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Impact of Milled Peek Versus Conventional Metallic Removable Partial Denture Frameworks on the Abutment Teeth in Distal Extension Bases. A Randomized Clinical Trial

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Abstract

Objectives: The goal of this clinical study was to evaluate the effect of digitally fabricated removable partial denture frameworks, constructed from new milled peek material (Juvora) on the abutment teeth in distal extension bases versus the conventional metallic frameworks.

Materials and methods: Twenty partially edentulous patients with distal extension bases were participated in this study. They were randomly divided into two groups. For Group I, a removable partial denture (RPD) frameworks were constructed from milled peek (Juvora). While for group II, (the control group) A conventional casted cobalt chromium RPD frameworks were constructed. Then after delivery of the RPDs, their effects on the abutment teeth supporting structures were evaluated after 3,6,12 months of follow-up. Pocket depth, gingival index as well as bone height changes were assessed for each abutment tooth .The results were tabulated and statistically analyzed.

Results: There was statistically significant difference between the two groups, after six and twelve months of follow up regarding the pocket depth and after twelve months of follow up for the gingival index scores. However, the bone height changes values of milled PEEK RPD group was lower than that of the conventional RPD, but the difference was statistically insignificant throughout the follow up periods, as p value >0.05. There was gradual increase in the all measured parameters in the two studied groups throughout the follow up period.

Conclusion: The digitally fabricated removable partial denture frameworks, constructed from new milled peek material (Juvora) showed more favorable effect on the abutment teeth in distal extension bases than the conventional metallic frameworks in terms of Pocket depth, gingival index as well as bone height changes. However, there were inevitable changes associated with RPD insertion.

Key words: Digital RPD frameworks, Milling, PEEK (Juvora), Distal extension bases, Abutment teeth

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Introduction

Removable partial denture is considered as an acceptable and economical treatment modality for patients with partially edentulous arches^[1]. Many longitudinal studies were accomplished on their effects on the oral health and the periodontium of the abutment and nonabutment teeth^[2-5]

Distal extension RPDs are represented as one of the most critical status for achieving successful long- term treatment outcome and preservation of the remaining natural teeth and their supporting structures. In the bilateral distal extension RPDs, the problems raised were related to the difference in support between the abutment teeth and the residual ridges .Functional load applied on the denture base creates an axis of rotation around the distal abutment teeth. Thus the abutment teeth act as a fulcrum for the partial dentures and are subjected to torque forces. The induced stresses are vertical, horizontal and oblique stress. This problem occurs prevalently in the mandible as it has less supporting structure. Therefore, it is important to consider a properly designed RPDs for the preservation of the remaining natural teeth.^[6,7]

Biocompatible metal such as cobalt-chromium is a widely used material for RPD frameworks. Metal -based frameworks have many ad-

vantages as they provide high strength and so could be used in thin sections. They have good thermal conductivity for more natural experience. However, esthetic problems with metal display, hypersensitivity, oral galvanism and adverse tissue reactions are recorded with metallic RPDs and increasing the demand to non- metallic frameworks^[8,9] Materials used in construction of RPDs play a major role in the periodontal health of the abutment teeth. Several clinical studies have reported that acrylic removable prosthesis tends to develop significant damaging effects on the periodontal status of abutment teeth more than the cast metal removable partial dentures. ^[10-12]

The Polyether ether ketone (PEEK) is an important high-performance polymer that has been used for industrial applications and medical fields for many years. Nowadays, PEEK is used in implantology and prosthodontics. Based on its favorable chemical, mechanical and physical properties, it is used in producing fixed and removable prostheses .The innovation of computer aided design and computer aided manufacturing (CAD/ CAM) technology increases its use as a removable partial denture framework as their mechanical properties are not adversely affected by the milling process like other materials. The advantages of PEEK partial denture frameworks are many. Its adequate biocompatibility and superior esthetics meet the patient desires, it also taste neutral (no metal taste) and has no thermal or electrical conductivity. Furthermore, its strength and light weight increases the patient comfort [12-17]

JUVORA dental disc made from PEEK-OPTIMA is a high performance polymer solution for long term fixed and removable prosthetic frameworks, provides resilience and more shock absorption than titanium for superior comfort.^[18]

Few clinical studies were reported focusing on the PEEK dentures and their effect on the abutment teeth. ^[19] So this study was carried out to evaluate the effect of CAD/CAM RPD frameworks, constructed from new milled peek material (Juvora) on the abutment teeth in distal extension bases.

Materials and methods:

Twenty partially edentulous patients with distal extension bases (Kennedy class I) were participated in this study. They were selected from

the out-patient clinic of the Faculty of dentistry, October University for Modern Science and Arts (MSA). All selected patients were male with age ranging from 40 to 55 years and free from any systemic disease. They had normal maxillo-mandibular relationship (Angle class I) with adequate inter-arch space. The opposing maxillary arch was completely dentulous. Alcoholic, smoker patients and those with para-functional habits, temporo-mandibular joint disorders or xerostomia were excluded. Only co-operative patients who were able to stick to the oral hygiene measures were enrolled in this study. A written consent was obtained from each participant after explaining the procedure of the study. The ethical principles of the faculty of dentistry research ethical Committee, October University for Modern Science and Arts (MSA) were followed (approval reference: ETH 10).

Prosthetic procedures: The participants were treated according to standardized clinical procedures for RPD construction. Both types of prostheses were fabricated from the produced definitive cast of the lower arch. Patients grouping: They were randomly divided into two equal groups. Group I, received a removable partial denture (RPD) frameworks constructed from milled peek (Juvora). While Group II (the control group) received a conventional casted cobalt chromium RPD frameworks For Group1, mandibular casts are scanned using digital scanner (Zirkonzahn S600 ARTI Scanner, Italy) which is a fully automated optical structured-light Scanner with scanning software, that allow for whole arch scan(Figure 1). The scanner was equipped with two high resolution, high speed cameras. The scan image will be sent directly to the CAD Software to design the framework. The CAD software (3Shape Dental System, version 2.9.9.3) was used to design the framework and generate a standard triangulation language (STL file). Digital surveying and determination of the most suitable Path of insertion of the RPD with subsequent block-out of undercuts is carried out (Figure2). The framework components were designed. Lingual plate major connector, denture bases, rests and RPI clasps were drawn by the software (Figure 3).

Finally, digitally designed PEEK RPD frameworks are produced by milling from Juvora block (JUVORA Ltd, Technology centre, Hilhouse Intternational ,Thornton Cleveleys, Lancashire, UK) using the CAD CAM milling unit (Roland DWX-50, 5-Axis Dental milling Machine, Chicago, USA) (Figure 4)



Figure 1: Optical scanning of the master cast



Figure 2: Digital surveying and block-out of undercuts



Figure 3: Digital designing of the framework components

For Group II, (the control group) a conventional casted cobalt chromium RPD frameworks were constructed. The RPD frameworks were then trial inserted intra-orally. All components of the framework were checked for being fully seated. Jaw relation registration was carried-out according to the wax wafer technique. Then removable partial dentures were completed in the conventional manner and delivered to patients after necessary occlusal adjustments. (Figure 5)

After delivery of the RPDs, their effects on the abutment teeth supporting structures were evaluated after 3,6,12 months of follow-up. Pocket depth, gingival index as well as bone height changes were assessed for each abutment tooth. The measurements were done by a single examiner to reduce inter-observer error, and each measure was taken for three times and the average of three values was obtained to minimize the intra-observer error. Evaluation of periodontal depth: Periodontal pocket depths were assessed for clinical evaluation of the RPD abutments. Graduated periodontal probe (William's probe) was gently inserted at each surface parallel to the long axis of the tooth be-



Figure 4: Milling of the framework from Juvora block

tween the abutment and the oral sulcular epithelium. Pocket depths were measured as the distance from the gingival margin to the base of the pocket and read to the nearest millimeters (mm). Measurements were made in the four surfaces of abutment teeth: mesial, distal, buccal and lingual surfaces and then mean of four readings were calculated. Evaluation of gingival index: Using the gingival index of Loe and Silness20, Score o revels Absence of signs of inflammation. Score 1, for Slight change in color and texture. Score 2, indicate visible inflammation and bleeding on probing. Score 3, for overt inflammation and spontaneous bleeding.

Bone height measurements: periapical x-ray films were taken to the abutment teeth according to the standardization of the periapical radiograph at the time of denture insertion and at each follow up visit. X ray sensor (EZ Sensor classic, vatech , Korea) was used which is connected by a cable to the computer monitor to display the image immediately after exposure. The computer software (EZDent-1 vatech Version 2.0.2.0 client, Korea) was used to estimate abutment alveolar bone height. (Figure 6)



Figure 5: Denture insertion intra-oral



Figure 6: Bone height measurements

Statistical analysis: Data were coded and entered using the statistical package SPSS version^[25]. Data was summarized using mean and standard deviation. Comparisons between groups were done using unpaired t test in normally distributed quantitative variables while non-parametric Mann-Whitney test was used for non-normally distributed quantitative variables. For comparison of serial measurements within each group paired t test was used in normally distributed quantitative variables while non-parametric Wilcoxon signed rank test was used for non-normally distributed quantitative variables. P-values less than 0.05 were considered as statistically significant.

Results

From table 1, it was clear that the mean probing depth measurements around the abutment teeth increased gradually in the two studied groups throughout the follow up period and it was statistically significant after six and twelve months of follow up periods. Table 2, revealed gradual increase in the mean value of gingival index scores in the two groups throughout the study period, which was statistically significant after six and twelve months of follow up in milled PEEK RPD group and was statistically significant in all time intervals in the conventional RPD group. The bone height loss around the abutment teeth was presented in table 3, which reveals gradual increase in the two studied groups throughout the follow up period. However, the mean differences of bone loss in the PEEK group were lower than that of the conventional RPD group and it was statistically significant after six and twelve months of follow up in the two studied group.

Up on comparing the two studied groups, the results were represented in table 4,5 and 6. There was statistically significant difference after six and twelve months of follow up regarding the pocket depth with statistically significant difference after twelve months of follow up for the gingival index. On the other hand , statistically insignificant difference was observed between milled PEEK RPD and conventional RPD in the bone height changes of abutment teeth throughout the follow up periods ,as p value >0.05.

		F	Peek RPD		Conventional RPD		
Measurement	interval	Mean	Standard	Р	Mean	Standard	P
		changes	Deviation	value	changes	Deviation	value
	immediate-	0.000	0.000		0.100	0.011	0.160
	3 months	0.000	0.000	1	0.100	0.211	0.168
	immediate-	0.200	0.250	0.024*	0.550	0.407	0.007*
Pocket depth (mm)	6 months	0.300	0.350	0.024*	0.550	0.497	0.007*
	immediate-	0.500	0.471	0.000*	1 150	0.626	<
	12 months	0.500	0.4/1	0.008*	1.150	0.020	0.001*
	3 months-	0.300	0.350	0.024*	0.450	0.438	0.010*
	6 months	0.500	0.550	0.024	0.450	0.450	0.010
	3 months-	0.500	0.471	0.008*	1.050	0 407	<
	12 months	0.500	0.7/1	0.000	1.050	164.0	0.001*
	6 months-	0.200	0.258	0.037*	0.600	0.450	0.003*
	12 months	0.200	0.200	0.057	0.000	0.459	0.005

			Peek RPD		Conventional RPD			
Measurement	interval	Mean	Standard	P	Mean	Standard	P	
		changes	Deviation	value	changes	Deviation	value	
	immediate-							
	3 months	0.200	0.422	0.157	0.500	0.527	0.025*	
	immediate-							
Gingival index Scores	6 months	0.500	0.527	0.025*	1.000	0.667	0.008*	
	immediate-							
	12 months	0.900	0.568	0.007*	1.700	0.823	0.004*	
	3 months-6							
	months	0.300	0.483	0.083	0.500	0.527	0.025*	
	3 months-							
	12 months	0.700	0.483	0.008*	1.200	0.789	0.01*	
	6 months-							
	12 months	0.400	0.516	0.046*	0.700	0.483	0.008*	

		F	Peek RPD		Conventional RPD			
Measurement	interval	Mean	Standard	P	Mean	Standard	Р	
		changes	Deviation	value	changes	Deviation	value	
Bone height (mm)	immediate-							
	3 months	0.000	0.000	1	0.000	0.000	1	
	immediate-	-0.023-	0.007	<	-0.142-	0.319	<	
	6 months	-0.023-		0.001*			0.001*	
	immediate-		0.048	<	-0.548-	0.322	<	
	12 months	-0.162-		0.001*			0.001*	
	3 months-		0.007	<	-0.142-	0.319	<	
	6 months	-0.023-		0.001*			0.001*	
	3 months-	0.170	0.048	<	0.540	0.322	<	
	12 months	-0.102-		0.001*	-0.548-		0.001*	
	6 months-	0.120	0.047	<	0.406	0.145	<	
	12 months	-0.139-	0.047	0.001*	-0.406-		0.001*	

Table 3: Effect of time on the bone height loss

	intervel	Pe	ek RPD	Conv	ventional RPD	
Measurement	Interval	Mean	Standard Deviation	Mean	Standard Deviation	P value
	immediate	1.100	0.316	1.250	0.354	0.331
Pocket depth	3 months	1.100	0.316	1.350	0.337	0.105
(mm)	6 months	1.400	0.394	1.800	0.350	0.027*
	12 months	1.600	0.459	2.400	0.516	0.002*

Table 4: Comparison between the two groups regarding the pocket depth

	intervel	Pe	ek RPD	Conv	ventional RPD	
Measurement	intervai	Mean	Standard Deviation	Mean	Standard Deviation	P value
	immediate	0.000	0.000	0.100	0.316	0.739
Gingival index	3 months	0.200	0.422	0.600	0.516	0.143
Scores	6 months	0.500	0.527	1.100	0.738	0.089
	12 months	0.900	0.568	1.800	0.789	0.023*

Table 5: Comparison between the two groups regarding the gingival index scores

	interval	Pee	ek RPD	Conv		
Measurement	interval	Mean Deviation		Standard Deviation	P value	
	immediate	15.287	0.730	14.972	0.995	0.430
Bone height	3 months	15.287	0.730	14.972	0.995	0.430
(mm)	6 months	15.264	0.729	14.830	0.855	0.238
	12 months	15.125	0.738	14.424	0.852	0.065

Table 6: Comparison between the two groups regarding the bone height loss

Discussion

The clinical and radiographic examination in this study revealed that RPD insertion caused some changes, in spite of the strict oral hygiene measures that were followed. These changes were observed in the two studied groups throughout the follow up periods and may be attributed to the fact that wearing a removable partial denture complicates the oral environment and restricts the flow of food and the self-cleaning action of the buccal mucosa and tongue, which results in the accumulation of the dental plaque on the prosthesis and surrounding tissues. Thereby the risk for development of gingivitis and periodontitis was increased, and this was reflected in our results as there is gradual increase in the three measured parameters.^[21:24]

The selection of lingual plate as a major connector in this study could be an influencing factor in our results which is supported by previous studies^[25,26] who indicated more severe gingival tissue reactions when the gingiva was covered by the denture that increase crevicular temperature, plaque accumulation, gingival inflammation and pocket depth. This finding was in accordance with Markkanen et al who observed an increase in depth of the pocket in RPD users.^[27]

Bone height loss around the abutment teeth was reported after six months of denture insertion for the two studied groups which may be explained on the bases that Plaque index increase after six months of wearing dentures as noted by Tatjana et al.^[28] Other investigators were in one line with our results, showing correlation between the interdental alveolar bone loss and plaque accumulation following partial denture insertion. Confirming that dental plaque have a negative effect on both attachment level and bone height of the abutment teeth. ^[5,29] This finding could be attributed also to the horizontal and lateral stress on the abutment teeth in the distal extension bases which may cause breakdown of periodontal tissue and bone loss.^[6,7]

There was statistically significant difference between the two groups after six and twelve months of follow up regarding the pocket depth with statistically significant difference after twelve months of follow up for the gingival index scores, milled PEEK RPD group showed lower mean values than the conventional RPD group. This finding could be attributed to the biocompatibility of that material together with the precise designing and manufacturing by computer software that ensure accurate adaptation and fitness of the denture framework components.^[30]

Regarding bone height loss of the abutment teeth, milled PEEK RPD group showed lower mean values than the conventional RPD group however the difference is statistically insignificant. This could be referred to its elastic and shock absorbent properties which could aid in favorable stresses transmitted to the abutment teeth.^[16]

Conclusion

The digitally fabricated removable partial denture frameworks, constructed from new milled peek material (Juvora) showed more favorable effect on the abutment teeth in distal extension bases than the conventional metallic frameworks in terms of pocket depth, gingival index as well as bone height changes. However, there were inevitable changes associated with RPD insertion.

References

1. Wagner B, Kern M. Clinical evaluation of removable partial dentures 10 years after insertion success rates, hygienic problems, and technical failures. Clin Oral Invest. 2000; 4: 74–80

2. Zlatarik DK, Kelebik A, Valentik-Peruzovik M.The effect of removable partial dentures on periodontal health of abutment and non-abutment teeth. J Periodontal. 2002; 73:137–144

3. Sesma N, Lagana DC, Morimoto S, Gil C.Effect of denture surface

glazing on denture plaque formation. Braz Dent J. 2005; 16:129–34. 4. Preshaw PM, Walls AW, Jakubovics NS, Moynihan PJ, Jepson NJ, Loewy Z. Association of removable partial denture use with oral and systemic health. J Dent. 2011;39:711–9.

5. Rodan R, Al-Jabrah O, Ajarmah M. Adverse effects of removable partial dentures on periodontal status and oral health of partially edentulous patients. JRMS. 2012;19:53–8

6. Manumeet B, Jitender B, Gyanander A, Shanender S . A review on stresses-induced by removable partial dentures. Int J Contemp Dent Med Rev. 2015, 10;1-5.

7. Lee HE, Wu JH, Wang CH, et al. Biomechanical analysis of distal extension removable partial dentures with different retainers. J Dent Sci. 2008;3:133–9.

8. Schwitalla A, Muller WD. PEEK dental implants: a review of the literature. J Oral Implantol 2013;39: 743-9

9. Campbell SD, Cooper L, Cooper L, Craddock H, Hyde T, Nattress B, Pavitt S and Seymour D. Removable partial dentures: the clinical need for innovation. J Prosthet Dent. 2017; 118: 273-280.

10. Suwal P, Kumar Singh R, Ayer A, Roy D and Roy R :Cast Partial Denture versus Acrylic Partial Denture for Replacement of Missing Teeth in Partially Edentulous Patients .2017; 6 (1):27-34

11. Tawse-Smith A, Rivillas CC, Orozco PS, Diaz JE, Pack AR. Clinical effects of removable acrylic appliance design on gingival tissues: a short-term study. J Int Acad Periodontol 2001 Jan; 3(1):22-7.

12. Kazem N ., Abd S ., Abdulla W., Dawood M., Admon M.and Sabah M.: The effect of removable partial denture on periodontal health status . G.J.B.B., 2017: 6 (3) 512-515

13. Wiesli MG, Ozcan M. High-performance polymers and their potential application as medical and oral implant materials: a review. Implant Dent 2015;24: 448-57.

14. Ma R, Tang T. Current strategies to improve the bioactivity of PEEK. Int J Mol Sci 2014;15: 5426-45.

15. Najeeb S, Zafar MS, Khurshid Z, Siddiqui F. Applications of polyetheretherketone (PEEK) in oral implantology and prosthodontics. J Prosthod Res 2016;60 :12-19.

16. Vaezi M, Yang S. A novel bioactive PEEK/HA composite with controlled 3D interconnected HA network. Int J Bioprint 2015;1: 66-76.

17. Costa- PALAU, S, Torrents-Nicolas, J, Brufau-Barbara, M and Cabratosa-Terms, Use of PEEK in the fabrication of a maxillary obturator prosthesis: A Clinical report. J Prosthet Dent 2014, 112, 680-682

18. Zoidis P, Papathanasiou I, Polyzois G. The Use of a modified poly ether ether ketone (PEEK) as an alternative framework material for removable dental prostheses. A clinical report. J Prosthet Dent 2015;25: 580-84.

19. Gediminas Skirbutis , Agnė Dzingutė , Viltė Masiliūnaitė , Gabrielė Šulcaitė , Juozas Žilinskas. A review of PEEK polymer's properties and its use in prosthodontics .Stomatologija, Baltic Dental and Maxillofacial Journal 2017, 19:19-23.

20. Loe H and Silness J.Periodontal diseases (1) prevalence and severity. Acta Odont Scand 1963; 21:533-551

21. Suzely Adas Saliba Moimaz, Nemre Adas Saliba, Orlando Saliba, Lívia Guimarães Zina, Márcio Rogério Curtis Bolonhez. Association between dental prosthesis and periodontal disease in a rural Brazilian community. Braz J Oral Sci. 2006 ; 5(19): 1226-1231.

22. Linda J. Dula,1 Kujtim Sh. Shala, Teuta Pustina– Krasniqi, Teuta Bicaj and Enis F. Ahmedi . The influence of removable partial dentures on the periodontal health of abutment and non-abutment teeth. Eur J Dent. 2015; 9(3): 382–386.

23. Yeung, A., Lo, E.C. Oral health status of patients 5-6 years after placement of cobalt- chromium removable partial dentures. J Oral Rehabil. 2000; 27(3): 183-9.

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24. Mantshumba Milolo Augustin, Duyck Joke, Sekele Isouradi Bourleyi, Lutula Pene Tatjana Shenda, Nyimi Bushabu Fidele, BileBopili Gabrie, Sofi Ndonga Pierre,Em Kalala Kazadi, Ekofo Inganya Ediz, Kumpanya Ntumba Pierrot, Mayunga Mbuebo, Ntumba Mulumba Kanda, Ignace Naert. Risks Factors of Caries and Periodontal Diseases in the Patients, after 5 Years Usea Partial Removable Denture. Open J. Stomato. 2016 ; 6, 185-192

25. Chandler JA, Brudvik JS. Clinical evaluation of patients eight to nine years after placement of removable partial dentures. J Prosthet Dent. 1984; 51(6): 736–743.

26. Nada M, Gharrphy S, Badawy MS. A two year longitudinal study on the effect of removable partial denture design on the health of the remaining teeth. Egypt Dent J. 1987; 33(1): 85-95

27. Markkanen H., Lappalainen R., Honkala, E. & Tuominen R. Periodontal conditions with removable complete and partial dentures in the adult population aged 30 years and over. J Oral Rehabil. 1987; 14(4): 355-360.

28. Tatjana P, Dubravka M, Larisa B and Bojana J: Influence of different types of partial dentures on dental plaque accumulation. Serbian dental J, 2005, 52: 97-103.

29. Paulo M B, Rua V C and Wellington C B: Periodontal aspects in patients wearing removable partial dentures. Rev. odonto ciênc. 2008;23(2):297-301.

30. Arnold C , Hey J , Schweyen R, Setz JM . Accuracy of CAD-CAM-fabricated removable partial dentures. J Prosthet Dent. 2018;119(4):586-592