EVALUATION OF AESTHETIC RESTORATIONS PREPARED BY UNDERGRADUATE STUDENTS ON TYPODONT MODELS

DİŞ HEKİMLİĞİ ÖĞRENCİLERİNİN FANTOM MODELLERE UYGULADIĞI ESTETİK RESTORASYONLARIN DEĞERLENDİRİLMESİ

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ÖZET

Diş hekimliği fakültesi müfredatı teorik ve pratik dersleri temel alır. Öğrenciler, dişlere uygulayacakları restorasyonların ideal fonksiyonel ve estetik özelliklerini yerine getirebilmek için, gerçek hastalardan önce fantom model veya simülatörler gibi güvenli ortamlarda pratik yaparlar. Bu çalışma, farklı dönemlerde eğitim gören diş hekimliği öğrencileri tarafından uygulanan sınıf IV estetik restorasyonları; yüzey parlaklığı, anatomik form, marjinal adaptasyon ve proksimal kontak noktası açısından değerlendirmeyi amaçlamıştır.

Fantom model üzerinde hazırlanmış sınıf IV kaviteler, 2, 3, 4 ve 5. sınıf diş hekimliği öğrencileri (n=15) tarafından restore edildi. Restorasyonlarda universal adeziv ve nanohibrit reçine kompozit kullanıldı. Daha sonra restorasyonlar modifiye FDI kriterlerine göre değerlendirildi. Elde edilen sonuçlar Kruskal–Wallis tek yönlü varyans analizi ve t-testi ile analiz edildi.

2, 4 ve 5. sınıf öğrencileri tarafından yapılan restorasyonların modifiye FDI skorları arasında istatistiksel olarak anlamlı fark bulunmamıştır. 3. sınıf öğrencileriyse insizal marjinal adaptasyon kriterinde, diğer öğrencilerden daha az başarılı bulunmuştur. Toplamda 60 restorasyondan 47 tanesi (%78,3), değerlendirilen tüm kriterlerde en az 'klinik olarak yeterli' olarak skorlanmıştır. Kadın ve erkek öğrenciler tarafından yapılan restorasyonların başarısında istatistiksel olarak anlamlı fark görülmemiştir.

Teorik ve pratik eğitim ile desteklenen iki yıllık preklinik çalışması, öğrencilerin klinik uygulamada ihtiyaç duyulan temel restoratif becerileri kazanmaları için yeterli olabilmektedir.

Anahtar Kelimeler: Operatif diş hekimliği, Diş hekimliği eğitimi, Klinik beceri, Preklinik eğitimi, Fantom model

ABSTRACT

The dental school curriculum is based on theoretical and practical courses. Before real patients, students practice on secure environments like typodonts or simulators to manage the functional and aesthetic properties of tooth restorations. This study aimed to evaluate the quality of class IV aesthetic restorations prepared by undergraduate dental students across different years of training, in terms of surface gloss, anatomic form, marginal adaptation, and proximal contact.

Four consecutive classes of dental students (n = 15) were tasked with restoring a class IV cavity on a typodont tooth. Restorations were performed using a universal adhesive and nanohybrid resin

composite. Evaluations were performed using the modified FDI criteria. Data were statistically analyzed by Kruskal–Wallis one-way analysis of variance, along with a *t*-test.

The FDI scores for restorations by second-, fourth-, and fifth-year dental students were not significantly different. Third-year students had less success than others only in terms of incisal marginal adaptation. Forty-seven of the 60 (78.3%) restorations were clinically sufficient in all of the evaluated criteria. There were no statistically significant differences between the restorations performed by female and male students.

The two-year preclinical training along with theoretical and practical education is sufficient for students to acquire basic restorative skills needed in clinical practice.

Keywords: Operative dentistry, Dental education, Clinical skills, Preclinical course, Typodont

1. INTRODUCTION

The essential components of dental education are preclinical and clinical courses supported by theoretical knowledge (LeBlanc et al., 2004). Before practicing on patients, students practice on typodonts or simulators in secure environments, allowing for repetition without harm to any patients (Afify et al., 2013; Azevedo et al., 2015; Bertoli et al., 2018).

Students conventionally attend preclinical laboratory courses, which introduce the concepts of dental procedures. In preclinical courses, students practice manual skills, including the reproduction of anatomical crown morphology using dental wax, as well as cavity preparation and restoration with rotary cutting instruments and dental restorative materials, respectively. After the preclinical courses, students apply and develop the skills and knowledge they gain by performing clinical procedures on patients under the guidance and observation of senior tutors.

Although undergraduate students are currently turning to web-based digital dentistry education equipped with multimedia instructions, they must also learn conventional treatment strategies and experience live face-to-face courses (Zitzmann et al., 2020). Learning dentistry procedures with direct visual applications will improve hand-eye coordination (Segura et al., 2018). Moreover, practice on a real 3D object will help create a professional practice memory (Magne, 2015; Mahmoodi et al., 2016; Reissmann et al., 2015; Roy et al., 2017; Yammine & Violato, 2015). The clinical success of class IV restorations, which encompass an important part of aesthetic dentistry, is directly related to the knowledge and technical skill of the operator. There are few studies comparing clinical and preclinical students in regard to restorative skill. Dental educators need this information to implement the necessary instructional lessons into the curriculum.

This study aimed to evaluate class IV restorations performed by dental students across different years of training, in terms of surface gloss, anatomical form, marginal adaptation, and proximal contact. We hypothesized that students would be able to perform acceptable restorations on typodonts after their second year and that their capability to manage the morphological and aesthetic properties of restorations would improve in subsequent years.

2. MATERIALS AND METHODS

2.1. Ethical considerations

This study was approved by the ethics committee of our institution (Reg Nr: 2019/25). All student participants provided their written, informed consent. Students were informed about the purpose, objective, and content of the research. In addition, it was assured that the data obtained from the study would be anonymized and that there would be no bias in rating the laboratory studies if they did not want to participate in the study. No compensation was offered for participation in this study.

This study was conducted within the framework of the ethical principles of the Declaration of Helsinki.

2.2. Operators

Sixty dental students from four consecutive education levels (second-year: n = 15; third-year: n = 15; fourth-year: n = 15; fifth-year: n = 15) volunteered for the study following theoretical training and preclinical courses. The participants included 35 (58%) women and 25 (42%) men.

2.3. Typodont model

A model of the upper jaw (maxilla; Frasaco GmbH, Tettnang, Germany) representing typical natural adult teeth with physiological contact points was used for this study. The maxillary left central incisor was designed to have a crown fracture on the facial aspect, according to the Ellis and Davey classification given in 1970 (Ellis & Davey, 1970) The extensive fracture of the crown involved considerable dentin, but not the pulp, representing a class IV cavity of 5 mm from the incisal angle to the gingival margin and the incisal edge. The students performed the restorations in Dental Simulation Units (KaVo Dental GmbH Bismarckring 39 Biberach, Germany).

2.4. Demonstration

Students were shown video instructions via slide shows that provided a step-by-step explanation of the restorative procedure; this was followed by live demonstrations in the laboratory with one-on-one supervision.

The students restored class IV cavities incrementally with a nanohybrid resin composite (Z550 Nano Hybrid Universal Restorative, 3M ESPE, MN, USA). A universal adhesive system (Scotchbond Universal Adhesive, 3M ESPE, MN, USA), including an etching procedure with phosphoric acid (Scotchbond Etchant, 3M ESPE, MN, USA), was used according to the manufacturer's instructions (Table 1).

2.5. Restorative Procedure

Tooth surfaces were etched with Scotchbond Etchant for 15 s. Subsequently, the cavities were thoroughly rinsed in water for 10 s and dried gently. Scotchbond Universal Adhesive was applied with a disposable brush, and the tooth surfaces were scrubbed with a brushing motion for 20 s. After gently air-drying once again for 5 s, followed by light curing for 10 s (Elipar DeepCure-S, 3M ESPE, MN, USA), Stripmat (Polidentia, Switzerland) was used to form the proximal contour and contact point. The restorative material was adapted with a flat-faced or elliptical condenser; the contour and finish line of the restorations was created carefully. Each layer was light-cured from the facial and lingual directions for 40 s.

After polymerization, the restorations were finished with carbide finishing burs (Komet, Lemgo Germany) and polished with interdental polishing strips and polishing discs (Sof-Lex System, Multi-Step, 3M ESPE, MN, USA). After these processes, the restorations were deemed complete.

2.6. Evaluation of Restoration

The restorations on the model were evaluated according to the modified FDI criteria (Hickel et al., 2007) by a calibrated observer (MŞ) using visual and tactile inspection (Mouth Mirror, Number 5 Hu-Friedy Chicago IL- Explorer No.23/CP-12 | XP23/126 Hu-Friedy) and scored accordingly (Table 2).

2.7. Statistical Analysis

SPSS version 21.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analyses. Non-parametric statistical techniques were used for data analysis. *P*-values <0.05 were considered statistically significant in all tests. For each criterion, the groups were compared using the Kruskal–Wallis one-way analysis of variance test (intergroup comparisons), followed by Tukey's post hoc test. The difference in the results between the sexes was compared using a *t*-test.

3. RESULTS

A total of 60 restorations were evaluated (Table 3). No statistically significant differences were seen among the education levels in terms of surface gloss (P = 0.608), anatomical form (P = 0.068), proximal marginal adaptation (P = 0.535), or proximal contact point (P = 0.212). Incisal marginal adaptation showed statistically significant intragroup differences ($P < 0.05$). The students in their second, fourth, and fifth years achieved significantly higher scores for incisal marginal adaptation than third-year students.

The *t*-test showed that the sex of the operator had no significant influence on the surface gloss (P = 0.479), anatomical form (P = 0.477), proximal marginal adaptation (P = 0.572), incisal marginal adaptation (P = 0.867), or proximal contact point (P = 0.574) of the restoration; 47 of the 60 restorations (78.3%) were deemed clinically sufficient on all criteria.

4. DISCUSSION

In this study, we used combined conventional and digital education technologies to demonstrate dental restorations. Class IV cavity restorations on typodont models were sufficient to assess the manual skills and training of second- and fifth-year dental students. Our hypothesis that evaluation scores would increase with education level was confirmed by the present study results.

In our study, all participants performed the experiment under the same conditions, including the same laboratory and duration of the experiment.

Ueda *et al*. reported that clinical experience is not correlated with the bonding effectiveness of the self-etch composite cement (Ueda et al., 2010).

In this study, third-year students were less successful than second-year students in incisal marginal edge adaptation. Our results are consistent with those of Miyazaki *et al*., who reported that dentistry students performing aesthetic restorations for the first time read the application instructions carefully and followed them meticulously, thus achieving clinically successful works (Miyazaki et al., 2000). Therefore, it appears that inexperience can be an advantage in certain cases.

On the contrary, third-year students, who have clinical experience, may be overconfident in regard to their technical performance. Although self-motivation plays a major role in achieving sufficient motor skill, this issue has not been investigated in relation to either performance or motor learning in dentistry. We found that fourth-year and senior students who have performed class IV restorations in the mouth achieved more successful restorations than those in the first class of the clinic, due to their superior clinical experience.

Senior fifth-year students—preclinical students who remain absent from the clinic and face-to-face education due to the pandemic—also work meticulously to make good use of their last phase of education before graduation and to prepare themselves for clinical practice in the limited time allotted. Individuals who display high levels of effort or motivation tend to perform well in clinical assessments (Kanfer & Ackerman, 1989; Yeo & Neal, 2004).

In the present study, restorations were evaluated *in vitro*, and deficiencies were easily detected in detail. Therefore, the key challenge faced by our students was the achievement of marginal integrity and not the other criteria.

We observed very poor results in terms to the anatomical form criteria, likely due to the use of polyester film strips. The inability to keep the transparent tape fixed, the difficulty in forming the contact point and gingival embrasure, and the concavity of the palatal surface made it difficult to achieve the appropriate anatomical form (Sherwood et al., 2017).

Participation of women in medical sciences, including dental medicine, has increased in the last few decades (Pallavi & Rajkumar, 2011). In one study, male students showed better clinical skills than female students, while there were no statistically significant differences in their theoretical knowledge (Kelsey et al., 2009). However, another study (Dulčić et al., 2017) did not find any such impact, which was consistent with the findings of our study. Dentistry is a field of science that requires knowledge-based attention. When these issues come to the fore in practice, gender is never a differentiating factor.

5. CONCLUSION

The results of our study show that dental educators must be aware of the potential differences in students' skills at each year of education. There is a complex relationship between clinical experience, competence, students' self-perceived confidence, and self-motivation.

Second-year students, who were unfamiliar with the restorative procedures, performed the clinical restoration application phases with maximum attention and care, while adequately managing their inexperience.

CONFLICT OF INTEREST

All authors state that they have no conflict of interest.

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Tables

Table 1. Properties of the materials used in this study

Material	Composition	Manufacturer
3M™ Scotchbond™ Etchant	32% by weight phosphoric acid etching gel	3M ESPE St. Paul, MN, USA
3M™ Scotchbond™ Universal Adhesive	MDP phosphate monomer, dimethacrylate resins, HEMA, Vitrebond™ copolymer, filler, ethanol, water, initiators, silane	3M ESPE St. Paul, MN, USA
3M™ Filtek Z-550 (shades A2–A3)	Matrix: Bis-GMA, UDMA, Bis-EMA, TEGDMA, PEGDMA Fillers: surface-modified zirconia/silica fillers, non-agglomerated/non-aggregated surface-modified silica particles (82 wt%, 68 vol% filler load)	3M ESPE St. Paul, MN, USA

Table 2. FDI evaluation criteria used to assess the restorations (Hickel et al., 2007)

Aesthetic properties ***Clinical assessment***	**1. Surface gloss**	**2. Anatomic form**
(1) *ideal*	(1.1) Similar to enamel	(2.1) Form is ideal
(2) *good*	(1.2) Slightly matt	(2.2) Form diverges slightly from the entire tooth
(3) *sufficient*	(1.3) Matt surface	(2.3) Form differs but is not aesthetically displeasing
(4) *unsatisfactory* (repairable)	(1.4) Rough surface; simple polishing is not sufficient	(2.4) The anatomic form is altered; the aesthetic result is unacceptable
(5) *poor* (replacement necessary)	(1.5) Quite rough; unacceptable plaque retentive surface	(2.5) Form is unsatisfactory and/or lost
Functional properties	**3. Marginal adaptation proximal-incisal**	**4. Proximal Contact**
(1) *Clinically perfect*	(3.1) Harmonious outline, no gaps	(4.1) Normal contact point (floss or 25-μm metal blade can be inserted)
(2) *Clinically good* (after polishing very good)	(3.2) Small marginal gap/facture, removable by polishing	(4.2) Slightly too strong but acceptable
(3) *Clinically sufficient* (no unacceptable effects but not adjustable without damage to the tooth)	(3.3) Gap < 250 μm, easily perceptible with a blunt explorer with a tip diameter of 250 μm	(4.3) Slightly too weak (50-μm metal blade can pass easily, whereas a 100-μm blade [two blades] cannot)
(4) *Clinically unsatisfactory* (repairable	(3.4) Gap > 250 μm, may result in exposure of the dentine or base	(4.4) Too weak (two 50-μm metal blades can pass)
(5) *Clinically poor* (replacement necessary)	(3.5) Restoration is loose but *in situ*	(4.5) Too weak

Table 3. Functional and aesthetic properties and the number of restorations for each score across different years of dental school (M: male, F: female, P: percentage)

Criteria	Score	2nd year			3rd year			4th year			5th year		
		M	F	P	M	F	P	M	F	P	M	F	P
Surface gloss	**1** **3**	5 2	5 3	66.6% 33.3%	7 1	6 1	86.6% 13.3%	3 2	9 1	80% 20%	3 2	8 2	73.3% 26.6%
Anatomic form	**1** **2** **3** **4** **5**	1 1 4 - 1	- 2 3 3 -	6.6% 20% 46.6% 20% 6.6%	1 2 3 2 -	- - 4 1 2	6.6% 13.3% 46.6% 20% 13.3%	- 2 3 - -	1 4 4 1 -	6.6% 40% 46.6% 6.6% -	1 1 3 - -	1 4 5 - -	13.3% 33.3% 53.3% - -
Proximal marginal adaptation	**1** **2** **3** **4** **5**	4 - 3 - -	2 - 5 - 1	40% - 53.3% - 6.6%	4 - 4 - -	5 - 2 - -	60% - 40% - -	2 1 1 - 1	6 - 4 - -	53.3% 6.6% 33.3% - 6.6%	3 - 2 - -	3 - 6 1 -	40% - 53.3% 6.6% -
Incisal marginal adaptation*	**1** **2** **3** **5**	7 - - -	6 - 2 -	86.6% - 13.3% -	3 - 4 1	1 - 5 1	26.6% - 60% 13.3%	5 - - -	10 - -	100% - - -	4 - 1 -	10 - -	93.3% - 6.6%) -
Proximal contact point	**1** **2** **3** **5**	4 - 2 1	5 - 3 -	60% - 33.3% 6.6%	4 - 4 -	2 - 5 -	40% - 60% -	4 - 1 -	7 - 2 1	73.3% - 20% 6.6%	5 - - -	6 1 3 -	73.3% 6.6% 20% -

*Significant difference in incisal marginal adaptation in third-year students ($P < 0.05$)