Assessment of Quality of Radiograph Taken by Undergraduate Students in Paediatric Dentistry Clinic: An Institutional Study

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ABSTRACT
Background: Dental radiograph acts as an adjunct to the clinical examination that aids the dentist to evaluate and definitively diagnose many oral diseases and conditions. Bitewings and periapical radiographs are the two intraoral radiographs that are commonly used in paediatric dental clinic. **Aim:** To assess the quality, justification and reporting of intraoral radiographs taken by the undergraduates dental students in the paediatric dental clinic. **Methods:** The folder of 154 paediatric dental patient treated by the 4th and 5th year undergraduates dental students during the 2018/19 academic session were retrieved retrospectively from the record unit. The quality of the radiograph was graded as grade 1, grade 2 or grade 3 by two calibrated examiners based on the National Radiological Protection Board (NRPB) criteria. The justification and reporting of the radiographs were also assessed. Data were analysed using the Statistical Package for the Social Sciences (SPSS) Version 27 software (IBM, Armonk, NY, USA). **Results:** A total of 108 radiographs were available for assessment, which consist of 55 bitewings and 53 periapical radiographs. 6.5%, 45.4% and 48.2% of the radiographs taken were graded as grade 1, grade 2 and grade 3 respectively. The justification for radiographical investigation were stated in 88.9% of the radiographs, while only 11.1% did not justify. Investigating interproximal caries and periapical status of the teeth were the most common justification for taking bitewings and periapical radiographs respectively. Only 5.6% of the radiographic findings were reported either in the examination and diagnosis form or in the patients' folder, while the remaining 94.44% radiographs were not reported. **Conclusion:** Majority of the undergraduate dental students took poor quality radiographs which renders the radiograph to be diagnostically unacceptable and failed to record the reporting in the patient's folder. However, majority of the dental students did justify the needs for the radiographic investigation.

Keywords: *Quality of radiograph, paediatric dentistry, periapical radiograph, bitewing radiograph, intraoral radiograph*

1. INTRODUCTION

Dental radiograph plays an important role in caries management. It acts as an adjunct to the clinical examination and can aid the dentist to evaluate and definitively diagnose many oral diseases and conditions. In term of diagnosing caries-related diseases, periapical and bitewing radiographs are the two most common intra-oral radiograph been used in the clinical setting [1]. Periapical radiograph is used to assess the periapical status of a tooth and its surrounding structures while bitewing radiograph is mainly used to assess the interproximal caries that cannot be detected during clinical examination.

Although taking dental radiographs might assist the clinician to diagnose the lesion correctly, any X-ray exposure entails a risk to the patient. Therefore, dentists must weigh the benefits of taking dental radiographs against the risk of exposing a patient to the radiations as the radiation effects can accumulate from multiple sources over time [2]. The concept of As Low As Reasonably Achievable (ALARA) should be practised where the radiograph is only taken when it is justified to give benefits to the patient which leads to the process of making a correct diagnosis using the lowest and minimal radiation dose possible.

Under normal circumstances the risk from dental radiography is very low. A high-quality diagnostic radiographs are an essential part of high-quality dental service and this in directly minimize the radiation exposure to the patient. The use of x-ray shield, high speed film, and the use of rectangular collimation of the x-ray beam also can minimize the risk of unwanted radiation exposure towards the patient. Nonetheless, it is essential that any radiographic examination should show a net benefit to the patient, weighing the total potential diagnostic benefits it produces against the detrimental effects that the exposure might cause. Justification for each radiograph's prescription should be made and the selection of appropriate radiograph is based on the individual patient's history and thorough clinical examination.

In addition, any procedural and processing error that leads to repeated intake of radiograph should be prevented. There are many factors that could lead to errors in radiograph taken. Rehman and his colleagues had classified the causes of error and faults as positioning errors such as cone cutting, film bending, elongation, and shortening, exposure errors such as dark or light radiograph and chemical processing errors such as yellow or brown stain [3].

As a teaching institution and as part of their training in the National University of Malaysia (UKM), the undergraduate dental students will need to take the intra-oral radiograph required by their paediatric dental patient by themselves. However, since the start of the curriculum back in 1999, a proper and thorough assessment of the quality of radiograph taken by undergraduate dental students in Paediatric Dental clinic have not been done. The information obtained may be useful for future improvement in terms of the quality of radiograph taken by the undergraduate dental students. This later will minimize the needs for taking repeated and multiple number of radiographs which could lead to unnecessary radiation exposure to the patients.

Therefore, this study aims to assess the quality of the intra-oral radiograph of paediatric patients taken by the undergraduate dental students of Faculty of Dentistry, UKM. Furthermore, we also investigated the justifications of taking and assessed the reporting of the radiographs taken in the patients' case notes.

2. MATERIAL AND METHODS

The ethical approval was obtained from the institutional ethical review committee (UKM PPI/111/8/JEP-2020-809). The method that was used in this research is based on retrospective record reviews. The list of patients that have been treated by the 4th and 5th year undergraduate dental students during the 2018/2019 academic session were obtained from the patient database from the Paediatric Dentistry clinic. Following that, their respective dental folders were requested from the Record Unit, Faculty of Dentistry, UKM.

The inclusion criteria for the subject of this research were paediatric patients that received dental treatment during the 2018/2019 academic session, paediatric dental patient that was treated by the undergraduate dental students and paediatric patients whom were indicated for radiographic investigation to aid in diagnosis of dental problem. Meanwhile, the exclusion criteria were paediatric patients that received dental treatment without any radiographic investigation and radiographs taken by the batch before or after the 2018/2019 academic session.

Two examiners were involved in the quality assessment of the radiographs and were calibrated with the dental radiology specialist as the gold standard. Inter- and intra-rater reliability test was done before commencement of the radiographic assessment.

The quality of radiographs were assessed and graded according to subjective quality rating of radiograph given by the National Board of Radiation Protection (NPRB) guidance of United Kingdom (UK) [4]. The grades were classified into Grades 1, 2, or 3, where Grade 3 had been further subclassified into 3(a) to 3 (e) (Table 1). The justification and the reporting of the radiographs were assessed from the patients' folder and case notes. All of the information were recorded in a proforma form. Later, all the data were analyzed using the Statistical Package for the Social Sciences (SPSS) Version 27 software (IBM, Armonk, NY, USA).

3. RESULTS

A Kappa score of 0.81 and 0.9 for inter- and intra-rater reliability was obtained respectively following calibration with the gold standard.

154 paediatric dental patients were seen during the academic session of 2018/19, which comprised of 52% male and 48% female. Looking at the year of study, Year 4 undergraduate dental students had seen 75 patients (62.7% male, 37.3% female) while Year 5 undergraduate dental students had seen 79 patients (41.8% male, 58.2% female). The mean age of patient seen by Year 4 and Year

5 undergraduate dental students was 11±2.67 and 8±1.07 years respectively (Table 2).

Table 1. Quality rating of radiograph given by the National Radiological Protection Board (NRPB) guidance of UK [4].

Rating	Quality criteria
Grade 1	Excellent - No errors of patient preparation, exposure, positioning, processing, or film handling.
Grade 2	Diagnostically acceptable - Some errors of patient preparation, exposure, positioning, processing or film handling, but which do not detract from the diagnostic utility of the radiograph.
Grade 3	Unacceptable - Errors of patient preparation, exposure, positioning, processing, or film handling, which render the radiograph diagnostically unacceptable. 3a: Errors in positioning / handling equipment (cone-cutting, elongation, foreshortened, horizontal overlapping, image distortion due to bending of film, marks due to film bending, tyre-track effect, crown of teeth not showing, apical teeth cut off) 3b: Errors in exposure setting (high density film, low density film, double exposure, blank image) 3c: Processing error (black film-fogging, fixer or developer cut off, yellowish brown discoloration, streaks on film, white spot or patch, black spot or patch, torn emulsion, film stacked together, fingernail or fingerprint artifacts) 3d: Other errors (Reticulation, tree-like static electricity markings, smudge-like electricity marking) 3e: Equipment error

Table 2. Demographic data of the patients seen by the Year 4 and Year 5 undergraduate dental students

	Year 4	Year 5
Mean age (±SD)*	11±2.67	8±1.07
Male, n (%)*	47(62.7%)	33(41.8%)
Female, n (%)*	28(37.3%)	46(58.2%)
Total, n (%)*	75 (100%)	79(100%)

*SD=standard deviation, n=numbers, %=percentages

From the 154 patients, only 24% patients had intra-oral radiograph taken. The number of radiographs taken were 124, which comprised of 52.4% bitewings and 47.6% periapical radiographs. Out of the 124 radiographs that has been taken, 16 were missing from the patients' folder. Therefore, only 108 radiographs (bitewings=50.9%; periapical=49.1%) were evaluated for quality of radiograph, justification of taking the radiograph and reporting of the radiograph (Table 3).

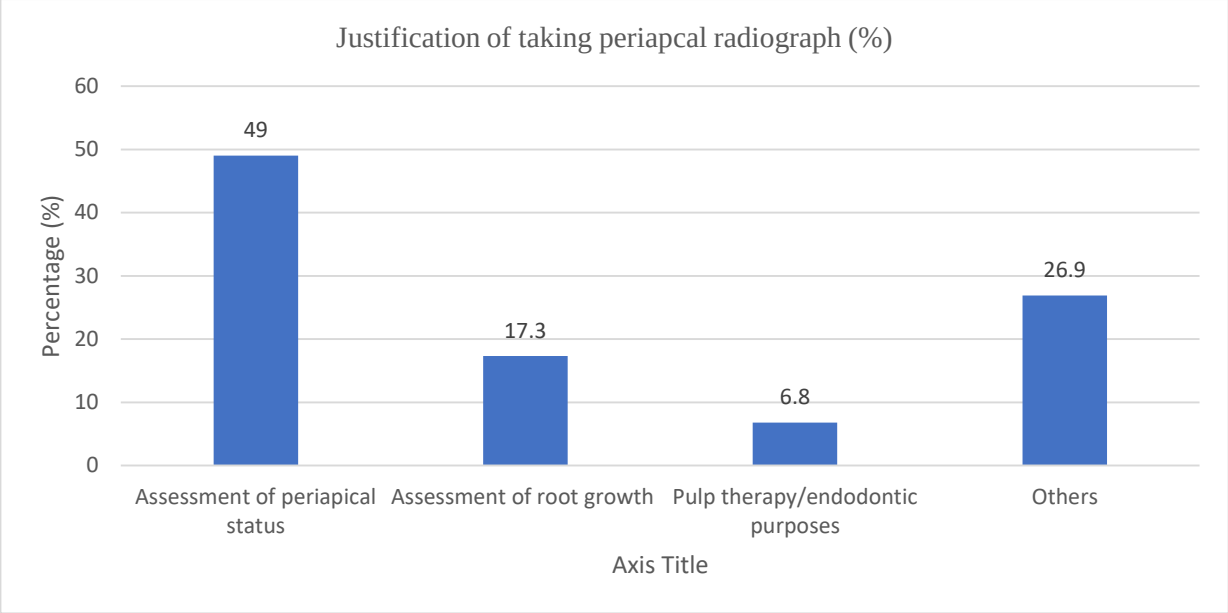
Generally, 6.5% radiographs taken was graded as grade 1, 45.3% was graded as grade 2 and 48.2% radiographs was graded as grade 3. When comparing in between the year of study, the quality of radiographs taken by Year 4 undergraduate dental students were 6.5% of grade 1 quality, 29.6% of grade 2 quality and 34.3% of grade 3 quality. For Year 5 students, none of the radiograph taken was graded as grade 1, while 15.7% and 13.9% was graded as Grade 2 and Grade 3 respectively. Looking at the Grade 3 radiographs, most of the error are due to error in positioning or handling of the equipment (37%), followed by error in exposure setting and processing error, both 5.6%. However, there were few radiographs with combination of more than one type of error on a single radiograph. There were 8 radiographs with a combination of positioning-exposure setting error (3a,3b) and 1 radiograph each of positioning-exposure setting-processing error (3a,3b,3c), exposure setting-processing error (3b.3c) and positioning-processing error (3a,3c) respectively (Table 4).

In term of justification for taking radiographs, 88.9% of undergraduate dental students had justified the needs for taking either periapical and/or bitewing radiographs, while only 11.1% did not state any justification for taking radiographs for their patients (Table 3). Most common justification for periapical radiographs was to assess the periapical status of teeth (49%) while for bitewing radiographs, most common justification was to assess the interproximal area of teeth for caries detection (51.1%) (Figure 1).

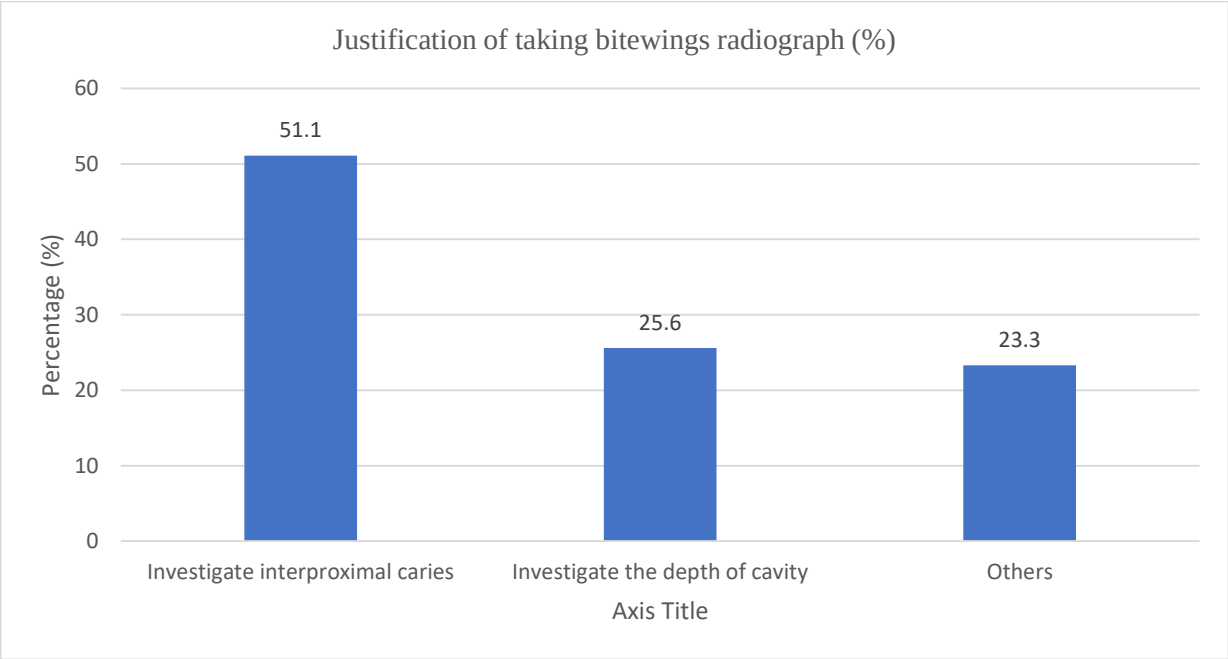
Regarding the reporting of the radiographic findings, only 5.6% of the radiographic findings were reported either in the examination and diagnosis form or in the patients' folder, while the remaining 94.4% radiographs did not have any radiological reporting. (Table 3).

4. DISCUSSION

Out of the 154 paediatric dental patients treated by the undergraduate dental students during the 2018/2019 academic session, only 24% of them had intra-oral radiograph taken. The remaining patients was either did not underwent any radiographic investigation or extra-oral radiograph was taken instead of intra-oral. Extra-oral radiographs were not assessed in our study as it was taken by the qualified dental radiographer



(a)



(b)

Figure 1. Justification for taking (a) periapical and (b) bitewings radiographs by the undergraduate dental students.

Table 3. Types, justification and reporting of the radiographs taken by the undergraduate dental student

	Types of radiographs		Justification of radiographs stated		Reporting of radiographs present	
	Periapical	Bitewings	Yes	No	Yes	No
Numbers, n (percentage, %)	53 (49%)	55 (51%)	96 (88.9%)	12 (11.1%)	6 (5.6%)	102 (94.4%)
Total	108(100%)		108 (100%)		108 (100%)	

Table 4. Quality of radiographs taken by undergraduate students according to the year of study

	Grade 1	Grade 2	Grade 3					
			3a	3b	3c	3a, 3b	3a, 3b, 3c	3a, 3c
Year 4, n (%)*	7(6.5%)	32(29.6%)	23(21.3%)	6(5.6%)	6(5.6%)	1(0.9%)	0	1(0.9%)
Year 5, n (%)*	0	17(15.7%)	7(6.5%)	0	0	7(6.5%)	1(0.9%)	0
Total, n (%)*	7(6.5%)	49(45.3%)	30(27.8%)	6(5.6%)	6(5.6%)	8(7.4%)	1(0.9%)	1(0.9%)

*n=numbers, %=percentage

Our study showed that majority of the radiographs taken by the undergraduate dental students lies in the grade 2 and grade 3 category. Only 6.5% of the radiographs taken were graded as grade 1. This is far below the standard set by the National Radiological Protection Board (NRPB) guidance of UK where it stated that grade 1 radiographs taken should not be less than 70%. Interestingly, there are limited studies that were reported in the literature assessing the quality of radiograph taken on paediatric dental patient by the dental students. Most of the studies was done on adults patient, mainly assessing the quality of periapical radiographs following root canal treatment.

One of the study done on paediatric dental patient was reported by Javed and his colleagues. They stated a higher grade 1 (45.7%) and lower grade 3 (16.7%) radiographs taken by the undergraduate dental students at their institution [5]. On the other hand, Salami et al reported 54%, 34% and 12% of grade 1, 2 and 3 radiographs respectively taken by the postgraduate dental students at their institution [6]. Although direct comparison cannot be made with our study due to the different level of education of the students, it is worth to mention as their results also did not meet the required standards which reflects the difficulty of taking a radiograph in a paediatric patient.

In present study, the most common type of error made was grade 3a which consists of errors in positioning and/or handling of equipment with a percentage of 65.5%, while processing error and exposure error occurred in only 6.5% of the radiographs. This findings are similar to other studies done previously. Both Nixon [7] and Emanuel and Sullivan [8] in their studies showed that most of the radiographs were rejected due to the faults in the positioning of either the x-ray tube or the film itself. In addition, our results also in agreement with the study reported by Peker and his colleague, where they reported almost 35% of the error are due to the incorrect angulation of the x-ray film [9].

The radiographs taken by undergraduate students of UKM were of poor quality. One of the factors could be the age of the patient. The mean age of patients seen by the Year 4 and 5 undergraduate dental students during the 2018/2019 academic session was 11±2.67 and 8±1.07 years respectively. Younger age patients tends to be less

cooperative compared to older age patients. This might be due to their anxiousness and difficulty in following the instructions given by the students while taking the radiographs. Herman and Ashkenazi reported a high poor quality radiographs taken among paediatric dental patient and concluded that most of the overlapping surfaces occurred correlates with the degree of the child's cooperation [10]. We also noticed that no radiograph with grade 1 quality was taken by the Year 5 undergraduate dental students as compared to Year 4 students (6.5%), suggesting the difficulty in dealing with paediatric dental patients from the lower age group.

Another factor that affected the quality of radiograph taken by undergraduate student were the size of the film holder and x-ray rim which are too big and poorly tolerated by the children. This can cause discomfort to the child and might trigger them to gag during the placement. Katsouda et al. [11] in their study reported about one-fifth of the children gagged during the radiographic examination (21%) and/or during the intraoral photography (20%). Meanwhile, a study conducted in Sweden reported that about 19% from 2363 children involved in the study reported of pain during the radiographic investigation [12].

In term of justifying the needs for the radiographic investigation, most of the radiographs taken were justified with only 11.1% of the radiographs did not have any justification stated. Although the number was high, students must aware that each of the radiograph taken must have a diagnostic value and abide to the ALARA concept to minimize the unnecessary exposure risk to the patient.

Radiographic report of a radiograph is mandatory and is part of a medicolegal documents [13]. It is also of important value during the post mortem investigation in forensic odontology. In the hospital setting, the reports is done by the qualified radiographer whereas in the dental clinic, the reporting of the radiograph is under the responsibility of the clinician. The reporting of the radiographs by undergraduate dental students were poor. Most of the students did discussed the findings with the clinical supervisor and lecturer in-charge, but forgot to write it down in the case note. Therefore, continuous education and reminder need to be emphasize from time to time. A sticker or a stamp that can be placed on the patients' folder can be an alternative and serves as a reminder to the students in order to overcome this issue.

Besides, training of the undergraduate dental students also plays a role in achieving good radiograph taking skill. The current training of taking radiograph that was taught to the Year 3 undergraduate dental students prior to their entry into the clinics did not cover the techniques of taking radiographs in children. Although the theoretical part was covered in the lectures, the hand-on part was lacking. Thus, lack of training for taking intraoral radiographs of paediatric patient among undergraduate dental students could be one of the factors for poor quality radiographs to be taken.

5. RECOMMENDATIONS

- All undergraduate dental students should receive adequate theoretical and practical training for the purpose of radiological practices especially in paediatric patients during Introduction to Clinical Dentistry(ICD) module that is being taught during third year.
- All undergraduate dental students should be trained on how to manage the patients with gagging problems and uncooperative young children.
- Use paediatric film size and ensure that correct radiation dose is set before taking radiograph.
- Emphasize the importance of justifying and reporting radiographic findings and the medicolegal issues that might arise if they fail to do so.
- To carry out similar retrospective study in a timely manner to ensure the quality of the radiographs taken is well maintained and in accordance with the required standard.

6. CONCLUSION

Majority of the undergraduate dental students took poor quality radiographs which renders the radiograph to be diagnostically unacceptable and failed to record the reporting in the patient's folder. However, majority of the dental students did justify the needs for the radiographic investigation.

Improvement on the errors through continuous audit and training can be beneficial for a high-quality education and a reduction in radiographic retakes during undergraduate dental students' training periods. Furthermore, patient, clinician and environment exposure could be minimised, as well as the time and money factor.

AUTHORS CONTRIBUTIONS

Conceptualization: N.I.M.B., B.A.A.A., A.S.I.Z., A.A.F., and S.N.M.P.S.; Methodology: N.I.M.B, B.A.A.A., A.S.I.Z., and A.A.F.; Investigation: N.I.M.B., B.A.A.A., A.A.F., and A.S.I.Z.; Software: N.I.M.B. and B.A.A.A; Validation: A.S.I.Z., A.A.F., and S.N.M.P.S.; Data curation and analysis: N.I.M.B., B.A.A.A., A.S.I.Z., and A.A.F.; Writing: N.I.M.B., B.A.A.A., A.S.I.Z., A.A.F., and S.N.M.P.S.; Supervision: A.S.I.Z, and A.A.F.; Funding acquisition: A.S.I.Z., A.A.F., and S.N.M.P.S. All authors have read and agreed to the published version of the manuscript.

ACKNOWLEDGMENTS

We would like to thank the Assistant Dean of Clinical Services, Faculty of Dentistry, UKM and the supporting staffs of the radiology unit Faculty of Dentistry, UKM for their help and support during the commencement of this study.

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