The Effect of the Phantom Models Used in Preclinic Education of 2nd Year Dental Students on the Success of Amalgam Restorations

Dişhekimliği 2. Sınıf Öğrencilerinin Klinik Öncesi Eğitiminde Kullanılan Fantom Modellerinin Amalgam Restorasyonların Başarısına Etkisi

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Citation: Tezel H, Peskersoy C, Atalayın Özkaya Ç, Kemaloğlu H, Devrimci EE, Karaçolak G, Ergücü Z, Özata F, Köse T. The Effect of the Phantom Models Used in Preclinic Education of 2nd Year Dental Students on the Success of Amalgam Restorations. *Int Arch Dent Sci.* 2025; 46(3): 189-197.

ABSTRACT

INTRODUCTION: The main factor in dental preclinical education, to learn working methods through realistic phantom jaws. The study aimed to compare the amalgam restorations prepared in preclinical education in different training models with objective evaluation criterion such as contour and contact.

MATERIAL and METHODS: Class II amalgam restorations made by second-year students in three groups: (S) stone model, (P) plastic model and (N) phantom model were evaluated by second-year faculty members and staff according to the determined criteria such as proximal cavity form, edge and contact compatibility, and compatibility of restorations' proximal and gingival areas (n=163). The restorations were prepared by the students in the phantom practice, considering, cavity preparation, liner, matrix-wedge, restoration phases and time allocated to each assignment (t=2 hours). McNemar-Bowker and Friedman tests were applied for the statistical analyses.

RESULTS: All models gave similar results in cavity preparation phase. However, there was no difference in the mesial or distal surfaces of amalgam restorations in stone and plastic models, the amalgam fit in the distal region in the phantom models was found more successful than others (p<0.05).

CONCLUSION: The use of phantom models that contains improved plastic teeth, which can imitate real teeth better will contribute more to student preclinical training in dental education.

Keywords: *Plaster model, Phantom model, Amalgam restoration, Preclinical training*

ÖZ

GİRİŞ: Diş hekimliğinde preklinik eğitimdeki en önemli unsurlarından biri fantom uygulamalarında çalışma yöntemlerini gerçeğe uygun fantom çeneler aracılığıyla öğrenmektedir. Bu çalışmada preklinik eğitiminde alçı, plastik ve gerçeğe uygun fantom modellerinde hazırlanan amalgam restorasyonların birbirleriyle kenar uyumu, kontakt gibi nitelikleri açısından karşılaştırılması amaçlandı.

YÖNTEM ve GEREÇLER: Çalışmada 2. sınıf öğrencilerinin alçı, plastik ve fantom modellerde yaptıkları Sınıf II amalgam restorasyonlar belirlenen kriterlere göre 2. sınıf öğretim üyeleri ve elemanları tarafından değerlendirildi (n=163). Restorasyonlar fantom pratiğinde öğrenciler tarafından her bir ödeve ayrılan birim süre (t=2 saat) göz önünde bulundurularak ve kavite, kaide, matris-kama, restorasyon aşamalarına uyularak hazırlandı. (A) alçı model, (P) plastik model ve (F) fantom model olmak üzere üç grup oluşturuldu. Her restorasyon Aproksimal Kavite Formu, Kenar ve Kontak Uyumu, Restorasyon Aproksimal ve Gingival Alanlarının Uyumu kriterleri üzerinden değerlendirildi. Verilerin istatistiksel analizinde öncelikle McNemar-Bowker ve Friedman testleri uygulandı.

BULGULAR: Kavite preparasyonunda tüm modeller benzer sonuçlar verirken, restorasyonların değerlendirmesinde, alçı ve plastik modellerde meziyal veya distal yüzeylerde fark bulunmadı. Fantom modellerde distal bölgedeki amalgam uyumunun meziyaldekine kıyasla daha başarılı olduğu tespit edildi (p<0.05).

SONUÇ: Gerçek dişleri daha iyi taklit edebilen ve özellikle fantom kafalara da adapte edilebilen geliştirilmiş plastik dişler içeren modellerin kullanımının, Restoratif Diş Tedavisi preklinik eğitimi sırasında, öğrenci manipülasyonuna daha fazla katkı sağlayabileceği kanısına varılmıştır.

Anahtar Kelimeler: *Alçı model, Fantom model, Amalgam restorasyon, Preklinik eğitim*

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Received Date: 10.05.2024
Accepted Date: 21.09.2024

INTRODUCTION

In restorative dentistry, preclinical education given to students is extremely important in terms of enhancing and strengthening the knowledge taught in theoretical courses with practical applications, gaining the necessary and sufficient manual skills for all kinds of clinical applications on the patient, and learning the ideal working positions. [1,2] Preclinical (phantom) studies, which are one of the most important elements of preclinical education, are also important in terms of teaching students direct and indirect working positions in the patient's mouth, holding hand tools correctly, working positions and using the light source correctly. [3] In addition, the mechanical and physical similarities of dental substitutes with dental tissues increase the mimicability of real clinical conditions in these practical applications, making it easier for students to recognize dental hard tissues.[4] Restorative treatments and procedures performed on materials with mechanical properties similar to enamel and dentin tissues play a role in making the education process more successful by increasing the learning levels and achievements of the students.[5,6]

Second- and third-year dentistry students first learn the restorative treatment procedures to be applied on the teeth of the patients in the clinic by applying the steps such as plaster models removed with special silicone molds, then plastic teeth placed in plastic jaws, and then cavity preparation, base and restorative material applications on extracted human teeth.[7,8] Plaster (stone) and plastic models are considered sufficient materials at the initial stage in teaching students the basic rules of practice due to their easy accessibility and applicability and the opportunity to work with a direct point of view.[7,8] However, the inability to provide indirect working conditions, the lack of a standard cavity design and restoration application due to the soft and heterogeneous nature of the materials are among the obvious disadvantages.[3] For these reasons, it is of great importance to use “Phantom heads and models” that have standard sizes and functions for each student that mimic the anatomy of the real head and neck region of the patients, and that the teeth on them are in real tooth hardness and forms.[2,9]

Working on models placed on phantom heads, which can mimic jaw movements and show occlusion relationships, has an important place in learning the terms used in the clinic and transferring them to practice.[9,10] For these reasons, educational activities using Phantom models improve students' practical outcomes compared to plaster models or plastic teeth placed in plastic molds. In addition, working with the appropriate position and angle in Phantom heads; In addition to contributing to the development of manual skills such as distance adjustment, hand-eye coordination, holding simple hand tools and mechanical tools such as anguldruva, it also provides students with many different practical information such as physiological and functional movements and limitations of tissues such as cheeks and lips.[5]

Another advantage of phantom heads over plaster and plastic models in imitating clinical conditions is their contribution to teaching students to work at maximum and minimum mouth openings, as they are cheek pads and joint movements compatible with real human head anatomy and physiology. The presence of cheeks in the heads and adjusting the vertical mouth opening especially in the posterior region plays a crucial role in the development of some fundamental haptic skills of students, in terms of preparing class 2 (OM/OD/MOD) cavities, applying different types of matrices to these cavities, insertion of restorative materials such as composites and amalgams, giving appropriate contours in the relevant teeth and ensuring contact relations.[11,12]

The aim of this study is to comparatively examine amalgam restorations made in plaster, plastic and phantom models in dental preclinical education in terms of their qualities such as cavity form, edge fit and contact.

MATERIALS and METHODS

Formation of Groups and Construction of Restorations

In the 2013 and 2014 academic years, second grade students (n=163) of Ege University Faculty of Dentistry were included in this study. All of the restorations which were evaluated in this study were performed by the 2nd grade students in Phantom Practice during the course of Restorative Dentistry. Three groups were formed: (S) plaster (stone) model, (P) plastic model (Klas Dental, Ankara, Turkey) and (N) phantom model (Nissin Dental Products Inc, Kyoto, Japan). Plaster models are made of type IV dental plaster (Die-Keen; Heraeus Kulzer Inc, South Bent, India.) Created. Prior to cavity preparation, the contacts on the plaster models were removed with metal amalgam sandpaper (Horico Dental, Hopf, Ringleb & Co. GmbH, Germany). While the typodont teeth were fixed with wax in plastic models, for phantom models special screws were used to fix the teeth.

In each group, under the supervision of the relevant faculty members and assistants, Class II (two and three-way) 4 mm deep amalgam cavities were prepared in accordance with the Black cavity rules. The occlusal width of the cavities was 1/3 of the intertubercle distance and the proximal margin was 1 mm above the enamel dentin border. MOD class II cavities were formed in the upper first premolar tooth and OM class II cavities were formed in the upper first molar tooth. No beveling was applied to the cavities because the final restoration will be amalgam. Zinc oxide eugenol (Alganol, Kemdent, Swindon Wiltshire, England), which is known to be the base material with the highest antibacterial effect and easy to apply was placed as a base material (liner) in the prepared cavities. [13] Ivory matrix was applied in OM/OD cavities and a ring (tofflemire) matrix was applied in MOD cavities. After the matrix application, the relevant teeth were wedged with wooden wedges of appropriate sizes (thickness and height) (Sycamore, Kerr Dental, Orange Co, CA, USA), considering the anatomical structure of the tooth, the form of the embrasure area, the location of the contact point and the distance between the teeth. Following the application of the base and matrix, amalgam restorations (Cavex non-gama 2 amalgam, RW Haarlem, Netherlands) were prepared by mixing the powder-liquid formulation with the amalgamator (Dentomat Compact Mixer, Dentsply, Konstanz, Germany) device in accordance with the manufacturer's instructions (Figure 1). Powder-liquid amalgam formulation was preferred because it was desired to manually adjust the hardening time of the amalgam according to the restoration size and to reduce the amount of residual amalgam to the maximum extent.

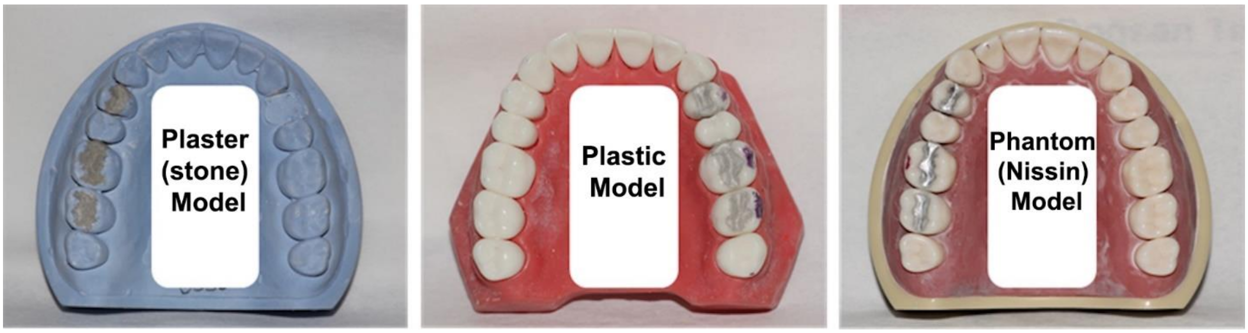

Figure 1.

Evaluation of Restorations

For the evaluation of the restorations, a scale was prepared in accordance with Black's principles, including cavity form, contact and edge compatibility criteria. Before the evaluation, faculty members and assistants were informed about the scale, and standardization was ensured among the observers. Evaluation for each tooth was carried out according to the specified evaluation criteria (Table 1). The edge fit criteria are shown in Figure 2.

Table 1: Criteria used in the evaluation of restorations

	Evaluation Criteria			
Aproximal Cavity Form (mesial, distal)	1: Normal		2: Not suitable	
Edge Fit (occlusal)	1: Normal	2: Redundancy (Flashing)	3: Indentation (Ditching)	4: Open margin
Contact (mesial, distal)	1: Normal	2: Open	3: Extreme	
Proximal area of the Restoration (mesial, distal)	1: Normal	2: Flashing	3: Open	
Gingival Edge of the Restoration (mesial, distal)	1: Normal	2: Flashing	3: Open	

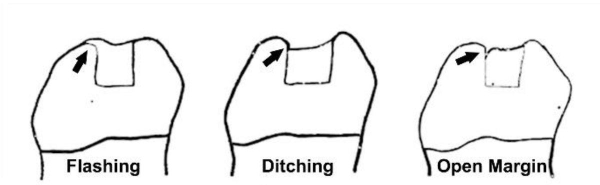

Figure 2.

In order to ensure the consistency of the observers within themselves, the evaluation stages were repeated at the end of 1 week and the average of the data obtained was recorded as the final grade. Criteria 2, 3 and 4 above, which were determined to provide calibration among observers, were standardized under the heading of unsuitable in line with the recommendation of the statistician. Thus, two main scores were determined under the heading of normal and inappropriate.

Statistical Analysis

The scores recorded by the observers were transferred to the computer environment. In the statistical analysis of the data, firstly, the McNemar-Bowker test was applied. In order to evaluate the level of achievement of the students on three different models, each parameter was recored as 'normal' and 'inappropriate' (other scores other than normal) and the Friedman test was applied. Thus, it was determined how many of the parameters the students performed normally in each type of model (for example, the number of students who did all of the parameters with normal scores or none of them). In pairwise comparisons, Wilcoxon test was applied. Statistical significance level was determined as p≤0.05.

RESULTS

In this study, which was created by evaluating the cavities and restorations prepared by 163 students on the plaster, plastic and phantom models used in preclinical dentistry education, it was seen that the type of model used did not statistically make a statistic difference in the mesial and distal contact harmony of the upper jaw first molar teeth and both mesial and distal contact fits of the premolar teeth (p≥0.05) (Table 2).

Table 2: Evaluation of restoration contacts

			EVALUATION CRITERIA			
Tooth no.	***Direction***	***Material***	***Normal***	***Not acceptable***		***p-Value***
				Open	***Excessive***	
Upper first molar tooth	M	S	107	30	26	0,266
		P	120	17	26	
		F	114	41	8	
Upper first premolar tooth	M	S	72	61	30	0,196
		P	74	41	48	
		F	87	64	12	
	D	S	79	55	29	0,227
		P	90	41	32	
		F	94	59	10	

* M; mesial, D; distal, S; Plaster (stone) model, P; Plastic model, N; Phantom (Nissin) model.

Table 2: Evaluation of apoximal cavity forms

			EVALUATION CRITERIA		
Tooth no.	***Direction***	***Material***	***Normal***	***Not acceptable***	***p-Value***
Upper first molar tooth	M	S	125	38	***a=0.000****
		P	76	87	***b=0.000****
		F	87	76	*c=0.294*
Upper first premolar tooth	M	S	104	59	***a=0.000****
		P	62	101	***b=0.000****
		F	74	89	*c=0.213*
	D	S	116	47	***a=0.000****
		P	55	108	***b=0.000****
		F	69	94	*c=0.120*

* M; mesial, D; distal, S; Plaster (stone) model, P; Plastic model, N; Phantom (Nissin) model.
** Statistically significant differences (p<0.05). **(S vs. P=a, S vs. N=b, P vs. N=c)**

Examples of contact images of amalgam restorations made in plaster, plastic and phantom models are shown in Figure 3. It was observed that the cavity forms prepared by the students in the mesial regions of the upper first molar teeth and the mesial and distal proximal regions of the upper first premolar teeth were better than those prepared in the plaster models (p≤0.05) (Table 3).

Figure 3.

Table 3: Evaluation of aproximal fit of restorations

			EVALUATION CRITERIA			
Tooth no.	***Direction***	***Material***	***Normal***	***Not acceptable***		***p-Value***
				Flashing	***Open***	
Upper first molar tooth	M	S	75	59	29	*0,247*
		P	73	72	18	
		F	86	43	34	
Upper first premolar tooth	M	S	90	52	21	***a=0.014*** *b=0.060 c=0.649*
		P	67	74	22	
		F	72	58	33	
	D	S	78	50	35	***a=0.007*** *b=0.470* ***c=0.000***
		P	54	82	27	
		F	85	51	27	

* M; mesial, D; distal, S; Plaster (stone) model, P; Plastic model, N; Phantom (Nissin) model.
** Statistically significant differences (p<0.05).

The difference in model in the upper first molar teeth did not statistically change the amalgam fit in the proximal region. On visual examination, it was determined that amalgam condensation was made in the mesial proximal parts of the premolar teeth with no gaps and overflows at the tooth-filling interface in plaster models compared to plastics ($p \leq 0.05$). In the distal proximal parts of the premolar teeth, it was determined that the students showed more success in both plaster and phantom models than in plastics ($p \leq 0.05$) (Table 4).

Table 4: Evaluation of gingival amalgam concordance

			EVALUATION CRITERIA			
Tooth no.	***Direction***	***Material***	***Normal***	***Not acceptable***		***p-Value***
				Flashing	***Open***	
Upper first molar tooth	M	S	74	36	53	*0,206*
		P	88	33	42	
		F	86	44	33	
Upper first premolar tooth	M	S	88	18	57	*a=0.581 b=0.105* ***c=0.019***
		P	94	20	49	
		F	73	53	37	
	D	S	83	19	61	*0,391*
		P	87	19	57	
		F	94	36	33	

* M; mesial, D; distal, S; Plaster (stone) model, P; Plastic model, N; Phantom (Nissin) model.
** Statistically significant differences (p<0.05).

Examples of proximal images of amalgam restorations prepared in plaster, plastic and phantom jaw models are shown in Figure 4. When amalgam condensations in gingival regions were evaluated, it was observed that only the upper first premolar teeth were statistically significantly more successful in the mesio-gingival regions in plastic models compared to phantom models ($p \leq 0.05$) (Table 5).

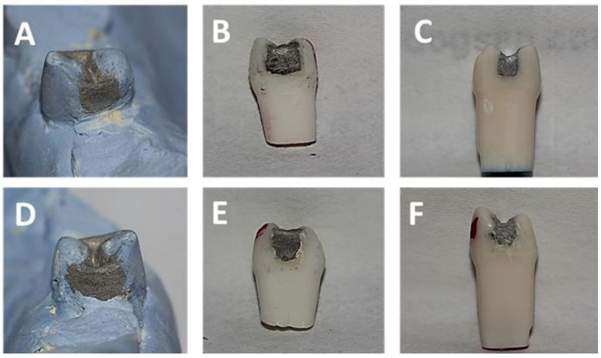

Figure 4.

Table 5: Comparison of mesial and distal contacts and proximal cavity forms in the upper first premolar tooth

Mesial and Distal Regions Contact Compatibility		**EVALUATION CRITERIA**			
Material	***Direction***	***Normal***	***Not acceptable***		***p-Value***
			Flashing	***Open***	
S	M	72	61	30	*0,472*
	D	79	55	29	
P	M	74	41	48	***0,017*****
	D	90	41	32	
N	M	87	64	12	*0,444*
	D	94	59	10	

Compatibility of Proximal Cavity Forms		**EVALUATION CRITERIA**		
Material	***Direction***	***Normal***	***Not acceptable***	***p-Value***
S	M	104	59	*0,096*
	D	116	47	
P	M	62	101	*0,265*
	D	55	108	
N	M	74	89	*0,500*
	D	69	94	

* M; mesial, D; distal, S; Plaster (stone) model, P; Plastic model, N; Phantom (Nissin) model.
** Statistically significant differences (p<0.05).

In the study, the effect of the direction of the prepared cavity on the results was examined. In this context, it was observed that statistically better contact fit was achieved in the distal proximal region in plastic models than in the mesio-lateral (Table 5), while the direction of the cavity did not statistically differ in all three models in terms of cavity form and amalgam fit in the proximal regions (Table 6).

In the evaluation of amalgam in the gingival region, the application in the mesial or distal region did not make a difference in plaster and plastic models, while the amalgam compatibility in the disto-gingival region was found to be statistically more successful in phantom models compared to the mesial ($p \leq 0.05$) (Table 6).

When it is evaluated how many of the criteria included in the study are fulfilled appropriately by how many students; While there was no difference between the plaster-phantom model and the plastic-phantom model, the difference between the plaster-plastic model was found to be statistically significant ($p \leq 0.05$) (Table 7).

Table 6: Comparison of amalgam-tooth concordance in the mesial and distal proximal region and gingival steps in the upper first premolar tooth

Proximal Region Amalgam – Cavity Compatibility		**EVALUATION CRITERIA**			
Material	***Direction***	***Normal***	***Not acceptable***		***p-Value***
			Flashing	***Open***	
S	M	90	52	21	*0,116*
	D	78	50	35	
P	M	67	74	22	*0,134*
	D	54	82	27	
N	M	72	58	33	*0,246*
	D	85	51	27	

Gingival Step Amalgam – Cavity Compatibility		**EVALUATION CRITERIA**			
Material	***Direction***	***Normal***	***Not acceptable***		***p-Value***
			Flashing	***Open***	
S	M	88	18	57	*0,899*
	D	83	19	61	
P	M	94	20	49	*0,395*
	D	87	19	57	
N	M	73	53	37	***0,026*****
	D	94	36	33	

* M; mesial, D; distal, S; Plaster (stone) model, P; Plastic model, N; Phantom (Nissin) model.
** Statistically significant differences (p<0.05).

Table 7: Evaluation of the final stage of the restorations

Material	Mean	Median	Standard deviation	*p-Value*
Plaster (S)	6,69	7	2,926	***a=0.001*** *b=0.151* *c=0.059*
Plastic (P)	5,77	6	2,834	
Nissin (N)	6,26	6	3,125	

* a; Plaster, vs. Plastic, b; Plaster, vs. Nissin, c; Plastic, vs. Nissin
** Statistically significant differences (p<0.05).

DISCUSSION

Depending on the changing needs and increasing demands in dental education, the models and tools used in pre-clinical education have started to vary. [14] Accordingly, plaster models used in the past are now replaced by models that can better imitate natural tooth tissues. Phantom teeth, which are among the models and teeth that have started to be produced in parallel with these developments, and which we use in our work, are made of fiber-reinforced plastic homogeneously.[3] Although the material is softer than natural teeth, it creates a feeling of greater resistance during cavity opening than plaster and traditional plastic teeth. At the same time, these teeth can better imitate natural teeth in terms of contact and contour. [15] Suksudaj et al. reported in their studies that the compatibility of the materials used in preclinical education with real tissues is an important factor in developing the coordination and psychomotor skills required for dental students. [16]

In this study, 2nd grade students at the Faculty of Dentistry of Ege University. In the phantom laboratory, the class students were made to prepare cavities and subsequent restorations on the upper first molar and premolar teeth in plaster, plastic and phantom models. For statistical comparisons, the data were scored as 'normal' and 'inappropriate'. In the study design, criteria such as normal, flashing, ditching, and open margin were determined at the beginning.[17] The purpose of this approach is to express the characteristics identified by the 'non-acceptable' score in order to provide calibration among observers during the evaluation of assignments.[4] In the literature, there are very few studies examining the relationships between the materials used in the restorative preclinic, the restorations performed and the practical success of the students in dental education. [18,19,20] Therefore, the main reason for conducting this research is to examine the effect of the materials used by the students in the preclinical on the cavities they open and the success of the restorations they make.

In all cavity types prepared in this study, it was determined that the cavities opened in plaster models were partially better than those in plastic and phantom models. However, the fact that the contacts are removed with metal sandpaper before the procedures in plaster models is a misleading factor that makes it easier to see the interfaces and to shape these areas with hand tools during cavity preparation. For this reason, we think that plaster (stone) teeth and the cavities opened in these teeth are not an adequate and accurate simulation tool for dental education.

When the proximal amalgam concordances were compared, it was observed that plaster teeth were more acceptable for the mesial contacts of the first premolar teeth and for both plaster and phantom teeth in the distal contacts compared to plastic teeth. Since the teeth in the plastic jaw models are not screwed like the teeth in the phantom jaw models, we think that the upper first premolar tooth in the plastic models may have moved or stretched while the wedge was placed both mesial and distal. As a result, it was determined that amalgam restoration scores in the proximal region were worse in plastic teeth than in plaster and phantom teeth. In a study by Clancy et al., they argued that the difference between plastic and phantom jaw models directly affects the quality of the restorations. They reported that the feedback given by the supervisory faculty members and students after the application of the study also supported this result. [19]

In plastic models, gingival harmony in the upper first molar teeth were found to be better compared to phantom teeth. We believe that this may be due to the fact that the teeth are not fixed with screws in plastic jaw models, on the one hand, causing the amalgam to overflow, and on the other hand, providing an opportunity for cleaning the amalgam in the gingival. When the contacts of the restorations were evaluated in terms of cavity direction, it was seen that the distal contacts were formed better in the plastic models than in the mesials. Since plaster and plastic models could not be adapted to Phantom heads, and it was intended to standardize cavity preparation and restoration stages for all models, no work was carried out on the Phantom head. Therefore, it is thought that the fact that the students made the restoration by positioning the jaws in different directions so that they could work comfortably caused this result. As stated in the paragraph above, gingival amalgam compatibility in phantom teeth is better than mesial in distal proximal teeth; It is thought to be caused by working by positioning the jaws in such a way that the posterior teeth are close to the student. This result is consistent with similar studies in literature. [18]

When it is evaluated how many of the criteria included in the study are fulfilled "appropriately" by how many students; It was observed that the difference between plaster and plastic model was found to be statistically significant. As a reason for this, it has been concluded that plaster teeth are superior to plastic teeth because the manipulation of plaster teeth is more comfortable, the proximal regions are better seen as a result of removing the contacts with metal sandpaper, and accordingly more comfortable to work with.

CONCLUSION

As a result of the findings obtained from our study, although it is seen that students are more successful on plaster and plastic models, we believe that these materials will not be as effective as Phantom models in improving student manipulation because they are not close to the hard tissues of teeth. We think that the use of models containing fiber-reinforced plastic teeth, which can better imitate real teeth in terms of size and morphology before the transition from preclinic to clinic, and which can also be adapted to Phantom heads, can contribute more to the transition of students to clinical education.

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