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Predoctoral Prosthodontic Curricula on Removable Partial Dentures: Survey of Turkish Dental Schools

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Abstract: This study was conducted to evaluate the predoctoral removable partial denture (RPD) curricula in Turkish dental schools in regards to materials, techniques, and approaches. A questionnaire consisting of eighteen multiple-choice questions was sent by e-mail to the senior members of the prosthodontic departments of seventeen long-established dental schools in Turkey. The response rate was 100 percent. All schools (100 percent) used custom trays for making final impressions of partially dentate arches, taught border molding of the custom tray for the edentulous areas, used modeling plastic impression compound in border molding the final impression trays, and used base metal alloys for RPD frameworks. None of the schools had an in-house laboratory that fabricates RPD frameworks, and none of the students cast the frameworks of their own RPDs. The majority of schools used irreversible hydrocolloid as a final impression (70.6 percent) and dental surveyor (76.5 percent) in the designing of RPDs. The majority of schools did not flask their own RPDs (64.7 percent), did not treat patients using RPDs with attachments (76.5 percent), and did not perform the altered cast technique in bilateral and unilateral distal extension RPD cases (76.5 percent). Sixteen schools (94.1 percent) had a minimum number of RPD arches that a student must complete in order to graduate. It was found that predoctoral RPD curricula in Turkish dental schools were both variable and similar.

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A removable partial denture (RPD) prosthesis is defined as any prosthesis that replaces some teeth in a partially dentate arch that can be removed from the mouth and replaced.[1] RPDs are still used in the conventional rehabilitation of partially edentulous patients.[2] According to Douglass and Watson's study,[3] the needs for RPD rehabilitation will increase by 15 percent from 2005 to 2020 in the United States. Although there are no available data on the predicted rates of partial edentulism or RPD needs in Turkey to our knowledge, an extended lifetime and a large increase in the number of elderly individuals are expected in the future. Therefore, there will be a large number of patients in need of RPDs, and predoctoral prosthodontic programs that include RPD education are still necessary to meet the dental therapeutic needs of the society.

The traditional methodology for the fabrication of RPDs can be summarized as follows. After an initial impression is made using an irreversible hydrocolloid (alginate), all necessary mouth preparation is completed, followed by a final impression by an elastomeric impression material or alginate using a custom tray. A border molding is also required to obtain a detailed impression of the distal extension edentulous areas. The determination of the design of an RPD using a dental surveyor is an essential component of RPD fabrication.[4] The majority of RPD frameworks are made from alloys based primarily on nickel, cobalt, or titanium as the principal metal component. Noble alloys may also be preferred. Apart from metallic structure, these dentures also contain acrylic component for the mounting of artificial teeth, which are produced from either acrylic or porcelain.[4,5]

Petropoulos and Rashedi[6] reported that, in 18 percent of dental schools in the United States, RPDs were not clinical requirements for graduation; they attributed this finding to the increased use of dental implants in partially edentulous patients. Although there is extensive evidence in the literature that dental implants are successfully used in the treatment of partially edentulous patients with RPDs, dental implant treatments are not within the clinical practice of undergraduate dental education programs in Turkey. This does not imply that patients treated in the student clinics are not offered the opportunity to receive an implant where indicated. The patients are always informed of such an option. If they prefer an

implant structure rather than a removable denture, they are referred to postgraduate clinics where those procedures are performed by postgraduate students under the supervision of their instructors. Although students are provided with didactic information regarding implants during their education, they do not perform this specific procedure on their patients.

Currently, there is a growing trend in Turkey to open new dental schools due to the increasing popularity of the profession of dentistry. Therefore, the revision of educational programs and the updating of dental education curricula are necessary, so that Turkish schools can be compatible with other dental schools in developed countries. Although many aspects of the prosthodontic curriculum of dental schools have been investigated,[6-12] none of these studies was performed in Turkey. Therefore, this survey was conducted to investigate the current situation regarding the teaching of RPD fabrication by gathering information related to predoctoral RPD curricula in Turkish dental schools and to make a general comparison with the results from schools in other countries.

Materials and Methods

This study was completed in October 2011. Following Institutional Review Board approval in terms of gathering of data from human subjects, a questionnaire was prepared that included eighteen multiple-choice questions. The questionnaire used by Petropoulos and Rashedi[6] was taken as the basis for the survey, with some modifications and additional items. The questionnaire was translated into the Turkish language by a translator with high-level proficiency in English. Later, the translation was reviewed by two prosthodontists with more than ten years of clinical and academic experience in terms of dental terminology. A pilot study was conducted to test the validity of the questionnaire by three faculty members in the Department of Prosthodontics, Faculty of Dentistry, Yeditepe University. Following their approval, the questionnaire was sent by e-mail to the directors or senior members of the prosthodontic departments of long-established dental schools in Turkey. Only one of the members from each institution answered the questionnaire. Among the forty-one dental schools currently present in Turkey, the seventeen included offer dental education for more than five years (official duration of dental education in Turkey), thus ensuring that they have an established educational system. A second follow-up e-mail was sent and telephone calls were made to those who had still not replied. All participants were assured at the beginning of the study that data collected would be kept strictly confidential and that the anonymity of the dental schools was ensured. It took one month to collect the data. Percentages were obtained with respect to each question. (For a copy of the questionnaire, contact the corresponding author.)

Statistical analyses were performed using SPSS (Statistical Package for Social Sciences) for Windows 15.0 program to compare the results of our study with other similar studies.[6,13] Only the answers of common questions in our survey and similar studies performed in other countries were statistically compared. Chi-square test and Fisher's exact test were used for the comparison of quantitative data. Significance level was set at $p<0.05$.

Results

All dental schools responded to the questionnaire, a response rate of 100 percent. The following are the answers given by the respondents.

For question 1 (What kind of artificial teeth do you have in your clinics for your students?), Table 1 summarizes the answers. To question 2 (Are you teaching your students to use a custom tray for making final impressions of partially dentate arches?),

Table 1. Type of artificial teeth used for partial dentures in Turkish dental schools

Type of Artificial Teeth	Number of Schools (%)
Ivoclar acrylic, Vita acrylic, Vita porcelain, and other	1 (5.9%)
Ivoclar porcelain, Optodent acrylic, Optodent porcelain, and other	1 (5.9%)
Vita acrylic only	1 (5.9%)
Optodent acrylic only	4 (23.5%)
Other	10 (58.8%)

Note: "Other" were Eray, MajorDent, Megaplus, Yamachi, and NT Optima acrylic.

all schools (100 percent) indicated that they teach their students to use a custom tray for making final impressions of partially dentate arches (Table 2). To question 3 (Do you teach border molding of the custom tray for the edentulous areas of the removable partial denture final impressions?), all schools (100 percent) reported that they teach border molding of the custom tray for the edentulous areas of the removable partial denture final impressions (Table 2). On question 4 (What material(s) do you teach for use in border molding the final impression trays for the partially edentulous patient?), sixteen schools (94.1 percent) reported that they teach using only modeling plastic impression compound in border molding the final impression trays. Only one dental school (5.9 percent) stated that they teach both modeling plastic impression compound and wax materials (Table 2). On question 5 (How much relief [area of relief] is used to relieve a custom tray for a removable partial denture?), seven schools (41.2 percent) indicated that they teach placement of relief both on teeth and edentulous areas. Three schools (17.6 percent) stated that they teach placement of relief only on edentulous areas. Four schools (23.5 percent) reported that they teach placement of relief only on teeth areas. One dental school (5.9 percent) stated that it does not

Table 2. Comparison between Turkish and U.S. dental schools

		Turkish n (%)	U.S. n (%)	p-value
Q.2	Yes	17 (100%)	21 (48.8%)	0.001**
	No	0	4 (9.3%)	
	Sometimes	0	18 (41.9%)	
Q.3	Yes	17 (100%)	35 (79.5%)	0.130
	No	0	7 (15.9%)	
	Sometimes	0	2 (4.5%)	
†Q.4	Modeling plastic impression compound only	16 (94.1%)	27 (61.4%)	0.021*
	Modeling plastic impression compound and wax	1 (5.9%)	2 (4.5%)	
	Others	0	15 (34.1%)	
Q.5	Relief on teeth areas only	4 (23.5%)	6 (14.3%)	0.156
	Relief on edentulous area only	3 (17.6%)	1 (2.4%)	
	Relief on teeth and edentulous areas	7 (41.2%)	29 (69%)	
	No relief	1 (5.9%)	3 (7.1%)	
	Others	2 (11.8%)	3 (7.1%)	
Q.10	Yes	6 (35.3%)	1 (2.3%)	0.001**
	No	11 (64.7%)	41 (93.2%)	
	Sometimes	0	2 (4.5%)	
Q.11	Base metal alloys	17 (100%)	42 (100%)	—
Q.12	Yes	4 (23.5%)	17 (38.6%)	0.266
	No	13 (76.5%)	27 (61.4%)	
Q.13	Yes	0	15 (34.1%)	0.006**
	No	17 (100%)	29 (65.9%)	
Q.15	Yes	7 (41.2%)	41 (95.3%)	0.001**
	No	10 (58.8%)	2 (4.7%)	
Q.16	Yes	2 (11.8%)	26 (59.1%)	0.001**
	No	13 (76.5%)	8 (18.2%)	
	Sometimes	2 (11.8%)	10 (22.7%)	
Q.17	Yes	16 (94.1%)	34 (77.3%)	0.125
	No	1 (5.9%)	10 (22.7%)	
Q.18	Yes	1 (5.9%)	20 (45.5%)	0.003**
	No	16 (94.1%)	24 (54.5%)	

Note: See Results section for wording of questions. Other than for Question 4, p-values determined by chi-square test.
†Fisher's Exact test
*p<0.05, **p<0.01

Source: Data on U.S. schools are from Petropoulos VC, Rashedi B. Removable partial denture education in U.S. dental schools. J Prosthodont 2006;15(1):62-8.

use relief. Two schools (11.8 percent) included that they teach placement of relief if there are any torus, exostosis, or undercut areas (Table 2).

On question 6 (In the fabrication of removable partial dentures, what type of articulator are students being taught to mount preliminary casts on?), nine schools (53 percent) reported that they use simple hinge type articulators with lateral movement capacity. Four schools (23.5 percent) reported that they use simple hinge type articulators without lateral movement capacity. Four schools (23.5 percent) reported that they use a semi-adjustable articulator (Table 3). On question 7 (In the fabrication of removable partial dentures, what type of articulator are students being taught to mount final casts on?), nine schools (53 percent) reported that they use simple hinge type articulators with lateral movement capacity. Four schools (23.5 percent) reported that they use simple hinge type articulators without lateral movement capacity. Four schools (23.5 percent) reported that they use a semi-adjustable articulator (Table 3). On question 8 (What materials are currently being used as a final impression material for partially dentate arches?), twelve schools (70.6 percent) stated that they use irreversible hydrocolloid (alginate), and five schools (29.4 percent) stated that they use polyvinylsiloxane (condensation or additional). None of the schools used polysulfide or polyether materials (Table 3). On question 9 (Do you teach using dental surveyor in the designing of removable partial dentures for students' clinical cases?), thirteen schools (76.5 percent) reported that they used surveyor in the designing of removable partial dentures for their patients, and four schools (23.5 percent) reported that they did not use surveyor (Table 4).

In response to question 10 (Do students flask their own removable partial dentures for their clinical cases?), six schools (35.3 percent) stated that their students flask their own removable partial dentures for their clinical cases, and eleven schools (64.7 percent) stated that their students do not flask their own removable partial dentures for their clinical cases (Table 2). On question 11 (What material is being used for removable partial denture frameworks?), all schools (100 percent) reported that they use base metal alloys for removable partial denture frameworks (Table 2). On question 12 (Are students treating patients using removable partial dentures with attachments?), thirteen schools (76.5 percent) reported that their students do not treat patients using removable partial dentures with attachments, and four schools (23.5 percent) reported that their students treat patients using removable partial dentures with attachments in their senior year (Table 2). On question 13 (Is there an in-house laboratory that fabricates removable partial denture frameworks?), all schools (100 percent) reported that there is no in-house laboratory that fabricates removable partial denture frameworks (Table 2).

To question 14 (Do students cast the frameworks of their own removable partial dentures for their clinical cases?), all schools (100 percent)

Table 3. Comparison among Turkish, U.S., and U.K. dental schools

		Turkish n (%)	U.S. n (%)	U.K. n (%)	p-value
Q.6	Simple hinge type articulator with lateral movement	9 (53%)	2 (4.8%)	1 (9.1%)	0.001*
	Simple hinge type articulator without lateral movement	4 (23.5%)	0	0	
	Semi-adjustable articulator	4 (23.5%)	40 (95.2%)	10 (90.9%)	
Q.7	Simple hinge type articulator with lateral movement	9 (53%)	1 (2.3%)	1 (9.1%)	0.001*
	Simple hinge type articulator without lateral movement	4 (23.5%)	0	0	
	Semi-adjustable articulator	4 (23.5%)	43 (97.5%)	10 (90.9%)	
Q.8	Polyvinylsiloxane	5 (29.4%)	3 (13.6%)	9 (60%)	0.004*
	Polyether	0	1 (4.5%)	0	
	Polysulfide	0	7 (31.8%)	0	
	Irreversible hydrocolloid	12 (70.6%)	11 (50%)	6 (40%)	

Note: See Results section for wording of questions.
p-values determined by chi-square test
*p<0.01

Sources: Data on U.S. and U.K. schools are from Petropoulos VC, Rashedi B. Removable partial denture education in U.S. dental schools. J Prosthodont 2006;15(1):62-8; and Lynch CD, Allen PF. The teaching of removable partial dentures in Ireland and the United Kingdom. Br Dent J 2007;203(8):E17.

Table 4. Comparison between Turkish and U.K. dental schools

		Turkish n (%)	U.K. n (%)	p-value
Q.9	Yes	13 (76.5%)	10 (90.9%)	0.619
	No	4 (23.5%)	1 (9.1%)	

Note: See Results section for wording of question.
p-value determined by Fisher's Exact test

Source: Data on U.K. schools are from Lynch CD, Allen PF. The teaching of removable partial dentures in Ireland and the United Kingdom. Br Dent J 2007;203(8):E17.

reported that their students do not cast the frameworks of their own removable partial dentures for their clinical cases. On question 15 (Is there a set protocol for post-insertion adjustment visits of removable partial denture patients in the clinics?), seven schools (41.2 percent) stated that they have a set protocol for post-insertion adjustment visits of removable partial denture patients in the clinics. Ten schools (58.8 percent) responded that they do not have a set protocol for post-insertion adjustment visits of removable partial denture patients in the clinics (Table 2). On question 16 (Do students perform the altered cast technique in bilateral and unilateral distal extension removable partial denture cases?), thirteen schools (76.5 percent) reported that their students did not perform the altered cast technique in bilateral and unilateral distal extension removable partial denture cases, and two schools (11.8 percent) reported that their students perform this technique. Only two schools (11.8 percent) stated that their students perform this technique if necessary, according to clinical situations (Table 2).

In response to question 17 (Is there a minimum number of removable partial denture arches that a student must complete in order to graduate?), sixteen schools (94.1 percent) indicated that they have a minimum number of removable partial denture arches in order to graduate. Fourteen of these schools further reported the minimum units specifically, and the mean number of units was eight (Table 2). On question 18 (Do transitional/interim removable partial dentures count as arches or partial arches toward graduation requirements?), only one dental school (5.9 percent) stated that transitional/interim removable partial dentures count as arches or partial arches toward graduation requirements, mentioning also that these were "worth one unit" (Table 2). Statistical analyses of the results of compared parameters in our and others' studies are shown in Tables 2, 3, and 4.

Discussion

There was general agreement among all schools (100 percent) in terms of the following items: using a custom tray for making final impressions of partially dentate arches, border molding of the custom tray for the edentulous areas of the RPD final impressions, modeling plastic impression compound in border molding the final impression trays, and base metal alloys for RPD frameworks. A possible reason for such findings may be related to the financial aspects of this type of practice. These procedures require the usage of relatively less expensive materials and products and thus may be more compatible with the university budget. It is a fact that the majority of the patients receiving treatment at the student clinics have social security and, consequently, the government reimburses the schools. This amount is substantially lower in comparison to the regular price of removable partial dentures at private institutions. This may necessitate the use of materials that have relatively lower prices. On the other hand, even though these materials are economically more suitable, this does not imply that they do not meet the requirements for achieving an acceptable RPD. Only one dental school (5.9 percent) reported teaching both modeling plastic impression compound and wax materials. These results differ from the study by Petropoulos and Rashedi[6] in the United States that found lower results (48.8 percent for custom tray and 61.4 percent for modeling plastic impression compound).

The type of artificial teeth used for RPDs was used by schools in the following order: Optodent acrylic (Bayer, Germany) only (23.5 percent), Vita acrylic (Bad Säckingen, Germany) only (5.9 percent), and other artificial teeth (58.8 percent), including Eray (Ankara, Turkey), Majordent (Moncalieri, Italy), Megaplus (Dentarum, Liechtenstein), Yamachi

(Gamagori, Japan), and NT Optima acrylic (Antalya, Turkey). Acrylic teeth seem to be used widely, probably because of the simplicity of adjustment, the ease of grinding without any adverse effect on their adhesion to the acrylic base, and the ease of fabrication and polishing after adjustments.[14] Financial constraints may also be a limiting factor to the use of acrylic artificial teeth.

None of the schools reported teaching their students about casting the frameworks of their own RPDs for their clinical cases. Eleven schools (64.7 percent) stated that their students do not flask their own RPDs for their clinical cases. Although dental practitioners do not perform flasking procedures in their clinical practices, basic knowledge is required during predoctoral education, and students observe the laboratory stages of RPDs in order to direct their dental technicians to produce ideal dentures after graduation. We recommend that students perform the flasking procedure at least once during their education, and it is appropriate that this procedure is included in the predoctoral prosthodontic curriculum. This can allow students to better understand the fabrication process, improve their skills for designing the frameworks, and communicate better with their laboratories.

Another finding from our survey was that nine schools (53 percent) used simple hinge type articulators with lateral movements to mount both preliminary and final casts of RPDs. Four schools (23.5 percent of the total) used simple hinge type articulators without lateral movements for these procedures, and only four (23.5 percent of the total) used semi-adjustable articulators. These results are significantly different from those in the study by Petropoulos and Rashedi,[6] which found that the semi-adjustable articulator was most widely used for mounting both preliminary casts (95.2 percent) and final casts (97.5 percent) of RPDs. In addition, a semi-adjustable articulator was reported to be used by 90.9 percent of dental schools in Ireland and the United Kingdom.[13] This difference may be attributed to the high cost of the semi-adjustable articulator, and financial problems may prevent the use of this type of articulator in Turkish dental schools. Correct mounting on an articulator exhibiting all jaw movements is an essential step of creating RPDs. It is an undeniable fact that the provision of inadequate occlusion and articulation may lead to undesirable consequences, including serious temporomandibular joint disorders. Thus, dental schools must be encouraged to enhance the usage of these articulators that mimic jaw movements precisely, and financial restrictions should not be a hindrance to the provision of such an important tool used in the production of successful prostheses.

Twelve schools (70.6 percent) in our study used irreversible hydrocolloid, and five schools (29.4 percent) used polyvinylsiloxane (condensation or additional) for the final impression. The lower cost of irreversible hydrocolloid impression materials compared to polyvinylsiloxane may be the reason for this result. These findings are significantly different from the results of the study by Petropoulos and Rashedi,[6] which reported that 50 percent of U.S. dental schools used irreversible hydrocolloid, 31.8 percent used polysulfide, and 13.6 percent used polyvinylsiloxane. On the other hand, 60 percent of schools used polyvinylsiloxane and 40 percent used irreversible hydrocolloid in Ireland and the United Kingdom.[13] Both elastomeric impression materials and irreversible hydrocolloid are acceptable means of making a reliable impression and can be advocated during clinical practice. The dentist's preference regarding either impression is expected to result in a favorable outcome.

Our survey found that thirteen schools (76.5 percent) used a surveyor in the designing of RPDs for patients. This result differs from those obtained from dental schools in Ireland and the United Kingdom, in which 90.9 percent of schools used surveyors.[13] This difference, however, is insignificant. The primary cause of such a result may be that the responsibility for using a surveyor in the designing of RPDs has generally devolved to dental technicians in Turkish dental schools (76.5 percent).

We found that the application of relief placement on a custom tray for an RPD among Turkish dental schools also varied: seven schools (41.2 percent) taught placement of relief both on teeth and edentulous areas, three schools (17.6 percent) taught placement of relief only on edentulous areas, and four schools (23.5 percent) taught placement of relief only on teeth areas. Only one dental school (5.9 percent) stated that its students do not use reliefs. These results differ from the study conducted by Petropoulos and Rashedi,[6] which reported 69 percent placement of relief both on teeth and edentulous areas, 2.4 percent placement of relief only on edentulous areas, 14.3 percent placement of relief only on teeth areas, and 7.1 percent no relief. However, the difference is insignificant.

In our study, sixteen schools (94.1 percent) reported requiring a minimum number of RPDs to be eligible for graduation, and the mean number

was eight. This finding is similar to one from the study conducted in the United States (77.3 percent).[6] The minimum number of RPDs prior to graduation ranged between two and five in Ireland and the United Kingdom,[13] and this value was lower than Turkey's. Implants have started to gain popularity in recent years, owing to a variety of advantages, such as the compensation of edentulous areas without necessitating abutment preparation and patient discomfort. However, it should be kept in mind that even these applications may pose some restrictions, and there might be cases in which RPD applications should be the treatment of choice. From this clinical point of view, it is evident that future dentists should be trained and given adequate experience in these types of dentures, and the role of removable appliances in clinical dentistry should not be underestimated. The more the dental student is trained on RPDs, the better insight he or she will gain in terms of clinical decision making.

Only one of the schools (5.9 percent) in our study counted transitional/interim RPDs as arches or partial arches and included that these were "worth one unit." The transitional/interim RPDs may also be the subject of postgraduate programs. In thirteen schools (76.5 percent), the altered cast technique in bilateral and unilateral distal extension RPD cases was not applied, while two schools (11.8 percent) reported that their students applied this technique. This is a higher percentage compared to a study[6] that found that 18.2 percent of schools did not require altered cast technique. Only two schools (11.8 percent) reported that students performed altered cast technique if necessary, according to clinical situations. The altered cast technique in distal extension RPDs helps to improve the edentulous tissues-teeth relationship of dentures and creates an environment in which residual ridge and dentition support dentures' compatibility. This technique enhances patient comfort and preserves remaining supporting teeth and residual ridge.[15] According to Holmes,[16] the altered cast technique was found to provide the least amount of movement from occlusal loading at the time of insertion with RPDs. With the use of the altered cast technique, RPDs are much more stable, resulting in the least amount of denture base movement. Therefore, the importance of this technique should be emphasized to students during their education.

According to the results of our study, a relatively low percentage of schools include precision attachments in the undergraduate curriculum. This was presumably because this topic is included in the postgraduate educational program. Precision attachments are helpful means to enhance esthetics and retention of RPDs, and there is generally a high demand among patients in terms of utilization of these elements in case an RPD is indicated. Thus, it is quite likely that future dentists will encounter patients requesting the inclusion of precision attachments for a better esthetic appearance and usage. Meanwhile, it is the dental practitioner's duty and responsibility to offer different alternatives to patients in the planning phase of their prosthodontic treatment. This renders the necessity of familiarizing the students with precision attachments prior to graduation. We anticipate that the low percentage of Turkish schools covering this topic in their curricula will gradually increase in the upcoming years, and faculty authorities will also consider the fact that dental practitioners of the future may be recruited in areas where prosthodontic specialists are lacking and where they will be faced with the responsibility of handling more sophisticated aspects of prosthodontic dentistry.

Seven schools (41.2 percent) in our study reported having a set protocol for post-insertion adjustment visits in the clinics; this is significantly lower than in the United States (95.3 percent).[6] Patients with new RPDs generally need an adjustment phase after insertion. Post-insertion adjustment visits are necessary to ensure proper fit of the RPDs to the residual ridge and soft tissues and occlusion.[17] It seems necessary that all dental schools in Turkey should develop a set protocol for post-insertion adjustment visits in their clinics and that students should be familiarized with the significance of continuous patient follow-up following dental treatment.

Conclusions

The results of our study reveal that Turkish dental schools use different techniques and materials for RPD fabrication; however, some aspects are similar. The teaching of RPDs comprises a significant aspect of contemporary dental education in Turkey, but some developments and modifications may also be necessary. Although there seems to be an evolution toward the widespread usage of implants all over the world, the ongoing necessity of RPD fabrication should not be overlooked, especially considering economic conditions as well as particular cases that do not permit the placement of implants. Thus, students should be given adequate experience regarding RPDs prior to graduation. Future studies that are performed

in different countries that focus on this aspect of education will be supportive in developing strategies to deliver the best information to dental students.

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