

Original article

Silicone loop alternative for posterior bitewing radiography

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ABSTRACT

Background: Bitewing radiography is a technique that depicts the crown of the maxillary and mandibular teeth and the crest of the alveolar bone in the same receptor. The use of film holders and paper loops in bitewing techniques is very helpful in standardising radiographs, but it has some disadvantages, including the lack of efficiency and discomfort. Therefore, silicone has been widely used in the medical field as a replacement for paper loops. **Purpose:** This study was conducted to describe the compatibility of the silicone material as an alternative for bitewing radiography. **Methods:** This research is experimental and a one-shot case study. It used the Mann–Whitney ($P < 0.05$) test for statistical analysis to compare the results of the radiographs using silicone loops and paper loops and to analyse the quality of each radiograph: object coverage, density, contrast, sharpness, geometry, and overlapping. **Results:** The images where silicone loops were used show adequate results in six radiograph quality assessments. There was no significant difference between the radiographs that were obtained using the silicon loop and the paper loop ($p > 0.05$). **Conclusion:** Silicone loops can be an alternative tool for bitewing radiography because they result in optimal image quality.

Keywords: bitewing radiographs; quality images; silicone

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INTRODUCTION

Bitewing radiography depicts the crowns of the maxillary and mandibular teeth and the crest of the alveolar bone in the same receptor.¹ This technique is particularly used to detect interproximal caries in their early stages of development before they become clinically visible, sees secondary caries under restoration, assesses this restoration, evaluates periodontal conditions and detects the calculus in the interproximal area.^{1–4}

The procedure for taking bitewing radiographs requires the patient to bite a small wing that is placed on an intraoral film, film holder, wing tab or paper loop.^{1,5} However, the use of film holders has disadvantages: it is expensive and less convenient than film holder.^{1,2} The use of paper loops has several disadvantages too, as the movement of the tongue can cause the film to move, which negatively affects the quality of the obtained images. This results in repeated radiographs, which are very detrimental to the patient. In addition, using the paper loop only once makes it

inefficient.^{2,3,6,7} Based on Kositbowornchai et al.'s research, the loop technique was 1.11 times more likely to cause overlapping than the holder technique.⁸

The use of silicone is common in the medical field. Silicone is biocompatible, durable and hydrophobic, it has low surface pressure and toxicity, as well as good chemical and thermal stabilities. Silicone can be used at high temperatures, so it can be sterilised using repeated autoclaves without any changes.⁹ The purpose of this study is to provide an alternative tool, especially to bitewing radiography, that can be used in the field of dental radiology and that can produce optimal radiographic images.

MATERIALS AND METHODS

This research is experimental and a one-shot case study. The research design consisted of a group of people who were given a treatment; the results were then observed. The first procedure included making the loop using wax

and the mould using a dental stone. Once the mould was ready, and after boiling off the wax, a silicone loop was made by mixing the silicone and the catalyst, then putting the mix in the mould and letting it stand until the silicone had set (Figure 1).¹⁰

The next step was to do the bitewing radiography using silicone and paper loops. Based on the results of the sample size calculation using the Federer sample calculation, the researcher used six samples of each bitewing radiographs using a silicone loop and a paper loop.¹¹

The film in a silicone or paper loop was placed on the lingual side of the phantom that was implanted with ten

natural teeth, and the anterior edge of the film was distal to the mandibular canine. The bite portion of the loop was in the interocclusal space where the phantoms were occluded. The X-ray tube positioned towards the film passed through the interproximal space of the premolar and molars (Figure 2).^{1–3} The researchers used aprons, and the X-rays were exposed using the Phot X II 303-H (Belmont, USA) X-ray machine with 70 kVp and 7 mA and a time of 0.35 second. After being exposed, the film was processed.

If the assessment of the bitewing radiograph quality with the silicone loop is said to be good, the next step will

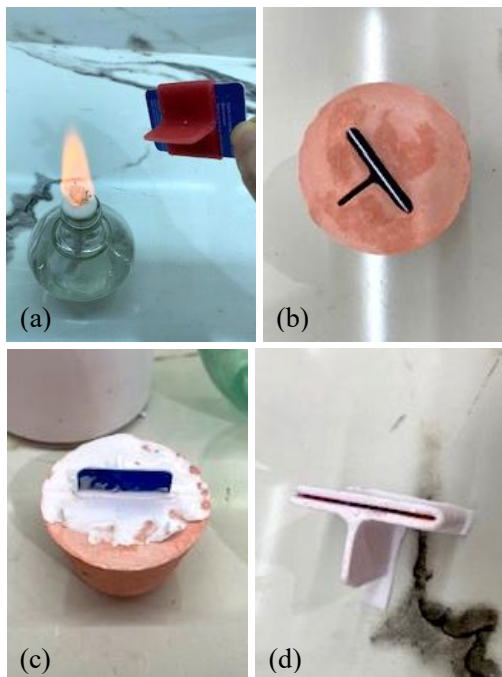


Figure 1. The process of making silicone loops: (a) making a loop wax; (b) the mould stone after boiling out the wax; (c) the silicone paste injected into the mould; (d) the silicone loop.



Figure 2. The process of making bitewing radiography with the silicone loop.

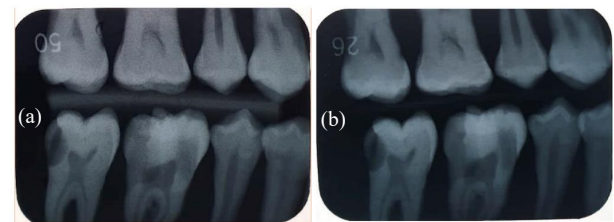


Figure 3. The resulting bitewing radiographs with the silicone loop (a) and paper loop (b).

Table 1. The Mann–Whitney test results.

Parameter	Silicone Loop	Paper Loop	Total	p-value
Coverage Object				
No	1 (100.0%)	0 (0.0%)	1 (100.0%)	0.317
Good	5 (45.5%)	6 (54.5%)	11 (100.0%)	
Density				
No	1 (2.0%)	4 (80.0%)	5 (100.0%)	0.093
Good	5 (71.4%)	2 (28.6%)	7 (100.0%)	
Contrast				
Good	6 (50.0%)	6 (50.0%)	12 (100.0%)	1.000
No	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Sharpness				
Good	4 (40.0%)	6 (60.0%)	10 (100.0%)	0.138
No	2 (100.0%)	0 (0.0%)	0 (0.0%)	
Geometry				
Good	6 (50.0%)	6 (50.0%)	12 (100.0%)	1.000
No	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Overlapping				
Yes	0 (0.0%)	2 (100.0%)	2 (100.0%)	0.138
No	6 (60.0%)	4 (40.0%)	10 (100.0%)	

be to compare the quality of the radiograph using a paper loop. The resulting bitewing radiographs were analysed for quality: object coverage, density, contrast, sharpness, geometry and overlapping.¹⁻³ In this study, a comparative test analysis was used to calculate whether there were significant differences in the results obtained by using these different tools. The Mann–Whitney test ($P < 0.05$) was used because the data was not normally distributed.¹²

RESULTS

The test was carried out to determine whether the tool that has been made is appropriate to be used as an aid in taking bitewing radiographs, which were reviewed based on the resulting images (Figure 3). The parameters to be tested included object coverage, density, contrast, sharpness, geometry and overlapping. The following are the calculation results of the Mann–Whitney test for the six tested parameters.

Based on the comparison test recapitulation in Table 1, it can be seen that all the parameters show no significant differences between the radiographs that were obtained using the silicon loop and the paper loop. This can be seen from the p-values of all the parameters, which are greater than 0.05. This means that these two tools have almost the same capacity in taking bitewing radiographs, which were reviewed based on the resulting images.

DISCUSSION

The silicone material can be used as an alternative for making bitewing loops to solve the shortage of paper loops. It is a supported silicone material that has been used in medical practices for over 60 years. Silicone elastomer bases can meet the food-grade standards. They constitute soft and durable material for medical devices, medical adhesives (sealants), mould making and prototyping and on-site healing gaskets.^{13,14} In addition to the tested silicone material, the results of the images from using this silicone loop can be considered positive based on the six assessments that have been made.

The radiograph quality assessments show that the resulting image when using a silicone loop based on the first assessment has a poor coverage object. The image should include the crown of canines, premolars, both maxillary and mandible molars and no cone cutting. However, the results show that the canine teeth are not in the image; this is because the canines are located in the arch, which makes it difficult to place the film. This is supported by Emanuel's research, which stated that 71% of the errors in bitewing radiographs were related to film placement.¹⁵

Table 1 shows that the resulting image when using a silicone loop produces a brighter density than the paper loop. The density of a radiograph is influenced by the exposure, thickness and density of the object. The presence

of a silicone loop will cause the X-rays to be slightly absorbed by the silicone and the object, resulting in a change in the density of the image.¹⁶

Both images provide equal contrast and geometry qualities. Kositbowornchai et al.'s research compared the in vivo bitewing film quality using the holder versus the paper loop techniques.⁸ The results showed that the qualities of the bitewing films taken by the loop and holder techniques were not significantly different.⁸ The contrast quality is influenced by the contrast of the object and film, X-rays and scattered radiation. This can be controlled by using the same object and film and setting the same kVp, mA and time.¹⁵ The distance of the X-rays from the objects and films when taking radiographs and the vertical and horizontal angulations were carried out correctly.² The use of silicone loop tools did not affect the radiograph's geometric accuracy, which is one of the most important assessments of the quality of a radiograph. The size of the natural teeth is the same as the teeth in the radiograph.^{1,2,16} Sinpitaksakui et al. compared the quality of bitewing radiographs using paper wings and loops and the XCP instrument (Rinn).¹⁷ The results showed that there were no differences in the distortion and blurred images between the two techniques.¹⁷

Apart from the results of the adequate radiograph quality, the design of the silicone loop has other advantages: the silicone material is elastic and soft, and silicone is environmentally friendly. This study has two limitations: the experiment was not performed in an actual oral cavity and the assessment of the radiograph quality was visual. Further research is needed in order to test silicone loops on humans to prove that silicone loops are comfortable and easily placed in the oral cavity. In conclusion, based on the radiograph quality analysis (object coverage, density, contrast, sharpness, geometry and overlapping), silicone loops can be used as an alternative tool for taking bitewing radiographs because they result in optimal image quality.

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