

Evaluation of the Quality of Class II Cavities with and without Dental Loupes

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ABSTRACT

Objective: High competency levels in Restorative Dentistry require manual dexterity, and one of the important ways a student can achieve this dexterity is by pre-clinical typodont exercises. This study sought to demonstrate the quality of prepared Class II cavities prepared without magnified vision and evaluated with and without (magnifying) dental loupes.

Methods: Typodont teeth mounted on either a lower or upper acrylic jaw base of phantom head had Class II amalgam cavities prepared on them under examination conditions by preclinical dental students. The tooth and type of Class II cavity prepared were noted. Evaluations of the prepared cavities was carried out initially without loupes and then subsequently with dental loupes using predetermined criteria. The data obtained were subjected to statistical analysis using IBM SPSS version 26.0

Results: Sixty typodont plastic teeth were utilized for the study. There was statistically significant difference in mean scores assessed with and without loupes, $p < 0.0001$ as well as between the grades of the cavity evaluated with and without loupes ($P = 0.004$). The mean score of MO cavities assessed with loupes was higher than the mean score of DO cavities and this was statistically significant, $p = 0.001$

Conclusion: The use of dental loupes is invaluable in the didactic assessment of dental students' work by their educators and instructors for higher quality training. Therefore, it is hereby recommended that both dental students and their educators should routinely use dental loupes during students' training to produce very proficient dental graduates who will deliver high quality dental care to patients during their professional careers.

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Key words: Class II, Evaluation, Dental Loupes

INTRODUCTION

In the quest to render optimal oral health care to patients by dental graduates at the completion of their training, dental schools operate curricula which place significant emphasis on the acquisition of cognitive and technical skills by undergraduate dental students.

Citation: Ibhawoh LO, Enabulele JE (2021). Evaluation of the quality of class II cavities with and without Dental Loupes. *Nig J Med Dent Educ*; 3(2):35-40.

Dental undergraduate study comprises both preclinical and clinical education. In the preclinical technique courses, psychomotor skills and clinical procedures are taught (Curtis et al, 2008) in simulated clinical conditions preparatory to clinical learning and practice. High competency levels in Restorative Dentistry require manual dexterity, and one of the important ways a student can achieve this dexterity is by pre-clinical typodont exercises (Huth et al., 2017). Traditionally, preclinical training in dentistry relied on practicing skills on plastic teeth under the supervision of dental experts (Xia et al, 2013). These plastic teeth are typically placed in jaws within a dental simulator. All preparations done on the plastic teeth are then checked and graded by an experienced dental instructor (Khalaf et al, 2020).

The use of traditional typodont (in mannequin-heads) has always been considered a valuable tool for simulating patient care procedures (Nunez et al., 2012) even though digital audio-visual three-dimensional approaches to the practical training of dental students have become more widely used. The advantages of using this method may include low costs, effectiveness in improving hand-eye coordination and manual dexterity, as well as the fact that it has good long-term credibility, having been the method of choice in preclinical dental training for decades (Khalaf et al, 2020).

Assessment is a critical element in the learning process as most students tend to focus on assessment and its outcome more than any other factor of the educational process (El-Kishawi et al, 2020). Evaluation of the preparations done on the plastic teeth have been shown to be associated with major challenges (Khalaf et al., 2020; Huth et al., 2017) such as the inability to calibrate the evaluation process due to the general focus on task outcome (Khakaf et al., 2020), lack of transparency/objectivity (Huth et al., 2017) and a heavy reliance on the instructor's subjective evaluation (Khalaf et al., 2020). This highlights a lack of consistency in students' evaluations, even when evaluating the same work at different times. In order to overcome these limitations, various dental teaching and assessment systems have been suggested as potential alternative feedback and assessment tools that can improve students' learning and self-assessment experiences (Sadid-Zadeh et al., 2018).

Enhancement of dexterity (motor skills) along with cognitive development is offered in preclinical training with one of the main specialties wherein this dexterity is required being operative dentistry and endodontics (Satwik & Neelakantan, 2016). It has been shown that there are challenges in introducing magnification near the beginning of

the dental training program despite its ergonomic advantages (Carpentier et al., 2019). The magnification provided by the use of loupes in dental practice allows for the detection of any slight discrepancy (such as a missed root canal in maxillary second premolars or undermined enamel walls in Class II cavity), facilitating possible correction, before any devastating ill effect occurs, thereby raising the quality of treatment provided (Narula et al, 2015).

Despite the increased interest and use of magnification (Farook et al, 2013) to make the practice of dentistry more precise, easier and more enjoyable by dentists and dental students (Narula et al, 2015) in other countries, there seems to be insufficient emphasis on the use of magnification in both clinical practice and in undergraduate training in Nigeria. Assessment of learning is an educational concept that motivates both the educator and learner to dynamically improve the learning process and facilitate a positive attitude towards future learning (El-Kishawi et al., 2020). It has been demonstrated that dental magnification loupes significantly enhance student performance during preclinical (Maggio et al., 2011) and simulation dental procedures (Braga et al, 2021) and are considered an effective adjunct by students who use them (Maggio et al, 2011). However, not much has been researched regarding the evaluation of cavities using dental loupes by assessors.

Studies (Satwik et al, 2016; Narula et al, 2015; Maggio et al., 2011) have evaluated Class II cavities prepared with and without dental loupes but have not assessed evaluation of Class II cavities with and without loupes. Hence, this study sought to demonstrate the quality of Class II restorations prepared with unaided eyes and evaluated with and without dental loupes.

MATERIALS AND METHODS

A total of 60 typodont teeth had Class II amalgam cavities prepared on them by preclinical dental students in 4th year who had just concluded the Operative Techniques course and were awaiting examinations in 2 Nigerian dental schools (University of Benin and University of Calabar), both in the South-South geo-political zone. The typodont teeth were mounted on either a lower or an upper acrylic jaw base of phantom head (dental mannequin) and the cavity preparations took place under examination conditions. The students were not aware of the criteria set out by the researchers on the assessment and record sheet for evaluating the cavities. The Class II cavities were prepared using contra-angled medium speed hand pieces with micro-motors, mouth mirrors, explorers, periodontal probes and tungsten carbide

preparation and finishing burs of flat fissure, inverted cone and round designs.

The data collection tool consisted of three sections. The first section garnered information on the tooth and type of Class II cavity prepared. The second and third sections involved entries of the evaluations of the prepared cavities without loupes and cavity evaluation using dental loupes (Task-Vision Dental Loupes by Vision USA, NJ, USA) at X2.5 magnification. Evaluations without the use of loupes were carried out and recorded first before evaluations using loupes were done and recorded. Each evaluation was done using criteria employed in a previous study (Satwik et al., 2016) but which were modified by the authors in this study (Table 1). Each criterion assessed- if excellent, was given a score of 2; if clinically acceptable, a score of 1 and if to be repeated, a score of 0. The summed total score was divided by a factor of 3.6 to get a maximum score of 10 which was graded as follows:

> 8- excellent, 5 to 8- clinically acceptable and <5 - to be repeated. All assessments were done once by the authors (one in each school) who had more than 10 years of clinical experience in Operative dentistry. The intra examiner reliability was 0.934 and 0.926 for the assessors. Visual acuity of the assessors had been previously corrected using prescription glasses.

All data collected were screened for completeness and analyzed using IBM SPSS version 26.0 software. The data were subjected to descriptive statistics in the form of frequency, mean, standard deviation and cross-tabulations. Paired sample t-test was used to assess the difference in mean scores evaluated with and without loupes. Student t-test was used to determine the difference in mean scores between the types of Class II cavities with and without loupes. Chi-square test was used to assess association between grade of evaluation with and without loupes. P-value was set at 0.05.

Table 1: Evaluation criteria used in this study

Parameter	Excellent (Score of 2)	Clinically acceptable (Score of 1)	To be repeated (Score of 0)
Outline form	Proper circumventing of cusps without encroaching into cusps	Minor circumventing of cusps without encroaching into cusps	No circumventing
Outline form	Smooth, regular, flowing curves,	Smooth, slightly irregular, flowing curves	Angular, irregular, no flowing curves
Outline form	Blends harmoniously with proximal	Blends harmoniously with proximal	Does not blend harmoniously with proximal
Outline form	Includes pits, fossae, major fissures and grooves	Includes some but not all pits, fossae, major fissures and grooves	Does not include pits, fossae, major fissures and grooves
Width	0.8mm	Up to 1.5mm	>1.5mm or <0.8mm
Depth	1.5mm from central pit	Up to 2mm	>2mm or <1mm
Depth	Smooth and flat	Smooth and flat	Rough or uneven
Depth	Parallel to occlusal table	Parallel to occlusal table	Slants
Occlusal walls	Smooth and straight pulpo-occlusally	Smooth and straight pulpo-occlusally	Rough and not straight pulpo-occlusally
Axial wall height	0.8mm	Up to 1mm	>1mm or <0.5mm
Buccal and lingual proximal walls	Smooth and flat plane	Smooth and flat plane	Rough, uneven or curved
Gingival seat width	0.5mm	Up to 1mm	>1mm or <0.5mm
Cavo-surface margins	Very smooth, crisp and supported	Fairly smooth, crisp and supported	Rough, nicked, indistinct and unsupported enamel
Gingival cavo-surface	Bevel neat and adequate, with no overhanging margins	Bevel adequate, with no overhanging margins	Overhanging margins and no bevel
Clearance from adjacent tooth	0.5mm	0.5mm	<0.5mm or >1.5mm
Mesial marginal ridge thickness	2mm	Not less than 1.5mm	<1mm
Cavity refinement	Line angles very well-defined	Line angles reasonably well-defined	Line angles indistinct
Adjacent tooth	No damage	Slight damage	Moderate or severe damage

RESULTS

Sixty typodont plastic teeth consisting of first molars (46.7%), second molars (25.0%), third molars (10.0%), second premolars (13.3%) and first molars (5.0%) were utilized for the study. The mandibular arch had 96.7% of the typodont teeth and 65.0% of the Class II preparations were Mesio-Occlusal (MO) cavities while the remaining 35.0% were Disto-Occlusal (DO) cavities (Table 2).

The scores of the cavities evaluated without dental loupes ranged from 5.2-9.6 with a mean of 8.03 ± 1.0 while the scores of the cavities evaluated with dental loupes ranged from 3.9-9.6 with a mean of 6.41 ± 1.8 . There was statistically significant difference in mean scores assessed with and without loupes, $p < 0.0001$ (Table 3).

Evaluation of the cavities without loupes recorded 55.0% of the cavities as excellent and the remaining 45.0% as clinically acceptable while

evaluation with loupes graded only 23.3% of them as excellent, 53.3% as clinically acceptable and 23.3% as needing to be repeated (Table 4).

There was statistically significant association between the grades of the cavity evaluated with and without loupes ($P = 0.004$) with 70.4% of those evaluated as clinically acceptable without loupes also assessed as clinically acceptable with loupes. However, 25.9% and 21.2% of those evaluated as clinically acceptable and excellent respectively without loupes needed to be repeated on evaluation with loupes (Table 5).

The mean score of MO cavities assessed without loupes was higher than DO cavities and this was not statistically significant ($p = 0.811$). However, the mean score of MO cavities assessed with loupes was higher than DO cavities and this was statistically significant, $p = 0.001$ (Table 6).

Table 2: Characteristics of the typodont teeth

Characteristics	Frequency	Percent
Tooth type		
First premolar	3	5.0
Second premolar	8	13.3
First molar	28	46.7
Second molar	15	25.0
Third molar	6	10.0
Arch		
Mandibular	58	96.7
Maxillary	2	3.3
Class II		
Mesio-Occlusal	39	65.0
Disto-Occlusal	21	35.0
Total	60	100.0

Table 3: Mean values across evaluation groups

Group evaluation	Range	Mean/SD	p-Value
Without loupes	5.2-9.6	8.03 ± 1.0	< 0.0001
With loupes	3.9-9.6	6.41 ± 1.8	

Table 4: Grading of the cavities with and without loupes

Grade	Frequency	Percent
Without loupes		
Excellent	33	55.0
Clinically acceptable	27	45.0
With loupes		
Excellent	14	23.3
Clinically acceptable	32	53.3
Need to be repeated	14	23.3
Total	60	100.0

Table 5: Association between grading of the cavities with and without loupes

Evaluation without loupes	Evaluation with loupes			Total
	Excellent	Clinically acceptable	To be repeated	
Excellent	13 (39.4)	13 (39.4)	7 (21.2)	33 (100.0)
Clinically acceptable	1 (3.7)	19 (70.4)	7 (25.9)	27 (100.0)
Total	14 (23.3)	32 (53.3)	14 (23.3)	60 (100.0)

P=0.004

Table 6: Mean difference in evaluation scores across types of Class II

Evaluation	Type of class II	N	Mean/SD	p-value
Without loupes	MO	39	8.19±1.0	0.811
	DO	21	7.74±0.9	
With loupes	MO	39	6.95±1.9	0.001
	DO	21	5.40±1.1	

DISCUSSION

Magnification has improved dental practice as every minute detail in Class II cavity preparations can be observed at a glance without straining the normal eyesight (Narula et al., 2015; Yadav et al., 2020). The distribution of the sixty typodont plastic teeth in this study conforms to the teeth that would normally receive Class II restorations. Mainly mandibular typodont teeth were prepared and Mesio-Occlusal (MO) cavities were more prevalent than Disto-Occlusal (DO) cavities as the students were asked to prepare the Class II cavity design as well as the tooth they preferred to work on. This may be because students find the preparation of mandibular teeth and Mesio-Occlusal cavities easier because they have better access and direct visualization during cavity preparation and restoration. However, a previous study on patients reported higher prevalence of Disto-Occlusal cavities (Talabani et al., 2015) and maxillary teeth requiring cavity preparation (Demirci et al., 2010). There is need therefore to encourage dental students to have adequate practice of tooth cavity preparations on both arches, on both sides of the jaws as well as on either mesial and distal interproximal surface to develop competencies to meet the challenges of restoring any area/surface of any tooth in the mouth.

The statistically significant difference in mean scores of the cavities assessed with and without loupes and the downgrading of up to a fifth of cavities previously graded by the assessors from excellent to needing to be repeated, after reassessment with loupes magnification, show that details of a cavity preparation may be missed by the naked eyes. Furthermore, a previous study demonstrated a difference between cavity preparations done wearing loupes and those done without it (Narula et al., 2015). This calls for the increased use of magnification not just for dental students, but for all dentists including dental

educators as this will improve dental practice as well as the assessment and evaluation of learning. As an individual's age advances, the visual acuity tends to diminish due to presbyopia. Magnifying loupes do play a major role in visualizing the minute details of the cavity without straining the eye muscles (Maggio et al., 2011), thereby compensating for the loss of near vision. Although the assessors in this study, who were in their early and late forties and had had their visual acuity checked and corrected with glasses, evaluation without loupes did not identify any cavity that needed to be repeated. This may have accounted for why no cavity evaluated without loupes magnification qualified to be repeated.

A lower proportion of the cavities were graded excellent when evaluated with loupes compared to when evaluated without loupes, suggesting better detection of rather serious errors by the assessors in this study.

A statistically significant association between the grades of the cavity evaluated with and without loupes supports existing evidence that using the appropriate visual enhancement be considered for all dental professionals to make the practice of dentistry easier and more enjoyable, and to reduce the risk of musculoskeletal injury (Narula et al., 2015) by ensuring and maintaining correct posture when working with loupes.

The mean score of MO cavities assessed with and without loupes were higher than scores for DO cavities. This may show that the students were better at preparing MO cavities than DO cavities as they may have been more comfortable preparing the former as suggested by their preponderant choice of Class II (MO) cavities for preparation. The statistically significant difference in evaluation scores with loupes between the types (that is, MO vs DO) of Class II cavities, further suggests that the students seem to be better at preparing MO cavities than DO cavities.

CONCLUSION

The use of dental loupes during restorative procedures provides not only the magnification which aids the attainment of the precision necessary in operative dentistry and enhances the quality of such procedures, but also, as this research highlights, is invaluable in the didactic assessment of dental students' work by their educators and instructors for higher quality training. Therefore, it is hereby recommended that both dental students and their educators should routinely use dental loupes during students' training to produce very proficient dental graduates who will deliver high quality dental care to patients during their professional careers.

Financial support and sponsorship

This work received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Conflicts of interest

The authors declare that they have no conflicts of interest.

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