

# Comparable Performance Between a Novel Film Holder and the Snap-A-Ray<sup>®</sup> Xtra Film Holder for Child Patients

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## ABSTRACT

**Aims:** This study evaluated the diagnostic quality of bitewing radiographs and children's acceptance between the Snap-A-Ray<sup>®</sup> Xtra film holder and the novel bitewing clear contact (BCC) child film holder.

**Material and methods:** A total of 120 bitewing radiographs were taken on the school-age participants within 6 months. At the initial visit, each participant was randomly assigned to have one side of their mouth imaged using the Snap-A-Ray<sup>®</sup> Xtra device, while the other used the BCC child film holder. After 6 months, the device used for each side was reversed. The diagnostic quality of the radiographs was assessed based on the degree of interproximal overlapping of adjacent teeth. The patients' acceptance scores were recorded using the three schematic faces scale. The diagnostic quality was compared using sensitivity, specificity, and area under the receiver operating characteristic (ROC) curve. The Wilcoxon signed-rank test compared the children's acceptance.

**Results:** Sensitivity and specificity values were 46.2 and 86.7% for the Snap-A-Ray<sup>®</sup> Xtra and 47.05 and 86.27% for BCC child film holders, respectively. The areas under the ROC curve for the Snap-A-Ray<sup>®</sup> Xtra were 0.695 [95% confidence interval (CI), 0.60–0.78] and 0.685 (95% CI, 0.59–0.77) for the BCC child film holder. Moreover, patients' acceptance of the two film holders was similar ( $p = 0.218$ ).

**Conclusion:** There was no significant difference in radiographic diagnostic quality and patient acceptance between the two film holders. Therefore, the BCC child film holder can be used as an alternative bitewing film holder.

**Clinical significance:** The BCC child film holder can be considered a viable alternative to conventional bitewing holders for pediatric dental radiography. Its design characteristics enable the acquisition of accurate radiographic images while potentially minimizing patient discomfort and anxiety during the procedure, which can be particularly beneficial when working with children.

**Keywords:** Bitewing clear contact child film holder, Bitewing radiograph, Film holder, Overlapping, Snap-A-Ray Xtra<sup>®</sup>.

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## INTRODUCTION

Dental caries, the most prevalent chronic ailment in children, affects not only the children's overall development but also their school performance, behavior, and family, and collectively impacts society. In some cases, dental caries become the cause of serious disability and even death in children.<sup>1</sup> The prevalence of dental caries in primary teeth has gained attention due to its potential predictive value for subsequent caries development. Data has shown that despite proximal carious lesions accounting for almost half of the overall carious lesions, there was a significantly greater number of untreated proximal caries than occlusal caries.<sup>2</sup> Of the diverse caries types in children, proximal caries assume significance owing to its rapid progression tendencies and the challenge posed in discerning the presence or absence of lesions.<sup>3</sup>

Early detection of a carious lesion in children is essential for implementing early preventive strategies and noninvasive intervention. Traditionally, visual examinations aided by dental radiographs are the primary diagnostic tools that enable dentists to manage the appropriate caries. Bitewing radiographs are the most efficient, accurate, and standard tool for diagnosing proximal caries in children.<sup>4</sup> Achieving the optimum diagnostic quality of bitewing radiographs and lessening the chance of errors to reduce unnecessary radiation exposure to child patients is crucial. Technical errors were frequently found in bitewing radiographs, for example, incorrect film, the cone of the radiograph machine placement, and inadequate film development.<sup>5</sup> A common technical error in

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bitewing radiographs is overlapping proximal surfaces of adjacent teeth.<sup>6</sup> A film holder facilitates obtaining appropriate radiographic images by minimizing improper film positioning or bending and maintaining the film's relationship to the evaluated structures.<sup>7</sup> However, these outcomes may be more challenging for children. Their mouths are smaller, making it difficult for the film to be positioned, and occasionally, there is less tolerance, more significant anxiety, and less understanding of what is required.<sup>8</sup>

Taking successful bitewing radiographs in young children requires behavior management techniques and adequate equipment.<sup>9</sup> Dixon and Hildebolt concluded that although currently



was reversed. The same experienced pediatric dentist took all the radiographs. The children wore a lead apron and thyroid collar for radiation protection (Fig. 2). The digital bitewing radiographs were taken with a PSIPX phosphor-plate standard imaging plate size 0 (SOPRO, La Ciotat, France), using an X-ray machine (Gendex Expert DC, Chicago, Illinois, United States of America) at 65 kVp, 7 mA, and 0.16 seconds scan time. The exposed image plates were scanned using a PSPIX2 SOPRO imaging plate scanner (SOPRO, La Ciotat, France).

### Radiographic Diagnostic Quality Evaluation

The diagnostic quality of the radiographs was evaluated based on the number of overlapping proximal sites. Six proximal contact sites on each bitewing radiograph were examined—between the primary maxillary canine and primary maxillary first molar, the primary maxillary first molar and primary maxillary second molar, and between the primary maxillary second molar and permanent maxillary first molar. The same sites were examined for the mandibular teeth. An overlapping score was determined at each location.

If a tooth was restored or was missing at the second visit, that site was excluded. Only the paired radiographs with different film holders with the same tooth proximal contact were evaluated at the first and second visits. The reliability of the diagnostic quality assessment was tested by randomly selecting 25 pairs of radiographs for double readings, 1 week apart, by two examiners. Image interpretation was performed using PowerPoint, projected on a Sharp Aquos LED black light 60-inch television, and read by one experienced pediatric dentist with good/excellent inter- and intraexaminer reliability levels. The film holder on the evaluated radiograph was blacked out; thus, the examiner was blinded to which film holder type was used. A proximal overlapping score of 1 (no overlapping) or 2 (overlapping less than half the enamel) was categorized into the good quality group. Score 3 (overlapping more than half the enamel depth) or 4 (overlapping to the dentin-enamel junction) comprised the moderate-to-low quality grade group.

### Patient's Acceptance Evaluation

The patient's acceptance of the different film holders was assessed using a face scale modified from Maunuksela et al.,<sup>13</sup> representing satisfaction = 1, indifference = 0, and dissatisfaction = -1 (Fig. 3). However, before taking the radiographs, the researcher spent a few

minutes establishing rapport with the child to determine if the child understood the meaning of the schematics' facial expressions. This assessment was done immediately after taking the radiographs on both visits.

### Behavioral Rating

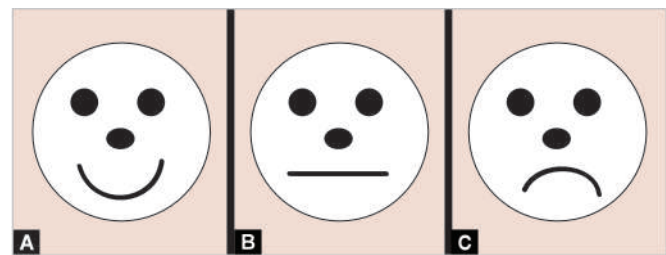
The researcher assessed the child patient's behavior during the radiographic examination by using the Frankl behavioral rating scale. This scale separated observation behaviors into four categories—definitely negative, negative, positive, and definitely positive.

### Statistical Analysis

Cohen's  $\kappa$  test was used to determine the inter- and intraexaminer reliability. The two film holders' overlapping scores were compared using sensitivity, specificity, and the area under the receiver operating characteristic (ROC) curve. The Wilcoxon signed-rank test compared the acceptance scores of both film holders. The significance level was set at  $p < 0.05$ . All analyzes were performed using the Statistical Package for the Social Sciences (SPSS) program, version 24 (SPSS Inc., Chicago, Illinois, United States of America).

### RESULTS

The children in this study ranged from 6 to 9 years old (mean age 8.2 years). At baseline, 35 children (11 males, 24 females) had bitewing radiographs taken at the first visit; however, only 30 children (nine males, 21 females) attended the second recall visit. Therefore, there was a total of 120 bitewing radiographs (60 bitewing radiographs



**Figs 3A to C:** Faces scale modified from Maunuksela et al. scale showing the three schematic faces representing: (A) satisfaction; (B) indifference; and (C) dissatisfaction, respectively



**Fig. 2:** The patient using the BCC child film holder

for each film holder) to evaluate after the second recall visit. Each bitewing radiograph had six contact sites for the overlapping evaluation. Of the 360 contact sites at baseline for all patients, only 304 sites were evaluated for the overlapped diagnostic quality after 6 months due to 56 contact sites being excluded. The excluded contact sites were due to restoration replacement, extraction, physiological exfoliation, and lost contact with the patient. Among the 304 sites, 283 sites had radiographs taken using the Snap-A-Ray® Xtra, 276 sites using the BCC child film holder, and 255 sites were taken by both film holders.

The  $\kappa$  statistic used to assess interexaminer reliability indicated the reliability of 0.843 and 0.9, which were good and excellent, respectively.<sup>14</sup> The intraexaminer reliability was 0.737 and 0.813, moderate and good, respectively. The examiner, with excellent and good inter- and intrareliability, assessed all the radiographs.

The number of contact sites using the Snap-A-Ray® Xtra for the film holder was 283 sites, and 276 sites for the BCC child film holder. All proximal contact surfaces were examined and scored, categorized into two quality grades—good quality or moderate-to-low quality (Table 1). The percentage of good quality scores for the Snap-A-Ray® Xtra was 79.86 and 80.43% for the BCC child film holder. The percentage of moderate-to-low quality scores for the Snap-A-Ray® Xtra and BCC child film holder was 20.14 and 19.57%, respectively. We compared the outcomes of overlapping grades at the same contact point evaluated between the Snap-A-Ray® Xtra and BCC child film holders. The results indicated that among the 255 sites examined, 24 were graded as moderate-to-low quality and 176 as good quality by both film holders. Furthermore, the sensitivity and specificity values were 46.2 and 86.7% for the Snap-A-Ray® Xtra and 47.05 and 86.27% for BCC child film holders, respectively.

We determined the diagnostic quality of the proximal overlapping based on the sensitivity and specificity of the two film holders. After plotting the sensitivity and specificity values for the two film holders using a ROC curve, the area under the curve (AUC) of the Snap-A-Ray® Xtra was 0.695 [95% confidence interval (CI), 0.60–0.78], and the AUC of the BCC child film holder was 0.685 (95% CI, 0.59–0.77) (Fig. 4).

When asked about their satisfaction with the Snap-A-Ray® Xtra ( $N = 30$ ), 58.33% indicated satisfaction, 38.33% stated indifference, and 3.33% indicated dissatisfaction. The patient's satisfaction with the BCC child film holder ( $N = 30$ ) was 51.67%, indicating satisfaction, 38.33% stated indifference, and 10% indicated dissatisfaction. There was no significant difference in the patient's acceptance between the two film holders ( $p = 0.218$ , Table 2).

The Frankl behavior rating scale was used to classify the children's behavior while taking the radiographs, and all were definitely positive, except for one patient, who was classified as positive.

The result of the diagnostic quality and the acceptance of the BCC child film holder showed no better performance than the Snap-A-Ray® Xtra.

## DISCUSSION

The Rinn instruments (Snap-A-Ray®) have been popular in private practices and dental school clinics for over 50 years. However, designing a new child film holder for pediatric dentistry posed a challenge. To address this, the College of Dental Medicine at Rangsit University, Pathum Thani, Thailand, invented a new bitewing film holder called the BCC child film holder. This study assessed the diagnostic quality of bitewing radiographs and children's acceptance when using these two film holders. The results demonstrate that the BCC child film holder gave similar diagnostic quality and had no significant difference in acceptance compared to the widely used Snap-A-Ray® Xtra film holder. Thus, the newly innovated BCC child film holder can be an alternative to conventional bitewing film holders for taking bitewing radiographs, particularly in pediatric dentistry settings.

This holder is made from clear acrylic as a U-shape of intraoral and extraoral parts. It is made from clear acrylic, giving a clear vision of the posterior teeth. One of the most common negative consequences of technical errors in bitewing radiographs is overlapping proximal surfaces.<sup>6</sup> The intraoral part has lines that indicate the position of the distal surface of the primary canine, the proximal position between the first and second primary molars, and the permanent first molar. There is a slot to place PSP plate size 0 without any grip or pressure on the plate. The extraoral part has two slots to insert the Styrofoam cartoon

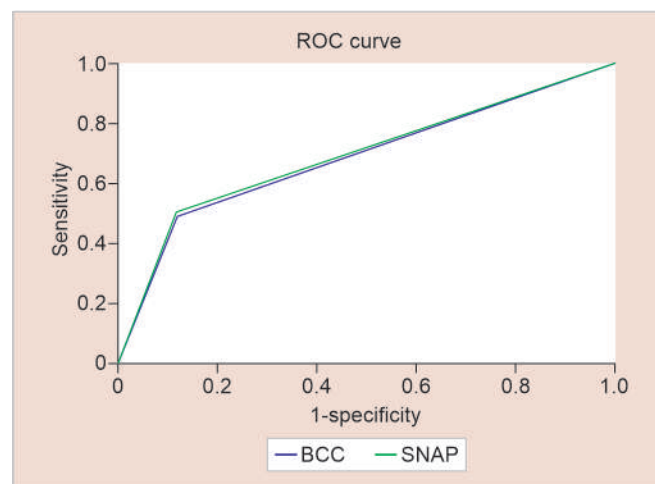


Fig. 4: Receiver operating characteristic (ROC) curve of the Snap-A-Ray Xtra® and BCC child film holders

Table 1: Percentage of proximal contact sites based on diagnostic quality grade

Film holder	Number of contact sites	Quality grade			
		Good		Moderate-to-low	
		N	%	N	%
Snap-A-Ray® Xtra	283	226	79.86%	57	20.14%
BCC child	276	222	80.43%	54	19.57%

**Table 2:** Patient's acceptance of the Snap-A-Ray® Xtra and BCC child film holders (Wilcoxon signed-rank test;  $p < 0.05$ )

Film holder	Number of children	Mean	SD	p-value
Acceptance Snap-A-Ray® Xtra	30	0.55	0.57	0.218
Acceptance BCC child	30	0.42	0.67	

ring to guide the X-ray central beam. This Styrofoam ring can be attached with a colored cartoon character sticker. The child can choose these varieties of stickers and can also bring them home as a token. These rings and colored stickers might play a part in alleviating the child's fear while taking the radiographs. This new film holder is applicable for both primary dentition and mixed dentition.

With the current concept of contemporary caries management, the quality of radiographic caries diagnoses is essential to deciding whether to perform a specific treatment. For an initial carious lesion on the outer half of the enamel, the most likely therapy is noninvasive, which includes fluoride application, oral hygiene instruction, and active surveillance.<sup>15</sup> Therefore, in our study, the final result of the diagnostic quality of the proximal overlapping assessment to the film holder used was categorized into two quality grades—good quality (no overlapping and overlapping less than half the enamel depth) and moderate-to-low quality (overlapping more than half the enamel depth and overlapping at the dentinoenamel junction).

Our study compared the Snap-A-Ray® Xtra and BCC child film holders' diagnostic quality using the percentage of sensitivity, specificity, and area under the ROC curve. Sensitivity and specificity have been used in several studies to evaluate a given diagnostic procedure's operating characteristics.<sup>16,17</sup> Sensitivity is the ability of a diagnostic test to accurately identify patients who truly have a disease, which in our study was defined as the ability to identify the contact sites that overlapped. Specificity is the ability to accurately identify patients who do not have the disease, which in this study was defined as identifying a contact site that is not overlapped.

Our results demonstrated that the Snap-A-Ray® Xtra diagnostic quality had a sensitivity value of 46.2%, which indicates that 46.2% showed a moderate-to-low quality score when using this film holder. Moreover, the specificity was 86.7%, meaning that the Snap-A-Ray® Xtra has a reasonable ability to correctly identify a contact site that is not overlapped and receives a good quality grade. The sensitivity of the BCC child film holder was 47.05%, and the specificity was 86.27%. Both film holders had a higher specificity compared with their sensitivity. A suitable film holder should have a high specificity percentage, representing that when the teeth are not crowded with normal contacts, the radiograph should not overlap. The rate of both film holders' sensitivity and specificity results indicated a remarkably similar performance in sensitivity and specificity.

The ROC curve of the Snap-A-Ray® Xtra and the BCC child film holders were similar and almost overlapped, and the AUC was 0.695 (95% CI, 0.60–0.78) and 0.685 (95% CI, 0.59–0.77), respectively. AUC is a measure of a diagnostic test,<sup>18</sup> and the AUCs were in the almost acceptable range, indicating that both film holders performed comparably. These findings suggest that each film holder's performance yielded similar good quality and moderate-to-low quality bitewing radiographs. Herman and Ashkenazi's study found that the Kwik-Bite film holders had the highest quality scores compared to Snap-A-Ray® and sticky tape.<sup>6</sup>

Although the BCC child film holder's performance was not superior to the Snap-A-Ray® Xtra film holder in our study, this novel film holder has an extraoral part with two small slots to insert the Styrofoam cartoon ring and acts as an extraoral guide for the X-ray central beam. The intraoral part has lines that mark the position of the distal surface of the primary canine, as well as the interproximal position between the primary first and second molars and the permanent first molar. The advantage of being designed to automatically align the central ray perpendicular to the film and the molars' interproximal position is that it is easier to place, simple, eliminates speculation, and requires less time for the operator to take the radiograph.

In contrast, the conventional Snap-A-Ray® Xtra film holder does not have an extraoral positioning device; therefore, the operator requires good judgment, effort, and experience to obtain a good quality bitewing radiograph. Harrison and Richardson compared the frequency of overlap on bitewing radiographs obtained using cardboard bitewing tabs and the Rinn Bitewing Kit taken by dental students and found no significant improvement when using a film-holding device.<sup>19</sup> In the present study, the experienced examiner used both film holders; however, there was no significant difference in the grading of overlapping on bitewing radiographs between the film holders. To validate the BCC film holder's performance, additional studies should be performed to obtain the results from inexperienced dental students or auxiliary dental personnel and compare the diagnostic quality with other extraoral positioning film holders.

We determined the patient's acceptance using the three schematic faces scale modified from Maunukela et al., which is considered the most straightforward tool to measure the degree of pain or discomfort in young children because they require little abstract thinking ability, and they have a range of expressions from smiling to crying.<sup>7</sup>

In our study, the BCC child film holder was designed using colorful Styrofoam and a cartoon sticker to act as a nonsocial reinforcer to enhance the child's cooperation and serve as an extraoral positioning device. However, the patient's acceptance was not significantly different from that of the Snap-A-Ray® Xtra film holder. All the children, except one, behaved definitely positively according to the Frankl behavior rating scale during the radiographic procedure. This might be because the BCC child film holder's design is somewhat toy-like, slim, and easy to place in the child's mouth, similar to the Snap-A-Ray® Xtra film holder.

Although the percentage of dissatisfaction with the BCC child film holder (10%) is higher compared with the Snap-A-Ray® Xtra (3.33%), this is likely due to its thinner bite plane (2.6 mm). When the patient bites down, the film may press on the floor of the mouth and cause discomfort. However, the thick bite plane (4.5 mm) of the Snap-A-Ray® Xtra may decrease the pressure exerted by the film. In contrast, the thinner BCC child film holder bite plane produced a radiograph that covers more of the furcation area of the maxillary and mandible teeth, which is beneficial for the pulpal diagnosis of primary teeth.

Pitts et al. compared children's acceptability to the bitewing procedures using the freehand technique, a Rinn positioner, and an HPL device.<sup>8</sup> The children's acceptance of all three techniques was high (89–97%), and there was no significant difference between the acceptability of the freehand method and those with film positioning devices. Pierro et al. modified the Kwik-Bite film holder to fit the child's mouth, finding that 74% of children aged 4 and 5 indicated satisfaction.<sup>7</sup> Their modification was done to generate adequate radiographs and provide a pleasant experience for the patient. Pediatric patients' acceptance of a dental procedure depends on several factors, such as their temperament, past pain experience, and dental anxiety.<sup>20</sup> The best acceptability response of the child patients may depend on the outward appearance of the equipment, variation in the child's dental arch and anatomy,<sup>19</sup> the perception of comfort, or the appropriate approach for behavior guidance. These aspects require further investigation. Moreover, the acceptability from the examiner's perspective is also worth evaluating. Future studies with larger sample sizes are needed; the BCC child film holder might be a potential alternative film holder for pediatric dentistry.

Within this study's limitations, the BCC child film holder, which has an inexpensive cost, slim design with an extraoral aiming device, and a toy-like appearance, was not significantly different in overlapping and the children's acceptance compared with the conventional Snap-A-Ray® Xtra film holder. Additional investigations, as aforementioned, should be performed to confirm its clinical advantages and academic and commercial benefits in pediatric dentistry.

## CONCLUSION

This study evaluated the diagnostic quality of the bitewing radiographs and the children's acceptance between the Snap-A-Ray® Xtra and the BCC child film holder. The diagnostic quality demonstrated remarkably similar sensitivity and specificity performance. There was no significant difference in patient acceptance between the two film holders. Therefore, the BCC child film holder can be used as an alternative bitewing film holder for school-age pediatric patients.

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