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Development and Validation of Class I Preparation and Restoration Quality Assessment Methods

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Authors' contributions

This work was done in collaboration among the three authors. Author DW developed and validate the methods JMP helped in validation of the method and wrote the first draft of the manuscript and authors TCN and PPNSG designed and supervised the study, and also revised the draft. All the authors read and approved the final manuscript.

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ABSTRACT

This study sought to develop and validate two methods of quality assessment, one for Class I cavity preparation and another for composite resin restoration. This was an experimental laboratory study. The methods are named Class I Cavity Preparation Assessment – COCA and Class I Cavity Restoration Assessment – COCRA. During the development of the methods, 5 items were elaborated for COCA and 10 items for COCRA. Each item should be classified as appropriate, partially appropriate, or inappropriate. For each method, after evaluation, all item values should be added with a maximum possible score of ten points. The reliability of the COCA and COCRA was estimated through intra-observer reproducibility. For the methods application, 80 Class I cavity preparation and restoration in first molars were evaluated. A descriptive statistical analysis was performed, and the intra-observer concordance was estimated using the intraclass correlation coefficient (ρ). As a result, it was possible to observe that the reproducibility for COCA of evaluator 1 (ρ=0.76) and evaluator 2 (ρ=1.00) was classified as good and excellent,

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respectively. The reproducibility for COCRA of evaluator 1 (ρ=0.99) and evaluator 2 (ρ=0.77) was classified as excellent and good, respectively. It was concluded that COCA and COCRA were valid and reliable for the assessment of quality of Class I cavity preparation and restoration.

Keywords: Dental students; class I quality; dental education.

1. INDRODUCTION

To achieve success in dental education, several aspects are important [1,2], among them the evaluation process, which is an important and challenging task [3-6].

It is well-known that the assessment methods directly influence students' ability and way of learning [7,8]. So, the lack of patterns and/or low quality of quality assessment methods can severely compromise students' learning curve [6,7]. Besides that, knowing how and in which point they are being evaluated can reduce students' anxiety and help them to improve their practical skills. Considering that self-evaluation is also an important point in this process [3], standardizing professors assessment criteria can help students to develop their own self-assessment criteria.

A precise feedback, from an accurate evaluation method, can improve learning process and students' motivation, promoting a good professional development [1,5,8] and helps to identify students that are having difficulties in progress satisfactorily, allowing professors to mediate as soon as possible [4]. Thus, it is of fundamental importance that there are standardized and reliable assessment methods in the educational environment. However, it seems to have few validate and reliable quality assessment methods published in literature. So, the objective of this study was to develop and validate two quality assessment methods, one for evaluating the quality of Class I cavity preparations and another for quality of restorations.

2. MATERIALS AND METHODS

2.1 Method for Evaluating Cavity Preparations

The methods developed herein is referred to the Class I Cavity Preparation Assessment (COCA), which have been proposed to evaluate class I cavity preparations at the preclinical level. The aspects of the preparations that were considered were design, mesiodistal length, buccolingual axis length, depth and roundness of the internal angles. Each of these items was classified as adequate, partially adequate, or inadequate based on the ideal anatomical characteristics for each parameter [9]. Each item received a score based on its classification: two points were given to adequate items (those in agreement with the recommendations for cavity preparations for composite resin given in the restorative dentistry course at the School of Dentistry of Araraquara), one point was given to partially adequate items (when the item evaluated was not completely correct), and zero points were given for inadequate items (those which did not meet the aforementioned recommendations). After each item received a score, the points were added up, with a maximum possible score of ten points.

2.2 Method for Evaluating Cavity Restoration

The methods developed herein is referred to the Class I Cavity Restoration Assessment (COCRA), which have been proposed to evaluate class I cavity restorations at the preclinical level. The aspects of the restorations considered were the presence and evidence of central grooves, the presence and evidence of secondary grooves, the angle of the buccal slopes, the angle of the lingual-palatal slopes, the fabrication of the mesial fossa, the fabrication of the distal fossa, buccal marginal adaptation, lingual-palatal marginal adaptation, mesial marginal adaptation and distal marginal adaptation. Each of these items was classified as adequate, partially adequate, or inadequate based on the ideal anatomical characteristics for each parameter [9]. Each item received a score based on its classification: two points were given to adequate items (those in agreement with the recommendations for cavity restoration for composite resin given in the restorative dentistry course at the School of Dentistry of Araraquara), one point was given to partially adequate items (when the item evaluated was not completely correct), and zero points were given for inadequate items (those which did not meet the aforementioned recommendations). After each item received a score, the points were added up, with a maximum possible score of ten points.

2.3 Cavity Preparations and Restorations

Class I cavity preparations and restorations were performed for composite resin on tooth numbers 16 (right maxillary first molar), 26 (left maxillary first molar), 36 (left mandibular first molar), and 46 (right mandibular first molar).

The procedures were performed following the technique established in the Restorative Dentistry I course offered by the São Paulo State University, School of Dentistry, Araraquara [10]. A #1014 diamond bur was used on low rotation. The preparation needed to exhibit rounded internal line angles to support the force of mastication and a depth/width corresponding to 1 to 1.5 burs. The handling of the composite resin was carried out using a suprafill titanium resin spatula, Almore spatula and MilleniumGolgran® No. 1 double carved.

A MOM-brand dental mannequin (Marília, São Paulo State, Brazil), which has artificial resin teeth specific for cavity preparation and restoration at the preclinical level, was used in the procedures. The mannequins were placed in dental chairs to simulate a clinical setting.

2.4 Validity and Reliability of the Method

After the COCA and COCRA were created, their validity was determined based on face and content validity. Its reliability was determined based on its reproducibility.

As part of the face validity process, eight dental surgeons with extensive experience in restorative dentistry were invited to judge whether the items and their respective classifications were comprehensible, clear, and compatible with the principles used to evaluate the quality of cavity preparations. For the content validity process, the same judges evaluated the items in terms of their necessity in evaluating preparation quality. The number of judges who categorized each item as necessary was used to calculate the content validity ratio (CVR), as proposed by Lawshe [11]. The proposal by Wilson et al. [12] was used ($CVR_{8;0.05}$=0.69) in the decision regarding the cut-off point for necessary versus unnecessary items.

The reliability of the method was determined using intra-examiner reproducibility. A research evaluated the quality of twenty class I cavity preparations for composite resin twice by considering the criteria offered in the proposed method.

2.5 Statistical Analysis

Intra-examiner agreement was estimated using the intraclass correlation coefficient (ρ). After adequate reliability was determined, the data on the dependent variables (quality of the preparations and restorations) were analyzed by descriptive statistics.

3. RESULTS

The criteria established in the COCA to evaluate the quality of cavity preparations are: 1) design (adequate: encompassing main grooves, respecting the curvature of the cusps; partially adequate: encompassing main grooves, not respecting the curvature of up to two cusps; inadequate: encompassing main grooves, but not respecting the curvature of more than two cusps or not fully encompassing the main grooves), 2) mesiodistal length (adequate: encompassing the mesial and distal pits; partially adequate: further of the mesial and distal pit, but maintaining the marginal ridge and dentin support; inadequate: marginal ridge compromised), 3) buccolingual axis length (adequate: diameter of 1.0 to 1.5 of the #1014 diamond bur; partially adequate: up to 2 times the diameter of the #1014 diamond bur; inadequate: greater than 2 times the diameter of the #1014 diamond bur), 4) depth (adequate: diameter of 1.0 to 1.5 of the #1014 diamond bur; partially adequate: up to 2 times the diameter of the #1014 diamond bur; inadequate: smaller than the diameter of the #1014 diamond bur or greater than 2 times the diameter of the #1014 diamond bur), 5) roundness of the internal angles (adequate: rounded internal angles and flat pulpal wall; partially adequate: rounded internal angles and irregular pulpal wall or non-rounded internal angles and flat pulpal wall; inadequate: non-rounded internal angles and irregular pulpal wall).

The criteria established in the COCRA to evaluate the quality of cavity restoration are: 1) presence and evidence of central grooves (adequate: main groove evidenced from the mesial to the distal pit, respecting the curvature of the cusps; partially adequate: main groove evidenced from the mesial to the distal pit, not respecting the curvature of up to two cusps; inadequate: main groove not evidenced from mesial to distal pit and/or not respecting the curvature of more than two cusps), 2) presence and evidence of secondary grooves (adequate: secondary groove evidenced, respecting the curvature of the cusps; partially adequate:

secondary groove partially evidenced, respecting the curvature of the cusps; inadequate: secondary groove not evidenced and/or not respecting the curvature of more than two cusps), 3) angle of the buccal slopes and 4) angle of the lingual-palatal slopes (adequate: proper angulation, respecting the tooth anatomy; partially adequate: improper angulation of one slope; inadequate: inadequate angulation, without respecting the tooth anatomy), 5) fabrication of the mesial fossa and 6) fabrication of the distal fossa (adequate: well-defined pits; partially adequate: partially defined pits; inadequate: nonexistent pits), 7) buccal marginal adaptation and 8) lingual-palatal marginal adaptation (adequate: probe passes freely through the tooth-restoration interface across the buccal and lingual surfaces; partially adequate: probe lightly holds or there is a slight gap up to one point on the buccal or lingual wall; inadequate: probe strongly holds or there is a large gap in one or more points of the buccal or lingual wall), 9) mesial marginal adaptation and 10) distal marginal adaptation (adequate: probe passes freely through the tooth-restoration interface across the mesial and distal surfaces; partially adequate: probe lightly holds or there is a slight gap up to one point on the mesial or distal wall; inadequate: probe strongly holds or there is a large gap in one or more points of the mesial or distal wall).

During the face validity process, the judges considered all of the items of the COCA and COCRA to be relevant and representative (75%-87.5%) and clear (75%-100%). They made some suggestions to improve the wording and standardization of the criteria. The CVR values were higher than the pre-established cut-off point (CVR=0.75-1.0).

The reproducibility values of evaluators 1 and 2 for the analysis of the quality of cavity preparations measured by COCA and restoration measured by COCRA are shown in Table 1.

Intra-examiner COCA reliability of evaluator 1 (ρ=0.76) and evaluator 2 (ρ=1.00) was classified as good and excellent, respectively and Intra-examiner COCRA reliability of evaluator 1 (ρ=0.99) and evaluator 2 (ρ=0.77) was classified as excellent and good, respectively.

The mean and standard deviation of the quality of cavity preparations measured by COCA and restorations measured by COCRA, according to the evaluated tooth are shown in Table 2.

It can be observed that the mean score of the quality preparations of the evaluated teeth varied from 6.70 to 7.65 and of the restorations from 7.00 to 7.68.

4. DISCUSSION

The principal objective of this study was to develop and validate two methods of quality assessment, one for Class I cavity preparation and another for composite resin restoration. To achieve this goal, two objective methods were developed to evaluate the quality of the preparations and restorations using well-established criteria.

It was possible to observe that the methods developed in this study are simple, objective, and easy to apply, as they do not require any device to be applied. The items included in COCA and COCRA methods are important to guarantee the aesthetics and function of the restorative procedures performed and, after a quick calibration of the examiners, they will become easy to be put into practice.

In order to establish the items and criterias for evaluating the quality of both methods, it was followed the recommendations of the Restorative Dentistry course of the School of Dentistry of Araraquara. The Criteria for the Evaluation of Direct and Indirect Restoration approved by the FDI World Dental Federation was also considered [13].

A reproducibility study was performed to determine intra-examiner agreement, and the data obtained demonstrate that the methods are reliable. This is a very important factor in any evaluation method concerned with obtaining reliable data and shows the easy calibration of the examiner for its application, as well as its stability over time [14]. This ease in the calibration of the examiners observed in this work is of great importance, as it is a relevant factor when implementing an evaluation method.

The use of standardized methods to evaluate the quality of dental procedures is essential for the good professional development of the students, in order to improve their learning curve and motor skills [1,5,8]. According to Norcini, Burch (2007) [5], the effectiveness of evaluative feedback can be increased if students are encouraged to participate in this process,

Table 1. Study of the reproducibility of evaluators 1 and 2 for the analysis of the quality of cavity preparations (COCA) and restoration (COCRA)

	COCA		COCRA	
	ρ	Classification	ρ	Classification
Evaluator 1	0.76	Good	0.99	Excellent
Evaluator 2	1.00	Excellent	0.77	Good

Table 2. Mean and standard deviation of the quality of cavity preparations (COCA) and restorations (COCRA), according to the evaluated tooth

Tooth	COCA		COCRA	
16	6.70	± 1.17	7.00	± 1.10
26	7.25	± 1.30	7.52	± 1.00
36	7.30	± 1.21	7.68	± 1.05
46	7.65	± 1.27	7.52	± 0.83

conducting self-assessments and turning this feedback into an action plan for the execution of the proposed procedures. If they are used to the assessment methods utilized by the professors, they can also make questions and participate more of the evaluation process, making this more interactive. But this movement may not be so strongly observed in professors due to lack of objectives methods for these approaches [15]. This further reinforces the importance of the use of standardized methods by professors and students. But to implement this kind of method in educational environments and to have the adherence of professors in its use, it is important to make it as efficient and simple as possible.

The development of a reliable, standardized and effective method is fundamental for the proper evaluation of students, but, in addition, it is necessary that the evaluations made by the examiners using this method are of equal quality and stringency, and that students receive effective feedbacks for their clinical development [4,5]. So, a method easy to calibrate and to be used like COCA and COCRA may be helpful.

Other strategies that could help on the assessment method's application are previous training, setting key points and using types of reminders. Holmboe et al. [16] observed in their study that strategies of remind, such as scoring sheet, can help professors to put the methods in practice and give a more qualified feedback to the students. A study showed that prior training impacts positively in the professors' performance and confidence during students' evaluation and feedback [17]. Another study showed that prior calibration of the faculty also helped they to better evaluate their students, which appeared more satisfied with the quality of feedback they received [3].

In the face validity study of the COCA and COCRA methods, all of its items were classified as necessary. The judges also considered the instruments to be simple, objective, and specific for evaluating the quality of class I cavity preparations and restorations at the preclinical level. These results show the relevance of these methods and how they can facilitate the evaluating process of professors, providing more consistent learning for their students.

In addition, to the best of our knowledge, methods for assessing the quality of restorative procedures at the preclinical level have not been found in the literature. This may occur because there is not a culture of standard assessments in the university, which just reinforces the relevance of this paper and the importance of the methods developed here, given its good results of validity and reliability.

4. CONCLUSION

Thus, the authors could conclude that the cavity preparation and restoration assessment tools proposed herein was found to be simple and reliable for evaluating specific aspects of the quality of class I cavity preparations and restorations and may be useful for standardizing assessments at the preclinical level.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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