ORIGINAL ARTICLE

ASSESSMENT OF INTEREXAMINER VARIABILITY AND CRITERIA FOR POST AND CORE PREPARATION BY ANALYTIC RUBRICS

SYED RASHID HABIB

ABSTRACT

The aim of this study was to assess the various criteria involved in the post and core preparations by the dental students, using an analytic rubric. Seventy-one dental students and six faculty members participated in the study. The students prepared an ivorine single rooted premolar for a cast post and core. The preparation included post-length, post-diameter, ferrule, pattern fabrication and adaptation of the post. The evaluators for the grading used a custom designed 10-point rubric. Variation in all the preparation parameters existed. Overall mean grade was 6.83+1.50 out of ten, with highest and lowest grades awarded were by the evaluator-6 (7.38+.95) and evaluator-4 (5.97+1.51), respectively. This indicated a moderate over all scoring / performance of the students. Students scored highest and lowest in the criteria of post-length (1.45+.47) and post-adaptation (1.30+.54), respectively. The maximum variation of 1.41 in grades was found between evaluator-4 (Total Grade=5.97) and evaluator-6 (Total Grade=7.38). The lowest difference of .02 in total grades was found between evaluator-2 (Total Grade=7.36) and evaluator-6 (Total Grade=7.38). The use of rubrics for the assessments of various success criteria of post and core preparations by the dental students is useful, and can help in finding the inaccuracies and deficiencies within each criterion of their work. Variations in the evaluator's grades still existed despite utilizing analytical rubrics, underscoring the need for continuous efforts in improvement of the rubrics.

Keywords: *Dental students; post and core; evaluation, analytic rubrics.*

This article may be cited as: Habib SR Assessment of interexaminer variability and criteria for post and core preparation by analytic rubrics. Pak Oral Dent J 2020; 40(3):190-96.

INTRODUCTION

The treatment options for the restoration of endodontically treated teeth (ETT) include; amalgam/composite resin restorations, composite resin onlay/overlay/inlay, ceramic onlay/overlay/inlay, gold overlay, and full coverage metal/metal ceramic/zirconia/all ceramic crowns.[1] The full/complete coverage crown is indicated in case of teeth already heavily damaged by dental caries, fractures etc.[2] Intraradicular devices (posts) are used in large numbers for the restoration of these ETT successfully. The selection of post design is critical as it influences the long-term success of the restored teeth.[3] These posts range from custom cast post and core to prefabricated single visit techniques. During the last few decades, a number of prefabricated posts systems are introduced in the market with varying success rate.[4] However, the use of casted post and core is considered the gold standard by many clinicians to ensure the long-term success of the ETT.[5]

The traditional custom cast post and core provides a better geometric adaptation to the excessively flared, elliptical, extremely tapered, irregular shape, atypical canals and requires minimum tooth structure removal.[6] A custom post and core can be casted from a direct resin pattern or an indirect one.[7] Fabrication of direct pattern from autopolymerising resin is considered the method of choice for the teeth with single canal. However, this method is technique sensitive and requires good hand skills to ensure a well fabricated casted post.[8]

As doctors of oral health, dentists are trained to diagnose, treat, prevent oral diseases and manage restorative procedures that preserve tooth structure, replace missing or defective tooth structure, maintain function/esthetic, and promote soft and hard tissue health.[9] In creating curricula, dental faculty must consider the competencies to be developed through the educational process, the learning experiences that will lead to the development of these competencies, and ways to assess or measure the attainment of competencies.[9] Preclinical training in dental education is vital in devel-

Corresponding Address: Dr Syed Rashid Habib, Department of Prosthetic Dental Sciences, College of Dentistry, King Saud University, P. O. Box 60169, Riyadh, 11545, Saudi Arabia. Office Phone: +966 1 467 7230 Mobile: +966 534750834
EMail: rashidhabib@hotmail.com; syhabib@ksu.edu.sa
Received for Publication: Jan 26, 2020
Revision: Feb 10, 2020
Approved: Feb 21, 2020

oping the dental students' psychomotor skills, manual dexterity and comprehension of procedures required for successful restoration of teeth. The provision of best possible dental treatment to the patients can only be achieved with successful completion of preclinical courses preceding the clinical course and graduation.[10]

Teaching and developing basic principles/skills of post and core restorations is a very important part of preclinical training in undergraduate dental curriculum. Nevertheless, the teaching and most importantly the assessment of post and core exercises is challenging for the dental faculty.[11] Traditional glance and grade (subjective) method, rubrics and digital grading are practiced in different institutes.[12] The subjective grading method has been popular for assessments of preclinical exercises in most of the dental schools.[13] Despite in saving time, it presents several disadvantages as it is more generalized assessment and not specific, grades are not true reflection of the students work and feedback to the students is not specific and useful for the students.[14] The use of criteria based evaluation systems popularly known as 'rubrics' is not new in dental education system. Historically it is in place for almost half of the current century.[15] The usefulness of rubrics in the dental education was highlighted and suggested by Dhuru et al.[15] in 1978. Faculty and researchers are still constructing and using the rubrics for their courses in the dental education.[12,16-18] Its practicality and ease, helps in assessments of the dental student's work, and specifically presents advantage over the current advanced digital evaluation devices, to which majority of the dental schools around the globe have limited access.[19] Use of analytic rubrics in preclinical dental courses give appropriate feedback about the student's strengths and weakness in each domain of the practical exercises/exams. According to Al Amri et al.[20], the rubrics also help the junior faculty members in true assessments of the students work like their senior colleagues.

Development of a rubric system for the assessment of each step involved in post and core preparations can help in finding out a dental student's deficiencies/ weak areas. Thus, the objective of the present study was to assess post and core preparations by the dental students, using a custom designed analytic rubric. The study also evaluated the inter-evaluator variability in grades awarded to the students.

MATERIALS & METHODS

The present research was carried out at Prosthetic Dental Sciences Department, College of Dentistry, King Saud University. An ethical approval for the study was obtained from College of Dentistry Research Center (CDRC Registration # FR0501).

The study participants were seventy-one third year dental students. Six Prosthodontic faculty members with minimum five years teaching experience were selected as the evaluators for the post and core preparations by the dental students. It was a double blind study where the students and examiners information was kept confidential from each other.

An ivorine single rooted lower right first premolar tooth (#44) was selected for the post and core preparation. The participating students were asked to perform endodontic treatment of the ivorine tooth, mount the tooth in sectioned arch jaw dentoform with resin, and section it horizontally at the junction of occlusal 2/3rd with cervical 1/3rd. The sectioning was performed to simulate the clinical scenario of badly broken down coronal tooth structure, which is an indication for cast post and core. After the students prepared the teeth, they were assessed radiographically for optimal endodontic treatment and visually for the mounting and sectioning (Figure 1). The students were asked to redo the teeth, which were found with poor quality of endodontic treatment and mounting.

The students have already completed a post and core preparations exercise earlier during their preclinical training. They were again given instructions regarding this post and core preparation task using direct technique of resin pattern fabrication. The students were also familiarized with the evaluation criteria (rubrics) used for evaluation before commencement of the exercise. The preparation included post length; post diameter; tooth preparation / ferrule; core build up / resin pattern fabrication; and post adaptation (Figure 2). Time allowed for the preparation was decided to be two hours and all the participating students finished on time.

The prepared teeth were collected and labelled after the exercise. A custom designed analytic rubric resembling a grid was used for the evaluations by six evaluators. This analytic rubric included all the important criteria of post and core preparation by direct technique.[8] The criteria were listed in the left most column with levels of grades against each criterion listed along the rows that included description of the grade to be awarded in squares (Table 1). The scoring for each of the criterion was completed and noted on the right most column. The final grade awarded to the student was calculated by summing up the scores of all the criteria (Table 1).

Each student's individual score was recorded on a separate sheet by all the six evaluators. The serial number on the prepared teeth and the printed sheets were matched and blinded for the evaluators. The evaluators were already familiar with the rubrics used for the preparation. However, they were further trained

and calibrated before they started the evaluation. The evaluators were provided with a printed version of the evaluation sheet and the evaluation criteria were described and explained to them in detail. The evaluators reviewed the evaluation criteria and then successfully completed grading independently for a sample of student's work.

The first two criteria were graded from the radiographs recorded before and after the post space preparations (Figure 1). The third and fourth criteria were evaluated visually by the evaluators, with the resin pattern and post inside the canal (Figure 2a). While the last criterion was graded visually after the resin patterns were removed from the teeth (Figure 2b). No time limit for the evaluations was set but the evaluators were requested to do the evaluations individually and not together.

In the current rubrics used for the study, five criteria of post and core preparation were evaluated, which were out of total ten grades, two for each criterion. The grades to be awarded against each criterion were further subdivided into: 2 points for excellent; 1.5 points for good; 1 point for fair/acceptable; 0.5 points for poor and 0 points for unacceptable. (Table 1).

Statistical Package for Social Sciences version #22 was used for the analysis of the collected data. The significance level was set at $P \leq 0.05$. The statistical analysis included descriptive statistics, ANOVA, and Post Hoc Tukey HSD test for assessment of variations in the final grades, against each of the five criteria and the inter-evaluator grading by the six evaluators.

RESULTS

In the present study, various criteria involved in post and core preparation were analyzed by using rubrics. Six different evaluators assessed the criteria for seventy-one third year preclinical dental students Table #2 describes the grading of individual criterion and total of all criteria by the six evaluators. One-way analysis of variance indicated significant difference for all the preparation criteria except for post adaptation among the evaluators, meaning the existence of variation in the grades awarded by the evaluators. Evaluator # 6 (7.38+.95) awarded the highest over all grades and the lowest grades were by the evaluator # 4 (5.97 ± 1.51). The overall total mean grades of all the evaluators was found to be 6.83 ± 1.50. This indicated a moderate over all scoring/performance of the students in the post and core preparation. The student's performance was best in post length ($1.45 \pm .47$) criterion and poor most in post adaptation criterion ($1.30 \pm .54$) [Table 2].

In Table 3 the inter-evaluators comparison of the total grades awarded by each evaluator is presented. Significant differences were found among the evaluator's total grades by Post Hoc Tukey HSD test. This indicated variations among the evaluator's grades. The maximum variation of 1.41 in the grades was found between evaluator # 4 (Total Grade=5.97) and evaluator # 6 (Total Grade=7.38). The least difference of .02 in total grades was found between evaluator # 2 (Total Grade=7.36) and evaluator # 6 (Total Grade=7.38).

With respect to the criteria utilized the greatest and least inter-evaluator variation with Post Hoc Tukey test was noted for the post diameter and post adaptation, respectively (Table 4).

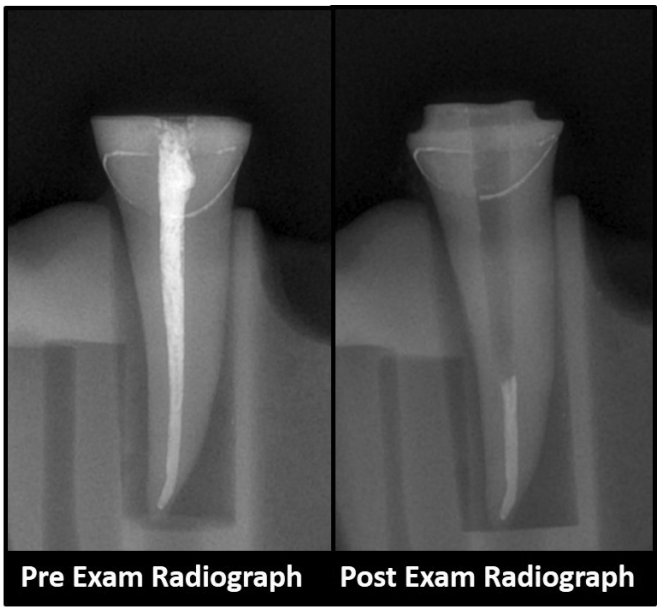

Fig 1. Radiographs recorded before and after the post space preparation.

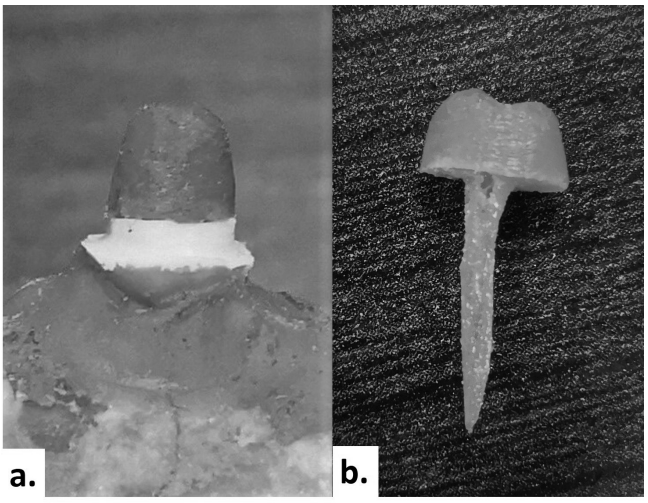

Fig 2: a. Final preparation of the tooth including ferrule and resin pattern fabrication.; b. Relined resin pattern.

TABLE 1. POST AND CORE EVALUATION CRITERIA.

Criterion	Grades					Score
	2 points Excellent	1.5 points Good	1 point Fair/ acceptable	0.5 points Poor	0 points Unacceptable	
Post length (radiograph)	Optimal length Post space prepared with Apical seal = 5 mm	Minimally under prepared Post space prepared with Apical seal = 5-6 mm	Minimally over prepared Post space prepared with Apical seal = 4 mm	Moderately over/under prepared Post space prepared with Apical seal = 3-4 mm or 6-7 mm	Severely over or under prepared Post space prepared with apical seal = < 3 mm or > 7 mm	
Post diameter (radiograph)	Optimal preparation No gap left on the walls	Minimally under prepared Gap left on the walls	Minimally over prepared Minor ledge formation / minor deviation of angle of drilling	Moderately over prepared Ledge formation / moderate deviation of angle of drilling	Severely over prepared Perforation / severe deviation of angle of drilling	
Tooth preparation/ferrule (visual inspection)	Optimal preparation 2mm of ferrule with chamfer margin	Minimally over prepared 1.5 mm of ferrule with chamfer margin	Moderately over prepared 1 mm of ferrule Margin not well defined	Severely over prepared < 1 mm of ferrule with no definitive margin	No preparation Absence of any ferrule / and no preparation margin	
Core build up / resin pattern (visual inspection)	Optimal Build up resin pattern blending with tooth structure with proper retentive features and well finished	Over tapered build up Core build up / resin pattern – blends with tooth structure with excessive tapered	Under build up Core build up / resin pattern = 2-3 mm and poorly finished	Moderately over/under build up Core build up / resin pattern = 5-6 mm or 1-2 mm with slight undercut	Severely over/ under build up Core build up / resin pattern = > 6 mm or < 1 mm with severe undercut	
Post adaptation (visual inspection)	Optimal adaptation Well-fitting, removable relined post / Absence of voids	Loose adaptation Loosely-fitting relined post / absence of voids	Tight adaptation Snuggly fitting relined post / post removable with force / presence of minimal voids	Voids on post Presence of gross voids / loosely fitting relined post	Non-removable post Post cannot be removed from the tooth / fracture of core from post	

Total score out of 10.

DISCUSSION

In the current study, various internationally recognized evaluation criteria for the post and core preparations were assessed.[2,5,6] The inter-evaluator variation in the assessments was also investigated. It is important for the dental students to develop skills for post and core step involved in the restoration of ETT in the preclinical courses.[20] However, assessment of the students for this exercise is challenging for the faculty. In the current study, an attempt was made in standardizing the evaluation instrument by using ivorine teeth of the same size and shape for all the students. The analytic rubrics used in this study attempted to overcome the difficulty of assessing the post and core exercises by the students. The students were familiarized with the criteria and this helped in standardization of the grading method as well as provided feedback that was more objective to each student for each criterion.

The results indicated an overall grade of 6.83 out of 10 (68.3%) as awarded by the six evaluators. This indicated a moderate score of achievement by the participating students compared to the average scores of

TABLE 2. MEAN (STANDARD DEVIATION) OF PARAMETERS FOR POST AND CORE PREPARATION (N=426).

Criterion	Evaluators (n=426)						Overall mean	P-value
	1 (n=71)	2 (n=71)	3 (n=71)	4 (n=71)	5 (n=71)	6 (n=71)		
Post length	1.39 (.48)	1.40 (.57)	1.43 (.54)	1.25 (.46)	1.55 (.31)	1.70 (.28)	1.45 (.47)	0.000
Post diameter	1.35 (.45)	1.51 (.45)	1.19 (.56)	1.04 (.53)	1.48 (.31)	1.57 (.26)	1.36 (.48)	0.000
Tooth preparation / ferrule	1.28 (.49)	1.54 (.44)	1.32 (.51)	1.23 (.44)	1.43 (.30)	1.37 (.26)	1.36 (.43)	0.000
Core build up / resin pattern	1.33 (.51)	1.62 (.62)	1.12 (.44)	1.21 (.43)	1.44 (.24)	1.32 (.29)	1.34 (.46)	0.000
Post adaptation	1.26 (.55)	1.28 (.74)	1.25 (.64)	1.22 (.59)	1.40 (.29)	1.40 (.24)	1.30 (.54)	0.176
Total out of 10	6.64 (1.51)	7.36 (1.59)	6.30 (1.75)	5.97 (1.51)	7.33 (.90)	7.38 (.95)	6.83 (1.50)	0.000

TABLE 3. INTER-EVALUATOR COMPARISONS OF THE TOTAL GRADES BY *POST HOC TUKEY HSD TEST.

Evaluator	1	2	3	4	5
1	-	.025	.709	.060	.043
2	.025	-	.000	.000	1.00
3	.709	.000	-	.745	.000
4	.060	.000	.745	-	.000
5	.043	1.00	.000	.000	-
6	.021	1.00	.000	.000	1.00

*p-value was significant at $p < .05$

the students for the tooth preparation exercises 7.6 out of 10 (76%) previously reported by Habib et al.[12] Unavailability of research studies on the evaluations of post and cores makes the comparison of the current study results with other studies difficult. For most of the evaluators, their average scoring compared to the overall mean (6.83±1.50) scoring was within a range of up to ±1 grade. However, it was evident that most of the evaluators had some agreement/consistency among their grades and this observation is close to findings of Satheesh et al.[21] who reported increased reliability of 90.2% with the use of analytic rubrics in their research study. The difference in the examiners teaching and evaluations experience that varied (5-30 years) could be the reason for the evaluators grade variations. Another explanation for the inter examiner variation could be the infrequent use of rubrics by the faculty for the post and core preparations. Traditionally the preclinical prosthodontic teaching focus mainly on tooth preparation exercises and the trainers/evaluators are well versed with the evaluation criteria for these exercises. Nevertheless, in the current study an attempt was made to standardize the grading for the relatively less frequent post and core preparation exercise.

It has been observed that the students in their preclinical fixed prosthodontic courses usually score better for the tooth preparation exercises[12,20] compared to the post and core preparations. This could be related to the time devoted to the post and core exercises which is much less compared to the tooth preparation exercises. Dental students spend most of their preclinical courses time for the tooth preparations and their provisionalization exercises. Another possible reason could be that the students undergo several tooth preparation exams, which significantly improves their tooth preparation skills compared to post and core exam, which is less frequent. Furthermore, steps like mounting and endodontic treatment involved in the preparation of the exam tooth further complicates the conduction of post and core exam. Nevertheless, the common presence of ETT/badly decayed teeth requiring cast post and core for the restoration of their teeth makes this important

TABLE 4. RESULTS OF POST HOC TUKEY HSD TEST* COMPARING THE SCORES OF 6 EVALUATORS WITHIN EACH CRITERION.

Criterion	Evaluator	1	2	3	4	5
Post length	2	1.00	-	-	-	-
	3	.998	.9999	-	-	-
	4	.451	.394	.205	-	-
	5	.291	.340	.571	.001	-
	6	.001	.001	.006	.000	.394
Post diameter	2	.251	-	-	-	-
	3	.251	.000	-	-	-
	4	.001	.000	.351	-	-
	5	.468	.999	.001	.000	-
	6	.031	.957	.000	.000	.822
Tooth preparation / ferrule	2	.005	-	-	-	-
	3	.996	.026	-	-	-
	4	.982	.000	.839	-	-
	5	.293	.668	.603	.061	-
	6	.839	.162	.982	.408	.947
Core build up /resin pattern	2	.003	-	-	-	-
	3	.055	.000	-	-	-
	4	.597	.000	.824	-	-
	5	.718	.174	.000	.032	-
	6	1.00	.001	.090	.718	.597
Post adaptation	2	1.00	-	-	-	-
	3	1.00	.999	-	-	-
	4	.997	.982	1.00	-	-
	5	.635	.778	.533	.339	-
	6	.635	.778	.533	.339	1.00

*p-value was significant at $p < .05$.

exercise/exam worthwhile.

With regards to the scoring in various post and core criteria, the students' performance was best (1.45±.47) in the post length preparations, followed by the post diameter (1.36±.48), ferrule (1.36±.43), resin pattern (1.34±.46) and post adaptation (1.30±.54). While different opinions exists as to the length of the post preparation, authors mostly agree that the post should not disturb the apical seal. Schwartz and Robbins (2004)[5] stated that leakage was reduced considerably when an excess of 4 mm of gutta-percha remained in the apex of the canal, a minimum requirement to prevent the leakage and reduce the chances of periapical infection.[2] According to some researchers the increase in post diameter leads to increased retention because of the increase in the surface area available for adhesion.[22] On the other hand, other studies reported that increasing post diameter was an inefficient way of increasing its retention and suggested the optimum diameter of the post to be one-third the diameter of the root.[22] To reduce failures and fractures, Mou et al[23] recommended that the optimum cast post to root diameter ratio should be approximately 1:4. However, the desired post diameter should be determined based on the morphology of the tooth to avoid unnecessary removal of sound tooth structure.[24] These important aspects were considered while designing of the evaluation criteria in the current rubrics. The better performance of the students in the post length and post width criteria could be related to their improved endodontic skills acquired from the preclinical endodontic courses.[25] From the results it was evident that students were struggling in the post adaptation criterion as well as the resin pattern fabrication which could be due to their underdeveloped skills in handling of the autopolymerising resin used for the relining, which requires practice and expertise.

The results of the current study should be interpreted with caution due to some limitations of the study.

The limitations included variations in the endodontic treatment of the prepared teeth, using ivorine teeth instead of natural teeth for the study and the sum of grades awarded in each criterion making the overall grade higher for some students, despite those students making major errors in some criterion. Nevertheless, the information provided in this study about rubrics for post and core assessment can help in reducing the burden on faculty in their preclinical evaluation. It is recommended to devote more time for the post and core exercises in the preclinical courses, utilize rubrics for the evaluations of prefabricated post and core exercises and revise/modify the rubrics regularly to ensure its effectiveness.

CONCLUSIONS

The use of rubrics for the assessments of various success criteria of post and core preparations by the dental students is useful, and can help in finding the inaccuracies and deficiencies within each parameter of their work. Variations in the evaluator's grades still existed despite utilizing analytical rubrics, underscoring the need for continuous efforts in improvement of the rubrics.

ACKNOLEDGEMENT

The author is thankful to the students who participated in the study and to the evaluators for their time and efforts in the evaluations of the student's exercise. The College of Dentistry Research Center / Deanship of Scientific Research at King Saud University (Registration number FR 0501) approved the research project.

REFERENCES

1 Santos-Junior AO, De Castro Pinto L, Mateo-Castillo JF, Pinheiro CR. Success or failure of endodontic treatments: A retrospective study. J Conserv Dent 2019 Mar-Apr;22(2):129-132.

2 Slutzky-Goldberg I, Slutzky H, Gorfil C, Smidt A. Restoration of endodontically treated teeth review and treatment recommendations. Int J Dent 2009;2009:150251. doi: 10.1155/2009/150251. Epub 2010 Jan 26.

3 Tikku AP, Chandra A, Bharti R. Are full cast crowns mandatory after endodontic treatment in posterior teeth? J Conserv Dent 2010 Oct;13(4):246-8. doi: 10.4103/0972-0707.73382.

4 Carvalho MA, Lazari PC, Gresnigt M, Del Bel Cury AA, Magne P. Current options concerning the endodontically-treated teeth restoration with the adhesive approach. Braz Oral Res 2018 Oct 18;32(suppl 1):e74. doi: 10.1590/1807-3107bor-2018.vol32.0074.

5 Schwartz RS, Robbins JW. Post placement and restoration of endodontically treated teeth: a literature review. J Endod 2004 May;30(5):289-301.

6 Khaledi AA, Sheykhian S, Khodaei A. Evaluation of Retention of two Different Cast Post-Core Systems and Fracture Resistance of the Restored Teeth. J Dent (Shiraz) 2015 Jun;16(2):121-8.

7 Dangra Z, Gandhewar M. All about Dowels - A Review Part I. Considerations before Cementation. J Clin Diagn Res 2017 Aug;11(8):ZG06-ZG11. doi: 10.7860/JCDR/2017/26472.10518. Epub 2017 Aug 1.

8 Rayyan MR, Aldossari RA, Alsadun SF, Hijazy FR. Accuracy of cast posts fabricated by the direct and the indirect techniques. J Prosthet Dent 2016 Sep;116(3):411-5. doi: 10.1016/j.prosdent.2016.02.002. Epub 2016 Apr 7.

9 Competencies for the New General Dentist. Retrieved from: https://www.adea.org/about_adea/governance/Pages/Competencies-for-the-New-General-Dentist.aspx

10 Velayo BC, Stark PC, Eisen SE, Kugel G. Using dental students' preclinical performance as an indicator of clinical success. J Dent Educ 2014 Jun;78(6):823-8.

11 Sadid-Zadeh R, Sannito NM, DeLuca JT. Comparison of Effectiveness of Two Teaching Methods on Acquisition of Skills in Preclinical Fixed Prosthodontics. J Dent Educ 2019 Mar;83(3):314-321. doi: 10.21815/JDE.019.032. Epub 2019 Jan 28.

12 Habib SR. Rubric system for evaluation of crown preparation performed by dental students. Eur J Dent Educ 2018 Aug;22(3):e506-e513. doi: 10.1111/eje.12333. Epub 2018 Mar 1.

13 Taylor, Carly & Grey, Nick & Satterthwaite, Julian. Assessing the Clinical Skills of Dental Students: A Review of the Literature. J. Edu. & Learn. 2013;2:10.5539/jel.v2n1p20.

14 Malouff, John & Thorsteinsson, Einar. Bias in grading: A meta-analysis of experimental research findings. Aust. J. Educ. 2016; 60:10.1177/0004944116664618.

15 Dhuru VB, Rypel TS, Johnston WM. Criterion-oriented grading system for preclinical operative dentistry laboratory course. J Dent Educ 1978 Sep; 42(9):528-31.

16 Bindayel NA. Reliability of rubrics in the assessment of orthodontic oral presentation. Saudi Dent J 2017 Oct;29(4):135-139. doi: 10.1016/j.sdentj.2017.07.001. Epub 2017 Aug 2.

17 Huth KC, Baumann M, Kollmuss M, Hickel R, Fischer MR, Paschos E. Assessment of practical tasks in the Phantom course of Conservative Dentistry by pre-defined criteria: a comparison between self-assessment by students and assessment by instructors. Eur J Dent Educ 2017 Feb;21(1):37-45. doi: 10.1111/eje.12176. Epub 2015 Dec 8.

18 Habib SR, Sherfudhin H. Students' self-assessment: a learning tool and its comparison with the faculty assessments. J Contemp Dent Pract 2015 Jan 1;16(1):48-53.

19 O'Donnell JA, Oakley M, Haney S, O'Neill PN, Taylor D. Rubrics 101: a primer for rubric development in dental education. J Dent Educ 2011 Sep;75(9):1163-75.

20 Al Amri MD, Sherfudhin HR, Habib SR. Effects of Evaluator's Fatigue and Level of Expertise on the Global and Analytical Evaluation of Preclinical Tooth Preparation. J Prosthodont 2018 Aug;27(7):636-643.

21 Satheesh KM, Brockmann LB, Liu Y, Gadbury-Amyot CC. Use of an Analytical Grading Rubric for Self-Assessment: A Pilot Study for a Periodontal Oral Competency Examination in Predoctoral Dental Education. J Dent Educ. 2015 Dec;79(12):1429-36.

22 Stockton LW. Factors affecting retention of post systems: a literature review. J Prosthet Dent. 1999 Apr;81(4):380-5.

23 Mou YB, Chen YM, Smales RJ, Yip KH. Optimum post and tooth root diameters for a cast post-core system. Am J Dent 2009;22(5):311-4.

24 AL-Omiri MK, Mahmoud A, Rayyan M, Abu-Hammad O. Fracture resistance of teeth restored with post retained restorations: An overview. J Endod 2010;36(9):1439-1449.

25 Martino N, Truong C, Clark AE, O'Neill E, Hsu SM, Neal D, Esquivel-Upshaw JF. Retrospective analysis of survival rates of post-and-cores in a dental school setting. J Prosthet Dent 2019 Jul 26. pii: S0022-3913(18)30702-9. doi: 10.1016/j.prosdent.2019.05.003. [Epub ahead of print].