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Research Report

Utilizing a film holder to enhance radiographic imaging in maxillary molar trifurcation

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ABSTRACT

Background: The parallel technique stands as a prominent method for radiographic examinations aiming to identify furcation involvement. Nevertheless, an inherent limitation lies in the frequent superimposition of the trifurcation region with tooth roots, potentially leading to inaccurate diagnoses. The Same Lingual Opposite Buccal (SLOB) technique was devised to yield radiographic images that alleviate superimposition at the trifurcation of the maxillary first molar. **Purpose:** To observe and compare the radiographic images of the trifurcation region of the maxillary first molar generated through the SLOB technique with the film holder modification set at a mesial and distal angulation of 20° with the parallel technique. **Methods:** This observational analytic research encompassed a sample size of 24 instances. Each individual sample underwent three separate exposures: the SLOB technique with a horizontal angulation of 20° towards both mesial and distal directions, and the parallel technique (serving as the control). **Results:** a significant difference in radiographic images of the trifurcation region of the maxillary first molar obtained through the SLOB technique, employing the film holder modification with a mesial angulation of 20° and a distal angulation of 20°, as opposed to the parallel technique (control). **Conclusion:** A radiographic image capturing the trifurcation of the maxillary first molar, devoid of superimposition, was successfully generated through the SLOB technique incorporating a horizontal angulation of 20° towards the distal direction.

Keywords: SLOB technique; trifurcation; film holder modification; dentistry; medicine

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INTRODUCTION

Radiographic examination plays an important role in aiding the diagnosis of dental and oral diseases and determining the treatment plans to be undertaken. Dental radiographs provide insights into tooth structures, hard tissues, and supporting soft tissues. Dental radiography is essential to identifying changes in teeth and anomalies occurring in hard and soft tissue structures that cannot be detected through clinical examination alone.[1–3] Radiographic images should depict dental anatomy and the anatomical relationships with the surrounding tissues. Poor radiographic quality may lead to inaccurate interpretations, resulting in effective diagnoses and treatment plans. Therefore, radiographs must be taken using accurate techniques.[4–6]

In the field of periodontics, radiographic imaging is needed to confirm disease diagnoses, illustrate changes occurring in periodontal diseases, determine the prognosis of periodontal diseases, and evaluate the results of treatments.[7] Radiographic images in periodontics are useful to assess bone conditions, both alveolar bone and bone in the furcation area, root structure, calculus, caries, periapical lesions, impacted teeth, maxillary sinus positions, and the condition of dental restorations.[8] Furcation involvement refers to bone damage in the furcation area caused by periodontal diseases. Furcation involvement incidences are reported to be 50% in the first maxillary molars.[9] Pathological conditions in the furcation area can be diagnosed using a periodontal probe and radiographic images. Radiographic findings must be related to clinical examinations. For example, radiographs may show furcation involvement, while probing may show that the attachment of soft tissue is intact without any access to the furcation area.[10]

The radiographic examination for furcation involvement that is most feasible uses the parallel technique as it provides detailed images. However, the parallel technique

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has limitations, such as the bifurcation of premolar teeth or trifurcation of upper molar teeth that often overlap with the corresponding roots, potentially leading to misdiagnosis of furcation involvement.[11] This issue needs to be addressed by taking radiographs from different angles. To date, commonly used radiographic techniques include periapical radiography with the bisecting-angle technique and the parallel technique. The same practices are followed at the Dental Radiology Unit of the Dental and Oral Hospital, Faculty of Dentistry, Universitas Airlangga, Surabaya. In the bisecting-angle technique, the film is placed as close as possible to the teeth, but the film is not parallel to the long axis of the film plane. On the other hand, the principle of the parallel technique is to place the film parallel to the long axis of the tooth, with the X-ray beam perpendicular to the tooth and the film. Standard periapical radiographs can only determine objects in two dimensions: anterior-posterior and superior-inferior relationships. The medio-lateral relationship cannot be determined. This relationship can be determined using the Same Lingual Opposite Buccal (SLOB) technique.[12]

The SLOB technique is a modification of the parallel technique that has been developed over time. The SLOB technique is effectively used for premolar and first maxillary molar teeth, as well as the first mandibular molar teeth. Radiographic imaging for the SLOB technique is performed by directing the cone for standard periapical projection and then shifting the X-ray beam by 20 degrees mesially or distally. This technique offers the advantage of identifying and separating overlapping structures. This is particularly important for teeth with more than two root canals located in the faciolingual plane.[13]

Based on the above description, the author aims to create a modified tool from the standard film holder that can be used to facilitate radiographic imaging in support of the SLOB technique for detecting the trifurcation area. This tool is expected to aid in accurately diagnosing furcation involvement in the first maxillary molar teeth. This tool is also expected to prevent or reduce failures in radiographic imaging, thus avoiding excessive X-ray exposure for patients and enhancing work efficiency while conserving dental film usage. Although the Dental Radiology Unit of the Dental and Oral Hospital, Faculty of Dentistry, Universitas Airlangga, Surabaya, already uses the SLOB technique to obtain radiographic images without overlap, the execution does not involve a tool to ensure the accuracy of angular adjustments by 20 degrees mesially or distally. This tool is intended to serve as a guide for precise angular adjustments for the SLOB technique.

MATERIALS AND METHODS

This study is an analytical observational research conducted at the Dental Radiology Unit of the Dental and Oral Hospital, Faculty of Dentistry, Universitas Airlangga, Surabaya. The research was carried out from February to May, and the sample criteria included both males and females (except for pregnant women) aged above 20 years, possessing healthy or diagnosed furcation involvement in the first upper molar teeth. The total research sample comprised 24 randomly selected individuals. To support this study, the author developed a modified tool from the standard film holder, aimed at facilitating radiographic imaging to support the SLOB technique in detecting the trifurcation area, thereby assisting in accurately diagnosing furcation involvement in the first upper molar teeth. Selected samples were provided with oral and written explanations, followed by obtaining informed consent. The radiographic images were observed by three observers.

The research findings were analyzed descriptively based on mean size, standard deviation, frequency, and percentage. Subsequently, inferential analysis was conducted to test the research hypotheses, aiming to ascertain differences. In cases where data did not exhibit a normal distribution, non-parametric statistics were employed, equivalent to parametric statistics, which included the Kolmogorov-Smirnov test, Friedman test, and Wilcoxon test. These three tests were used due to the observation of three groups, namely the SLOB technique with horizontal mesial 20° angulation, horizontal distal 20° angulation, and parallel technique (control), all within the same sample group.

RESULTS

The research results were visually observed, rendering the data qualitative in nature. The generated data was on an ordinal measurement scale, using a total of 24 research samples, comprising 11 females and 13 males. The author conducted three exposures on each sample using the SLOB technique, wherein the SLOB technique altered the horizontal angulation by 20 degrees mesially and distally, and the parallel technique (control). Subsequently, the radiographic images, i.e., the radiographic representations, were observed by three observers: the primary supervising lecturer, the secondary supervising lecturer, and the author. A value of 0 was assigned to the trifurcation area that exhibited overlap, while a value of 1 was assigned to the trifurcation area that did not exhibit overlap.

Table 1. Number and percentage of scores for 20° mesial angulation, 20° distal angulation, and parallel technique

Observer	SLOB Technique				Parallel Technique (Control)	
	Mesial Angulation 20°		Distal Angulation 20°			
	Score 0 (%)	Score1 (%)	Score 0 (%)	Score 1 (%)	Score 0 (%)	Score 1 (%)
Observer 1	24 (100%)	0 (0%)	11 (45.8%)	13 (54.2%)	21 (87.5%)	3 (12.5%)
Observer 2	24 (100%)	0 (0%)	11 (45.8%)	13 (54.2%)	16 (16.7%)	8 (33.3%)
Observer 3	24 (100%)	0 (0%)	3 (12.5%)	21 (87.5%)	20 (83.3%)	4 (16.7%)

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Table 1 presents the observation data results from three observers on radiographic outcomes using the SLOB technique with a 20° mesial angulation, a 20° distal angulation, and the parallel technique (control). In the first set of data, regarding the 20° mesial angulations, all three observers agreed to assign a value of 0 to all radiographic outcomes, encompassing 24 radiographs (100%). This indicates that all radiographic images using the SLOB technique with a 20° mesial angulation exhibited overlap in the trifurcation area of the first upper molar teeth. The subsequent data set involves the SLOB technique with a 20° distal angulation. Observer 1 and Observer 2 assigned a value of 0 to 11 radiographs (45.83%) and a value of 1 to 13 radiographs (54.17%). Observer 3, on the other hand, assigned a value of 0 to 3 radiographs (12.5%) and a value of 1 to 21 radiographs (87.5%).

The last set of observation data pertains to the parallel technique used as a control. Observer 1 assigned a value of 0 to 21 radiographs (87.5%) and a value of 1 to 3 radiographs (12.5%). Observer 2 assigned a value of 0 to 16 radiographs (66.67%) and a value of 1 to 8 radiographs (33.33%). The author's observations were not significantly different from those of Observer 1 and Observer 2, with more assignments of value 0, specifically to 20 radiographs (83.33%), and a value of 1 to 4 radiographs (16.67%). The subsequent observation data results will be further analyzed. To determine whether to use parametric or non-parametric statistical tests, a normality test of the data was conducted using the Kolmogorov sample. The normality test is considered normal if the significance value is greater than 0.05.

Table 2 shows the results of the normality test using the Kolmogorov-Smirnov test. For the parallel technique (control), the significance value is 0.001. For the 20° mesial angulation, the calculation couldn't be performed because all three observers assigned a value of 0. On the other hand, the 20° distal angulation has a significance value of 0.103. The prerequisite for using parametric statistical tests is that all three values have a significance greater than 0.05. Since only the 20° distal angulations are normal, a non-parametric statistical test, the Friedman test, is used. Table 3 illustrates the Friedman test results. For the parallel technique (control), the mean is 1.9. The 20° mesial angulation has a mean of 1.38, while the 20° distal angulation has a mean of 2.73. This depicts that the radiographic images with the most visibility or the best quality are achieved with the SLOB technique using a 20° distal angulation adjustment. To assess the significant differences among each pair of the three groups, the Wilcoxon test was conducted. A difference is considered significant if the significance value is less than 0.05 and it is proven that differences exist among the three groups.

Table 4 indicates the relationship between the parallel technique (control) group and the group with a 20° mesial angulation adjustment, which has a significance value of 0.006, less than 0.05. This finding demonstrates that there is a significant difference between the groups. Table 5 reveals the relationship between the parallel technique (control) group and the group with a 20° distal angulation adjustment, which has a significance value of 0.002, less than 0.05. This finding confirms the presence of a significant difference between the groups. Table 6 demonstrates the relationship between the group with a 20° mesial angulation adjustment and the group with a 20° distal angulation adjustment, which has a significance value of 0.000, less than 0.05. This finding further confirms the presence of a significant difference between the groups.

Table 2. Normality test of data using Kolmogorov-Smirnov test

	Parallel	Mesial	Distal
Kolmogorov-Smirnov	1.898	-	1.218
p	<0.05*	-	0.103

*Data normal at p>0.05

Table 3. Friedman Test

Groups	Sample	Mean
Parallel (control)	24	1.9
Mesial Angulation 20°	24	1.38
Distal Angulation 20°	24	2.73

Table 4. Wilcoxon Test for the pair of the parallel technique (control) and 20° mesial angulation adjustment

Groups	Mean Rank	Sum of Ranks	P
Parallel Technique (control)	5	45	<0.05*
Mesial Angulation 20°	0	0	

*Significant different at p<0.05

Table 5. Wilcoxon Test for the pair of the parallel technique (control) and 20° distal angulation adjustment

Groups	Mean Rank	Sum of Ranks	P
Parallel Technique (control)	8	32	<0.05*
Distal Angulation 20°	12.28	221	

*Significant different at p<0.05

Table 6. Wilcoxon Test for the pair of the 20° mesial angulation adjustment and the 20° distal angulation adjustment

Groups	Mean Rank	Sum of Ranks	P
Mesial Angulation 20°	0	1	<0.05*
Distal Angulation 20°	11	231	

*Significant different at p<0.05

DISCUSSION

Radiographic examinations in periodontics play a vital role in confirming diagnoses, illustrating changes occurring in periodontal diseases, determining the prognosis of periodontal diseases, and evaluating the outcomes of treatments.[9] Radiographic assessment for furcation involvement is best facilitated by the parallel technique, as it can provide detailed images. However, the parallel technique has limitations; for instance, bifurcations in premolar teeth or trifurcations in upper molar teeth often overlap with the corresponding roots, leading to diagnostic errors in furcation involvement.[10] This phenomenon was confirmed in the author's study at the Radiology Dental Unit of the Dental and Oral Hospital, Faculty of Dentistry, Universitas Airlangga, Surabaya, where overlapping images were observed in an attempt to visualize the trifurcation area.

The tube shift technique, also known as the SLOB technique, is a modification of the parallel technique, utilizing what is referred to as Clark's rule or the buccal object rule.[7] This technique involves positioning the film parallel to the tooth and shifting the cone direction slightly mesially or distally, superiorly or inferiorly to the parallel projection.[14] This approach exposes previously unseen root canals. Furcation involvement incidence is reported to be 50% in the upper first molars.[10] Based on these two observations, a study was conducted to assess radiographic images of the trifurcation area of the upper first molar teeth using the SLOB technique on 24 research samples. As this was a preliminary study, the decision was made to use the SLOB technique with both mesial and distal 20° horizontal angulation adjustments rather than only a 20° mesial or distal angulation adjustment.

The determination of a 20° angle adjustment has been established as a recognized theory, but no tools are available to ensure precise 20° cone shifts. Experience gained by operators at the Radiology Dental Unit of the Dental and Oral Hospital, Faculty of Dentistry, Universitas Airlangga, Surabaya, enabled them to produce non-overlapping radiographic images through manual estimation of the angle shift. This prompted the author to develop a modified film holder to support the use of the SLOB technique, which was subsequently employed in this study. This research employed a modified film holder as an aid for radiographic imaging using the SLOB technique. Each research sample underwent three exposures: the SLOB technique with both mesial and distal 20° horizontal angulation adjustments and the parallel technique, used as a control. The research outcomes, in the form of radiographic images, were observed by three observers, comprising the primary and secondary supervising lecturers as well as the author. These images were assigned a value of 0 if overlap was observed and a value of 1 if no overlap was present. Radiographic outcomes using the SLOB technique with a 20° mesial angulation adjustment and the parallel technique (control) displayed overlapping molar roots in the upper first molars, causing the trifurcation area to be concealed. Conversely, with the SLOB technique and a 20° distal angulation adjustment, the three separate roots were faintly visible, and the trifurcation area of the upper first molars was discernible.[12]

The research results conclude that utilizing the SLOB technique with a 20° distal angulation adjustment yielded numerous trifurcation images that were not overlapping, thus supporting the diagnosis and treatment of furcation involvement in the upper first molars. Walton suggested that for upper molar teeth, a slight shift of the X-ray tube towards the mesial "pushes" the lingually situated root apices towards the mesial direction, making them visible. Discrepancies between theory and research findings are possible due to various factors, including the subjective nature of observations, which can lead to differences in the interpretation of overlapping or non-overlapping areas as well as anatomical variations in tooth roots among Indonesians compared to Caucasians.[15]

The research process to achieve radiographic images without overlapping in the trifurcation area requires precise cone placement and angulation. Suboptimal outcomes can often arise if the angulation is incorrect. Improper cone placement and angulation can lead to the trifurcation area appearing to overlap with the maxillary sinus or even with the roots of the upper first molar itself. However, the SLOB technique has its limitations, including decreased image clarity. If the primary X-ray beam changes direction relative to the object and the film (passing through the object and penetrating the film at an angle), the object will become blurred. The contrast between radiolucent and radiopaque objects is not as distinct. Blurriness in the image will increase with larger cone angulations, and other structures may appear to overlap.[12] Therefore, the modification of the film holder as an aid in SLOB radiography must ensure a precise 20° angulations, allowing the cone placement to undergo an accurate 20° horizontal angulation shift towards the mesial or distal directions, resulting in optimal radiographic outcomes.

CONCLUSION

Based on the research findings regarding the use of a modified film holder for SLOB radiographic imaging in the upper first molars at the Dental Radiology Unit, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, the results demonstrate clear images of the non-overlapping trifurcation area. This clarity is observed in the radiographs taken using the SLOB technique with a 20° horizontal distal angulation adjustment. In the Friedman test, the distal 20° angulations showed the highest average of 2.73. Additionally, this study proves the significant differences in the radiographic depiction of the trifurcation area in the upper first molars, which were obtained using the SLOB technique with the assistance of a modified film holder with both 20° mesial and distal angulation adjustments, as well as the parallel technique (control).

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