

The Influence of Local Anesthesia Pre-Clinical and Clinical Education Methods on Predoctoral Dental Students

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Abstract

One of dentistry's most basic and essential processes is administering a local anesthetic. Before beginning any procedure on patients, many clinical specialties in dentistry require the administration of a local anesthetic. Students may find it challenging to master optimal local anesthetic techniques as they demand refined technical skills to enable painless administration. Therefore, before administering their first injection, students must complete their educational requirements regarding knowledge and practice. Non-human objects, cadavers, simulation models, and student-to-student administration are some methods utilized for learning local anesthesia in undergraduate dental education institutions worldwide. Therefore, this study was conducted to evaluate and compare the learning outcome of students who undertook the contemporary preclinical teaching program (lectures and clinical), shadowing a higher-level student to administer the local anesthesia to the patient, to those who provide a modern teaching and learning program (lectures and preclinical simulation for a semester then lecture and clinical practice student to student in the 2nd semester), before practicing on the patient the following year. This study is retrospective longitudinal data gathered from the local anesthesia assessment sheets for 3rd, 4th and 5th undergraduate dental students and compared their marks before and after implementing the local anesthesia modern teaching method from 2018 to 2021. This study aims to determine whether a modern approach teaching program in local anesthesia delivery affects undergraduate dental students' perceived and actual learning outcomes.

Keywords: Clinical education; Dental education; Dental student; Dental training; Dental teaching methodologies; Local anesthesia.

INTRODUCTION

Local anesthetic administration is one of the most routinely practiced skills in dentistry. A local anesthetic is required to prevent patients from feeling uncomfortable during invasive procedures. To be capable of administering local anesthesia painlessly, dental professionals should be well versed in head and neck anatomy, especially the innervation of the underlying hard and soft tissue.¹ Dental students in the United States commonly injected anesthetics during clinical encounters while getting just rudimentary didactic training.²

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Recent dental college graduates claimed that the procedures utilized to educate residents on anesthetic were insufficient for them to confidently administer local anesthesia and voiced doubt about their competence to do so.³ Despite the necessity of local anesthetic and the need to avoid its hazards, research on local anesthesia education has been minimal.

Mishaps can arise in the course of the administration of local anesthesia if the precise method and anatomical landmarks are not fully understood.^{4,5} The practice of aspirating can prevent intravascular injection of the inferior alveolar artery while establishing needle contact with the medial surface of the ramus can prevent unintentional injection of the parotid gland.^{6,7} Although it is uncommon for dental needles to amputate a nerve shaft or its fibers, damage to a nerve caused by needle contact can cause long term paresthesia.^{6,8} Improved and upgraded training in the administration of local anesthesia can boost the performance and competence of dental students and graduates.

Factually, the application of LA (local anesthesia) was initiated in 1884 by Halsted and Hall, via injection of a cocaine emulsion into the mandibular foramen.⁹ Student-to-student injection, anatomic models, instruction from text books, and lecture hall learning are some of the recently employed strategies in teaching local anesthetic administration.¹⁰⁻¹¹ Anatomic models for learning local anesthesia can imitate the mandible and soft tissue structures, or the entire head can be fitted with sensors to offer feedback on students' technique and approach. Human cadavers have also been proposed as teaching models for injection techniques in the preclinical stage, however, ethical objections have been raised.¹¹⁻¹² These techniques of teaching local anesthesia result in wavering levels of students' confidence, administration effectiveness, and patient satisfaction. As a result, local anesthesia education has become a point of contention for the scientific community.¹³

Simulation based instruction and training have been treated as a channel between education (lecture-based courses) and the medical practice in dental teaching.¹⁴ Buchanan suggested that the practical implementation of simulation methodology in the predoctoral dental program warranted "a smoother transition from preclinical education to the clinical setting".¹⁵ In clinical trials, simulation has been used successfully in the medical fields in the past; examples include teaching airway management and operational anesthetic methods, particularly

in anesthesiology.¹⁶ Manikin models have also been utilized in dentistry for familiarization with the oral mucosa and hard tissues, before dental students' clinical performance.¹⁷ The use of manikins as a beneficial preclinical teaching instrument for training dentistry students in local anesthetic methods, where the small oral opening may be a limiting issue, is straightforward and quick to adopt. Students were excited about the novel instructional technique, as evidenced by the previous research on simulation for clinical training.¹⁸ Skills associated with local anesthesia are quite important for dental experts and Lee et al. (2015) testified in their study that "students who received local anesthesia from students who had practiced on the simulation model experienced fewer post-injection complications one day after receiving the IAN block", whereas no significant improvement in the success level of anesthetizing class students was reported.¹⁹

Various techniques for teaching preclinical dentistry and local anesthesia are utilized to bridge the theory to practice gaps. Inanimate objects, such as oranges, chicken limbs, and simulation models, are injected.²⁰ The typical methodology for pre-clinical practice in dental education has been student to student, giving their first local anesthetic injection.²¹ Under the guidance of competent oral health practitioners. Students typically administer their earliest injection to their companions, always with consent. Although administering a local anesthesia is a medically intrusive treatment that can result in moral, medical, legal, and ethical issues, it is still the preferred learning procedure for patient comfort.^{2,22} The preferred method of instruction continues to be student-to-student practice, according to Calleros and Aboytes (2017) study, However, Chandrasekaran et al. (2014) discovered that during student-to-student practice, students faced a significant amount of anxiety and chose to use simulation models for preclinical instruction.²¹

Over the last decade, there has been debate about how preclinical teaching could help undergraduate students build the skills needed to exhibit competence and gain self-confidence. Therefore, this study was conducted to evaluate and compare the learning outcome of students who undertook the contemporary preclinical teaching program (lectures and clinical), shadowing a higher level student to administer the local anesthesia to the patient, to those who provide a modern teaching and learning program (lectures and preclinical simulation for a semester then lecture and clinical

practice student to student in the 2nd semester), before practicing on the patient the following year.

MATERIALS & METHODOS

The Review Ethics Committee (REC) approved this study at 31/8/2022.

Data gathering

The local anesthesia assessment sheet is the same rubric for the 3rd, 4th, and 5th year students, Students who trained with old teaching method assessed their marks when they are at 3rd year (2017-2018, 141 students) and 5th year (2019-2020, 139 students), also students who trained with new teaching method assessed their marks when they are at 3rd year (2018-2019, 195 students) and 4th year (2019-2020, 99 students), in addition student of 3rd year (2019-2020, 178 students) and 3rd year (2020-2021, 147 students) were included to this study. Each step had a score, the evaluators were the calibrated supervisors from the dental school, who were enrolled in assessing students at pain control & anesthesia subject which is in the curriculum of 3rd year dentistry at our school.

Data Preprocessing

The assessment scores of students from different years were organized into tabular forms along with their sex and year of education. This primary data set was then analyzed using PROC means from SAS software to calculate descriptive statistics, including mean, median, mode, and standard deviation. The melt function was then used to convert the data frame into longitudinal data with each row representing a data point. The melting data was then converted into score data to create a data frame of the students' marks. The final product of this preprocessing was an experimental dataset on which further analyses were conducted.

Comparison of 3rd year students' marks before and after the implementation of new teaching methods

ANOVA was calculated for the performance of 3rd year students in assessments before and after the implementation of the new teaching methodology in the 2018-2019 year. ANOVA was conducted to determine whether sex, class, and session had any impact on the scores of students in assessments.

Post-hoc testing to measure the impact of new teaching method

To assess the impact of the session (different teaching methodology before and after the 2018-2019 year) on 3rd year students, their scores were

compared before and after the implementation of the new teaching methodology using t-test analysis. The students were categorized into 2 groups based on sessions i.e., group 1 (included 2017-2018 cohort; traditional teaching methodology), and group 2 (included students from the same cohort but in different years, that is, 2018-2019, 2019-2020, and 2020-2021; modern teaching methodology). The pairwise comparison was based on the P.adj value.

Improvement of score in the following years under new teaching methods

A T-test was conducted again to compare the performance of students in assessments based on changes in the teaching practices. For this purpose, experimental data containing descriptions of 3rd year and 4th year students (3rd year promoted students) was extracted from the melt data and the significance value (p-value) determined whether the difference in average assessment scores was improved under the new teaching method or not.

Improvement of score in the following years under old teaching methods

To quantify the difference in the performance of students under the old teaching methods, assessment scores of 5th year students from the 2019-2020 cohort and the same students in the 3rd year were compared and analyzed using a t-test.

Compare scores of all classes in a session

The target participants were 3rd year and 4th year students, introduced to new teaching methodology, and 5th year students, limited to old teaching methodology. A T-test was conducted to determine whether there is a significant difference in assessment scores and their over all performance under the new teaching methodology.

RESULTS

Impact of teaching method on the score of students

Comparing 3rd year students' marks

A comparison was conducted on all 3rd year students' marks (before and after the session 2018-2019) to analyze the effect of teaching methods on assessment results since the new teaching methods were implemented in the 2018-2019 session. The p-value of the test indicates that there was no significant impact of gender on student grades. As a result, male and female students performed equally

well on tests. None the less, assessment scores were influenced by the student's class as well as the

session (Table 1). As a result, the average scores across all years (or sessions) differed.

Table 1: Analysis of variance table of student marks

Term	df	Sum sq.	Mean sq.	Statistic	p. value
Sex	1	0.0025	0.0025	0.0026	0.9591
Year	2	145.7365	72.8682	76.4709	0.0000
Session	1	44.7066	44.7066	46.9169	0.0000
Residents	656	625.0952	0.9529		

Table 2: Pairwise comparison table of student marks

Y.	Group 1	Group 2	n1	n2	Statistic	df	p	p.adj	p.adj significance
Score	2017-2018	2018-2019	141	195	2.2309	271.0972	0.026	0.026	*
Score	2017-2018	2019-2020	141	178	-3.0922	193.7816	0.002	0.005	**
Score	2017-2018	2020-2021	141	147	-9.4901	157.5288	0	0	***

Post-hoc testing to measure the impact of new teaching method

A comparison of the scores of all 3rd year students before and after using the new teaching methods was conducted to determine whether the new teaching method had a substantial impact on assessment scores. Between the 3rd year students before and after the 2018-2019 year, there is a considerable difference in average assessment scores (Table 2).

Students received higher grades because of the new teaching methods, and assessment scores increased as a result of the implementation of new teaching methods (Fig. 1).

Improvement of score in the following years under new teaching methods

Testing was repeated on the same students who

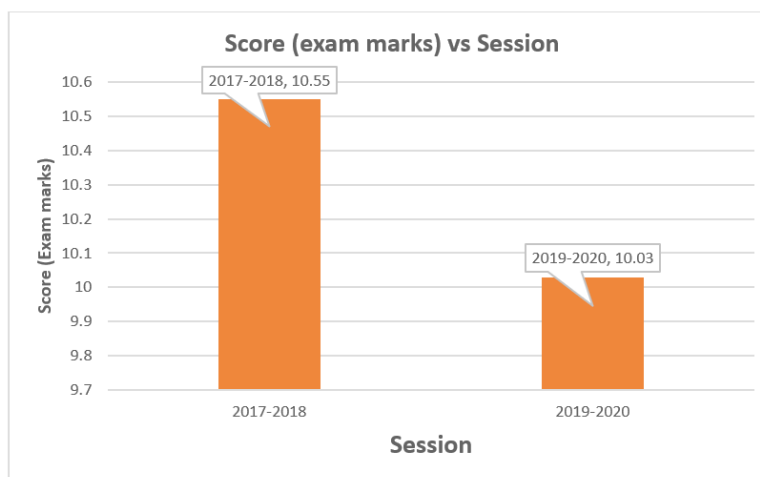
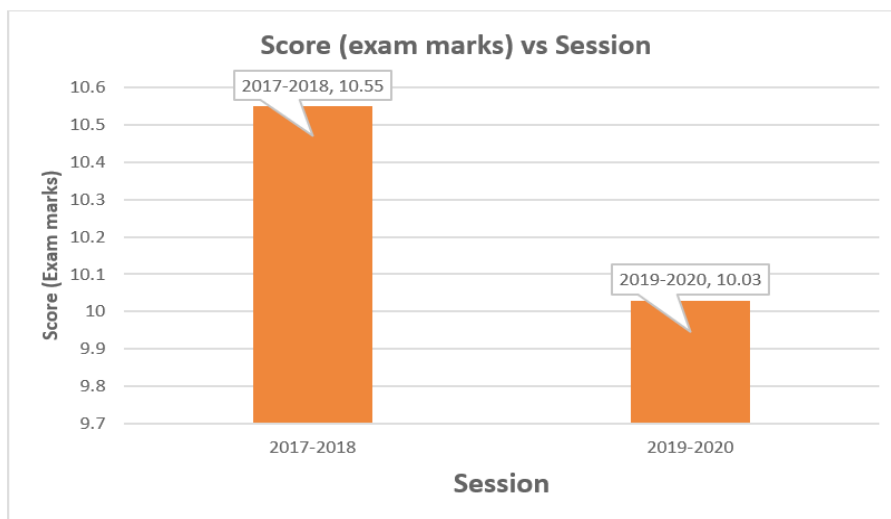


Fig. 1: (a) Comparison of the scores under old "5th year" and new teaching methods "3rd and 4th years". (b) Score shifting from 3rd to 5th year under old teaching methods. (c) Score shifting from 3rd to 4th year under new teaching methods.

previously followed the old teaching techniques. The goal was to determine whether the new teaching methods improved students' scores in the following years. Data for 4th year students in the 2019-2020 year who participated in the 3rd year

during the 2018-2019 year was made available. A determination was sought to evaluate whether 4th year results would be higher than the 3rd year scores if new teaching approaches were used. The test's p-value (2.86106) is highly significant, indicating a



considerable difference in average scores between the third and fourth years under the new teaching methods. However, it was noted that the 4th year score was much higher than the 3rd year score (Fig. 1c). As a result, we find that the new teaching methods enhanced assessment scores significantly.

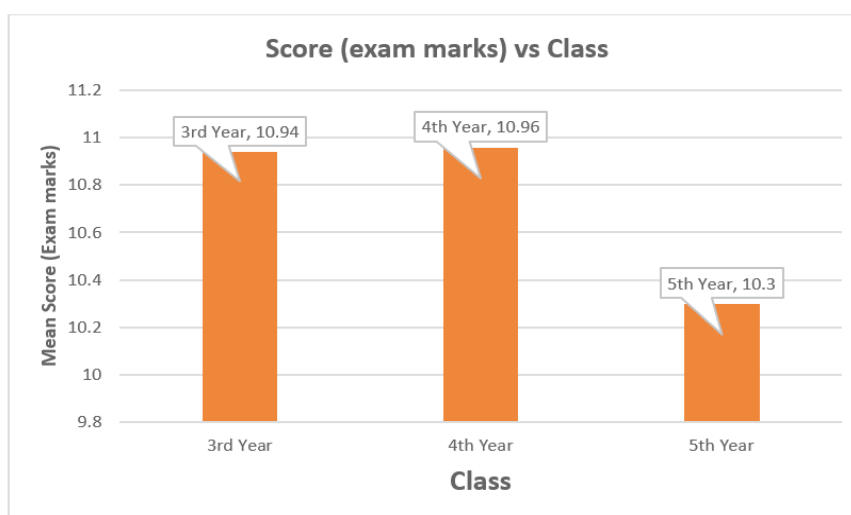
Improvement of score in the following years under old teaching methods

Test scores of the same students who previously followed the same old teaching methods as present were evaluated to determine if the old teaching methods enhanced students' scores over the following years. Data were evaluated on 5th year

students in the 2019-2020 year who participated in the 3rd year during the 2017-2018 year. An evaluation was conducted on the 5th year scores to determine whether the scores were notably higher or lower than the 3rd year scores. The test's p-value (0.188) was not significant, indicating that under old teaching methods, there was no significant difference in average scores between the third and fifth years. The 5th year score was essentially identical to the 3rd year score (Fig. 1b). As a result, we can conclude that traditional teaching approaches did not increase assessment results.

Compare scores of all classes in a session

Evaluating score data for 3rd, 4th, and 5th year



students for the 2019-2020 academic year; the 3rd and 4th years used new teaching methods, while the 5th year continued to use traditional teaching methods. In the 2019-2020 school year, was there a substantial difference in results between 5th year

students and 3rd and 4th year students who are using innovative teaching approaches? Was there a substantial difference in results between 3rd and 4th year students who had already been exposed to innovative teaching methods? As a result, the

general hypothesis was whether new teaching approaches improve students' performance in a session. If so, would it have a different impact depending on the class?

In the 2019 - 2020 academic year, the assessment scores of 3rd and 4th year students differed significantly from those of 5th year students. However, in the 2019-2020 session, the scores of 3rd and 4th year students (who are using the new teaching approaches) were not significantly different. The test between the third and fourth scores had a p-value of 0.869, which was not significant. Furthermore, the p-values of the test between 3rd and 5th grades and 4th and 5th year were 1.46 104 and 0.001, respectively, both highly significant, implying that the new teaching approaches enhanced students' scores in all classes roughly equally. In the 2019-2020 academic year, the average score of 3rd and 4th year students was virtually equal and comparatively higher than that of 5th year students who were still using conventional teaching methods (Fig. 1a).

DISCUSSION

With the advancement of the modern world, it is necessary to modify teaching methods. This introduction of a new teaching method exhibited significant results likely to improve their skills if provided with a better understanding of the subject at hand. There is a developing pattern in institutions to provide early clinical patient exposure in quite a large number of dental programs. The security of a patient is an essential concern and teaching establishments should ensure students undertake pre-clinical simulation training and assessment before practicing clinical procedures on patients.²³ Common complications that may occur include precipitation of intense chest pain, vasovagal syncope, and epileptic seizures that might be experienced during dental injections because of nervousness and needle fear.⁶ Other local anesthesia complications can occur such as needle breakage, damage to nerves, damage to soft tissues, and trismus.²⁴

The assessments completed in this study compared third year students as a longitudinal study. In the first scenario, the differences in the perception and learning of opposite genders, i.e., male and female, were tested. The results indicated that there was no significant difference in the learning capabilities of male and female students. Bokhari et al., 2022 also reported results similar to this study. In the second scenario, the third year students were taught the anesthesia protocol by

employing new teaching methods for one year, and the results were obtained by evaluating their skills in their 4th year 2019-2020. The completed assessment exhibited increased scores under the new teaching method.²⁵ A nearly equivalent study was performed by Marti et al., in 2019. Here, they applied the simulation method along with the normal study methods and it was found that the students that were trained using the simulation method for the application of anesthesia were more skilled in their profession.²⁶ In another study conducted,²² undergraduates that had been trained using simulations (utilizing marginally unique simulation models) demonstrated better standards than the rest of the lot of 43 that had no training in such regards. Though the utilization of simulation training methods did not provide any significant changes to the overall outlook of the students involved, when they were assessed, it was revealed that modern teaching methods had improved the composure and calmness of students during injecting anesthesia.²⁷

In the third scenario, students in the third year that were taught with old teaching methods were evaluated in the next year. Their test results were found to be nearly the same as before, indicating there was no improvement gained. In the next case, the test scores for the upcoming years of these undergraduate students were compared. One group was continuously trained using new methods and the other group was taught using old methods. The mean gained and the test score evaluated indicated that new methods were more favorable for the students. The implementation of new teaching methods not only improved the test score only but also provided students with confidence. A nearly identical one done by Mc Gaghie et al. in 2010, concluded that clinical practices conducted in simulation environments for the administration of anesthesia should be added to the curriculum, as it makes them more confident and helps them gain experience.²⁸

It can be surmised that consideration of new teaching methods could be implemented in all institutes of dental studies. The sample size taken for the research is significant although, additional research can be conducted by taking samples not only yearly, but by comparing the effects of new teaching methods among students of different institutions.

CONCLUSION

Students are taught how to administer oral

injections in the majority of dental schools by having them practice the procedure on peers or through simulation models. Many dental schools do not gain written informed consent from students who are receiving oral injections from classmates. Some students who received oral injections from classmates experienced difficulties as a result of the technique. Additionally, when trainees practice simulation models, they report anxiety while administering local anesthetics to patients for the first time. Our goal is not to criticize these conventional techniques, but to urge educators to adopt new teaching approaches that help students perform better on tests and in their professional careers while also being more mindful of the legal, ethical, and physical safety concerns that these activities raise.

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