Keys to Successful Intraoral Radiography

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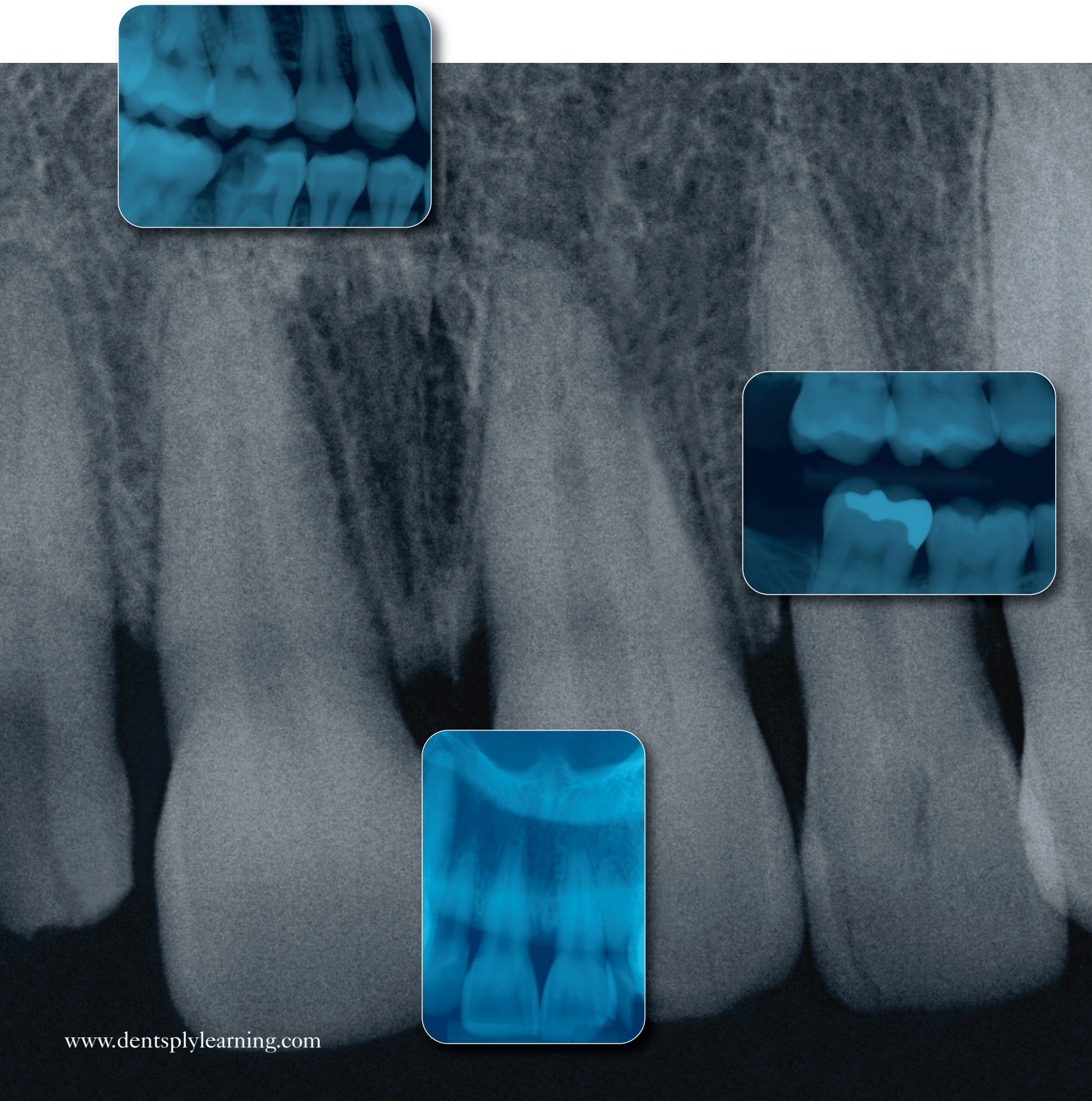

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Educational Objectives

1. Practice safety measures to minimize radiation exposure to dental patients.
2. Apply the principles of paralleling and bisecting angle technique to intraoral radiography.
3. Identify and correct common errors that occur when taking intraoral radiographs.

1. Introduction

Radiographic examinations are one of the primary diagnostic tools used in dentistry to determine disease states and formulate appropriate treatment. Radiographs often confirm what is observed clinically and many times reveal findings not apparent from the clinical examination alone.

Dental radiographs should be prescribed according to selection criteria guidelines and taken only for diagnostic and treatment purposes. Selection criteria guidelines are based on evidence of disease patterns and take into consideration the patient's medical and dental history, clinical signs and symptoms of disease, risk factors, age and dentition, and new or recall patient status. Only bitewing radiographs have time-based intervals that are determined according to risk factors for caries. For a complete review of these recommendations, refer to The Selection of Patients for Dental Radiographic Examinations, Revised 2004.[1]

Dental radiographs are valuable diagnostic tools when the image quality is adequate for proper interpretation. Film-based and digital radiographic images both require the use of careful technique and precautions to maximize the diagnostic and interpretative value of the radiograph while at the same time minimizing patient exposure to radiation. Maximizing the diagnostic value of radiographs starts with correct receptor position, ensuring that the x-ray beam is centered and aligned at the correct vertical and horizontal angulations and exposed at the correct time.

Key Objectives

- Maximize diagnostic value of intraoral images
- Minimize patient exposure to radiation

"...best practices include the use of lead aprons and collars."

II. Minimizing Patient Radiation Exposure

There are numerous methods that can be employed to minimize patients' exposure to radiation. These include the number of radiographic images taken, receptor selection, x-ray beam filtration and collimation, and patient shielding. Together these methods can significantly reduce patients' exposure.

Number of Radiographs Taken

Since radiation exposure has a lifetime cumulative effect, only essential dental radiographs should be taken. Keeping the total number of radiographs to a minimum requires an assessment of their necessity on a patient-by-patient basis. This is the purpose and goal of selection criteria. Retakes contribute to an increased number of radiographs and as a result increased radiation exposure. Operator technique must be optimal to avoid retakes.

Receptor Selection

For film-based radiography, F speed film is recommended. The speed of the film depends upon the sensitivity of the emulsion to the x-ray beam. The faster the film, the shorter the exposure time and the less total radiation delivered to the patient. Digital receptors are faster than film, reduce the amount of radiation needed to produce a diagnostic image and eliminate chemical processing errors. Digital receptors are available in two formats, photostimulable phosphor plate (PSP) receptors or rigid wired or wireless charge-coupled devices (CCD) or complementary metal oxide semi-conductors (CMOS) receptors.

Limiting the Number of Radiographs

- Individual patient assessment of need and number required
- Operator technique to minimize retakes

X-ray Beam Filtration and Collimation

X-ray beams contain both high-energy and low-energy photons. Low-energy photons are absorbed by the patient; to minimize this exposure, aluminum filtration is used. Beam collimation limits the diameter of the beam at the patient's face, which should not exceed 7 cm, or 2.75 inches. Both round and rectangular collimators are available; the rectangular collimator reduces the beam's diameter more and exposes 60% less tissue compared to round collimators.[2] Several options are available for rectangular collimation: semi-permanent rectangular PIDs from the x-ray machine manufacturer or a secondary removable rectangular collimator that is affixed to the standard round PID.

Patient Protection

Patients rely upon dental professionals to provide safe and effective treatment. Patient protection includes the use of lead collars and lead aprons. Lead collars are designed to protect the thyroid. These devices have been found to substantially reduce radiation to the thyroid during dental radiographic examinations.[3] There are varying perspectives on the necessity of lead aprons and thyroid collar shields. Selection criteria guidelines recommend that every precaution should be taken and patient shielding be used whenever possible; particularly for children, women of childbearing age, and pregnant women.[1] The National Council on Radiation Protection (NCRP) Report 145, Radiation Protection In Dentistry, states that if all of the safety measures outlined in the report are rigorously followed, a lead apron is not required.[4] However, the radiation safety measures include rectangular collimation of the x-ray beam, use of fast image receptors, application of selection criteria, and a variety of other standards that all must be in place in order to eliminate the use of the lead apron. In addition, the NCRP Report 145 states that thyroid collars shall be provided for children and should be provided for adults except when they interfere with examination as in the case of panoramic imaging.[4] Most dental offices do not use rectangular collimation of the x-ray beam and, as a result, would not be in compliance with NCRP guidelines. Therefore, best practices include the use of lead aprons and thyroid collars and other safety measures that help the clinician comply with the ALARA (As Low As Reasonably Achievable) principle and keep the exposure to the patient to a minimum.

In addition, the clinician must remember that the lead contained in lead aprons and collars is thin and malleable, and if the apron or collar is folded or improperly stored, the lead can be bent and damaged. Collars and aprons should be hung up to avoid damage. As an alternative to leaded aprons, light weight options are available that incorporate materials that effectively absorb the scatter radiation but are not as heavy or ungainly to use and may be more comfortable for patients.

III. Positioning Guidelines for Intraoral Radiographs

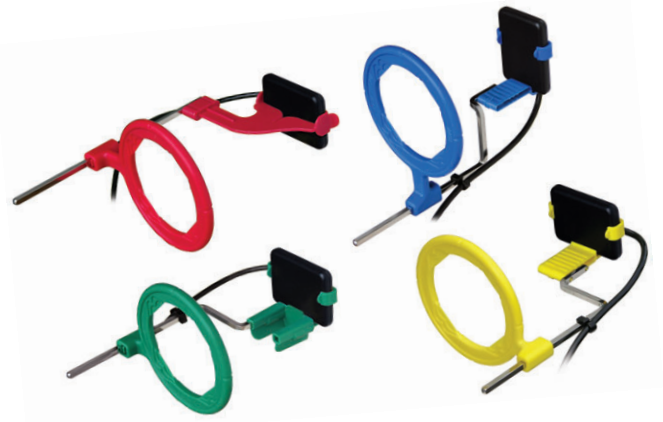
Periapical and bitewing Intraoral radiographs can be captured using film or digital receptors. As described previously, digital receptors include wired and wireless rigid sensors and photo-stimulable phosphor plates. Both systems are computer-based technologies that require specific hardware and software components for operation. Digital receptors are available in sizes comparable to film; typically 0, 1, 2, but not all manufacturers produce all three sizes. Accurate positioning is critical to the production of diagnostic images and helps avoid retakes. Intraoral radiographic images are taken using paralleling, bisecting, and bitewing techniques. Devices used to accomplish this include receptor instruments with ring guides, standard biteblocks, and bitewing tabs.

Paralleling Technique

The paralleling technique is used for both periapical and bitewing radiographs and is the most accurate technique for taking these projections. For film or digital radiographs, the receptor should be placed vertically and horizontally parallel with the teeth that are being radiographed. The x-ray beam should be directed at right angles to the teeth and receptor. In the case of periapical radiographs, the film or digital receptor should be placed parallel to the full length of the crown and root of the teeth being imaged. The paralleling technique for bitewing radiographs is simpler in the sense that the receptor is more easily placed in the patient's mouth even if the palate is shallow or the patient gags.

Film and Digital Receptor Instruments

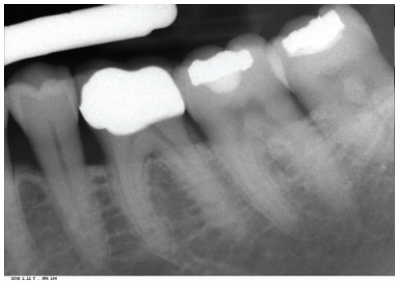
Receptor instruments with x-ray beam ring guides improve the accuracy of the PID (Position Indicating Device, or x-ray cone) alignment to ensure correct beam angulation and beam centering. Receptor instruments combine a receptor holder with an arm that has an attached ring indicating the position for the PID. This helps the operator avoid common errors by specifically directing the x-ray beam toward the receptor. Regardless of the instrument used, the placement of the receptor relative to the teeth must be correct. Instruments are available for paralleling, bisecting, and bitewing techniques, as well as for endodontic imaging where endodontic files may impede proper positioning of the receptor behind the tooth.



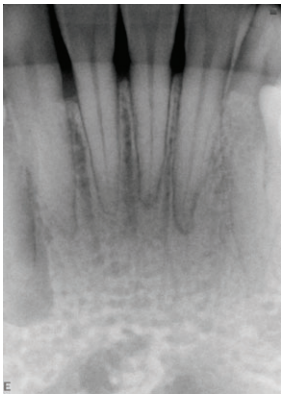
The XCP® (for film) and XCP-DS® (shown, for sensors) systems help achieve precise alignment of the x-ray beam.

XCP-ORA® simplifies the procedure by using one ring and arm for all anterior, posterior and bitewing indications.

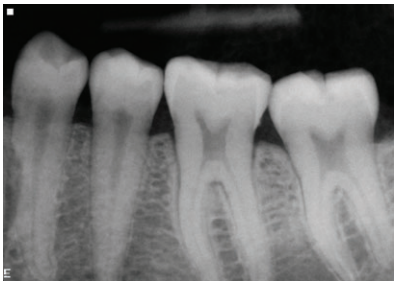
Common Errors



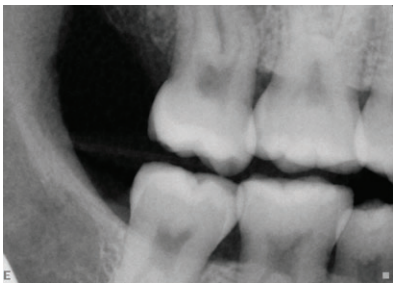
Placement



Foreshortening

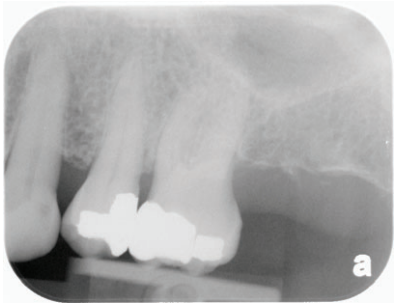


Elongation



Overlapping

Cone Cut



Underexposure

IV. Common Errors

When the principles of radiographic technique are not applied, technical errors will occur. Errors need to be identified, understood and corrected so that they do not continue to occur. The most typical technique errors occur in placement, vertical angulation, horizontal angulation, x-ray beam centering and exposure. Placement errors occur when the clinician fails to properly place the receptor to record the correct teeth, or cuts off the crowns or apices of teeth. Vertical angulation errors distort the length of the structures and result in either foreshortening or elongation. Foreshortening requires a decrease in the vertical angle for correction while elongation requires an increase in the vertical angle. Vertical angulation errors are more common in bisecting angle technique than with paralleling technique. Horizontal angulation errors result in overlapping of proximal surfaces and limit caries and bone loss evaluations. To correct, the horizontal angle must be directed through the proximal surfaces of the teeth. Overlapping occurs more commonly with tab bitewings. However, overlapping can occur with bitewing instruments if the receptor is not placed parallel to the horizontal plane of the teeth. Cone cut errors are caused by not centering the x-ray beam over the receptor. Lack of centering produces partial exposure of the receptor with a "cut" where x-rays did not interact with the receptor. Receptor instruments with beam guides facilitate beam centering over the receptor when properly assembled. Exposure errors result in light or dark images due to improper exposure time or lack of consideration of patient size and the thickness of structures.

"...accurate positioning of the receptor and x-ray beam is even more critical to avoid cone cuts and crown or apical cut-offs."

Receptor Differences

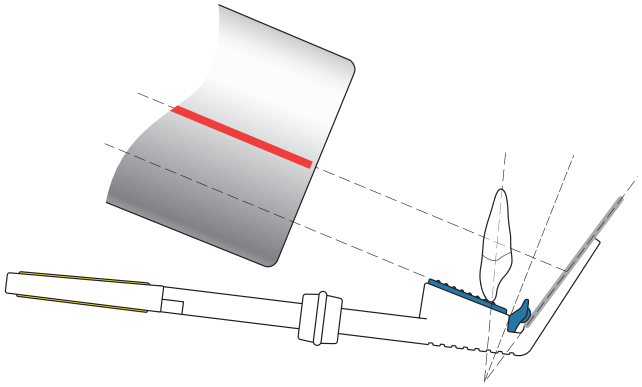
Rigid digital receptors are more difficult to use initially, may result in more errors for both periapical and bitewing radiographic images compared to film, and can cause more discomfort for the patient. To avoid these problems, rigid receptors should be placed close to the midline to aid proper placement and to reduce discomfort. It is particularly important if a patient has a shallow palate or floor of mouth to employ this method, both to avoid discomfort and to avoid distortion of the image. Rigid sensors have a slightly smaller surface area for recording the image than film does. Therefore, accurate positioning of the receptor and x-ray beam is even more critical to avoid cone cuts and crown or apical cut-offs. Due to the sensor's rigidity, more errors have been found than with the use of film; more horizontal placement errors occur posteriorly, and more vertical angulation errors anteriorly.[5] This can be overcome with experience and understanding of the differences between rigid receptors and film. Phosphor plate receptors are more flexible and thinner than the other digital sensors but have the same dimensions as film, thus making the transition from film to digital radiography somewhat easier. However, the plates must be handled carefully, scanned to digitize the image, and exposed to intense light before they can be reused. Rough handling may produce plate scars, result in image artifacts, and necessitate plate replacement, making them less user-friendly in these instances.

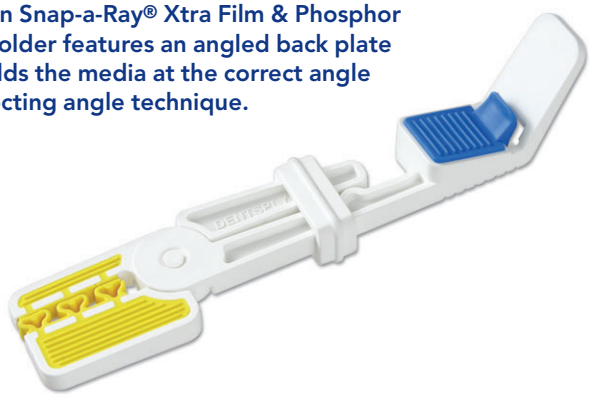
Tab Bitewing Technique

For children or patients who gag easily, tab bitewings are less cumbersome and more comfortable for the patient than instrument holders. Position the receptor parallel to the horizontal plane of the crowns of the teeth being imaged; otherwise, overlapping will occur. Bitewing tabs hold the digital receptors or traditional film in position intraorally. Neither has any directional capability for PID positioning and beam direction. However, careful placement and beam alignment will produce good results. The vertical angulation is typically set +5° with the beam centered to the tab. The tab should be aligned with the teeth contacts, which will indicate the correct horizontal angulation. Central ray entry points will help with x-ray beam centering, as will using the lines on the PID that indicate the direction of the x-rays. Universal holders are available that can be used for rigid digital sensors.

Bisecting Technique

The bisecting technique may also be used for periapical radiographs. In this case, the receptor is placed diagonal to the long axis plane of the teeth. The beam is then directed at a right angle to a plane that is midway between (bisects) the receptor and the teeth. This technique produces less optimal images because the receptor and teeth are not in the same vertical plane. However, it is a useful alternative technique when ideal receptor placement cannot be achieved due to patient trauma or anatomic obstacles. This technique is more operator-sensitive. If the angle is not correctly divided,





The Rinn Snap-a-Ray® Xtra Film & Phosphor Plate Holder features an angled back plate that holds the media at the correct angle for bisecting angle technique.

elongation or foreshortening will occur. A variety of holders can be used for different locations in the mouth for accurate positioning of the receptor. One approach the clinician can use is to align the PID parallel to the receptor initially and then reduce the vertical angle about 10°, which will approach the bisecting plane. Also, starting angles can be used that will get the operator close to the bisecting plane in each area of the mouth. These angles can be aligned using the angle meter on the side of the x-ray head.

Arch	Maxilla	Mandible
Molar	+15° to +25°	+5° to -5°
Premolar	+25° to +35°	-10° to -15°
Canine	+40° to +50°	-10° to -15°
Incisor	+40° to +50°	-10° to -15°

Special Considerations While Positioning

Gagging

Gagging patients can be challenging and require patience and reassurance from the clinician. It is important to be organized, pre-set the exposure time, pre-align the PID, and be ready to act quickly. The most common area to elicit the gag reflex is the maxillary molar periapical view. Placement of the receptor toward the midline and away from the soft palate will reduce the tendency for gagging. There are a variety of strategies that will help manage the gagging patient: breathing through the nose, salt on the tongue, distraction techniques (lifting one leg in the air, bending the toes toward the body, humming), use of topical anesthetics, and tissue cushions on the receptor.

Similar approaches can be useful when the patient experiences discomfort from the receptor, particularly the use of topical anesthetic agents and receptor cushions.

Self-adhesive media cushions can greatly enhance patient comfort.

Use of a cotton roll on or under the biteblock can provide additional room in shallow palate situations.

Anatomical Variations

Shallow Palates

- Use bisecting technique instead of paralleling technique
- Move receptor more toward the midline
- Use of a cotton roll on or under the biteblock can provide additional room

Presence of tori

- Ensure maxillary tori are between the teeth and receptor
- Place receptor behind mandibular tori

Narrow arches

- Place receptor as far lingual as possible
- Use size 1 receptors in anterior segments or occlusal technique

Edentulous situations

- Place receptor more toward the midline
- Use cotton rolls on the biteblock to replace missing teeth

Endo

- Place receptor more lingual to avoid endodontic files
- Use special endodontic receptor instruments

V. Summary

Dental radiographs are valuable diagnostic tools and expose the patient to minimal amounts of radiation. Nonetheless, dental professionals must ensure that patients are protected from the harmful effects of cumulative exposure to radiation. Patients can be protected through the use of lead collars and aprons and by ensuring that only necessary radiographs are taken and that radiation exposure is kept low. One of the critical factors in minimizing the number of radiographs is to ensure that retakes are not required due to improper technique or processing problems. Receptor instruments are valuable tools that guide the x-ray beam and thereby assist in the accuracy of dental radiography.

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Author Profile

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