

Critical appraisal study skills among dental students in Kanpur rural region: A randomized control study

ABSTRACT

Context: Critical appraisal (CA) is a way of determining and interpreting information by objectively considering its significance, results, and importance to an individual's work, and it is based on careful empirical assessment.

Aims: The aim of the study was to assess the effect of CA exercises on the quality of preclinical tooth preparation skills and the confidence level of undergraduate dental students.

Settings and Design: This was a randomized control study conducted at a private dental college in Kanpur rural region, Uttar Pradesh.

Subjects and Methods: One hundred and forty-three student volunteers were randomly divided into CA (CA; $n = 78$) and control (C; $n = 65$) groups. Both groups were given a conventional lecture and video demonstrations; the CA group also gave CA exercises. Six evaluators assessed the incisor, canine, premolar, and molar preparations made by all students.

Statistical Analysis Used: Descriptive statistics were used to describe the groups across all parameters. An independent samples *t*-test was conducted to compare the eight parameters of the two groups.

Results: The mean overall scores assigned to the CA group by all evaluators were significantly higher (independent *t*-test, $P < 0.05$) than the C group for incisor (CA: 6.19 ± 1.28 , C: 5.34 ± 1.86), canine (CA: 5.88 ± 1.37 , C: 4.94 ± 1.68), premolar (CA: 5.88 ± 1.09 , C: 4.73 ± 1.19), and molar (CA: 5.94 ± 1.63 , C: 5.39 ± 0.04) teeth. The CA group also demonstrated a significant increase in self-confidence over that of the C group (repeated measures general linear model $F = 7.886$, $P = 0.0421$).

Conclusions: Critical assessment activities greatly enhanced undergraduate dental students' preclinical tooth preparation abilities, as well as their confidence level.

Keywords: Dental education, pedagogy, preclinical practice, prosthodontics, tooth preparation

INTRODUCTION

Critical appraisal (CA) is defined in one standard definition as "appraisal based on the careful analytical evaluation."^[1] Parkes *et al.* describe CA as the process of assessing and interpreting evidence by systematically considering its validity, results, and relevance to an individual's work.^[2] CA skills are considered integral parts of evidence-based learning (EBL).^[3] Convincing arguments have been made to promote EBL as the principal teaching method in medical and dental colleges.^[4,5] Shin *et al.* found that EBL leads to improved knowledge in students even 10 years after leaving medical college.^[6] Norman and Shannon found significant improvements in undergraduate students' knowledge trained in critical appraisal skills.^[7] The benefits of CA skills have also been observed in other dimensions of student learning. In the 21st century, medical

and dental students must think their way through abstract problems, work in teams, distinguish good information

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from bad, and be multilingual and globally/environmentally sensitive to be more effective in their disciplines. The benefits of CA skills have also been observed in other dimensions of student learning. In the 21st century, medical and dental be multilingual and globally/environmentally sensitive to be more effective in their disciplines.^[8,9]

The preclinical laboratory offers an excellent controlled platform to conduct research in health professions education. Polyzois *et al.* have shown that evaluation exercises can improve the preclinical performance of dental students in operative dentistry.^[10] However, the effects of appraisal training exercises on dental students' clinical/preclinical performance have been obtainable in scarce literature. Furthermore, the psychological aspects of evaluation, namely loss of confidence due to increased self-consciousness and over-expectation, have been less studied in dental education. The current study was thus designed to examine the effect of CA exercises on the quality of preclinical tooth preparation skills and the confidence level of undergraduate dental students.

SUBJECTS AND METHODS

Study design and site

This research was a randomized control study conducted between January and March 2021 on students of a private dental college in rural areas in Kanpur.

Selection of study participants and ethical considerations

Students were enrolled in this study based on the following inclusion criteria: final-year undergraduate dental students who had not been taught the procedure and principles of tooth preparation, and final-year undergraduate dental students who had not attempted a tooth preparation. An institute ethical committee-approved informed consent was obtained from all eligible students. Both groups were exposed to a conventional classroom lecture followed by video demonstrations of maxillary incisor, canine, premolar, and molar preparations in the preclinical laboratory. Then, the students were randomly divided into two groups: the CA group ($n = 78$) and the control (C) group ($n = 65$) by a computer-generated list. The two groups were comparable in age, gender, and grades in a preclinical prosthodontic practical examination conducted in the previous year. The pretest power of the study was determined to be 88.7% at $n = 65$ in the control group.

Calibration of examiners

Six faculty members at the college volunteered to be evaluators in this study.

Reproducibility test

There were zero dropouts in this study. The sample available for data analysis was $n = 78$ in the CA group and $n = 65$ in the C group. A *post hoc* power analysis test was also performed to test the validity of the results.

Data collection procedure

After the demonstration, the CA group was asked to critically appraise the quality of previously prepared maxillary incisors ($n = 8$), canines ($n = 7$), premolars ($n = 8$), and molars ($n = 6$). After evaluation, the correct answers were discussed with the students. Subsequently, the group was asked to complete another CA exercise on another independent set of the previously prepared incisor ($n = 8$), canine ($n = 8$), premolar ($n = 8$), and molar ($n = 8$) teeth and the answers were discussed as before.

Students from both groups were asked to prepare a maxillary incisor, canine, premolar, and molar tooth on standardized preclinical typodont models. The 168 teeth prepared by all participants were tagged and packaged in an envelope with random dummy numbers to ensure evaluator blinding. Each tooth was evaluated under seven parameters. The following parameters were used to evaluate the incisor and canine teeth: proximal taper, labial biplanar reduction, incisal edge preparation, lingual reduction, margin preparation, undercut-free preparation, and overall score. The following parameters were used to evaluate premolar and molar teeth: proximal taper, occlusal reduction, functional cusp bevel, buccolingual taper, margin preparation, undercut-free preparation, and overall score. The teeth prepared by the two groups were shuffled and placed into a single pool for assessment. Each parameter was blindly rated on a scale of 10 by all six evaluators.

Both groups were asked to complete a pretest dental institute-approved self-confidence, self-evaluation questionnaire immediately after the lecture and video demonstration and posttest self-confidence, and self-evaluation questionnaire after completing all the tooth preparations.^[11]

Statistical analysis

Descriptive statistics were used to describe the groups across all parameters. An independent samples *t*-test was conducted to compare the seven parameters of the two groups. A repeated measures general linear model test was done to compare the change in confidence and self-evaluation before and after the exercise between the two groups. The scores of each individual parameter from all six evaluators were combined before analysis.

RESULTS

Demographic characteristics

A total of 143 dental college undergraduates were enrolled in the study: 65 in the control group and 78 in the CA group [Table 1]. The mean age of the study participants was 22.8 and 24.6 years within the range of 21–25 years. Females were more in number: 58 – control group and 70 – CA

Table 1: Characteristics of control group and critical appraisal group in study

	Control group (n=65)	CA group (n=78)	Significance P<0.05
Age (years)	21-23	22-25	-
Mean age	22.8	24.6	-
Males	7	8	-
Females	58	70	-
Year in undergraduate school	Third year	Final year	-
Previous education	HSC	HSC	-
Preclinical prosthodontic examination scores, mean±SD	72.96±2.56	78.84±5.34	<0.001

HSC: Higher secondary school, SD: Standard deviation, CA: Critical appraisal

group. Preclinical prosthodontic examination scores for the control and CA groups were 72.96 ± 2.56 and 78.84 ± 5.34 , respectively [Table 1].

Association between prevalence of critical appraisal exercise and associated factors

The independent samples *t*-test revealed a statistically significant improved performance in the CA group's scores over the C group for the mentioned criteria. The CA group's incisor teeth received significantly higher ratings for taper, incisal bevel preparation, undercut-free preparation, smoothness of preparation, and overall score [Table 2]. The CA group's canine teeth were rated significantly better in terms of taper, incisal bevel preparation, undercut-free preparation, smoothness of preparation, and overall score [Table 3]. The premolar teeth prepared by the CA group were rated significantly better in proximal taper, buccolingual taper, occlusal reduction, functional cusp bevel, margin preparation, undercut-free preparation, smoothness of preparation, and overall score [Table 4]. The molar teeth prepared by the CA group were rated significantly better in occlusal reduction, functional cusp bevel, smoothness of preparation, and overall score [Table 5]. Furthermore, there was a substantial increase in students' self-confidence in the CA group when compared to the C group (repeated measures general linear model [Table 6].

DISCUSSION

The results of this study show that CA-based skills increased the quality of these undergraduate students' teeth preparation significantly. Similar to the Veeraiyan and Sekhar study, the outcomes of this investigation exhibit great internal validity.^[12] Because the critical evaluation activities do not include any hands-on practice, the findings of this study can be attributed solely to teaching methods and psychological components of learning. Many factors could have confounded the observed effects of CA-based skills: initial teaching methodology, Hawthorne effect, evaluator variation, CA exercise, peer review observational learning, self-efficacy, self-confidence, development of self-concept, role-play, and critical pedagogy.^[12]

The method and medium of instruction employed in the initial teaching methodology can greatly influence the

quality of learning by the student.^[13] Traditional lectures are considered to be one of the most effective methods of teaching in dentistry.^[14,15] Video demonstration enhances the learning from a lecture and is considered to be one of the most standardized modes of instruction.^[16] Since the teaching method used in this study ensured equal exposure to lecture and video demonstration between the CA and C groups, they could not have influenced the observed difference in the quality of tooth preparation performed by the two groups. Another important factor that could influence the outcome of any study is the Hawthorne effect; however, the influence of this effect was erased by the addition of a matched randomized control group in the study. Variation among the six evaluators is also not a concern in the results of this study because the data from the evaluators were averaged to arrive at a mean evaluation score for each tooth of each participant. Furthermore, since this factor was common to both groups, it could not have selectively influenced the results of the CA group.

The CA exercises were exclusive to the CA group and so could have affected the results of the study. Although the role of CA on the students' skills has not been studied before, one study mentioned the existence of a possible correlation between EBL and clinical skill.^[2] The results of our study suggest that the CA-based skill exercise improved the quality of tooth preparation in a preclinical setting effect. Although the exact mechanism through which the exercise improved the performance is unclear, a combination of factors could offer a possible explanation. Critical assessment-based skill exercises teach students to understand what an evaluator looks for. This knowledge can help students focus on methods to minimize errors and improve performance. This form of observational learning has been shown to have a powerful impact in general education settings.^[17-19]

In our study, only the CA group did a review of previously prepared teeth, which probably increased their awareness of the common errors in tooth preparation, which was similar to the study done by Veeraiyan and Sekhar.^[12] This awareness, in turn, could have contributed to the difference in the quality of the preparation prepared by the two groups.

Table 2: Comparison of mean scores (\pm standard deviation) of control group and critical appraisal group in incisor preparations

Incisor evaluation	Control group (n=65)	*CA group (n=78) Mean/SD**	Significance P<0.05
Proximal taper	5.27 \pm 1.36	6.49 \pm 1.14	<0.001
Labial plane reduction	5.89 \pm 1.37	6.55 \pm 1.38	0.0049
Lingual reduction	4.96 \pm 1.69	5.68 \pm 1.47	0.0073
Bevel	4.36 \pm 1.56	5.67 \pm 1.43	<0.0001
Margin	5.37 \pm 1.54	6.99 \pm 1.42	<0.0001
Undercut-free preparation	5.98 \pm 1.08	6.77 \pm 0.83	<0.0001
Overall score	5.34 \pm 1.86	6.19 \pm 1.28	0.0016

*The CA group performed significantly better than the control group with independent samples t-test, **SD: Standard deviation. CA: Critical appraisal

Table 3: Comparison of mean scores (\pm standard deviation) of control group and critical appraisal group in canine preparations

Canine evaluation	Control group (n=65)	*CA group (n=78) Mean/SD**	Significance P<0.05
Proximal taper	5.38 \pm 0.64	6.84 \pm 0.94	<0.0001
Labial plane reduction	4.95 \pm 2.01	5.88 \pm 1.24	0.0009
Lingual reduction	4.98 \pm 1.09	4.94 \pm 1.47	0.8561
Bevel	4.89 \pm 1.56	5.38 \pm 1.54	0.0617
Margin	5.98 \pm 1.63	5.68 \pm 1.68	0.2830
Undercut-free preparation	5.69 \pm 1.86	5.94 \pm 1.97	0.4397
Overall score	4.94 \pm 1.68	5.88 \pm 1.37	0.0003

*The CA group performed significantly better than the control group with independent samples t-test, **SD: Standard deviation. CA: Critical appraisal

Just as blinded peer review improves the quality of research in a journal, a similar effect could have influenced the output of the CA group. Bandura's self-efficacy theory states that an individual's performance is directly proportional to their expectation. The expectation of a student has been reported to increase with previous success and gain in knowledge.^[20,21]

The self-efficacy of the CA group could have improved following the gain in knowledge due to the CA exercise. Improvement in self-efficacy leads to greater self-confidence, which can greatly improve individual performance (known as the Galatea effect).^[22,23] Along with self-confidence, one's self-esteem, stability, and self-crystallization create self-concept.^[20,24] The confidence level of the students in both groups increased during our study. However, the increase in confidence level was greater in the CA group than in the control group. Although this finding was not statistically significant, the role of the Galatea effect on the quality of tooth preparation cannot be ruled out.

There were some limitations to this study; however, there was a significant improvement in undergraduate students' skills, still the relationship between the magnitude of CA

Table 4: Comparison of mean scores (\pm standard deviation) of control group and critical appraisal group in premolar preparations

Premolar evaluation	Control group (n=65)	*CA group (n=78) Mean/SD**	Significance P<0.05
Proximal taper	5.52 \pm 1.16	6.13 \pm 1.08	0.0014
Buccolingual taper	4.98 \pm 1.68	6.08 \pm 1.05	0.0001
Occlusal reduction	4.88 \pm 0.91	6.72 \pm 0.88	<0.0001
Bevel	3.94 \pm 1.21	5.33 \pm 1.84	<0.0001
Margin	4.63 \pm 1.34	5.69 \pm 1.38	<0.0001
Undercut-free preparation	4.71 \pm 1.94	5.73 \pm 1.44	0.0004
Overall score	4.73 \pm 1.19	5.88 \pm 1.09	0.0001

*The CA group performed significantly better than the control group with independent samples t-test, **SD: Standard deviation. CA: Critical appraisal

Table 5: Comparison of mean scores (\pm standard deviation) of control group and critical appraisal group in molar preparations

Molar evaluation	Control group (n=65)	*CA group (n=78) Mean/SD**	Significance P<0.05
Proximal taper	5.72 \pm 0.98	6.33 \pm 0.76	<0.0001
Buccolingual taper	5.88 \pm 0.64	6.24 \pm 0.81	0.0043
Occlusal reduction	4.69 \pm 0.82	4.22 \pm 0.92	0.0017
Bevel	3.68 \pm 0.54	8.36 \pm 1.54	<0.0001
Margin	5.98 \pm 0.87	6.28 \pm 1.25	0.1047
Undercut-free preparation	5.63 \pm 0.49	6.37 \pm 1.02	<0.0001
Overall score	5.39 \pm 0.84	5.94 \pm 1.63	0.0151

*The CA group performed significantly better than the control group with independent samples t-test, **SD: Standard deviation. CA: Critical appraisal

training and the improvement in student skill has not been investigated. Furthermore, the impact of multiple CA exercises has yet to be determined. Other limitations include the fact that the results are based on a single data set obtained from a small group of dental students from a single institution.

CONCLUSION

This study's findings could serve as a foundation for future research into the psychological aspects of learning in preclinical dentistry. Multiple appraisal exercises could be combined to determine the best training for students in different settings. Furthermore, more research is needed to determine whether the observed findings apply to all aspects of education. Because the study focuses on the psychological aspects of learning, the long-term effects of these exercises must be reviewed. CA exercises appeared in our study to significantly improve the preclinical incisor, canine, premolar, and molar tooth preparation skills and the confidence levels of undergraduate dental students.

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Table 6. Comparison of mean (\pm standard deviation) pretest and posttest confidence levels reported by control group and critical appraisal group

	Control group (n=65)	*CA group (n=78)	Significance P<0.05
Pretest confidence level	2.69 \pm 0.54	3.88 \pm 0.67	<0.0001
Posttest confidence level	3.37 \pm 0.86	3.65 \pm 0.73	0.0370

*CA group showed a greater increase in confidence level than the control group. SD: Standard deviation. CA: Critical appraisal

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Conflicts of interest

There are no conflicts of interest.

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