use. Dental xray generators should be located within the dentistry theatre and enable quick, easy, safe, convenient imaging. Dental X-ray generators are relatively economic, pay for them-self in a short period with normal use, and are highly recommended.

Controlled Area

The controlled area applies during periods of xray exposure and is considered as 1.5m around the head of the in-use generator and patient. Since the beam may be aimed virtually 360degress in any direction it is essential to accurately identify the potential area exposed to x-radiation during use, make this area safe and ensure that the beam will not be aimed outside of this zone.

Operators must thus be out of the main beam and preferably >2m away from the head of the generator and patient. The main beam is not fully attenuated by the patient and operators must not enter the main beam area. The British Institute of Radiology and Institute of Physics and Engineering in Medicine state that two layers of plasterboard should provide adequate protection, even from the main beam. However, composition of walls, floor, doors and windows within the controlled area must be assessed and NRPB guidelines advise the use of natural protection, eg brick walls, to enclose the area. Lead lining the surgery is not required, however brick, stone, barium paint/ plaster, lead-lined doors, lead glass offering >0.25mm lead equivalent may be considered, especially to stop the main beam. No entry zones to prevent accidental exposure are required and the 2m radius around the head should be made clear (minimum 1.5m radius, taped-out or delineated by walls). Where an operator cannot place themselves outwith the controlled area, protection must be provided, eg a 0.5mm lead screen equivalent. A lead apron >0.25mm lead equivalent may alternatively be used. In each case the operator and their protection should not be in the main beam.

Scatter - Care to avoid scatter is required, for example metal tub-tables or trolleys within the range of the beam; lead-rubber can be used to line the operatory area/ rest the patient's head on and also to create low vertical guards.

Warning light – A red xray warning light should be present outside the controlled area. This should automatically turn on when power is present to the generator and a 'kill-switch', to cut power, must be safely located outside the controlled area exposure zone. This prevents inadvertent movement of personnel into the controlled area whenever power is present, and in the event of emergency, eg xray malfunction and generator off-switch failure, the power to the generator can be shut-off without risk of exposure.

Dosimeters – In dentistry, X-radiation dosimeters are worn where large numbers of exposures (>100/week) are taken or where a new system is in a trial period. In veterinary practice this dental exposure must be considered additive to other exposure risks, thus dosimeter typically required.

Pregnancy – All operators and other personnel must remain 1.5metres or more behind the generator head and out of the main beam. No specific requirements are necessary for pregnant staff, however the reassurance of lead PPE or screen eg wall may be preferred.

Settings

Typically dental X-ray generators have fixed kV, mA and focal distance; only time alteration is necessary.
Focal distance – set by tube, commonly 10-20cm
Potential: 60-70kV
10-20mAs
Time – typically indicated via digital display. The control panel often shows images of different sized animals, different teeth and three different processing types (film/ phosphor plate/ sensor). Selecting the appropriate combination gives a good guide to suitable settings and is useful whilst learning. However, every generator-sensor and patient combination varies, thus trial to obtain ideal settings is required. This may be reduced by purchasing generator and processing system from a single source where ideal settings are already established. Ultimately the operator learns to recognise appropriate time settings for patients and the pictorial element of a control panel becomes redundant. Some digital systems are especially 'forgiving' and few variations in settings are needed despite varying patient size, bone density and tooth to be imaged.

Digital setting displays

Construction

Practice and individual needs vary thus one should carefully consider the pros and cons of each generator type before purchase. It is highly recommended to trial any system before purchase to ensure it will suit requirements.

Whether fixed or mobile generators are elected the following ‘six s’s’ checklist is advised:
Specific, simple, safe, solid, settings, service

Specific	Designed specifically for dental use	Other uses should not detract from the main focus.
Safe	All necessary UK standard safety certification	Avoid cheap imports, second hand/ uncertain origin, internet purchases etc
Solid	quality materials and construction	longevity
	joints and boom-arms solid, generator head remains in position when released	no drift or jumps causing positioning error
Simple	In use, for all team members - experienced and new	Light and manoeuvrable to hold in position
	Clean, functional design & easy to clean	free of novelties, complex setting patterns and gizmos
	Clear angle dial visible on rotational section	to easily set, check or reproduce beam angle
Settings	Low minimum exposure time setting* (even if you plan to use film initially)	avoid overexposure when imaging a small cat with digital processing – future proof
Service	good warranty and service back-up	Remote & on ground. UK, USA – time zone issues? Opinion of current users!

Specific – dental xray generators, with small cone-beam area, may also be used for skull and TMJ views in cats, small and exotic pets and orthopaedic cases eg feet.

Safe – only ever purchase quality equipment from within the EU carrying the CE mark (required by Medical Devices Directive) as a minimum. Failure to do so contravenes Health and Safety at Work Regulations. Some cheap, imported hand-held devices may even cause radiation burns.
The generator should be installed by a suitably qualified person to the required safety standard, providing Critical Examination and Acceptance Testing.
Servicing every 3 years is required (annual for hand-held generators).

Solid – The generator needs to stand up to regular use within a practice, both handling and cleaning, thus quality, hard-wearing materials and construction advised. Once the generator head is positioned it should not move (eg sag, drift or jump) due to either design issue or joint loosening. Where joints gradually work loose and drift is noted, the joints should be easily and reliably tightened.

Simple – Use should be easy, clear and intuitive in terms of generator movement, display and controls or settings. Complexity is not required and detracts from ease of use; a push-type exposure activation button with audible and simple light signal to mark the period of exposure is ideal. Clean design enables efficient cleaning between patients.

Settings – Modern digital processing systems, both CR and DR, require only very short exposure times. These vary with manufacturer and to build flexibility into a dental xray set-up it is advisable to purchase a generator capable of very short exposure times such that any digital processing system, now and in the future, will be compatible. The minimum time setting on older generators designed for use with film is typically too high for use with digital processing systems and lead to overexposure, especially with small patients where exposure times are lowest.

Service – Ensure that the warranty is adequate and that, in case of need, urgent advice can be obtained. It is often advantageous to purchase a generator and processor from the same source, to take advantage of both lower total cost offers and back-up for both elements. Advice may be via internet or telephone but be aware that if remote and out of the UK the service may be unavailable when required due to time zone differences. Check that you also have recourse to local engineers available if required.

Type

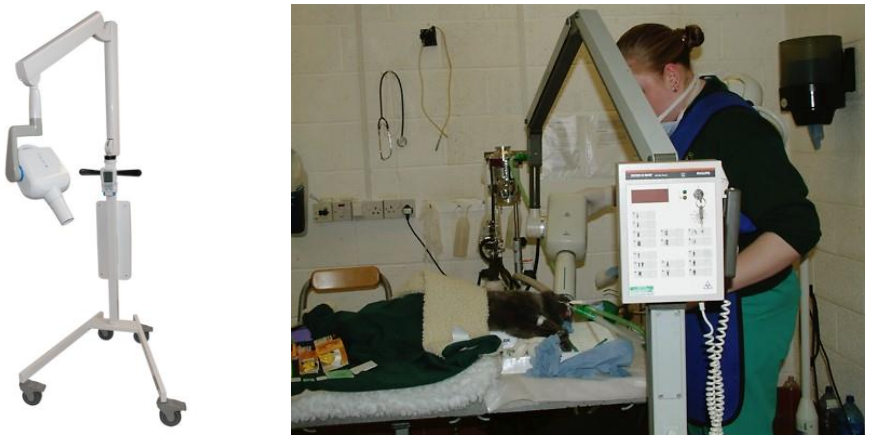
Dental xray generators may be mobile or fixed/ mounted:

Fixed/ mounted – wall or ceiling. The wall adjacent to a dental theatre table is commonly used as this enables instant, convenient use and they fold relatively flat to the wall when not in use. These generators are well suited to single-site centres.


Wall-mounted dental xray generator

Mobile – trolley-mounted and hand-held are available.

1.Trolley mounted - whilst moveable eg from one room to another within a practice, have a large, heavy floor trolley mount. This creates a large foot print and limits the manoeuvrability, positioning and flexibility of the generator. The footprint, in combination with operating table footprint and type, can greatly reduce the point to which the head reaches across a table – particularly limiting when imaging small patients.


Trolley-mounted ‘mobile’ dental xray generator

2. Hand-held mobile – these generators are relatively very small and light, with ‘pistol’ or ‘camera’ versions. Originally designed for military and emergency use, they are easily carried and transported for use within practices and in the field. These generators are thus popular for multi-centre practices wanting a single generator, locations with minimal space and where flexibility for equine work etc is required. They are self-screening to enable use whilst held by the operator’s hand. With a quality unit held 0.5m from the body and beam aimed horizontally away from the torso this eliminates the need for wearing lead protection such as a gown and neck (thyroid) protector, however PPE may be preferred and is advised with non-horizontal beam use.

There has been some concern recently over the use of hand-held xray generators. This appears to have stemmed from the original dental xray safety guidance being specific to fixed eg wall-mounted generators where the area affected by the beam can easily be described and operator is distant from the generator head. Clearly, the ability to move a generator would alter the area of use, however the same could be said of a trolley-mounted generator. Each area of intended use must be assessed for safety and strictly adhered to. Whilst the operator is potentially more exposed using hand-held generators, these units should have increased shielding to counter this, preventing leakage and back-scatter. Where the xray beam cannot be aimed directly away from the operator's body (ie typically a horizontal beam) the torso and feet could be exposed, thus care (re beam direction and to hold the generator away from the body) and use of lead PPE is advised. Full information can be obtained via Public Health England's 2016 Guidance on the Safe Use of Hand-Held Dental Xray Equipment, PHE-CRCE-023.

Hand-held generators may also be mounted on a tripod giving additional flexibility in use provided there is space to enable tripod positioning. This is also required if the shielding is inadequate, to ensure operators are kept >/= 1.5m (preferably >2m) from the generator's head.

Pistol and camera hand-held mobile generators

<u>Image Capture & Processing</u>

Non-Digital: Film

Skull views are of limited value due to the degree of superimposition. This is true for both standard screen film and smaller, non-screen film in A6-A5 sized plastic envelopes. Intra-oral, non-screen film is necessary to obtain high quality, diagnostic images of oral anatomy. These superior results are due to:

i) Reduced superimposition - small film sizes allow intra-oral placement

ii) Higher resolution image via non-screen film

<u>Sizes available</u>: paediatric (0, 1), adult periapical (2) and occlusal (4). Sizes 2 and 4 are of greatest use in the veterinary situation; however sizes 0 or 1 are useful in cats and exotics. Bitewing film is also available; this is useful for human screening but not small animal imaging.

Processing Fig1. dental films

The plain white side with convex corner marker or ‘nipple’ faces the x-ray tube. The opposite side is typically a contrasting colour, labelled, and has a tab to open the film package. Inside are a sheet of lead leaf and paper enveloping the film. The ‘nipple’ is punched into all layers, including the film. This enables a standard positioning protocol - nipple points towards the X-ray tube and rostral aspect of the mouth - in lieu of left/right marking, and thus orientation of images.

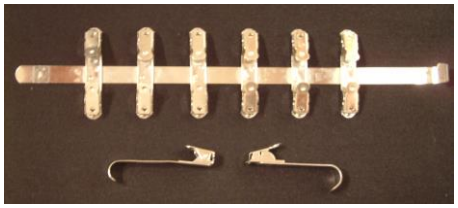
Film Processing:

a) WET – Today this has largely been superseded by digital processing, with its obvious advantages of speed, simplicity, archiving (ease, space-saving and lack of degradation) and avoidance of harmful chemicals. However, film does give good images and is very useful in case of emergency.

i. Hand - rapid developing and fixing fluid designed for dental films (speed D) gives best results. A row of three-four cups containing in sequence: developer, water, fixer, +/- additional water (ie 3 – 4 cups) is placed in either an existing darkroom or chair-side darkroom. The latter is a small light-proof box with orange/ red viewing window to eliminate green light; effectively a miniature darkroom. Clips hold each film for dipping and a clip ‘tree’ used to hang and dry fixed films.
Images are processed by dipping alternately and viewed within 2 minutes, however additional fixing for 10mins is advised to minimise fade and enable archiving.

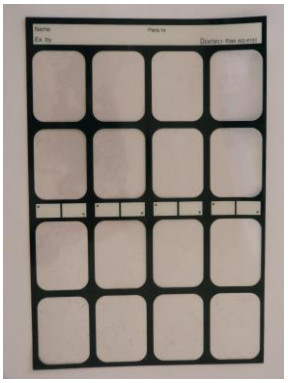
Processing Fig 2. chair-side dark room (3-cup)


Processing Fig 3. interior of 4-cup chair-side dark room


Processing Fig 4. Film clips and clip-tree

Wet, hand-processing sequence -

1. Film envelope opened in a darkroom and contents removed; film accessed; layers of paper and lead discarded.
2. Film is handled only by the edges and a clip placed on an outer edge (nipple position) to minimise artefacts such as fingerprints.
3. Dip into:
    a. Water – brief, optional
    b. Developer- until an image is apparent, usually 30seconds (reduced with fresh chemicals and increased temperature).
    c. Water- short rinse/ agitation.
    d. Fixer- 60seconds required before viewing the image. Brownish discolouration indicates that further time (then fixer replacement) is necessary, especially as chemicals become exhausted.
    e. Water - short rinse before initial view.
    f. Final fix - approximately 10 minutes in fixer.
4. Rinse films thoroughly with cold water after final fixing; remove all ‘soapy’ feel from the film.
5. Dry fully, place in labelled envelopes or specifically designed plastic mounts.


Processing Fig 5. Film mount

ii. Self-developing – available in size 2, with film in one area and processing fluids another, joined by a hollow connecting 'stalk'. The fluids are squirted into the film area via the stalk, agitated by hand for a set time (eg 60s) then film removed and gently rinsed. This is convenient but each film is expensive (thus costly when learning) and images are relatively poor.


Processing Fig 6. self-developing film

b) AUTOMATIC - some machines can take dental films as well as standard films - check first to prevent their loss within the processor. Compact, dental film processors are available, giving a dry-film image in 4minutes.

Digital

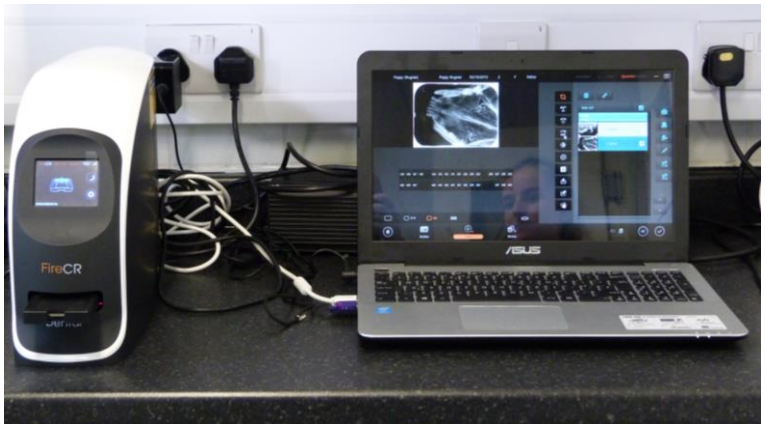
Digital systems (CR and DR are included for this article) are now preferred due to their speed and efficiency. CR and DR each have relative advantages and disadvantages though both are recommended. Individual systems also show relative merits, for example some appear more efficient and forgiving of exposure ranges, faster or better image quality. Software allows image manipulation but shouldn't be used as a crutch to poor technique and, vitally, must be clear and user-friendly. Always request a demonstration or (ideally) trial, to assess what suits you and how simple and instinctive it appears to all potential users. A good gauge is how readily VNs warm to the system as it is often they who will perform system set-up, close-down and processing, and their enthusiasm is critical!

Computed Radiography 'CR' – Effectively the digital version of a film, this uses phosphor plates to capture the image. Conversion of energy from exposed PSP (photostimulable phosphor plate) to image-data is indirect, requiring the scanner/ reader, which transfers this to data the computer software then processes, forming the digital image seen on the computer screen. The efficiency allows low exposure times to be used, however this varies markedly between manufacturers. The reader also wipes the image, preparing the PSP for re-use.

Phosphor plates are similar in appearance to film - thin, flexible and may be scratched. Sizes 0-5 are available though most use sizes 2 and 4. The whole of one surface is coated in active material, thus all area able to produce an image. They are placed in a size-matched polyvinyl envelope to protect from saliva contamination and some scratches; the envelope seal and outer perimeter of 1-2mm which cannot contribute to image formation must be considered. One side of the PSP and envelope indicates that the opposite (plain coloured) side should face the xray beam; this side of the envelope also protects the active/ coated side of the plate from light. The envelopes require replacing per view if fully sealed, or per patient if not. Processing is rapid (varies with manufacturer, typically 5-10s) but the plate must be manually loaded. This should be performed quickly after exposure and/ or plates kept dark (in an envelope) to prevent light-induced image fading. Note that PSPs are especially sensitive to red light, thus dark-rooms may be unsuitable.

PSPs are multi-use, studies indicating typically around 200 hundred times (variable with make; this author has used PSPs for far more images without discernible image deterioration). The image is wiped prior to re-use by exposure to bright light, ideally automatically provided by the PSP reader.

Processing Fig 7-8: PSPs and protective envelopes; plain sides of envelope and plate (blue, active coating) align.



Processing Fig 9: PSP processing system of reader and computer processing software ready for use.

Processing Fig 10-12: Fire CR PSP reader – note magnetic area of feed-tray for easy alignment of PSP; size 2 plate removed from envelope and positioned.

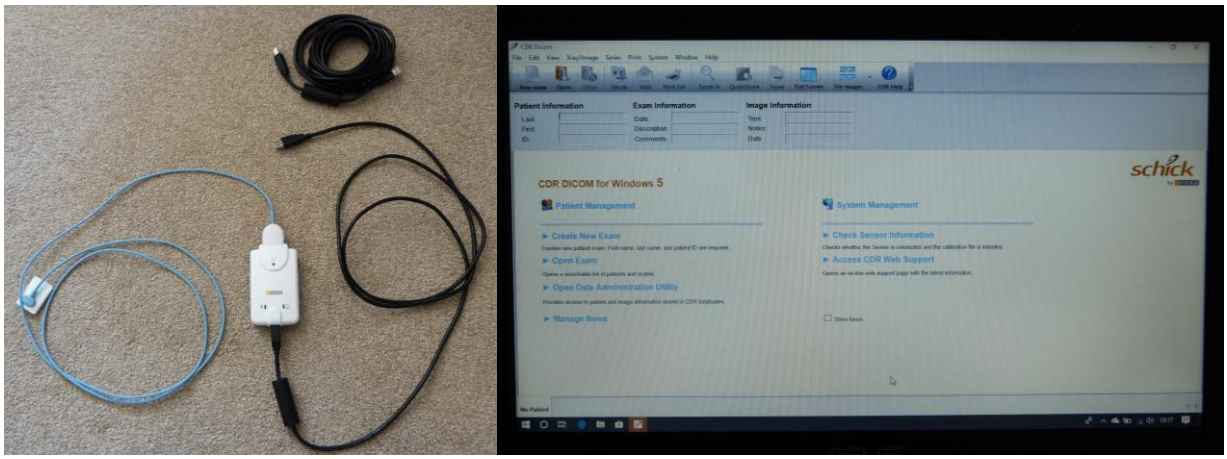
Processing Fig 13-15: Tray pushed inwards then automatically taken into reader; rapidly processed image appears on screen. Clear, simple software is advantageous and encourages use.

Processing Fig 16-17: Processed and cleared PSP delivered on tray for placement into protective envelope and re-use.

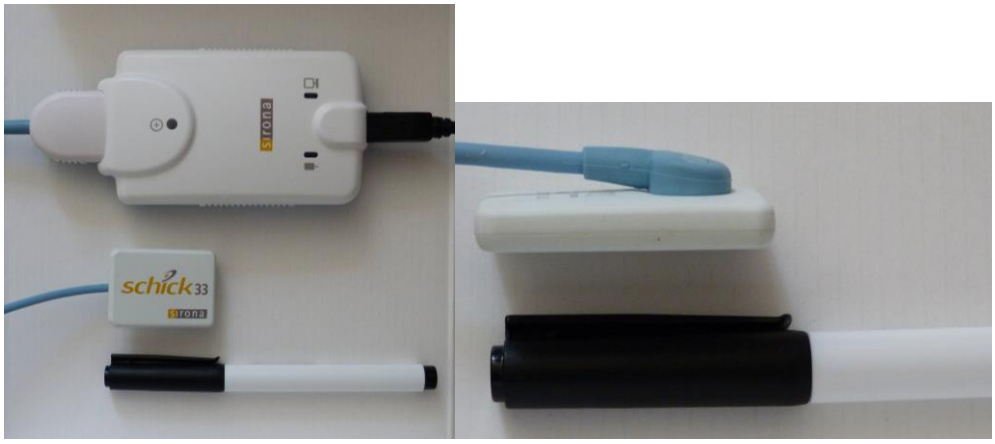
Alternatively, some systems utilise the cassettes typical of large plates on a standard CR system, enabling dental imaging capability. The specific cassette for dental plates has several slots within which various dental plate sizes can be placed. Once the cassette is full (usually after multiple views are taken) it is loaded into the processor in the same manner as ‘normal’ cassettes. It is important to protect the plates from light whilst other images are obtained and cassette filled or the images will be compromised. This system is useful for sporadic use but a dedicated dental processor is far faster, gives better images and enables much clearer identification of which image relates to which teeth (on a mouth/ tooth template rather than ‘random’ mosaic of images). The corner marker, as for film, assists in working out right and left; if absent scratch a small shape into a corner of each plate, visible on both the plate and resultant image.

Digital Radiography 'DR' – Sensors convert x-radiation into electrical signal, allowing direct image processing onto a linked computer screen. CCD (charge coupled device) and CMOS (complementary metal oxide semiconductor) types exist; their relative merits alter as technology develops. The dose efficiency is very high thus minimum exposure times are required. Only size 0 - 2 are available, however size 2 is most useful and can handle the majority of requirements for dental radiography. Sensors have a corner marker (for left/ right) visible only on the image, but this can be deduced and becomes less essential as a mouth template on the software is used. Sensors are in relatively 'chunky', robust, plastic housing and resist flexion. The outer perimeter of 1-2mm is thus plastic and does not contribute to image. Protective sleeves are available for sensors, primarily for contamination control, however they can prove slippery. This author prefers to cut fingers from a large examination glove, producing five grippy protectors; the sensor and wire is cleaned and protector replaced between patients.

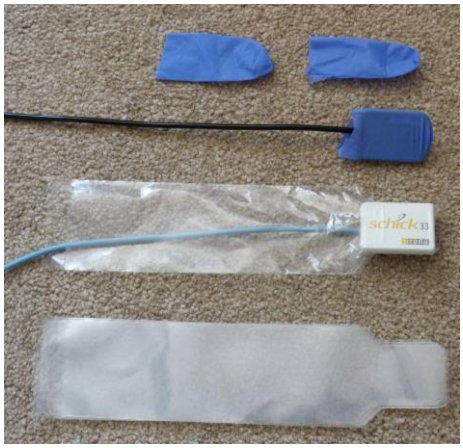
Typically the sensor is wired to the computer (ensure adequate wire length and care re trip-hazard) but wireless, blue-tooth transmission is also available. Use of a high definition screen is advised for optimal image quality. Speed of processing and image availability is very rapid, around only 5s.



Processing Fig 18-19: Schick33 DR sensor, cables and software (cables in standard and long length - latter seen coiled). Length gives flexibility but shorter cable optimises image quality. Simple, instinctive software for rapid, user-friendly application.



Processing Fig 20-21:
Cable-box and size 2 sensor dimensions. Sensors all have cable attachment thickness.



Processing Fig 22: Sensors and protective sheaths.

Radiographic Technique

NB As film, plates and sensors may be used, for the purposes of technique description, the term 'film' may be seen as interchangeable with plate or sensor.

Intra-oral techniques overcome much of the issue of tooth superimposition inherent to the oral cavity. Two techniques are utilised: parallel and bisecting angle. Parallel technique is of limited use in canine and feline oral dentistry due to their anatomy; bisecting angle technique enables accurate, diagnostic imaging of anatomy despite the inability to position a film directly behind the object.

A diagnostic view of a tooth requires that all roots and 3-5mm 'periapical' bone (bone around the 'apices'/ root tips) is present. This enables assessment and detection of 'periapical pathology', eg abscess. Small film sizes eg size 2 may be inadequate to capture both periapical and crown anatomy of larger teeth in some patients. In DR systems only a size 2 sensor is typically available. To overcome this either:

- a film size large enough to capture all tooth anatomy is selected (eg size 4)

or

- film size remains and the tooth's root ('radicular') and periapical area is prioritised, and crown 'sacrificed' off the film. A second film may be used to view coronal anatomy (the crown) if necessary.

In truth anatomy of roots (radicular and periradicular) is usually sufficient provided crestal bone (around the base of the crown and immediately adjacent to teeth) is included. This enables assessment of periodontal disease and pulpal disease (including abscesses) of each tooth in detail, typically recognised as optimal accuracy for periodontitis and endodontic (pulpal) disease in humans. Larger films enable more speed as multiple teeth fit on, however especially where teeth are close together this can be at the expense of detail.

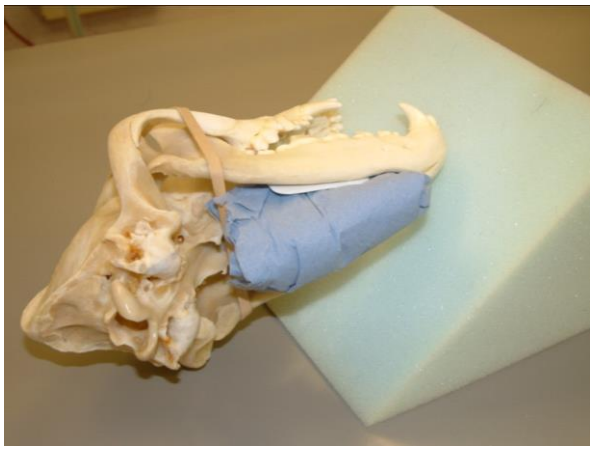
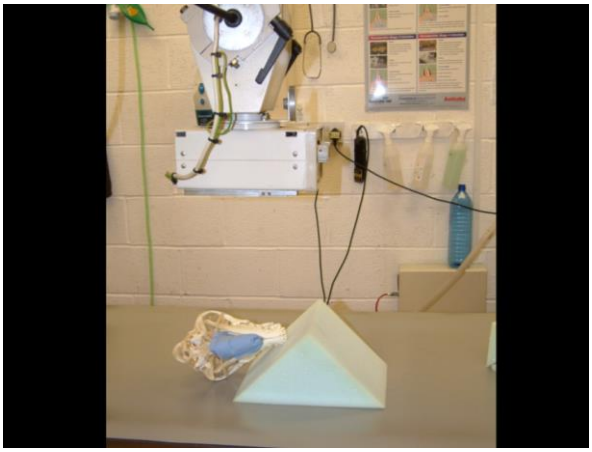
Parallel Technique

This technique requires the object positioned parallel to the film and X-ray beam directed perpendicular to both. It is used when imaging body cavities or limbs. Performed correctly there is minimal image distortion.

Parallel technique use is limited intra-orally to:

- views of the mandibles or maxilla for trauma or oncological purposes.
- mandibular teeth caudal to the mandibular symphysis, ie premolars and molars.

The position of the mandibular symphysis prevents parallel imaging of rostral premolars and bisecting angle technique is required.

parallel technique, mandibular dentition; note wedge to avoid rostral tipping

Films are positioned with object of interest centred for maximal diagnostic information, ie to include periapical bone but minimise film extension beyond the tooth or teeth oral cavity. Mandibular premolars and molars thus require film placement ‘sandwiched’ between the tongue and mandible. The ventral film edge is palpated as level with the ventral mandibular border to ensure adequate periapical bone inclusion.

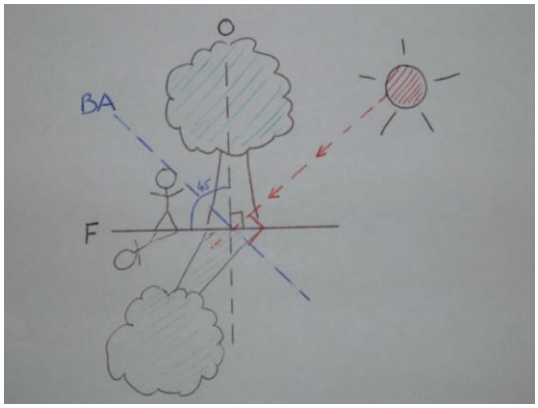
Bisecting Angle Technique

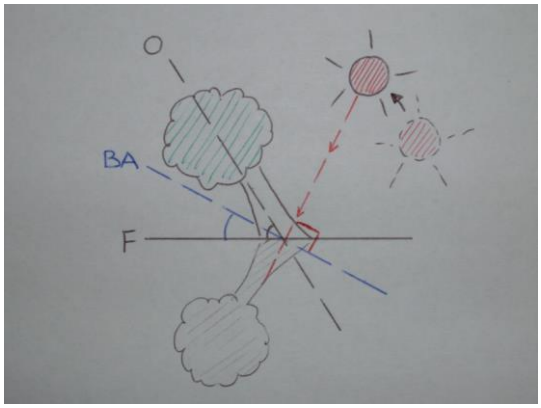
Bisecting angle technique enables the operator to image areas of oral cavity and dentition with minimal superimposition and maximal accuracy where parallel technique is impossible due to adjacent structures. Parallel imaging of maxillary dentition, for example, is not possible; the palate prevents the required film placement and only the crown and a tiny portion of root will be imaged. Bisecting angle technique overcomes the need for the film to be placed directly behind the object in question.

The bisecting angle line (‘BAL’) is an imaginary line derived by splitting the angle between object and film into two equal halves. An X-ray beam angled to hit the BAL at 90 degrees produces an image matching true object size.

Many teeth curve, thus a ‘best fit’ line is used along the root (or from crown to root) to create the object angle. This will produce some areas of minor distortion but is usually diagnostic.

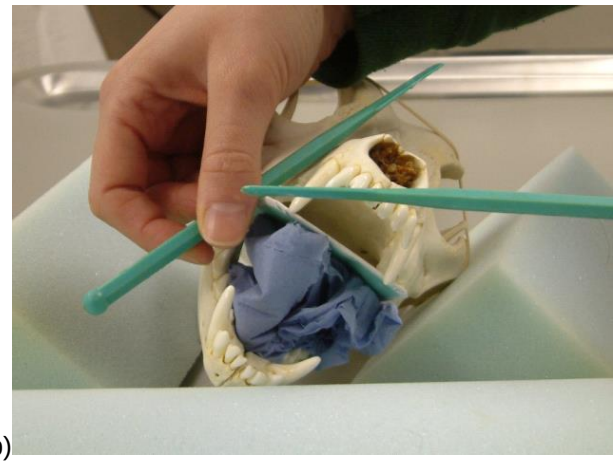
Bisecting angle theory may be illustrated by an object’s shadow – at a certain time of day (ie sun-beam angle) shadow size matches the object size.



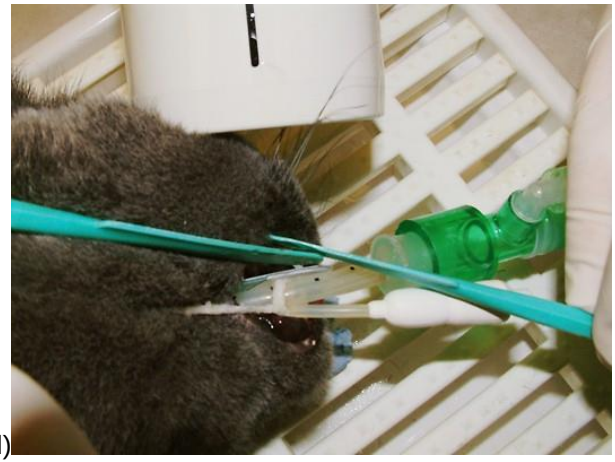


Figures: assessing bisecting angle for a) mandibular incisors, b)maxillary cheek teeth (note use of wedges where standard xray machine used) c)maxillary cheek teeth using dental xray machine (note ease of positioning)

a) 

b) 

c) 

d) 

d)bisecting angle assessment maxillary canine e) dental xray machine positioned with beam perpendicular to BA f) slight tipping of beam-without alteration of angle towards BA- to avoid superimposition of maxillary premolars*] see the 3photos below

e)  f) 

The manoeuvrability of a dental Xray generator head enables easy beam angling. A standard Xray generator with vertical beam only requires careful positioning of the patient's head.
PLEASE ALSO SEE AIMING GUIDE

Parallax

To obtain a 3D impression of a tooth and assess structures more fully, multiple views (ie views in several planes) are required. This particularly applies to multi-rooted dentition where roots superimpose, and also teeth such as canines, with ovoid rather than circular cross section. The bisecting angle, and thus xray beam angle, remains unaltered but plane alters. When applied to two objects at different distances away from the beam, the image of the object more distant appears to move in the same direction as the altered generator head/ beam origin, while the image of the nearer object appears to move in the opposite direction. This parallax effect can thus enable an operator to determine which root they are viewing. It has also been described as the 'SLOB' rule – 'Same Lingual, Opposite Buccal' but many find this more confusing! This principle is also utilised to avoid superimposition of adjacent teeth; slightly altering the plane 'throws' the image into a clear space, eg maxillary canine: towards palate and away from premolars in its arcade.

  108 with superimposition of mesial root apices

  108 with both mesial root apices visible

Processing

DR Sensor

Provided settings on the xray generator are suitable, the digital processing provides an image within a couple of seconds. This then appears on the screen, for which a high-definition version is advised. The image can be altered to suit, typically definition can be sharpened, and contrast and brightness altered. Images can also have the grey-scale manipulated, image inverted (thus dark of lucency and lightness of opacity reversed), rotated etc. The aim should be to obtain images which show excellent clarity and resolution without manipulation. To attain this some practise on a variety of patients with differing tissue depths and densities is required, thus creating a permanent record of optimal settings.

CR Sensor

Personnel are required to correctly align the plate and feed it into the processor from the open protector sleeve. This typically creates an image on both the processor and the HD computer screen; similarily to using a DR sensor, the digital image can then be manipulated. Once the information is moved to the processor from the phosphor plate, the processor clears the plate and ejects it outside the processor, to be placed in a sleeve ready for re-use.

Summary

Equipment required to instigate intra-oral radiography represents a small investment in order to achieve greatly enhanced diagnostic capability. Once mastered, the techniques can be utilised in daily surgery with little increase in operative time. The information gleaned by intra oral radiography is essential in the investigation of dental, oral and maxillofacial trauma and disease. It should be regarded as a vital, daily tool for the formulation of an accurate diagnosis and appropriate treatment plan. Radiographs are also a powerful educational tool for colleagues and clients and thus assist explanations of disease and enable informed decisions to be made. Elimination of guesswork enables avoidance of many potential surgical complications – this can save time and frustration as well as give much improved outcomes for our patients.