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Challenges in complete denture fabrication: Opinions and experiences of postgraduate students*

Kultida Raksinkant, D.D.S.[1]
Napa Sukjai Suansuwan, D.D.S, Grad.Dip. in Clin.Sc. (Prosthodontics), M.Sc. (Prosthetic Dentistry), Ph.D. (Biomaterials), F.R.C.D.S. (Thailand)[2]
Waranuch Pitiphat, D.D.S., M.P.H.M., M.S, Sc.D. (Epidemiology), F.R.C.D.S. (Thailand)[3]

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[1]Ph.D. student, Faculty of Dentistry, Khon Kaen University
[2]Assistant Professor, Department of Prosthodontics, Faculty of Dentistry, Khon Kaen University
[3]Associate Professor, Department of Community Dentistry, Faculty of Dentistry, Khon Kaen University

Abstract

Objectives Limited information is available on prosthodontic postgraduate students' views regarding complete denture education. This study aimed to investigate the opinions and experiences of Thai prosthodontic postgraduate students toward complete denture laboratory practice.

Materials and methods A self-administered questionnaire was mailed to all dentists who currently enrolled in prosthodontic postgraduate programs in Thailand during the academic year 2012. The questionnaire consisted of close-and open-ended questions on opinions and experiences related to laboratory work in complete denture fabrication.

Results The response rate was 95 percent. Majority indicated that, among all laboratory procedures, posterior teeth arrangement was the most difficult (82%), most time-consuming (93%), and most needing an aiding device (81%). Eighty-one percent of those who indicated this step as the most difficult to perform specified that there were challenges in establishing the appropriate occlusal scheme. More than half (54%) of those who marked this step as most needing an aiding device gave the reasons that posterior teeth arrangement had several critical steps, and it requires more skill. The respondents who indicated posterior teeth setting as the most time-consuming (93.2%) spent on average 16.7 ± 14.8 hours (mean ± SD) on this step (range 1.5-63 hours).

Conclusions Posterior teeth setup appears to be the most difficult step which directly corresponds with the three most common errors. The negative opinions of students toward this step indicate the aspects of complete denture training that need improvement. Novel teaching techniques should be developed to reduce common errors as well as save the time for teeth arrangement.

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Key words: *complete denture; dental education; laboratory practice; prosthodontic postgraduate students; teeth arrangement*

Correspondence: *Waranuch Pitiphat waranuch@kku.ac.th*

Introduction

Complete tooth loss among elderly is common in most developing countries (Ettinger, 1993). In Thailand, the 7th National Oral Health Survey in 2012 revealed that 7.2% of people aged 65 to 74 years and 32.2% of those aged 80 to 89 years were fully edentulous (Bureau of dental health, 2012). With a dramatic change in age structure over the past decades, population aging is an emerging concern in Thailand. The number of population aged 60 years and over has been projected to exceed 17 million and will constitute 26% of all Thais by 2050 (Knodel et al., 2011). Complete dentures are therefore highly essential for these geriatric populations.

Despite public needs, most general practitioners either do not offer complete dentures in their practices, or do so with fear, uncertainty and frustration. The treatment results are often barely acceptable or unacceptable in the patients' view. This could be because the complete denture procedures taught to undergraduate dental students are time-consuming and involve complicated multistep techniques that are hard to adapt to dental practices (Christensen, 1991). Therefore, interested general practitioners often seek specialty training in prosthodontics to improve their skills in this area.

Postgraduate trainings in prosthodontics in Thailand include higher graduate diploma programs, two-year and three-year master degree programs, and three-year residency training programs. In all curricula, students are assigned to treat edentulous patients with conventional complete dentures. They have to work on all laboratory procedures by themselves for at least one case. By doing this, students can achieve necessary skills and understand more on each step of denture fabrication.

Complete denture laboratory teaching in dental schools has been reported to vary in content (Clark et al., 2010). Students' skill level is related to their attitude and time spent in complete denture laboratory practice (Sharma et al., 2014). To improve the effectiveness of teaching approach and enhance the students' skills, instructors should be aware of students' concerns regarding each laboratory step in complete denture fabrication. These particularly include difficulties of the procedures, time spent, common errors and students' opinions toward each laboratory step. To our knowledge, there was no published report of such information in the last 30 years among prosthodontic postgraduate students. Previous studies on complete denture education and practice were mainly conducted among new graduates and undergraduates, but not postgraduate student population (Preston, 1989; Clark et al., 2010; Wieder et al., 2013). For example, dental graduates from a US dental school reported an average satisfaction level of 78% in regard to their undergraduate experience in complete dentures. Another study of complete denture education in the UK showed that 45% of the respondents who were new graduates did not enjoy their undergraduate training, while 32% felt that they lacked of confidence and experience in complete denture treatment (Wieder et al., 2013).

The purposes of this study were to investigate the opinions and experiences of Thai prosthodontic postgraduate students toward the difficulties of complete denture laboratory practice, particularly in teeth arrangement procedures. We chose to study the postgraduate students, rather than the undergraduate students, because they have more skill and knowledge in complete denture fabrication. The information gained from this study can be used to improve the educational methods in complete denture laboratory practice as well as to assist the development of aiding device for complete denture fabrication.

Materials and methods

This cross-sectional investigation was carried out among second-year and third-year prosthodontic postgraduate students from five leading dental schools in Thailand that currently run postgraduate programs in Prosthodontics. There were a total of 93 postgraduate students during the first semester of academic year 2012. All of them were invited to participate in the study.

A self-administered questionnaire was originally designed for the purpose and pretested by seven prosthodontists with over 10 years of teaching experience in the Department of Prosthodontics. This was further pilot tested in a group of 65 first-year postgraduate students in the same programs as the study population, to ensure the feasibility and validity of the questions. The questionnaire's reliability was good with a Cronbach's alpha coefficient of 0.91.

The questionnaires with a cover letter providing details on the purpose of the study were mailed to the subjects. It was anonymous but coding was used to identify non-respondents. The questionnaire was sent up to three times to the non-respondents, then the identifying codes were destroyed. Recipients were given three weeks to reply each time.

The questionnaire consisted of three sections. The first section included questions on age, gender, years of practice since dental graduation, current graduate program and year of enrollment. The second section investigated the experiences of the postgraduate students toward laboratory work of complete denture fabrication. Questions were about the opinions on the most difficult step, the most time-consuming step, and the step for which a future aiding device would be most needed, among the seven steps of complete denture fabrication. Additional questions were about common mistakes found in laboratory practice. The students were also asked to choose in order of preference the steps of work that they would like to have an aiding device. The final section contained questions investigating the opinions and experiences of the postgraduate students toward complete denture teeth arrangement. Students were asked if they agreed with nine statements related to the teeth arrangement procedures. In addition, the students were asked to indicate the time duration used for posterior teeth arrangement and mark the difficulty level on a 5-point Likert scale, ranging from 1 'not at all difficult' to 5 'extremely difficult'.

Data were analyzed using descriptive statistics with IBM SPSS statistical software v.19.0 (Chicago, Illinois, USA).

Results

Characteristics of the respondents

About 84% of the postgraduates (78/93) responded to the first mailing. An additional 10 responded to the second mailing but the third mailing resulted in no additional responses (total N=88; 94.6%). Characteristics of the respondents are shown in Table 1. Seventy-eight percent of the respondents were female. The average age (± standard deviation, SD) was 29.5 ± 2.7 years, and 81.8% were in a range of 26-30 years. The average duration of practice after graduation was 4.7 ± 2.1 years, and 73.9% graduated from a dental school within the past 5 years. Half of the respondents (52.3%) were studying in master degree program, 39.7% in residency training program, and 8.0% in higher graduate diploma program.

Opinions and experiences toward each step in complete denture laboratory practice

Seven steps related to complete denture fabrication were rated by the respondents in regard to the difficulty of the task, time needed for completion, and the need of an aiding device (Table 2). Posterior teeth arrangement was considered as the most difficult (81.8%), the most

Table 1 Characteristics of the prosthodontic postgraduate students in the survey. (N=88)

Characteristics	n (%)
Gender	
Male	19 (21.6)
Female	**69 (78.4)**
Age (years)	
26-30	**72 (81.8)**
31-35	11 (12.5)
36-40	4 (4.6)
≥ 41	1 (1.1)
Years of practice after graduation	
1-5	**65 (73.9)**
6-10	22 (25.0)
≥ 11	1 (1.1)
Prosthodontic course enrolled	
Residency training program	
2nd year	15 (17.0)
3rd year	20 (22.7)
Master degree program	
2nd year	24 (27.3)
3rd year	22 (25.0)
Graduate diploma program	
2nd year	7 (8.0)

time-consuming (93.2%), and the step in which an aiding device would be most desirable (80.7%). Eighty-one percent of those who indicated this step as the most difficult to perform specified that there were challenges in establishing appropriate occlusal schemes, especially balanced occlusion. More than half (54%) of those who marked this step as the one in which an aiding device would be most needed gave the reasons that there are several requirements to fulfill in posterior teeth arrangement, and that it requires skills. The respondents who indicated posterior teeth setting as the most time-consuming (93.2%) reported that they spent on average 16.7 ± 14.8 (mean ± SD) hours on this step for one patient (median 11, range 1.5-63 hours). In comparison, the respondents who indicated anterior teeth setting as the most time-consuming (4.5%), indicated

Table 2 Opinions of prosthodontic postgraduate students on each laboratory procedure in complete denture fabrication. (N=88)

Laboratory procedure	Most difficult n (%)	Most time-consuming n (%)	Most needing a future aiding device n (%)
Special tray fabrication	0	0	2 (2.3)
Baseplate and occlusion rim fabrication	1 (1.1)	0	5 (5.7)
Anterior teeth arrangement	5 (5.7)	4 (4.5)	4 (4.5)
Posterior teeth arrangement	**72 (81.8)**	**82 (93.2)**	**71 (80.7)**
Waxing	2 (2.3)	2 (2.3)	2 (2.3)
Flasking and processing the denture	4 (4.5)	0	3 (3.4)
Selective grinding	4 (4.5)	0	1 (1.1)

Table 3 Errors found in laboratory work of postgraduate students. (N=88)

Errors	n (%)
Incorrect angulation and inclination of upper anterior teeth	7 (8.0)
Incorrect position of lower anterior teeth, too far labially from the ridge	10 (11.4)
Improper overjet and overbite	11 (12.5)
Incorrect occlusal plane of upper posterior teeth	**29 (33.0)**
Incorrect position of lower posterior teeth, too far buccally, not related to the ridge crest	**48 (54.5)**
Incorrect occlusal scheme	**66 (75.0)**
No occlusal contact in centric position	25 (28.4)
Others: deviated midline, no compensating curve	3 (3.4)

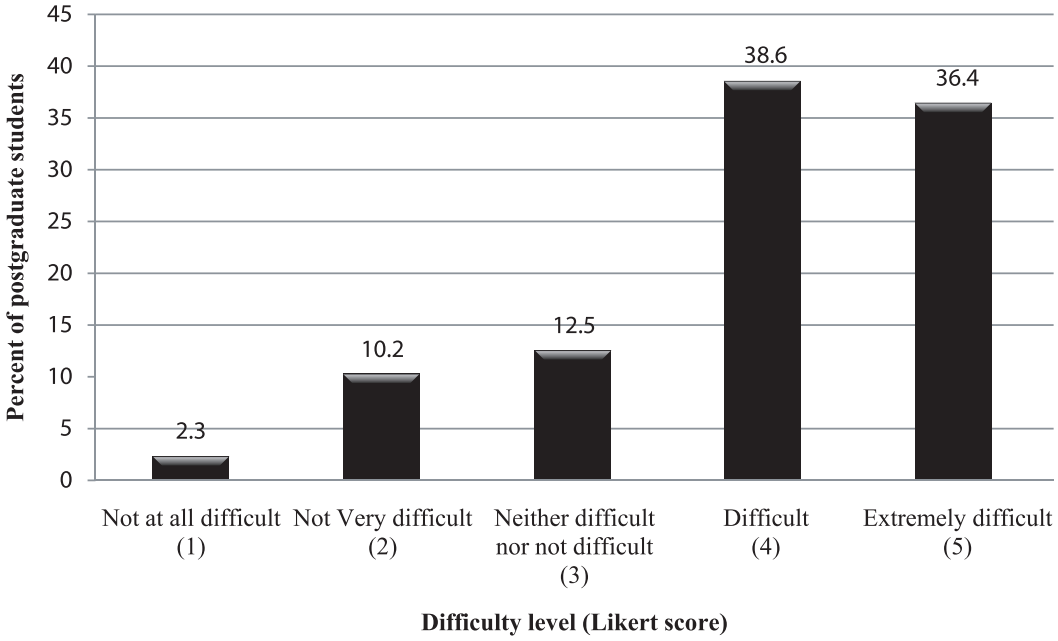

Figure 1 Difficulty level ranked for posterior teeth arrangement by postgraduate students. (N=88)

Table 4 Top three laboratory procedures that future aiding devices are most needed. (N=88)

Procedure	n (%)		
	1st Rank	2nd Rank	3rd Rank
Setting the anterior teeth	6 (6.8)	11 (12.5)	10 (11.4)
Setting lower posterior teeth relative to the ridge crest	10 (11.4)	13 (14.8)	**25 (28.4)**
Maintaining the original occlusal plane	14 (15.9)	**29 (33.0)**	14 (15.9)
Establishing the occlusal scheme	**37 (42.0)**	15 (17.0)	15 (17.0)
Establishing proper occlusal contact in centric position	13 (14.8)	14 (15.9)	17 (19.3)
Establishing the compensating curve	8 (9.1)	6 (6.8)	7 (8.0)
Total	**88(100)**	**88(100)**	**88(100)**

that anterior teeth arrangement needed the average time of 10.4±11.1 hours (median 5.2, range 4-27 hours).

During laboratory practice, the postgraduate students indicated that errors in their laboratory work commonly found by the instructor were failure to establish an appropriate occlusal scheme (75.0%), incorrect position of lower posterior teeth in relation to the ridge crest (54.5%), and the occlusal plane alteration (33.0%; Table 3). They also indicated that future devices would be most needed to aid in establishing occlusal scheme (42.0%), maintaining the original occlusal plane (33.0%), and arranging lower posterior teeth in relation to the ridge crest (28.4%; Table 4)

Table 5 Average time spent and difficulty level for posterior teeth arrangement in a normal edentulous patient by course enrolled and year of practice after graduation

Prosthodontic course enrolled	n	Average time spent			Difficulty level	
		Mean ± SD	Median	Range	Median	Range
Course enrolled						
Residency training						
2nd year	15	14.2 ± 15.8	9	4.0-63.0	4	1.0-5.0
3rd year	20	**10.6 ± 12.8**	**8.5**	**1.5-63.0**	**4**	**2.0-5.0**
Master degree						
2nd year	24	25.9 ± 20.0	22.5	2.0-63.0	5	2.0-5.0
3rd year	22	15.7 ± 12.7	13.5	4.5-63.0	4.5	2.0-5.0
Graduate diploma						
2nd year	7	**26.3 ± 19.3**	**22.5**	**4.0-63.0**	**5**	**4.0-5.0**
Years of practice after graduation						
1-3	19	17.0 ± 19.6	9	4.0-63.0	4	1.0-5.0
4-6	58	17.8 ± 16.1	12.8	1.5-63.0	4	2.0-5.0
6-9	9	28.5 ± 23.3	28.5	4-45.0	4	1.5-63.0
≥ 10	2	18.6 ± 13.7	22.5	12.0-45.0	1.5	1.0-2.0

Opinions and experiences toward complete denture teeth arrangement

Figure 1 shows that 38.6% and 36.4% of the respondents indicated posterior teeth arrangement as difficult and extremely difficult, respectively. Mean difficulty score was 4.0 ± 1.1 out of a maximum score of 5. The average time used (including time spent outside the classroom) for posterior teeth arrangement for a patient with class I jaw relationship and moderate ridge resorption ranged from 1.5 to 63 hours, with a mean of 17.9 ± 16.9 hours and a median of 10 hours. The 2nd-year students in graduate diploma program and master degree program used the highest time for posterior teeth setting, with a median of 22.5 hours and they specified this step as highest difficult level, with a median score of 5. In comparison, 3rd-year student in residency training program used the least amount of time, with a median of 8.5 hours and specified this step as least difficult level with a median score of 4 (Table 5).

Students who graduated from a dental school within 6-9 years spent the longest time for posterior teeth setting, with a median of 28.5 hours. Interestingly, students who graduated within 1-3 years spent the shortest time, with a median of 9 hours. The posterior teeth arrangement was indicated as least difficult level (median = 1.5 point) by students who graduated from a dental school for more than the 10 year.

Table 6 Numbers and percentages of the respondents that agreed to the statements related to the teeth arrangement procedures. (N=88)

Statement	n (%)
Teeth arrangement is time-consuming.	**74 (84.1)**
Teeth arrangement cannot be done in one time; corrections are always needed.	**71 (80.7)**
It is hard to set anterior teeth properly and correctly.	18 (20.5)
It is hard to use facial contour of wax rim as guidance for placing upper anterior teeth and to evaluate its correctness.	20 (22.7)
It is hard to arrange lower posterior teeth to be correctly related to the ridge crest and to evaluate its correctness.	66 (75.0)
It is hard to maintain the original occlusal plane in the arranged teeth and to evaluate its correctness.	64 (72.7)
It is hard to achieve the correct occlusal scheme.	62 (70.5)
It is hard to create proper occlusal contact in centric position.	22 (25.0)
It is hard to obtain the compensating curve and balanced occlusion.	44 (50.0)

Majority of the respondents (84.1%) agreed with the statement that 'teeth arrangement is time-consuming'. Similar level of agreement was demonstrated for the statement that teeth arrangement is a procedure that frequently needs to be repeated (80.7%). More than half agreed with the statements about the difficulties in posterior teeth arrangement in the following aspects: arranging and evaluating lower posterior teeth in relation to the ridge crest (75.0%), maintaining and assessing the occlusal plane of the arranged teeth to that of the occlusion rim (72.7%) and achieving appropriate occlusal scheme (70.5%). Only 22.7% and 20.5% of the respondents agreed with the statements associated with the difficulties of anterior teeth arrangement. These results are shown in Table 6.

Discussion

This is a first study that investigated the opinions and experiences of prosthodontic postgraduate students in Thailand toward the difficulties of laboratory practice of complete denture. Students in their 2nd-year in the program or higher were selected to study since they had already had adequate experience in complete denture laboratory practice as well as treating edentulous patients for at least one case. Furthermore, the questionnaires were mailed to the postgraduate students during the beginning of the first semester of the academic year 2012, at which time the 1st-year student had just enrolled in the program and still did not have sufficient training in laboratory practice.

The study investigated the difficulties faced by postgraduate students in complete denture fabrication during the laboratory phase. Among several steps, posterior teeth arrangement was marked as the most difficult and time-consuming procedure. This was confirmed when the majority of the respondents rated the procedure as extremely difficult and difficult with the average difficulty score of 4.0 out of 5. The top three procedures that the students most needing an aided device are parts of the posterior teeth arrangement, including establishing appropriate occlusal scheme, maintaining original occlusal plane, and setting lower posterior teeth related to the ridge crest. These also correspond to the common errors reported by the students. A novel device should be developed to help the postgraduate students in these three procedures in order to reduce common errors in posterior teeth arrangement, improve treatment outcomes as well as save the time. To assess whether lower posterior teeth were properly placed on the ridge crest, professional experience is considerably needed. It is important to place the artificial teeth in areas of the ridge most capable of supporting the occlusal force (Kawahata et al., 1998). Various methods for analyzing the relationship between the residual ridges and the position of artificial posterior teeth have been introduced in previous studies. These included instrument and profile gauges, Moiré topography, and computer-assisted technique, but they are not widely available (Sanghvi et al., 1981; Takamata et al., 1989; Kawahata et al., 1998). Therefore, we recommend that the new device should assist the students in setting bucco-lingual position of lower posterior teeth. In addition, the device should fix the level of the occlusal plane which has been properly established by the occlusion rims, because the plane should not be changed during posterior teeth arrangement (Jordan, 1978). Finally, the device could be considered as useful if it is accurate, simple, and inexpensive.

In teeth arrangement step, the occlusal form and arrangement of individual teeth may influence the occlusal patterns of the finished denture (Jordan, 1978). These patterns affect the esthetics of dentures as well as masticatory function. In order to provide functional and esthetic teeth arrangement for a trial denture, many characteristics are considered to be crucial. For example, the plane of occlusion as determined by occlusion rims should correspond with the original level; thus, very little change could be accepted during posterior teeth arrangement (Jordan, 1978). Moreover, the central fossae of the lower posterior teeth should be aligned over the crest of the lower ridge or at the centre of the ridge (Lang and Razzoog, 1983; Kawahata et al., 1998). Even to this date, practical approaches in arranging artificial teeth to achieve all requirements of complete denture are rarely available. Therefore, teeth arrangement is still considered as a complicated work and is frequently conducted by experienced technicians. However, dental students are assigned to do it by themselves because practicing teeth arrangement will assist them in visualizing and understanding the required concepts of complete denture. It is also an exercise that acclimatizes the students to prosthetic materials as well as helps to improve their perceptual motor skills (Nilsson and Meng, 2007). For these reasons, the majority of dental schools in Thailand and the U.S. assign this step for their students to practice in class and to be assessed during practical examinations (Jaggers et al., 1985; Rashedi and Petropoulos, 2003).

Previous studies in the US (Rashedi and Petropoulos, 2003), and Spain and Portugal (Montero et al., 2013) reported that undergraduate students spent on average 74 hours and 32.6 hours in preclinical

complete denture laboratory practice. These studies did not consider the laboratory time that students might spend outside the classroom and the time spent specifically for teeth arrangement procedure. In our study, we asked the postgraduate students to report the total time spent for posterior teeth arrangement for one patient including the time outside the classroom. Our pilot study in two experienced technicians found that the average time used for a posterior teeth arrangement was 1.5-2.0 hours. In postgraduate students, we expected that the suitable time for this procedure to be 3.5-4.0 hours. However, our result revealed that they spent a much longer time, with a median of 10 hours.

Our finding showed that the amount of time spent for teeth arrangement varied by program of study and the number of years in the program. The 2nd-year students enrolled in residency training program spent less time than did the 2nd-year counterparts in master degree and graduate diploma programs. This could be expected because the residency training program allocates more working hours on clinical and laboratory practices in comparison to the other programs. When compared within the same training program, the 2nd-year students used more time than those in the 3rd-year. This could also be expected because the students in higher year would have more learning and practice hours, and thus acquired more skills.

A previous study in India (Sharma et al., 2014) found that 3rd-year postgraduate students showed more positive attitude in research practice as compared to those in the 2nd year. In our study, the program of study and the number of years in prosthodontic program was also related to the attitude towards the posterior teeth arrangement. The posterior teeth arrangement was indicated as more difficult by the 2nd-year students in master degree and graduate diploma program compared to those in residency training program. However, the year of practice after graduation was not related to the self-rated difficulty level or laboratory time for posterior teeth arrangement. This maybe because the new graduates often assigns a technician to work on all laboratory works. With increasing time of practice after graduation, their skill level can be improved in clinical procedure, but not in laboratory procedure such as posterior teeth arrangement.

Our results clearly showed that posterior teeth arrangement in complete denture is a challenge for postgraduate education. The complete denture curriculum for prosthodontic postgraduate students could be improved by increasing the laboratory practice hours, particularly in posterior teeth setting, in all training programs. More learning and practice could help students to enhance their manual skill. In addition, the course director and prosthodontic instructor should explore the simplified laboratory technique for the top three procedures of teeth arrangement which produced the common errors in laboratory practice. The instructors should assign the postgraduate students to work on these procedures using that technique and continually evaluate the teaching-learning outcome, such as the amount of laboratory time for posterior teeth arrangement, the attitude and skill of the postgraduate students, and the errors found in laboratory work. At the same time, students should be encouraged to make great efforts in developing their skills.

It should be noted that the elements contained in our questionnaire did not cover all aspects of complete denture fabrication, but included most of the significant points. The questionnaire was reviewed by experts in prosthodontics and pilot-tested to be assured of its validity and reliability. However, the

students' interpretation of time spent on posterior teeth arrangement might be inconsistent resulting in a wide range report between 1.5 and 63 hours. Despite the possibility of misinterpretation, the unusually long time spent implied that some postgraduate students disfavored this procedure and they lacked knowledge and skill in teeth arrangement. A US study also found that students entering specialty training often lacked knowledge and skill in complete denture prosthodontics (Preston, 1989).

Strength of the study was the high response rate of 94.6% which indicates that our samples were a good representative of the study population. A questionnaire was mailed to all population of Thai prosthodontic postgraduate students during academic year 2012. However, the limitation of this study was the small number of dentists who currently enrolled in prosthodontic postgraduate programs in Thailand. The prosthodontic training program in Thailand was provided in few dental schools and the numbers of postgraduate students were restricted. In addition, the amount of time used for each laboratory procedure indicated by students might not be definite answer because of the limitation of students' memory. Further study should address the reasons why more female than male choose prosthodontic postgraduate training program. The next plan should also investigate the definite time used for each laboratory procedure in complete denture laboratory practice, and the time should be record during actual procedure by the researcher.

Conclusions

Our results suggest that the prosthodontic postgraduate students raised the posterior teeth arrangement as most problematic laboratory procedure in complete denture curriculum. The procedure is shown to be the most difficult, most time-consuming and most needing a future aiding device. The time used for posterior teeth arrangement (including time spent outside the classroom) for a general edentulous patient was quite long, with a mean of 17.9 ± 16.9. The students in second year higher graduate diploma program used the highest average time for posterior teeth arrangement, while third year student in residency training program used the least amount of time. The common errors found in complete denture laboratory practice are also related to posterior teeth arrangement.

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