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Practical Tips for Successful Bitewing Radiographs in Children

Abstract: Bitewings are a fundamental tool for treatment decision-making in young patients as they provide essential information on caries depth, the presence of a dentine bridge and pulp retraction, radiographic signs of pulp necrosis and presence of a permanent successor. The article updates the practitioner on the use of bitewing radiographs for primary molars and provides hints and tips for maximizing success in children.

CPD/Clinical Relevance: The correct use of bitewing radiographs is essential for clinical decision-making in children.

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Bitewing radiographs are one of the most valuable special investigation tools used to assist diagnosis in primary molars in the paediatric dental patient. The term 'bitewing' (BW) refers to the little tab (or wing) in the centre of the X-ray film on which the patient bites to hold it in place, thus providing an equal image of both the maxillary and the mandibular teeth.

Recommendations for the use of bitewing radiographs have changed in recent years with the publication of contemporary guidelines that have moved away from screening radiographs in young children,[1] in favour of targeting individuals following a risk-based analysis. New evidence has emerged to inform the practitioner regarding patients or lesions that will benefit most from taking bitewing radiographs.[2] Therefore, dentists should be aware when a radiographic examination is indicated to aid treatment decision-making for their patient.

High-quality bitewings are essential for treatment planning, especially for deep caries lesions.[3] Bitewings allow an estimation of the extent of dentine caries lesions and their proximity to the pulp, as well as the pulp response to the lesion (pulp retraction by deposition of tertiary dentine). More than a half of all primary molars have accessory canals in the furcation area,[3] so pulp necrosis is often apparent by detection of an inter-radicular rather than a peri-apical radiolucency. This area is more clearly visible on a bitewing than on a peri-apical radiograph.[4] Furthermore, bitewings assist in assessment of the status of previous restorations, marginal bone levels, and presence of permanent successors, which is imperative if planning for extractions and space maintenance.[5] Finally, there is anecdotal evidence that a child's ability to cooperate during bitewings can assist the clinician in determining whether the child will tolerate further dental intervention.

Unfortunately, despite the many advantages of bitewing radiographs, they are reportedly underused by many practitioners, especially those in general practice.[6] This may be due to many reasons, including a lack of knowledge about the importance of radiographic images for diagnosis, lack of confidence in treating children and difficulties with children's behaviour during the radiographic examination.[6,7]

This article updates the general practitioner on the use of bitewing radiographs for primary molars and provides an overview of current guidelines and practical tips to maximize success when dealing with young children.

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What is the current evidence for the efficacy of bitewings in children?

It has been shown that second primary molars tend to have more occlusal surface caries than first, but first primary molars

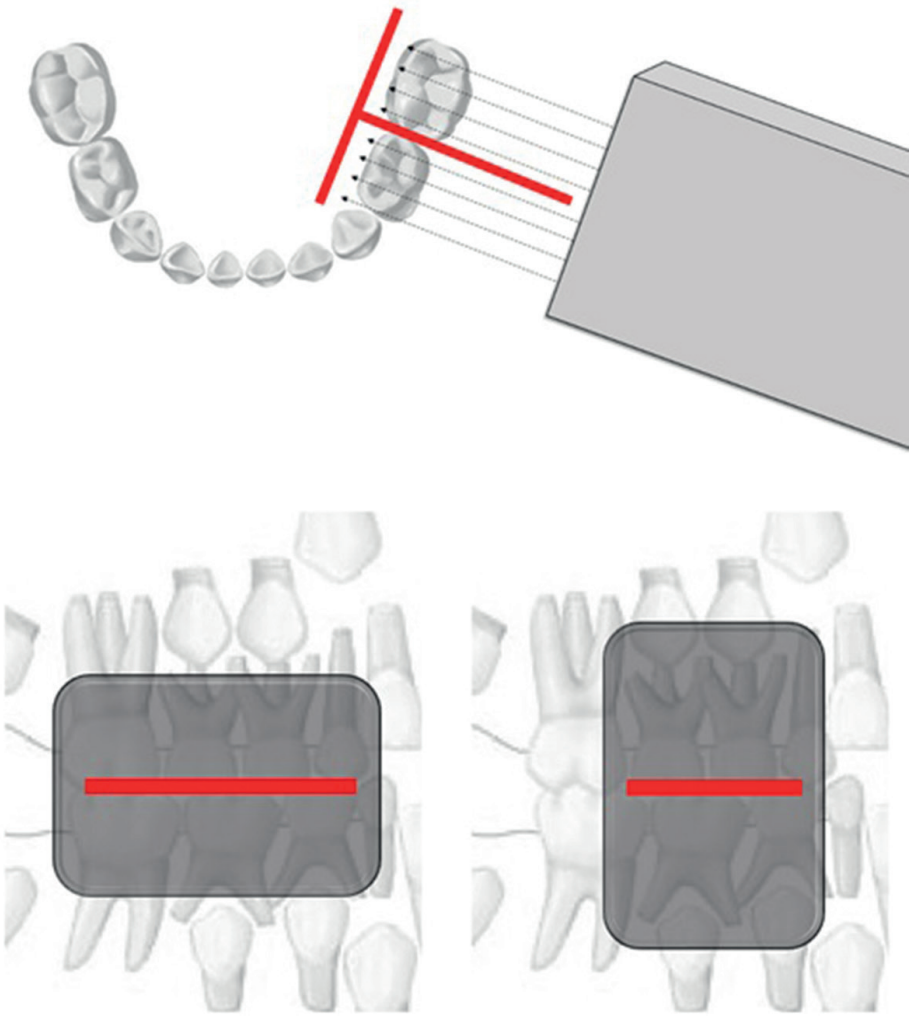


Figure 1. The use of a rectangular collimation for horizontal and vertical bitewings in the primary dentition.

experience more proximal caries than their distal neighbours.[8] Visual caries examination of a clean dry tooth with good lighting will detect the presence or absence of occlusal caries (high specificity/sensitivity);[9] however, proximal caries lesions are more difficult to detect and visual examination has a low sensitivity with many false-negatives.[10,11] This may be explained by the position of the initial lesion at or below the broad flat contact points.[12]

Bitewing radiographs are not accurate for the detection of occlusal enamel caries owing to the overlapping fissure pattern.[8] However, they are good in determining the extent of occlusal caries into dentine and visualizing the presence of a dentine bridge between the lesion and the pulp chamber. Bitewings also have high sensitivity for proximal caries and increase their detection compared to visual examination alone.[10] However, the clinician needs to be aware that bitewings can over-diagnose proximal carious lesions leading to false-positive results (decreased specificity).[9,11]

Guidelines for radiograph examination in children have been developed to identify those individuals who may benefit from radiographic examination rather than a screening tool.[2,13] There is evidence that children with a low caries risk benefit less from bitewings for caries detection.[14] However, bitewing radiographs are a vital tool for caries diagnosis in children with a high caries risk and with more advanced caries lesions (dentine threshold).[2,13] Bitewings are fundamental tools for treatment decision-making because periapical and inter-radicular pathology cannot be identified and accurately determined without them.[5,15]

What are the recommended bitewing intervals for children?

There are various recommendations reported in the literature regarding bitewing intervals; however, there is a general agreement that the interval should be based on caries risk assessment.

The FGDP (UK)[16] and the AAPD guidelines[17] for radiographs suggest that a posterior bitewing exam should be taken at 6–12-month intervals for children with caries or at high caries risk if proximal surfaces cannot be examined visually or with a probe until no active caries lesion can be detected, or if the child moves to another risk category.

In contrast, the latest EAPD guidelines[2] recommend that a bitewing should be taken only if the child presents with clinical signs of carious lesions and is therefore at high caries risk. If the child presents with caries restricted to enamel, a new bitewing should be taken every 2–3 years. If the child presents with caries beyond the enamel-dentine junction (into dentine), the time interval for the next bitewing should be 1 year. However, owing to the lack of clinical evidence on this topic, the practitioner should always keep in mind the need for an individualized and patient-specific justification.[2]

How is radiation risk minimized?

Radiation risk is age-dependent and young children are at an increased risk owing to the increased rate of cell division.[18] Therefore, radiograph prescription should be individualized and justified after considering whether the benefits outweigh any potential risks. The use of ALARP principles (As Low As Reasonable Practicable) can help prevent unnecessary exposure, as well as overexposure.[19]

To minimize the radiation dose for children, exposure settings should be customized to deliver the lowest dose of radiation needed.[20] Best practice involves the use of a rectangular collimator (Figure 1) to reduce the area exposed and minimize scattered radiation. This results in a significant dose reduction of at least

Criteria	Rating	Quality criteria	Target: percentage of radiographs taken
1st edition (2001)	Grade 1	No errors of patient preparations, exposure, positioning, processing or film handling	Not less than 70%
	Grade 2	Some errors of patient preparation, exposure, positioning, processing or film handling, but which do not detract from the diagnostic utility of the radiograph	Not greater than 20%
	Grade 3	Errors of patient preparation, exposure, positioning, processing or film handling, which render the radiograph diagnostically unacceptable	Not greater than 10%
2nd edition (2020)	A Diagnostically acceptable	No errors or minimal errors in either patient preparation, exposure, positioning, image (receptor) processing or image reconstruction and of sufficient image quality to answer the clinical question	No less than 95%
	N Not acceptable	Errors in either patient preparation, exposure, positioning, image (receptor) processing or image reconstruction that render the image diagnostically unacceptable	Not greater than 5%

Table 1. Subjective image quality ratings of dental radiographs comparing the first and second editions of the guidelines published by FGDP (UK).

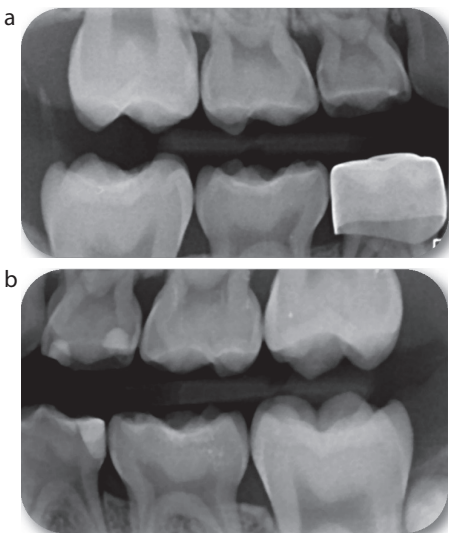


Figure 2. (a,b) Ideal horizontal bitewings.

50% and provides a higher image contrast.[21] In addition, a faster image receptor speed (F-speed film) is recommended over a slow speed (D-speed film), because this also reduces the exposure doses by 60%.[22]

The use of digital intra-oral radiography also contributes to a reduction in radiation doses compared to conventional films.[23] The most commonly used digital imaging system for bitewings in children are the photo-stimulable phosphor plates (PSP) sensors that require a laser scanner to transfer the obtained image to a computer.[24] The use of PSP can reduce the radiation dose by more than 30% when compared to conventional films.[25] Other digital sensors include charge-coupled devices (CCD); however, these can be challenging to use in young children owing to the sensor thickness and positioning of the integrated cable.

According to UK regulations, no thyroid collar is required for bitewing exposures because the beam is not aimed in the direction of the thyroid gland.[26] However, if rectangular collimators are not available, the use of a thyroid collar may be required.[19,26] The presence of a second person in the room should be avoided; however, in cases when it is necessary because of the child's behaviour or young age, the use of a lead apron for the accompanying person is recommended as per local rules under IRR 2017 for carers and comforters.[19]

There is evidence that most parents appreciate the benefit of dental radiographs, although most also lack knowledge regarding its safely and the risks involved.[27] Dental practitioners must be able to effectively communicate these risks, especially if parents express reservations for a radiographic exposure.[28] It is helpful to put this risk in context for parents by relating the radiation dose to something equivalent. For example, the dose of radiation received from a dental intra-oral radiograph is very low (0.005 mSv) and is equivalent to eating approximately five bananas (one banana = 0.001 mSv). This is also equivalent to less than 1 day of exposure to natural background radiation.[29,30] However, practitioners must be mindful that parents/guardians have the right to accept or reject the procedure.

How is bitewing quality graded?

A bitewing should have sufficient diagnostic quality. Reporting the quality of radiograph is mandatory, as set by the National Radiological Protection Board (UK).[16] This can allow auditing of the quality of radiographs taken and ensure the consistent production of adequate quality radiographs. A subjective quality rating system can be used for this purpose. In the first edition of the guideline (2001), a three-point scale (grades 1–3) was used. The current guidelines, published in 2020[19] suggest the use of a two-point scale with a performance target that should be achievable in most dental practices. Both criteria are described in Table 1.

What are the various bitewing techniques in children?

An ideal bitewing radiograph should be of good diagnostic quality with good contrast and show an equal amount of the maxillary and mandibular teeth.

The sensor can be placed in either a horizontal or vertical orientation (Figure 1). Horizontal bitewings should show the distal surface of the primary canine, the first and second primary molar and the entire first permanent molar (Figure 2). However, it will not always allow visualization of furcation areas or roots of primary molars. Vertical

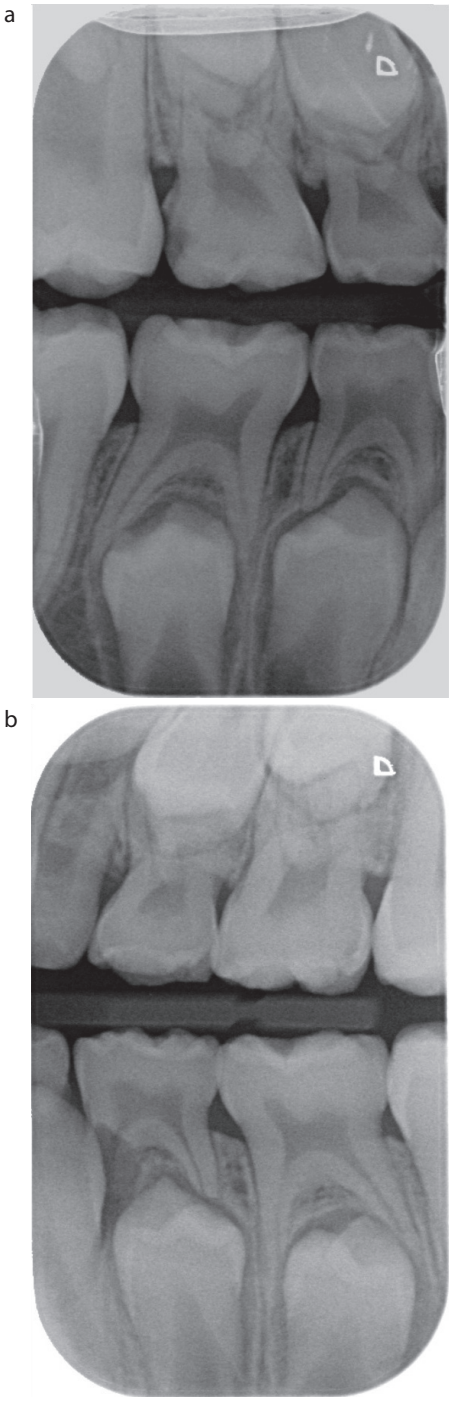


Figure 3. (a,b) Ideal vertical bitewings.

Figure 4. Different phosphor plate sensor sizes used in paediatric dentistry with measurements in centimetres.

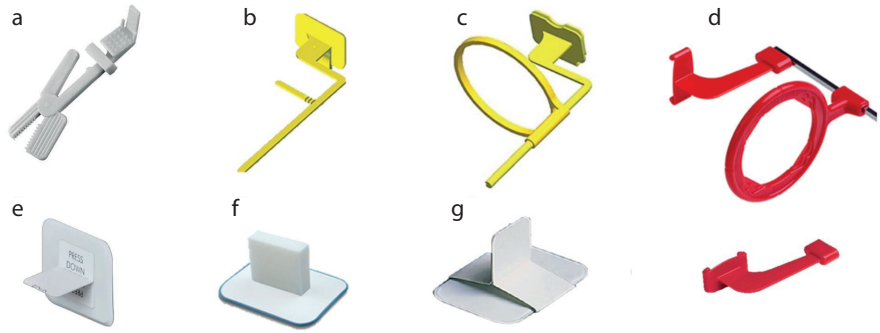


Figure 5. Bitewing holders. **(a)** Snap-a-ray holder (Dentsply, USA). **(b)** Simple yellow Hawe-Neos Kwikbite without ring (Kerr Corporation, USA). **(c)** Simple yellow Hawe-Neos Kwikbite with ring (beam aiming device) (Kerr). **(d)** Red Rinn XCP holder and attachments for horizontal bitewings and vertical bitewings below. (Dentsply, USA). **(e)** Adhesive Bitewing Tabs/FASTab bitewing holders (Dentsply). **(f)** Hager Emmenix Flap Foam Bite wing tabs. (Hager Worldwide, USA). **(g)** Rayvue Bitewing holder (Vista Dental Products, USA).

bitewings should show the distal surface of primary canines, the first and second primary molars and only the mesial surface of the first permanent molars, including the furcation and the roots of primary molars (Figure 3).

For imaging the primary dentition, different phosphor plate sensor sizes are available. Size 0 or 1 is more commonly chosen, while size 2 is usually reserved for the late mixed dentition (Figure 4). For a young child in the primary dentition who can only tolerate a size 0 or a size 1, the use of sensors in a horizontal position might result in missed information. In order to overcome this, placement of the sensor in a vertical orientation is a useful alternative. In addition, vertical bitewings may be easier for a young child to tolerate because the sensor is narrower in the vertical direction and does not encroach as far distally on the soft tissues. This technique can also be used for a child in a mixed dentition, although visualization of the first permanent molar will be compromised. The decision to use a vertical or horizontal technique will be determined by the clinical presentation of the teeth in question.

The armamentarium for bitewing radiographs in children includes a selection of different sensor sizes and holders appropriate for the child's age and size. Different types of sensor holders, with and without a beam-aiming device, are available. The use of holders is recommended when exposing bitewings to ensure the sensor is held firmly in position. A beam-aiming device helps the operator to position the tube head ensuring that the X-ray beam is in the correct position and angulation, to avoid image distortion and coning-off. Figure 5 shows different types of bitewing holders.

How do I manage the child during the bitewing procedure?

In addition to the correct armamentarium, a patient and caring dentist is essential for successful bitewing radiographs in children. Tell-show-do techniques can be used for behaviour support.[31]

- Introduce the patient to the 'camera' so that they can familiarize themselves with the environment.
- Show the patient the sensor and the holder, and explain that you want to take a picture of their teeth.
- Explain that it might feel funny and they

might feel pressure near to tongue and in the roof of their mouth.
- Use careful words to describe the procedure.
- Explain to the child where the sensor is going to be situated (simulation with your finger is often helpful, especially near the floor of the mouth). The procedure can be demonstrated beforehand with a mannequin/doll.
- Sit the patient in the chair in an upright position. Use a head rest if available to ensure that the patient is in a comfortable position – this will also avoid movements during exposure.
- Place the thyroid collar if necessary.
- Ensure that the patient understands what is about to happen using the behaviour support techniques described above.
- Ensure that the patient's occlusal plane is parallel to the floor to avoid positioning errors.
- Explain to the child that they need to sit still without moving for a couple of seconds until the sensor is exposed, use of countdown is helpful. Patient reassurance, positive reinforcement and practice are the key for success.

Dealing with patients with a strong gag reflex can be challenging during radiographs. Gagging is an involuntary reflexive defence mechanism of the body and can be present in up to 20% of children during intra-oral radiographic examination.[32,33] Simple management includes patient positioning, deep nasal breathing and distraction techniques. Continuous pronunciation of an 'S' sound during the exposure can maintain the tongue in a favourable position away from the sensor, while allowing mouth expiration during breathing. The child can also be asked to squeeze their thumb with their hands in an effort to refocus the mind on pressure elsewhere.

Success is based on the correct selection of the armamentarium and bitewing technique (horizontal versus vertical), and also appropriate management of the child during the exposure. Figures 7 and 7 illustrate the step-by-step procedures for horizontal and vertical bitewings, respectively.

Figure 7. Step-by-step guide for horizontal bitewings in children. **(a)** Rotate the sensor into position. **(b)** Positioning of the bite tab on to lower teeth. **(c)** Ask the child to bite on it fully. **(d)** Positioning of the rectangular collimator.

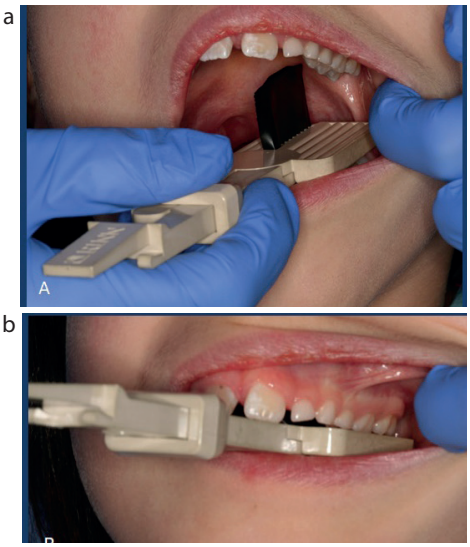


Figure 7. Step-by-step guide for vertical bitewings using a Snap-a-ray. **(a)** Position the bite tab onto the lower teeth first. **(b)** Ask the child to bite on it fully.

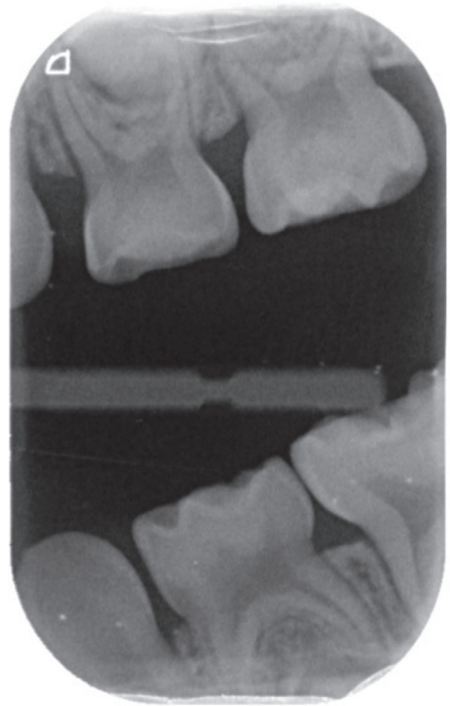


Figure 8. Child did not bite fully onto the tab compromising the bitewing quality.

Troubleshooting

The child is struggling to tolerate the bitewing
It is important to position the bitewing tab over the lower teeth before asking the child to bite fully, because this makes it easier for the child to close in the correct position. If the child is still struggling to close on the bitewing tab (Figure 8), a snap-a-ray should be considered. Snap-a-ray holders are particularly versatile holders that have shown to be frequently chosen in young and less cooperative children.[34] Because it has a thicker bite platform compared to other holders, it allows some separation between the teeth during biting, which may be easier to tolerate. This holder is most useful when used with a size 1 for vertical bitewings in the primary or early mixed dentition.

Overlapping proximal contacts
Horizontal alignment errors may occur when the beam is not aligned perpendicular to the sensor, resulting in overlaps of the proximal surface (Figure 9). The use of a sensor or receptor holder with a beam-aiming device can reduce this occurrence, and ensure a more perpendicular angulation between the beam and the plane of the sensor.

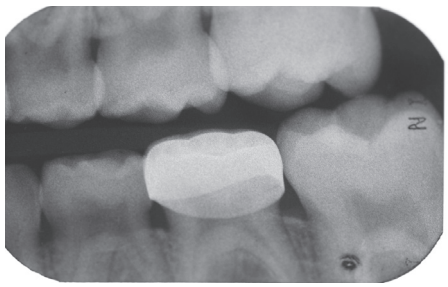
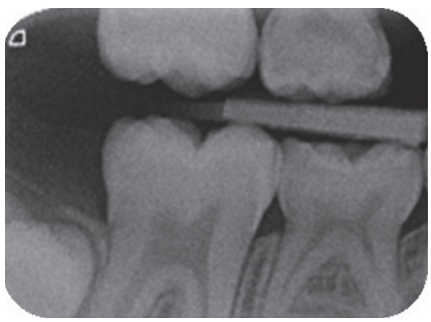


Figure 9. Example of overlapping contact points between the upper second primary molar and first permanent molar.

a



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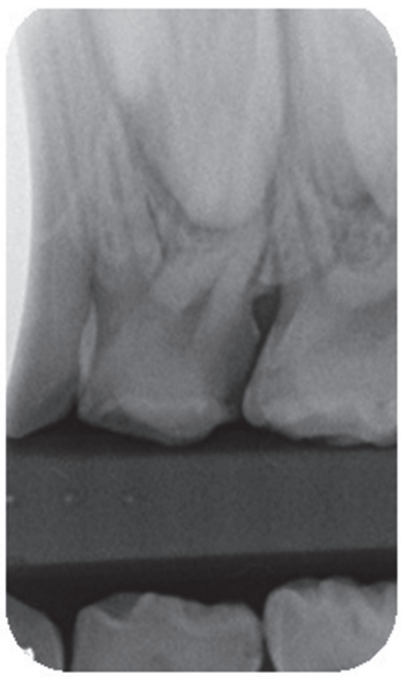

Figure 10. Example of poor sensor positioning. **(a)** Sensor positioned too far posteriorly. **(b)** Unequal distribution between upper and lower teeth.

Errors in sensor positioning

Another common alignment error may occur when the sensor is placed too far anteriorly or posteriorly in relation to the primary molars. This is common when the sensor is not positioned appropriately before the child bites together, or when the sensor moves within the holder (Figure 10).

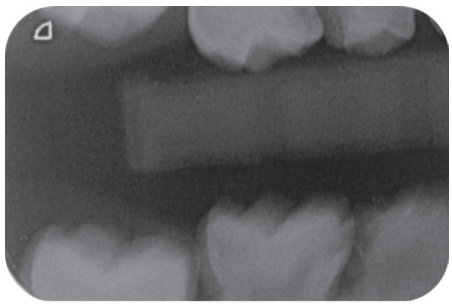

Figure 11. Example of blurry radiographic image owing to child movement during exposure.

Figure 12. Vertical bitewing with a cone cut when using a rectangular collimator without a beam-aiming device.

This occurs more often with the use of adhesive tabs rather than a rigid holder/aiming device. To avoid this, ensure that there is no interference during sensor positioning because this can generate discomfort, and check whether the child is biting fully into the bite block and holds it together until the exposure has ceased. The operator should position the sensor and holder adjacent to the lower teeth first before asking the child to bite on the wing with the upper teeth.

Blurry image

If the child moves during the exposure, a blurry radiographic image will be produced (Figure 11). To avoid this situation, the operator needs to prepare the child with tell-show-do techniques to ensure that movement can be avoided.

First, ensure that the headrest height is appropriately adjusted so the child's head is stabilized. Secondly, clinicians should not underestimate the value of patience and practising the steps of the technique before execution. For younger children, when behaviour is challenging, a willing parent/guardian can be present in the room to provide emotional support. Children should be watched during all steps of the radiographic exposure to ensure that the sensor, the X-ray tube or patient are not moved during exposure. A radiograph should not be taken if the practitioner suspects that movement cannot be avoided.

Cone-cuts

This occurs when the X–ray beam cone is not centred and well aligned to the receptor (sensor) and results in no exposure of the area. Cone-cuts appear as a missing portion of the image on the sensor (Figure 12). This is common owing to rectangular collimation use, and can also occur if radiograph is taken without a beam-aiming device.

Conclusion

Bitewing radiographs provide essential information on caries depth and pulp status, which is fundamental for treatment decision-making. Practitioners should justify each bitewing exposure according to contemporary guidelines and be able to effectively communicate radiation risk to parents. Success is based on the correct selection of techniques and aids from the armamentarium, as well as appropriate management of the child during the exposure. With the use of a systematic approach, patience and practice, it is possible to achieve good quality bitewing radiographs even in young children.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.
Informed Consent: Informed consent was obtained from all individual participants included in the article.

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