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Original Article

Flipped classroom teaching model with video instruction improves skills in local anesthesia training

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KEYWORDS

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Background/purpose: Local anesthesia (LA) training is an essential clinical skill in dental education. However, the traditional teaching method of student-to-student injection has ethical concerns. This study investigated whether a flipped classroom (FC) teaching model with instructional videos improves students' skills in administering LA.

Materials and methods: Fourth-year dental students in 2017 (traditional teaching, n = 70) and 2018 (FC model, n = 79) were assessed for their ability to perform an inferior alveolar nerve block and lingual nerve block. The FC group watched pre-recorded videos prior to a hands-on training session. Skills were evaluated using a 24-item checklist converted to letter grades. Perceptions of the FC approach were also surveyed.

Results: The FC group showed statistically significantly higher final grades than the traditional teaching group ($P < 0.05$). Most FC students agreed that the videos improved clarity and learning objectives.

Conclusion: The FC teaching model with procedural video instruction improved skills and confidence in administering LA over traditional teaching methods. Videos can be a beneficial supplement in pre-clinical dental training.

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Introduction

In dental education, local anesthesia (LA) is a necessary procedure that requires proper teaching and training. Several training methods include laboratory models with sensors, cadaver models, virtual technologies, and student-to-student practice. Despite the existence of other methods, student-to-student injection remains the most common training method in many dental programs.¹ However, this method can cause anxiety in students and has potential moral, medicolegal and ethical implications. There is debate in the field about the best way to provide preclinical training to support students in developing the skills and confidence needed to perform LA competently.

The flipped classroom (FC) is a subtype of learning in which students access teaching content online before class time and participate in activities.² Multimedia formats are often emphasized due to increased completion of preclass assignments.³ It can replace teacher-led in-class instructions with individual homework or group activities. Blended learning is also becoming the norm for core content delivery in many institutions.

The effectiveness of the FC approach compared to traditional dental learning has not been clearly established. The purpose of this study was to investigate the difference in the level of student skill level in LA between this FC model and traditional methods for fourth-year grade students.

Materials and methods

The study protocol was reviewed and approved by the institutional review board of the Chung Shan Medical University Hospital (approval no. CS1-20050). Participants were recruited from the 2017 academic year (70 students) and the 2018 academic year (79 students).

In Taiwan, a large number of clinical subjects start to be studied in the fourth year of the school of dentistry. The Chung Shan Medical University which is in the second semester of the fourth year, includes a series of lectures and preclinical training of students-to-student dental local anesthetic. Lectures provide foundational knowledge on the armamentarium, maxillary and mandibular LA techniques, neurophysiology and pharmacological aspects of LA and its potential local and systemic complications. And preclinical training is organized after these lectures. Each student had to exchange roles as clinician and recipient. We give a face-to-face live demonstration (LD) before the from student to student of dental local anesthetic preclinical training in the 2017 academic year. This LD included the introduction of the dental chair, correct posture, lighting concept, basic principles of asepsis and infection control, dental syringe, needle, cartridge, and techniques of the inferior alveolar nerve (IAN) and lingual nerve block, which takes about 30 min. The present study used an aspirating dental syringe equipped with a 35 mm long, 27-gauge needle with a dental cartridge. The local anesthetic used for these injections was 3% mepivacaine and without adrenaline. The students have to complete indirect IAN block⁴ and lingual nerve block. The practice was supervised by three qualified oral and maxillofacial specialists at the

Chung Shan Medical University Hospital and instructed during the procedure at any time. The three specialists have reached a consensus. If the students' skills are inappropriate, they are also corrected immediately. The final student assessment was achieved with the 24-item checklist (Table 1). It is scored on a letter grade scale based on the number of items: A (22–24 items), B (19–21 items), C (16–18 items), D (13–15 items), and E (under 14 items).

We have replaced LD with the prerecorded and well-edited procedural video since the 2018 academic year. The video length has been quoted as less than 6 min for each subject. The videos were uploaded to the university's online learning platform, and each was made available before the 2018 s semester. All students in the 2018 academic year were required to preview and understand the contents before the preclinical training. There was an open discussion with the instructors when they came to the clinic and practice. And the preclinical training still followed the previous rules. The same three specialists achieved the final assessment with the same 24-item checklist. We used the chi-square test to compare the score difference between these teaching models. All data were analyzed using SPSS (SPSS Inc., Chicago, IL, USA). $P < 0.05$ was considered a statistically significant difference.

Furthermore, students completed a 5-point Likert scale questionnaire at the end of the practice, with results expressed as a mean rating for each item, serving as a secondary indicator for efficacy. The scoring criteria in the questionnaire included: 5 points, strong agreement; 4 points, agreement; 3 points, general agreement; 2 points, disagreement; and 1 point, strong disagreement.

Results

A total of 149 students in the retrospective study, in the class of 2017 ($n = 70$) and 2018 ($n = 79$), attended this course. The chi-square results on whether the final student's assessment of the student shows significant differences according to the teaching modes are presented in Table 2. ($\chi^2 = 13.532$; $P < 0.05$)

The 2018 academic year questionnaire was handed after preclinical training, and the findings are reported in Table 3. We conducted a survey among 79 students with a Likert scale questionnaire. The majority of students thought that the videos were clearer than traditional lectures, and these videos made the learning objectives clear.

Discussion

To deal with the COVID-19 pandemic, many higher educational institutions adopted online learning. FC allowed for a more convenient and flexible learning experience with personalized learning and improved in-class teaching efficiency.⁵ Online learning applied to dental students, and when self-study precedes discussion, the learning is richer and the results are better.⁶ We will transform our existing courses into well-edited short videos for online delivery. A positive correlation was still found in the video duration.⁷ Students will have the opportunity to watch and prepare in advance. Subsequently, they will demonstrate their learning outcomes through hands-on practice and

Table 1 Final student's assessment of IAN block practice. Abbreviations: IAN, inferior alveolar nerve.

	Index item	Correct or not
Aseptic technique and position adjustment	Stainless steel cotton jar open correctly	
	Get the contents from stainless steel cotton jar correctly	
	Use sterilization forceps correctly	
	Open the sterile packaging properly	
	Correct sitting position and light position	
	Correct adjustment the unit position	
	Does not pollute the environment when wearing gloves	
IAN* block and lingual nerve block technique	Install anesthesia tube and fix with harpoon correctly	
	Dictate the procedure of indirect technique correctly	
	Use proper size of beta-iodine cotton ball for area disinfection	
	Tension the soft tissue to detect the internal oblique ridge (By thumb or index finger)	
	Hold the syringe steady and correctly (without dripping out the anesthetic)	
	When arriving the injection target and aspiration is performed to prevent intravascular injection	
	If intravascular injection happened, recheck the needle position again	
	3/4 tube of anesthetic injection for IAN block	
	Withdrawn the needle 10 mm for lingual nerve block (1/4 tube)	
	Injection the anesthesia as the speed 1 tube/min	
	Exam clinical signs and symptoms after anesthesia	
	Test anesthesia works at right area	
	Clean up after surgery	Prevent needle injury with scoop technique
Reset the dental unit to original place, let patient to up-right position		
Discard the needle correctly from syringe without capping		
Discard the anesthesia tube at right box		
Discard other consumable at right box		

Table 2 Chi-square test results concerning the effects of teaching mode on the students' final achievement. A, B, and C were presented as the number of items. A: 22~24 items, B : 19~21 items, C : 16~18 items.

	Letter grade scale			Total
	A	B	C	
Live demonstration in 2017 academic year class, number (%)	27 (39)	35 (50)	8 (11)	70
Procedural video in 2018 academic year class, number (%)	54 (68)	19 (24)	6 (8)	79
Total	81	54	14	149

$\chi^2 = 13.532; P = 0.001$

evaluation. We strongly agree that duration is negatively correlated with engagement, and a consolidation task takes the learning of the videos and asks the students to engage with it through other assessments.⁸ The hybrid of physical practice and online courses may become the future trend of learning courses.

It is important to provide students with a checklist as an assessment criterion before practice. This allows them to grasp the critical learning points. Previous research has also found that students appreciate having assessment criteria, which helps them determine if their performance is correct.⁵ We did not present related statistics for each item in the checklist. These elements can be used to analyze the learning weaknesses to correct the teaching content or methods.

The "percentage system" is traditionally derived from the criterion-referenced evaluation, which uses a numerical value from 0 to 100 to express results as a standard for judging learning proficiency. The "Percentage system" lacks a clear and consistent reference, which may change due to the difficulty of teachers' evaluation and testing, and it is easy to cause students to chase after the difference in scores. Most universities in Taiwan still use the percentage system as the primary learning assessment method, but some have introduced the letter grade system in recent years.⁸ Letter grades can be used to objectively assess behavioral skills that are essential for dentists. Through carefully designed rubrics, letter grading can be awarded with objectivity to reflect student progress in developing these skills.⁹ We think that letter grading is also

Table 3 Perceptions of the students to the teaching methods in 2018 academic year students.

Item/question Number (%)	Strongly disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly agree 5
Watching videos will be clearer than traditional live demonstration	0 (0%)	1 (1.3%)	9 (11.4%)	33 (41.8%)	36 (45.6%)
Learning objectives are clear	0 (0%)	0 (0%)	0 (0%)	33 (41.8%)	46 (58.2%)
There are too many operative items in this dental anesthesiology in the fourth grade	5 (6.3%)	34 (43%)	38 (48.1%)	1 (1.3%)	1 (1.3%)
The overall difficulty of the practice (5 = most difficult, 1 = easiest)	0 (0%)	0 (0%)	49 (62%)	27 (34.2%)	3 (4.8%)

easy to present the effectiveness of different teaching modes.

Research in dental education reveals that in the past, there was a greater emphasis on administering IAN block anesthesia using direct techniques.^{10,11} However, our teaching approach utilizes indirect techniques with internal oblique landmark. The primary advantage is that the internal oblique ridge is closer to the mandibular foramen than is the external oblique ridge of the mandibular ramus coronoid notch. We aim to develop a better understanding of the surrounding anatomical structures, as this will ultimately facilitate a smoother transition to direct techniques in the future.

In recent years, numerous devices have been introduced in the field of educational assistance, such as oral anesthesia manikins,¹² virtual reality,¹³ and augmented reality,¹⁴ to provide more realistic simulated teaching and learning experiences. These devices are designed to help reduce anxiety among students. However, students still need hands-on experience, as actual clinical practice remains the best way to validate what has been learned. In the future, we will incorporate these related devices into our curriculum to enhance the student's familiarity with the course.

In conclusion, this study found that the use of prerecorded and well-edited procedural videos as a supplement to dental education was effective in enhancing learning outcomes. The study compared the performance of dental students who watched these videos with those who did not and found that the students who watched the videos showed a statistically significant improvement in their final achievement. Thus, the results of this study suggest that using procedural films may benefit dental education as an adjunct tool.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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