# Periapical Long Cone Paralleling Technique

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Authored by:

Dr. Mindy Cash

Authored by:

Dr. Susanne Perschbacher

## Introduction

Periapical radiographs are the most common intraoral radiographic images produced in the examination of the oral and maxillofacial structures. They provide important information about the teeth and surrounding structures, including the alveolar processes, periodontium and neighbouring anatomic structures. The entire crown and root of the imaged teeth are depicted which allows the detection of many important findings such as caries, periodontal bone loss and inflammatory periapical pathology. Intraoral radiographs have a higher spatial resolution as compared to extraoral radiographs, allowing the detection of the subtle changes that occur in these dental diseases. The status of restorations, the presence of calculus and other anomalies can also be examined on these images. Periapical radiographs are an important diagnostic test that provides the dentist with important information which contributes to the production of a comprehensive treatment plan.

Periapical radiographs can be taken to examine a specific area or areas, or they may be prescribed as a Full Mouth Series of radiographs. A full mouth series of radiographs images the entire dentition and is generally composed of 20 films, including 4 bitewing radiographs and 16 periapical radiographs. Intraoral periapical radiographs can be produced using two different techniques; the bisecting-the-angle technique and the more commonly used long cone paralleling technique.

## The Long Cone Paralleling Technique

The long cone paralleling technique positions the receptor (i.e. film) parallel to the long axis of the teeth and guides the central ray of the x-ray beam to be directed at a right angle to the teeth and the receptor. This method produces images of the teeth on the receptor with minimal distortion. Orienting the film parallel to the teeth requires it to be positioned more

towards the center of the mouth, especially in the maxilla, which places it a greater distance from the teeth to be imaged. This increased object-film distance creates magnification in the resulting image. To counteract this effect, the x-ray source is moved further away in order to increase the focal spot-object distance by using a long position indicating device (PID) or “cone”. This reduces distortion by directing only the most central and parallel rays toward the receptor. A Rinn instrument is commonly used to help position and stabilize the film in the mouth as well as aim the x-ray beam. This device is comprised of a receptor holder/bite block, an aiming ring and a connecting rod. Use of this device will be discussed throughout the procedure.

## Materials

- Size #1 periapical film.
- Size #2 periapical film.
- Rinn instrument; including anterior and posterior rods, rings and film stabilizers.
- Lead apron.
- Thyroid collar.
- Gloves and other materials necessary for infection control procedures.

## Patient Preparation

The patient is seated in an upright position in the dental chair. The patient is asked to remove eyeglasses, any removable dental appliances and any metallic piercings or jewelry that may be in the path of the x-ray beam. The patient is covered with a lead apron and thyroid collar.

*Common Errors:*

1. Leaving eyeglasses or metallic jewelry on the patient during the production of intraoral dental radiographs may produce images of these objects on the films, which can obscure the anatomic structures we are trying to evaluate. This occurs when the x-ray beam is attenuated by the objects in its path, producing a white (radiopaque) image on the film and blocking the image of other structures in the view.

### Instrument Preparation

From this point forward gloves should be put on and all infection control procedures must be followed. The Rinn instrument is assembled. The Rinn instrument includes separate anterior and posterior film holders, rods and rings. These are colour coded for easy assembly.

#### Anterior Rinn instrument

Hold the anterior rod by the end opposite the prongs, with the prongs pointing to the left. The prongs of the anterior rod are inserted into the anterior film holder so that the smooth back of the film holder is directed up, away from the rod, and the grooved bite surface is facing you,

pointing towards the rod. The anterior ring is slid onto the rod, with the ring pointed up, so that the opening of the ring is centered over the film holder. This set-up is used for the anterior maxillary and mandibular teeth.

### Posterior Rinn instrument

Similarly the posterior rod, ring and film holder unit is assembled. Hold the posterior rod from the end opposite the prongs, with the prongs pointing to the left. Insert the prongs into the posterior film holder with the smooth back of the film holder pointing up and the grooved bite surface facing you, pointing towards the rod. The posterior ring is slid onto the rod, with the ring pointing to the left and slightly up, so that the opening of the ring is centered over the film holder. Care must be taken in this step because the ring is offset and is easily misaligned. This assembly will work to image the posterior 1st and 3rd quadrants but must be re-oriented to image the 2nd and 4th quadrants. This is because the unit is designed so that when inserted in the mouth, the cheek rests between the ring and the film holder so that the film can reach the most posterior teeth. When switching the orientation of the assembly, it is best to change the position of one component at a time rather than disassembling the entire unit and beginning again. First, hold the assembly by the free end of the rod with the film holder pointing up. Grasp the film holder and remove it from the prongs. Turn it upside down so that the film holder points down with the smooth back still away from the ring. Turn the whole assembly over so that the film holder again is directed up. Now remove the ring and flip it towards you and reinsert it onto the rod. The ring should now be pointing to the right and slightly up. The film holder should now be re-centered in the opening of the ring.

*Common Errors:*

1. Incorrectly assembling the Rinn instrument will incorrectly guide the PID, and produce an image with an unexposed portion of the film that is clear and follows the shape of the outline of the PID. This type of error is termed a “cone cut.”
2. Placing the posterior Rinn assembly into the incorrect quadrant causes the rod to get caught on the cheek and doesn’t allow the assembly to be positioned correctly into the mouth. This is uncomfortable for the patient and may produce an inadequate view of the teeth and surrounding bone.

## Machine Preparation

It is good practice to prepare the x-ray machine prior to positioning the film in the patient’s mouth. This prevents extra time being spent selecting settings while the patient holds the film in place, which may be uncomfortable. Ensure the dental x-ray unit is turned on and adjust it to the appropriate exposure setting. Exposure settings will vary based on the x-ray machine, film speed, patient size and area of the mouth to be examined.

The PID of the dental x-ray unit is positioned on the side to be examined, allowing it to be readily available for use, once the film has been placed in the patient's mouth.

*Common Errors:* Incorrectly setting the x-ray unit may result in images that are suboptimal in terms of density and contrast which may make the film diagnostically inadequate.

## Film Preparation

Size #1 films are used for periapical radiographs in the anterior maxilla and mandible. These include periapical radiographs examining the anterior teeth from cuspid to cuspid. These films are inserted into the film holder of the Rinn assembly in a vertical orientation with the dimple on the film positioned into the slot and with the white side of the film facing out.

For periapical radiographs in the posterior areas, imaging teeth of the maxilla and mandible from the cuspids back, size #2 films are used. These are positioned in a horizontal orientation, with the dimple on the film positioned into the slot of the film holder and with the white side of the film facing out.

Placing the dimple in the slot positions it towards the occlusal or incisal surface of the teeth, where it is less likely to obscure important structures on the resulting image.

When assembled the operator should be able to look through the ring (from the view of the PID) and see the entire film, framed by the ring. In other words, the entire film will ultimately be exposed to radiation.

*Common errors:*

1. Using the wrong size film or the wrong film orientation for the area of the arch being examined may make positioning the film difficult or provide incomplete coverage of the region to be examined.
2. Positioning the dimple on the film so that it is not in the slot will place it over the apical region of the image and may obscure important anatomic structures.
3. Positioning the film backwards in the film holder will produce an image that is light and reversed, with a superimposed geometric pattern from the embossed lead foil.

## Positioning The Film

The film is positioned in the mouth so that the full crowns and roots of the teeth to be imaged and their surrounding bone are captured on the film. The film and film holder is inserted into the patient's mouth and rotated into the correct region to be imaged. The film holder should then be gently guided onto the occlusal/incisal surface of the teeth to be imaged while the patient is instructed to close his or her teeth onto the bite surface. It is critical that the film holder is deliberately seated on the teeth to be imaged and that the operator maintains the desired position of the film to prevent shifting while the patient closes. It is also vital that the

patient has his or her teeth fully closed onto the grooved bite surface of the film holder. This ensures that the film is positioned in a way to cover the apical area completely. Simultaneously, the film/film holder combination should be positioned parallel to the lingual/palatal surfaces of the teeth. This is accomplished by making sure that the patient is biting on the center part of the grooved bite surface of the film holder. The film and Rinn instrument combination must remain stable when the patient is in occlusion and the operator lets go of the Rinn assembly. At this point, improved stabilization or any small adjustments to the film position can be achieved by having the patient separating his or her teeth just enough to make any refinements.

*Common errors:*

1. If the patient is not biting completely on the bite surface of the film holder two types of errors may occur:
    1. The Rinn assembly will not be fully seated (not apically positioned adequately) producing an image where the apical portion of the teeth and surrounding bone are cut off and a black image of air is seen on the coronal portion of the image.
    2. The Rinn assembly will be unstable and may shift positions producing a blurred or improperly positioned image.
2. If the Rinn assembly is not stable due to the patient's occlusion, movement causing blurring or an improperly positioned image may result. Cotton rolls may be used to help stabilize the Rinn assembly but must never be placed between the RINN instrument bite surface and the teeth to be imaged.
3. If the patient bites too close to the bend in the film holder, the film will not be parallel to the lingual/palatal surfaces of the teeth and the Rinn instrument will be tipped. This causes the x-ray beam to be directed at an angulation that is too steep resulting in a foreshortened image.

## Common Challenges

Several common anatomic limitations may make positioning the film for periapical radiographs challenging.

1. **Shallow and/or sensitive floor of mouth**: Patients often complain of discomfort when the film holder is positioned in the anterior floor of the mouth because the edge of the film feels sharp against the sensitive tissues under and beside the tongue. It is important to be very gentle when placing the film so that patient trust is established. Some further techniques to make this procedure more comfortable for the patient include:
    1. Gently softening the edges of the film by rounding it very carefully between the fingers. This must be done only slightly and the film must never be bent outright. Bending the film produces an artifact on the image that may render the film unusable.
    2. Coaching the patient to relax his or her tongue and the floor of their mouth. When these muscles are held tense, the floor of the mouth becomes elevated and further limits the space available and contributes to discomfort. These muscles also tend to relax as the patient closes his or her mouth which helps create space for film positioning.
    3. As a last resort, tipping the film holder so that the free edge of the film moves more towards the tongue. This is not ideal because it may result in foreshortening of the image due to a steeper beam angulation, however, it allows the structures in the area to be visualized.
2. **Gagging**: Some patients have a very sensitive gag reflex which makes positioning films, especially in the posterior regions of the mouth, very difficult. For most patients, this can be overcome enough to take good quality images. The following techniques are generally helpful:
    1. Work quickly and confidently. Often gagging is exacerbated in patients who are nervous and worried they will have to be in an uncomfortable position for too long.
    2. Coach the patient to breath through his or her nose, even when they have their mouth open. This reassures them that they will still be able to breathe when the film is positioned in the mouth. Remind them frequently while placing the film to continue breathing through their nose.
    3. Instruct the patient to wiggle his or her toes inside their shoe once the film is in place. This creates a distracter which helps overcome the gag reflex but should not cause the patient's head to move.

       Rarely, a gag reflex is so intense that adequate film positioning cannot be obtained. Alternative imaging modalities, such as a panoramic radiograph, may be considered in such a case.

3. **Shallow palate**: In some patients, the palatal vault is shallow and does not provide ample room for film placement in the maxilla. The film will sometimes become excessively bent against the palate, creating elongation on the superior region of the image, and the patient may complain of discomfort.  This situation can be ameliorated by these techniques:
    1. Always positioning the film holder away from the teeth, towards the center of the hard palate, where there is the most room.
    2. Gently softening the edges of the film, as discussed above.
    3. When necessary, tipping the film holder so that aiming ring moves superiorly which allows the patient to close his or her teeth together on the bite surface. This must not be over done or there will be excessive foreshortening of the image and superimposition of the zygomatic process of the maxilla over the maxillary molars.
4. **Partially edentulous arch**: Many patients are missing some teeth which can make stabilization of the film holder difficult. It is always important to make sure the film holder is centered over the teeth to be imaged and not drifting or tipping into the edentulous spaces. In most cases stabilization is achieved just by the patient closing on the bite surface, however, when necessary, improved stabilization may be achieved in the following ways:
    1. If the patient has a removable denture for the arch opposing that which is being imaged, they may wear it to increase the surface available for stabilization.
    2. A cotton roll may be placed in an edentulous space to support the edge of the film holder and prevent it from tipping. Cotton rolls, however, can be cumbersome and should be used judiciously.

## Guidelines for ideal film positioning

### Maxillary and Mandibular Central Incisor View

*Guidelines:* Contact between central incisors positioned in the center of the film.

*Teeth in view:* Maxillary View: Right and left central and lateral incisors.

*Mandibular View:* Right and left central and lateral incisors.

### Maxillary Lateral Incisor View

*Guidelines:* Contact between the central and lateral incisors is positioned in the center of the film.

*Teeth in view:* The entire central and lateral incisors are imaged and a portion of the cuspid and the contralateral central incisor is in the view.

### Maxillary and Mandibular Canine Views

*Guidelines:* The film is positioned so that the canine is in the center of the film. In addition, the goal is to “open” the contact between the canine and the 1st premolar.

Teeth in view: The entire canine, 1st premolar and all or part of the lateral incisor.

### Maxillary and Mandibular 1st Molar View/Premolar View

*Guidelines:* The film is positioned far enough mesially so that a portion of the canine (into dentin) is imaged. The remainder of the film will image the teeth distal to the canines.

*Teeth in view:* A portion of the canine (into dentin) is imaged, as well as the 1st and 2nd premolars, the 1st molar and some or the entire 2nd molar.

### Maxillary and Mandibular 2nd Molar View

*Guidelines:* The film is positioned so that the distal aspect of the last molar in the arch is fully imaged including its root apices. Generally, positioning the mesial edge of the film at the middle of the 2nd premolar allows the third molar region to be covered. Teeth in view: When the film is correctly positioned the anterior edge of the film usually captures either a portion of the 2nd premolar or the mesial aspect of the 1st molar. The view shows complete images of all the molars present including the distal aspect of the last molar.

## Common Errors:

The goal of a full mouth series of periapical radiographs is to produce an image of every surface of all the teeth that are present.

1. Incorrect positioning of any of the above periapical views produces insufficient image coverage and may not allow a comprehensive radiographic interpretation.
2. When imaging the maxillary lateral periapical radiograph, the operator often centers the lateral incisor in the view. This commonly produces an incomplete image of the ipsilateral central incisor and totally misses the contralateral central incisor.
3. The maxillary canine periapical radiograph is the film that is most commonly imaged incorrectly. The anatomical curve at the corner of the arch makes the production of a quality film challenging. Overlap of the contact between the canine and 1st premolar occurs as a result of a horizontal angulation error. This error can occur during the production of the mandibular canine periapical radiograph, but is less common because the arch shapes creates less restriction for placement of the RINN instrument.
4. The maxillary and mandibular 1st molar periapical radiographs are commonly positioned too far back (distally) into the patients arch, therefore totally missing the canine in the image and often only imaging a portion of the 1st premolar.

5. During imaging of the maxillary and mandibular 2nd molar periapical radiographs, failure to push the film far enough back (distally) into the patient's arch produces an image with the distal aspect of the crown and/or roots missing. A line drawn vertically down from the outer canthus of the eye will approximate the location of the third molars therefore the aiming ring should cover this region. To further assist distal coverage of the film, the film can be slightly set back in the slot so that the mesial edge of the film is flush with the edge of the film holder.

## Aiming the position indicating device

Once the apparatus is stabilized in the correct position, the ring of the Rinn instrument is slid along the rod so that it is close to, but not touching the patient (within 1 cm of the skin surface). The PID of the dental x-ray unit is then centered and aligned on the aiming ring. Aligning the PID is accomplished by ensuring that the open end of the PID is flush with the aiming ring. The PID should not touch the ring but there should be equal space between them from all angles.

*Common errors:*

1. If the PID is not centered on the aiming ring there may be incomplete exposure of the film, resulting in a cone-cut on the image.
2. If the PID is misaligned and is not flush with the aiming ring, distortions or overlap of structures may result.

## Film exposure

The film is now ready to be exposed. The operator should instruct the patient not to move. The operator then exits the operatory and exposes the film by firmly pressing and holding the activating button on the x-ray machine. This produces an audible beep. When the exposure is complete the operator must promptly remove the film from the patient's mouth in order to minimize patient discomfort.

*Common errors:*

1. Early release of the exposure button may result in insufficient exposure to the film to produce an adequate image.

When taking a Full Mouth Series of radiographs, the anterior periapical radiographs are made first. Each film is dispensed individually, preventing contamination. After the necessary exposures are made, the films are processed.

## Film evaluation

Following processing, the films are arranged in their appropriate anatomic position on a viewing box in a darkened room. Films must be placed with the convex surface of the dimple pointing up to ensure correct orientation. They are initially evaluated for image adequacy. The films should reveal clear unobstructed images of the teeth and the surrounding bone being examined. In some instances anatomical or positional variations may obstruct areas on a particular periapical radiograph, which may be seen clearly in a different view. Inadequately imaged areas may require a re-take. When the operator is satisfied with the adequacy of the radiographic series, the patient should be dismissed. A radiologic interpretation must then be completed for all radiographic images obtained.

*Common errors:*

1. Setting up the film in the wrong anatomic position may lead to inappropriate diagnosis and treatment.
2. Setting up the film with the dimple facing down will orient the film in the contralateral quadrant which could lead to inappropriate diagnosis and treatment.