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RESEARCH ARTICLE

POLYAMIDE FLEXIBLE DENTURES – A BETTER OR WORSE STRATEGY

Ajila Theresita F, MDS,[1] Ilakkiya Shanmuganathan, MDS,[1] Alex Mathews Muruppel, MDS, FPFA[2*]

1. Postgraduate, Department of Prosthodontics, Rajas Dental College and Hospital, Tirunelveli, Tamilnadu
2. Professor, Principal and Head of Department of Implantology, Rajas Dental College and Hospital, Tirunelveli, Tamilnadu

* ***Corresponding author:*** *Dr. Alex Mathews Muruppel, Principal and Head of Department of Implantology, Rajas Dental College and Hospital, Tamilnadu, India – 627105;*
Phone number: 94469 12294;
e-mail: principal@rajasdentalcollege.edu.in

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Abstract

Background: Polyamide dentures have added advantages over the acrylic dentures in terms of esthetics, comfort and versatility to adapt to the undercut areas. However, the effect of flexibility of these dentures from the view of residual ridge resorption has always been obscure.

The aim of this study is to compare the type of denture base with the distribution of masticatory forces by examining the changes on the alveolar mucosa in the histological picture before and after insertion of two widely used dentures.

Materials and methods: A total of 20 participants were included in the study, among which 10 patients were allocated for acrylic removable partial dentures and 10 patients were allocated for polyamide flexible removable partial dentures. The patients were asked to rinse their mouth and cement spatula was used to collect the epithelial mucous cells non-invasively by scraping the crest of the residual alveolar ridge with light pressure in premolar-molar area both before insertion and 2 weeks after insertion of the removable partial dentures. The said swab was then smeared on a clean glass slide and fixed in 95% ethyl alcohol and was stained by Papanicolaou (PAP) stain. The PAP-stained smear was analyzed for the presence of keratinized cells and the number of keratinocytes was counted for both acrylic and polyamide denture groups.

Results: The results show that both types of denture bases altered the alveolar mucosal keratinization but there was a significant difference in number of keratinized cells between all the three groups. Polyamide flexible partial dentures showed more ortho-keratinized epithelium, which favours better occlusal load distribution.

Conclusion: The results concluded that there was decreased masticatory load on the residual alveolar ridge under polyamide denture group due to the flexibility of the denture base material compared to that of the acrylic denture group.

Key-words: *Acrylic dentures; Polyamide dentures; Residual ridge resorption; Masticatory load distribution; Keratinocytes.*

Introduction

For ages, poly methyl methacrylate (PMMA) has been used to fabricate dentures. These acrylic denture bases had their own advantages and disadvantages. Some of the problems with these acrylic denture bases include brittleness of methyl methacrylate, allergy to methyl methacrylate monomer and rigidity leading to difficulty in insertion in undercut areas.[1]

With the innovation of the nylon-derived denture base material in the late 1950s, an excellent alternative to conventionally used methyl methacrylate dentures arrived as the so-called flexible dentures. These denture bases not only provide excellent aesthetics and comfort, but also provide flexibility to adapt to the undercut areas.[2] However, this flexibility has always been a question in view of residual ridge resorption. The primary purpose of denture construction is not restricted to teeth replacement, but also to maintain and preserve the surrounding supporting tissues. So, denture base selection should primarily be based on their effect on the alveolar mucosa and secondarily on patient comfort and esthetics.[3] However, there is paucity of information in the literature with regard to comparative assessment of the effect of polyamide dentures and acrylic dentures on the supporting tissues. Thus, our study aimed to compare the effect of acrylic and polyamide dentures on the distribution of masticatory forces by examining the changes on the alveolar mucosa in the histological picture before and after insertion. The null hypothesis was that no difference would be found in the number of parakeratinized, orthokeratinized and intermediate cells before insertion and 2 weeks after insertion of both acrylic and polyamide denture groups.

Methods

Study Design and Sample Size Estimation

This prospective split-mouth study was conducted at the Institute's Department of Prosthodontics after approval from the Institutional Ethics Committee of the University. A total of 10 cases per group were included in the study. The sample size was calculated with 80% power and an alpha level of 5%.

Inclusion and Exclusion Criteria

A total of 20 subjects were chosen amongst patients reporting to the Department of Prosthodontics who had bilaterally edentulous posterior spaces (Kennedy's Class I) with opposing natural teeth. The patients included were of the male gender and in the third decade of life. The exclusion criteria for the subjects were patients with hard or soft tissue pathosis and with recent extraction. Uncontrolled diabetics, alcoholics, smokers or patients having pernicious habits like bruxism and tongue thrust were excluded from the study. A detailed informed consent was taken from the patients in accordance with Helsinki's protocol.

Randomization

The patients were randomly allocated to the PMMA or polyamide group using the slip method. Both the groups were written on two different slips and jumbled in a bowl. One of the slips was picked up by the patient, and the patient was allocated to that group. Group I (Acrylic denture group) consisted of 10 patients who received heat cure polymethyl methacrylate removable partial dentures and group II (Polyamide denture group) consisted of 10 patients who received amide derived (nylon) removable partial dentures.

Smear biopsy

A cytological smear was collected from the crest of the residual alveolar ridge in the premolar- molar area on the day of insertion and 2 weeks after insertion. Patients were asked to rinse their mouths and the side of a cement spatula was used to scrape the epithelial squamous cells on the residual ridge with light pressure at premolar-molar area. The material was smeared on a clean glass slide and immediately fixed in 95% ethyl alcohol. Then they were stained by Papanicolaou (PAP) stain at the Institute's Department of Oral Pathology.

Assessment of changes in alveolar mucosa

Microscopic examination by blinded pathologist was done under ordinary, light microscope for morphological analysis and to select the most nuclei rich fields to be counted.

According to Ramulu et al, keratinized cells were stained yellow to orange, parabasal cells were stained faint green to blue and the granular cells were stained pink to red.

Counting of keratinized cells by computer image analyzer

The computer image analyzer with the software Leica Quin 500 was used to automatically count number of nuclei seen in keratin (representing keratinized cells that showed yellow to orange stain). An average of 5 nuclei rich fields was done under magnification power x400 in 3070392 µm² field.

Statistical analysis

Study data was analyzed statistically using Statistical Package for the Social Sciences (SPSS) software (IBM SPSS Version 22.0. Armonk, New York: IBM Corp.). Kolmogorov–Smirnov Z test was used to check the normality of the data. One-way analysis of variance (ANOVA) and paired t-tests were used to find the difference in intermediate cells, parakeratized and orthokeratinized cells within and between the two study groups. A p-value < 0.05 was considered statistically significant.

Results

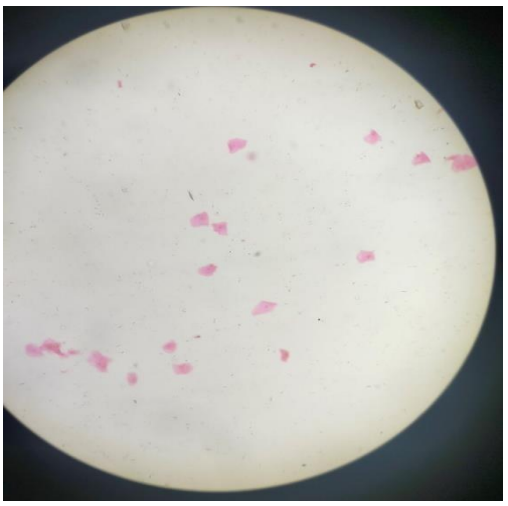
Microscopic examinations

At the time of insertion, the specimens were formed of keratin (orange) and few intermediate cells (pink). It was formed mainly of parakeratinized type (contains nuclei) with scattered small areas of orthokeratin (no nuclei with the keratin) (Table 1, Figure 1).

Table 1 Intra-group Comparison

			N	Mean	Standard Deviation	p-value
Group I Acrylic Denture	**Ortho Keratinised**	**Before**	10	25.50	2.95	0.001*
		After	10	17.60	2.87	
	Para Keratinised	**Before**	10	45.40	3.16	< 0.001*
		After	10	55.80	1.75	
	Intermediate Cells	**Before**	10	29.10	5.80	0.288
		After	10	26.60	3.30	
Group II Polyamide Denture	**Ortho Keratinised**	**Before**	10	25.50	2.17	< 0.001*
		After	10	58.40	2.22	
	Para Keratinised	**Before**	10	46.10	1.91	< 0.001*
		After	10	17.50	1.43	
	Intermediate Cells	**Before**	10	28.40	3.06	0.008*
		After	10	24.10	2.76	
p-value based on Paired-*t*-Test * = Statistically Significant (p < 0.05)						

Figure 1 *Control group*



After 2 weeks, the acrylic denture group specimens were formed mainly of parakeratinized type with very few areas of orthokeratin (Table 2, Figure 2), while the polyamide denture group specimens were formed of keratin of both types with predominating orthokeratin (Table 3, Figure 3).

Table 2. Inter-group Comparison (Ortho Keratinised)

	N	Mean	Standard Deviation	p-value
Group I A	10	25.50	2.95	< 0.001*
Group I B	10	17.60	2.87	
Group II A	10	25.50	2.17	
Group II B	10	58.40	2.22	
			Mean Difference	**p-value**
Group I A			**Group I B**	< 0.001*
			Group II A	1.000
			Group II B	< 0.001*
Group I B			**Group II A**	< 0.001*
			Group II B	< 0.001*
Group II A			**Group II B**	< 0.001*
p-value based on Analysis of Variance (ANOVA) followed by Post-hoc Analysis using Bonferroni Test after adjusting for multiple comparisons * = Statistically Significant (p < 0.05)				

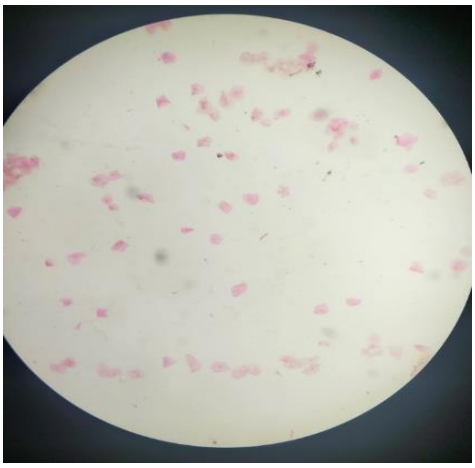


Figure 2. *Acrylic denture after 2 weeks of insertion*

Table 3. Inter-group Comparison (Para Keratinised)

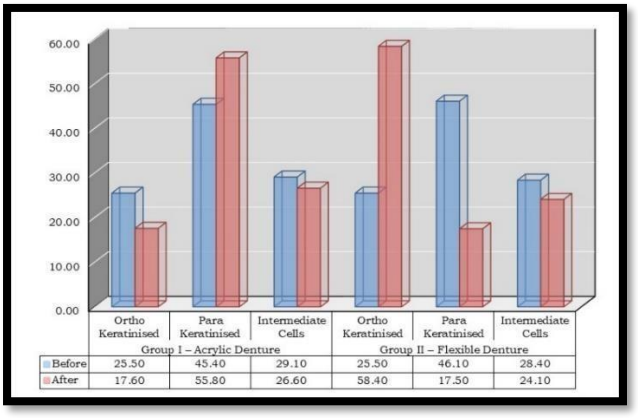
	N	Mean	Standard Deviation	p-value
Group I A	10	45.40	3.16	< 0.001*
Group I B	10	55.80	1.75	
Group II A	10	46.10	1.91	
Group II B	10	17.50	1.43	
			Mean Difference	**p-value**
Group I A			**Group I B**	< 0.001*
			Group II A	1.000
			Group II B	< 0.001*
Group I B			**Group II A**	< 0.001*
			Group II B	< 0.001*
Group II A			**Group II B**	< 0.001*
p-value based on Analysis of Variance (ANOVA) followed by Post-hoc Analysis using Bonferroni Test after adjusting for multiple comparisons * = Statistically Significant (p < 0.05)				

Figure 3. *Amide denture after 2 weeks of insertion*

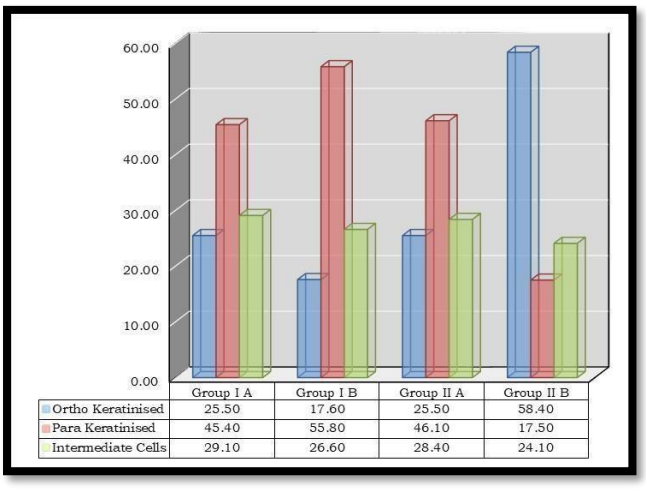
Some granular cells that appeared pink with granular cytoplasms and few parabasal cells that stained blue were also detected.

Computer image analysis

The highest number of nuclei was detected in the group that used acrylic dentures followed by control group (before treatment) while the lowest value was seen in the group wearing polyamide dentures (Graph 1).



The difference between groups was highly significant ($p < 0.001$). Assessment of the change in the number of nuclei within each group by using paired-t-test revealed a statistically significant difference between the mean of numbers of nuclei before and after the use of the denture in both groups ($p < 0.05$) (Graph 2).



Discussion

Following tooth extraction, the alveolar ridge undergoes rapid changes in the first month, followed by slower changes over the next 4-5 months. Successful prosthesis rehabilitation involves reducing residual ridge resorption, preventing drifting of remaining teeth, and restoring missing teeth function.[4]

Removable Partial Denture (RPD) is one of the treatment options for replacing the lost teeth. The removable partial dentures remain the best option for insufficient supporting bone, inappropriate anatomy, and particular financial constraints on a patient. Despite advancements in implant technology. These removable partial dentures can damage the oral tissues, if not properly designed to distribute the occlusal forces.[5] According to Kydd's study, the minimum resting period after denture wear is 6-8 hours in 24-hour time period. The flexibility of the partial denture also appears to act as a tissue conditioner. The slight movement of a flexible partial denture over the tissue stimulates the blood circulation in supporting tissues and allows dynamic transfer of occlusal forces that appear to reduce the atrophy that can set-in beneath a saddle when it does not engage the tissue and bone (Parvizi et al, 2004).[6] A masticatory cycle of removable dentures approximates 1.3 (± 0.20) Hz (Veyrune et al. 2007). It is noteworthy that the average period of occlusal pressure (from start to finish) is quoted as 0.110–0.169 s (Okuma et al. 2004), compared with the commonly accepted time of 0.5 s for half the chewing cycle.[7] Therefore, the duration of occlusal pressure is shorter than the chewing cycle, which leaves a longer time for recovery from mucosal deformation than the relatively short time of half a chewing cycle. Furthermore, flexibility of the major connector eliminates the fulcrum effect across the arch and therefore accompanying leverage forces too.

Several studies have compared the impact of various denture bases, impression techniques, and tray designs on residual ridge distortion during and after insertion. The present study aimed to evaluate the PMMA and amide dentures' ability to distribute occlusal forces on the alveolar ridge using microscopic examination of smear biopsies performed before and 2 weeks after denture insertion, in order to devise strategies for removable partial denture design which could reduce masticatory load on the residual alveolar ridge and therefore provide better modalities for denture base materials.[8]

Minimally invasive biopsy techniques employed in the current study does not affect denture stability or cause patient discomfort. The study examined histological changes and analyzed the number of keratinized cells to determine the rate of epithelial turnover during increased stress in the premolar region, since it is the site where prominent keratinization takes place due to maximum occlusal force generated in the range of 65–110 N (Ogata and Satoh1995).[9] Before denture construction, the alveolar ridge was covered by parakeratinized stratified squamous epithelium, which lost granular cell layers and retained nuclei within the stratum corneum. Parakeratosis refers to the rapid turnover of epithelial cells, which prevents them from maturing normally.[10] Parakeratin is a protective barrier against negative stimuli and is typically formed after inflammatory or neoplastic processes.[11]

After acrylic denture construction, the surface epithelium experienced hyperparakeratinization, as evidenced by the absence of intermediate cells, despite taking biopsies at the same depth. The presence of nuclei with varying optical densities in different layers further supported this theory. Additionally, even after denture construction, the para-keratinized epithelium showed increased nuclei density, indicating increased forces on the mucosa.

Flexible denture construction resulted in a predominantly ortho-keratinized surface epithelium. The epithelium's outer layer consisted primarily of nuclei-free keratin (orthokeratin) and pink granular cells. Detection of parabasal cells (stained blue) that cannot be removed by superficial smear biopsy substantiated the observation of reduced epithelial thickness. This reduction in epithelial thickness denotes that there was a better distribution in the masticatory forces which allows better maturation of epithelium and emergence of ortho keratinization.

A previous study by Abdel Fdeel et al stated that the major connector of polyamide dentures behaves as a stress-breaker, acts as a tissue conditioner and thus it reduces the leverage caused by the rotational forces on the denture[12,13] and thereby prevents any undue effect on the underlying mucosa, which is in accordance with the results of our study. Though the findings of this study are indeed path-breaking and hallmark in regard to the effect of polyamide dentures on the underlying mucosa, there are certain limitations

such as a small sample size and short-term assessment period. Furthermore, the sensitivity (30-87%) and reproducibility (43-68%) of cytological smear is poor. The minimally invasive smear evaluation could be further validated by alternative protocols for assessing the mucosal and bone changes underlying the flexible dentures.

Conclusion

The present study depicted the effect of acrylic and polyamide flexible dentures on the underlying mucosa. The advantages offered by the polyamide dentures should be taken into consideration before deciding on the treatment plan for the patient. Further long-term evaluation is needed to substantiate the results of the present study.

Declarations

Conflicts of interest and financial disclosures

The author declares that he has no conflict percent and there was no external source of funding for the research in question.

Ethical approval

The study was approved by the University ethics committee and was conducted in accordance with the Declaration of the World Medical Association.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Source of funding

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REFERENCES

1. Thakral GK, Aeran H, Yadav B, Thakral R. Flexible partial dentures – A hope for the challenged mouth. *Peoples J Sci Res.* 2012;5:17-23
2. Le Bars P, Bandiaky ON, Le Guéhennec L, Clouet R, Kouadio AA. Different Polymers for the Base of Removable Dentures? Part I: A Narrative Review of Mechanical and Physical Properties. *Polymers.* 2023;15:3495. doi:10.3390/polym15173495
3. Goiato MC, Panzarini SR, Tomiko C, Luvizuto ER: Temporary flexible immediate removable partial denture: a case report. *Dentistry Today*. 2008;27(3):114-116
4. Singh OP, Kaur R, Nanda RM and Sethi E. Residual ridge resorption: A major oral disease entity in relation to bone density. *Indian Journal of Oral Sciences*. 2016;7:3-6. doi:10.4103/0976-6944.176383
5. Gibson BJ, Baker SR, Broomhead T, et al. 'It's like being in a tunnel': Understanding the patient journey from tooth loss to life with removable dentures. *Journal of Dentistry*. 2024;145:104964. doi:10.1016/j.jdent.2024.104964
6. Iselin W, Meier C, Lufi A, Lutz F: The flexible gingival epithesis. The practical procedure, laboratory technics and clinical experience. *Schweizer Monatsschrift for Zahnmedizin.* 1990; 100(8):966-979
7. Kaplan P. Flexible removable partial dentures-design and clasp concept. *Dentistry Today*. 2008;27(12):120,122-123
8. Meijer GJ, Wolgen PJ. Provisional flexible denture to assist in undisturbed healing of the

reconstructed maxilla. *The Journal of Prosthetic Dentistry*. 2007;98(4):327-328

9. Naylor WP, Manor RC. Fabrication of a flexible prosthesis for the edentulous scleroderma patient with microstomia. *The Journal of Prosthetic Dentistry*. 1983;50(4):536-538

10. Chen J, Ahmad R, Li W, Swain M, Li Q Biomechanics of oral mucosa. *J R Soc Interface*. 2015;12:20150325. doi:10.1098/rsif.2015.0325

11. Essam A. Aziz and Nermine R. Amin, cytological study of mucosal tissue reaction to different modern interim esthetics restorations. *EDJ*. 2015:61:1-14

12. Ramulu S, Kale AD, Hallikerimath S, Kotrashetti V. Papanicolaou stain Comparing with modified ayoub-shklar and haematoxylin-eosin stain for demonstration of keratin in paraffin embedded tissue sections. *J oral maxillofac pathol.* 2013;17:23–30. doi:10.4103/0973-029x.110698

13. Łukomska-Szymańska M, Brzeziński PM, Zieliński A, Sokołowski J. Cytological response of palatal epithelium to TiN-coated CoCr alloy denture. *Folia Histochem Cytobiol*. 2012;50:104-110