

THE EFFECT OF RIDGE HEIGHT ON RETENTION OF ACRYLIC AND FLEXIBLE DENTURES IN PATIENTS WITH COMPLETE EDENTULOUS MAXILLARY ARCH: A PILOT STUDY

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ABSTRACT

Introduction: Removable denture still stands as the preferred option in the management of completely edentulous arch in the developing society. The prosthodontist is challenged with providing a retentive denture to the patient, alleviating the effect of tooth loss. The retention of these prostheses is influenced by the material used for its fabrication and the edentulous ridge height, hence the need to assess the retention of acrylic and flexible complete denture and the effect of edentulous ridge height.

Aim: This study was to assess and compare the effect of ridge height on retention of flexible and acrylic complete upper dentures.

Materials and Methods: Ten patients with complete upper edentulous arches were recruited and randomly allocated into two groups (A and B). Acrylic and flexible, complete maxillary dentures were fabricated for each participant. Group A wore the acrylic denture first, while group B wore the flexible denture first. Each participant was recalled after using the denture for one week, one month, and three months for data collection. At cross over time (3 months after wearing the first denture), individuals in group A were given flexible dentures, while those in group B received acrylic dentures. The patients were recalled again for data collection by one of the researchers. Kapa Intra examiner reliability test was 83.3%. Information related to denture retention were obtained and entered into IBM SPSS software version 23 for analysis. Paired t-test and linear regression were used to test for association between quantitative variables. A P-value of 0.05 was regarded as significant.

Results: Ten individuals with mean age of 66.5 ± 9.7 years and mean anterior ridge height of 15.5 ± 2.95 mm participated in this study. The subjective and objective assessments of the dentures showed that acrylic denture possessed a better retention than flexible denture. The effect of anterior ridge height on retention, showed a statistically significant difference ($p = 0.006$ for acrylic denture, $p = 0.001$ for flexible denture).

Conclusion: This study suggested that acrylic denture possesses better retention compared to the flexible type and far better in situation with lower ridge heights.

Keywords: Retention, Acrylic denture, Flexible denture, and Ridge height

INTRODUCTION

Complete edentulism is an irreversible condition that is incapacitating and debilitating, leading to functional, physical, social, and psychological disabilities.¹ It has a global impact and is described as the final marker of disease burden for oral health.² It is defined as the state of the oral cavity with loss of all the natural teeth and supporting tissues in a dental arch or both arch(s).^{3,4}

Following tooth loss, there are some intra and extra oral anatomical changes which have varying effects on the individuals' oral health, general health, and quality of life.^{2,5} The mechanisms connecting poor general health and tooth loss could be linked to the dietary and lifestyle modification of edentulous patients. A likely pathway of this association involves the grave effect of tooth loss on nutrition, with a negative

outcome on systemic health.⁶ Most patients regard tooth loss as mutilating and a condition that require urgent dental intervention.⁷

Among the myriad of anatomic changes associated with tooth loss is alveolar ridge resorption. Ridge resorption is perceived to be a physiological process, affecting the lower jaw four times more severely than the upper jaw.⁸ This leads to a reduced alveolar bone height and denture bearing area. The resorptive changes of the alveolar ridge (height and width) affect the lower facial height and appearance (aesthetics); leading to changes in the facial tissue profile. This may present as soft tissue collapse of the cheek, or class III ridge relationship. The rate of anatomic degenerative changes varies from person to person and the cause is still not clear. It is believed that a combination of local and systemic factors such as length of edentulism, parafunctional habits, age, gender, bone density, and systemic diseases such as osteoporosis may be contributory.²

The prevalence of tooth loss varies from country to country and it occurs more commonly among the elders, and individuals of low social economic status. ⁽⁸⁾Various factors such as the cost, patient choice, and the duration of edentulism, the extent of tooth loss, expertise, and laboratory support determined the choice of teeth replacement options. The options available include the use of removable dentures, and implants retained prosthesis to improve retention, performance and satisfaction, among others. The removable denture still stands as the most available, affordable, and preferred alternative in the management of complete edentulous arch in a developing society like ours.^{9,10,11}

Retention in a complete denture is a feature that resists the displacement of a denture in an occlusal direction. The retention of the denture is of utmost interest to the patient and a matter of great reward to the dentist. There are factors that affects how well retained an acrylic removable complete denture could be and they include the edentulous ridge height, forces of adhesion, cohesion, interfacial surface tension, gravity, intimate tissue contact, peripheral seal (border seal), weight of the denture, atmospheric pressure, and neuromuscular control.^{12,13} Acrylic resin has been the material of choice in the fabrication of complete denture. However, the presence of residual monomer in acrylic denture that has the tendency to irritate the oral soft tissue ¹⁴ prompted the need for an alternate material. Polyamide appeared to be the most preferred alternative denture base resin with some outstanding qualities such as; high toughness, low density, abrasion resistance, and resistance to chemical attack. There is controversy on

the flexibility but it gives a higher resistance to shock and fatigue stress compared to acrylic denture. The flexible denture material is not without a downside as its flexibility is also seen to be a disadvantage for denture bases. In addition, it has a higher water sorption which gives room for colour change and allows colonization of microorganism.¹⁵

There are conflicting views on the retention of polyamide due to its flexibility. Some authors^{16,17,18} have shown that the flexibility of the resin allows it to be easily adapted to bony tissue undercut (bilateral), providing good retention. However, other reports^{19,20} showed that flexibility is not a plus where there were no undercuts during a complete denture fabrication, because the retentive peripheral seal are often broken during function. The most important single factor in complete denture on which retention depends is the border seal.^{21,22} The glossary of prosthodontic terms defined the border seal as the contact of the denture border with the underlying or adjacent tissues to prevent the passage of air or other substances and in turn enhance retention.²³ The effectiveness of peripheral seal on retention is largely dependent on the amount of ridge height present on the arch, which in turn has a direct effect on retention; the higher the ridge height the better the retention. To this extent restoration of a severely resorbed ridge using conventional complete denture has met a great difficulty especially in a developing society like ours where an average individual lives below the poverty level and cannot afford procedures such as implant retained prosthesis. Hence the need to assess the amount of ridge height that is adequate to provide retention for a complete denture made of acrylic or flexible denture bases with good retentive outcome.

As a result of the controversies surrounding the retention of flexible denture, this study compared the retention of maxillary complete flexible and acrylic dentures and also estimated the amount of clinical ridge height that is adequate to retain a complete denture made of acrylic and flexible resins.

PATIENTS AND METHOD

Consecutive individuals with completely edentulous maxillary arch that consented to participate in the study and fulfilled the inclusion criteria were recruited, treated and reviewed over a period of 12 months; March 2019 to February 2020. The participants were randomized into two groups (group A and B) by picking a letter, A or B from a ballot box. Two identical dentures using a duplicate master cast were fabricated for each participant following standard procedures as described by Gehan.²⁴ Group A participants used acrylic dentures (pink shade, heat cure

acrylic resin, dental product of India, Mumbai) first, while those in group B wore the flexible dentures (Flexite plus, Mineola, New York) first. Each participant was recalled after using the denture for one week, one month, and three months for data collection. At cross over time (3 months after wearing the first denture), individuals in group A were given flexible dentures, while those in group B had acrylic dentures inserted. The participants were recalled after 24 hours for review and possible denture adjustment following which a one week period was observed for possible adjustment and denture settling, this also allows the effect of previous denture to wear out without depriving the patient the benefits of using his/her denture. The patients were then recalled again for data collection after using the second denture for one week, one month, and three months for data collection by one of the researchers (OF). Kapa Intra examiner reliability test was 83.3%. Information related to denture retention were obtained and entered into IBM SPSS software version 23 for analysis. Shapiro - Wilk test was used to test for normality of data, Paired t-test to compare retention of acrylic and flexible dentures, while straight line graph and linear regression were used for test of association between ridge height and retention of acrylic and flexible dentures. A P-value of 0.05 was regarded as significant.

Inclusion criteria

- (1) Individuals with complete edentulous maxillary arch of at least six-months duration with either complete dentate, partially dentate or fully edentulous opposing lower arch.
- (2) Individuals who do not have any systemic or neuromuscular disorder that might affect chewing.
- (3) Individuals who do not have any temporomandibular joint (TMJ) disorder.
- (4) Individuals with class I facial profile
- (5) Individuals that were willing to participate in the study.
- (6) Individuals with good mouth opening.

Exclusion criteria

- (1) Individuals with habits like bruxism, and other parafunctional habits.
- (2) Individuals who have undergone chemotherapy/ radiotherapy.
- (3) Individuals with previous history of allergy to acrylic resin.
- (4) Individuals with abnormal tongue movement and/or size.
- (5) Individuals with xerostomia or excessive salivation.
- (6) Individuals with unfavourable ridge undercut that can preclude the use of acrylic complete denture.

A self-structured questionnaire was administered to each participant by one of the examiner (OF) to obtain necessary information. The questionnaire obtained information on socio-demographic variables, ridge height and retention of dentures from the participants. Visual Analogue Scale (VAS) was used to assess patients' satisfaction for retention at the end of the 3 months of using each denture. Patients were requested to place a vertical point/line on the 100 mm scale to indicate the degree of retention of the denture in use and satisfaction for retention was graded as 01-30: Totally dissatisfied, 31-50: Dissatisfied, 51-79: Satisfied, 80 - 100: Totally satisfied.

Subjective assessment of retention was done using a standard questionnaire as described by Kapur,²⁵ and was graded from 0 to 3 as follows; grade 0 = No retention (the denture displaces itself when patient talks), 1=Minimum retention (denture offers slight resistance to vertical pull and no resistance to lateral pull), and 2=Moderate retention (denture offers slight resistance to lateral pull), while 3=Good retention (denture offers maximum resistance to vertical and lateral forces).

The objective measurement of retention was obtained using the pull digital force gauge (model HF 500, manufactured in China, by Zhengzhou Nambei Instrument/Equipment Company). The S shape hook was connected to a ring positioned on the maxillary dentures 2 cm posterior to the incisive edge of the upper central incisors for each denture type and pulled vertically until dislodgment occurred. The highest reading recorded just before the dislodgement was obtained and the reading taking three times following which an average value was recorded (Figure 1).

The height of the ridge was measured on the master cast by one of the researchers (OF) using a pair of a digital calliper (digital Vernier calliper- 150mm, made in China Mainland Qingdao Tlead International Company Limited), taking the reading of the most depressed and least depressed area of the ridge in millimetres following the method used by Campbell.²⁶ The measurements were taken three times following which the average was found for the anterior (most and least depressed) and posterior (most and least depressed) ridge height using the canine tubercle as a land mark (The anterior ridge height span between the left and right canine tubercles. While, the posterior ridge measurement was considered as area of the ridge, distal to the canine tubercles). The instrument was reset to zero after each use.

The principal investigator (OF) pre-tested the questionnaires using two edentulous patients who were

not part of the study. Areas of discrepancies were noted and corrected, questions which were not easily understood were rephrased. The digital force gauge was calibrated by ensuring that the readings returned to zero before and after each use and the instrument was fully charged for optimal battery performance before use. One of the researchers, a Consultant Prosthodontist assessed the two participants involved in the pre-test and took records for retention, using force gauge and ridge height, using the calliper. The reading obtained by the principal investigator was compared to the result generated by the consultant and the level of agreement was 91.7%.

Institutional Ethical approval (with assigned number UI/EC/17/0537) was obtained before the commencement of the study. All participants also signed a written informed consent during the recruitment exercise.

RESULT

A total of 10 participants with completely edentulous upper jaw participated in the study. Each participant had two different types of complete upper dentures. The mean age of the participants was 66.5 years \pm 9.7 years, while the majority, (80%) were 60 years and above. Seven (70%) of the participants had completely edentulous lower ridge, while three (30%) had lower partial edentulous jaw (Table 1). The participants had

Table 1: Characteristics of participants

General characteristics	Frequency N=10	Percentage %(100)
Sociodemographic characteristics		
Gender		
Male	5	50
Female	5	50
Age group (years)		
\leq 60	2	20
>61	8	80
Status of the lower jaw		
Complete edentulous	7	70
Partial edentulous	3	30

varying degrees of ridge height. The highest anterior ridge height (least depressed) was 21 mm seen in 2 (20%) patients while the lowest (most depressed) anterior ridge height was 12 mm seen in 1(10%) patient. The highest posterior ridge height (least depressed) was 20 mm seen in 1 (10%) patient while the lowest (most depressed) posterior ridge height was 3 mm seen in 1(10%) patient (Table 2)

The patient's evaluation of retention on VAS scale showed that three (30%) of the respondents gave a

Table 2: Frequency distribution of ridge height

Ridge height (mm)	Frequency N=10	Percentage %	Mean (SD)
Highest ridge height (Anterior)			
11.0	1	10	18.2 (3.12)
15.0	2	20	
18.0	1	10	
20.0	4	40	
21.0	2	20	
Lowest ridge height (Anterior)			
12.0	1	10	15.5 (2.95)
13.0	3	30	
15.0	2	20	
16.0	1	10	
18.0	1	10	
20.0	2	20	
Highest ridge height (Posterior)			
10.0	4	40	12.6 (1.49)
11.0	1	10	
12.0	1	10	
13.0	1	10	
15.0	2	20	
20.0	1	10	
Lowest ridge height (Posterior)			
3.0	1	10	6.0 (1.49)
5.0	2	20	
6.0	3	30	
6.2	1	10	
7.0	1	10	
8.0	2	20	

score of 90 and another three (30%) gave a 100-point rating on VAS, while one (10%) each gave rating of 50, 60,80, and 85-points for acrylic denture. While for flexible dentures 30% of the respondents gave a 90-point VAS score, two (20%) of the respondents gave



Figure 1: Digital force gauge meter

Table 3: Dentist's assessment of retention of acrylic and flexible dentures using digital force gauge meter.

Acrylic at 1 week		Flexible at 1 week		Acrylic at 1 month		Flexible at 1 month		Acrylic at 3 months		Flexible at 3 months	
Force (N)	n(%)	Force (N)	n (%)	Force (N)	n (%)	Force (N)	n (%)	Force (N)	n (%)	Force (N)	n (%)
12.5	1 (10)	10.0	1 (10)	12.0	1 (10)	10.8	1 (10)	12.5	1 (10)	10.0	1 (10)
19.8	1 (10)	14.0	1 (10)	19.0	1 (10)	14.8	1 (10)	20.0	1 (10)	14.8	1 (10)
24.5	1 (10)	14.5	1 (10)	27.0	1 (10)	20.0	2 (20)	32.0	1 (10)	20.0	1 (10)
26.0	2 (20)	16.0	1 (10)	28.3	1 (10)	22.0	1 (10)	36.0	1 (10)	22.0	2 (20)
26.9	1 (10)	20.0	1 (10)	30.0	1 (10)	28.4	1 (10)	36.4	1 (10)	30.0	1 (10)
30.0	1 (10)	28.4	1 (10)	32.9	1 (10)	36.4	1 (10)	38.9	1 (10)	37.0	1 (10)
52.0	1 (10)	36.0	1 (10)	39.0	1 (10)	42.0	2 (20)	39.0	1 (10)	45.0	1 (10)
62.0	2 (20)	39.0	1 (10)	60.0	1 (10)	50.0	1 (10)	55.0	1 (10)	48.0	1 (10)
-	-	48.0	2 (20)	61.0	1 (10)	-	-	63.3	1 (10)	50.0	1 (10)
-	-	-	-	63.3	1 (10)	-	-	65.0	1 (10)	-	-

N = Newton



Figure 2: measuring vertical ridge height using digital Venire calliper

a score of 50, 70 and 80-point each and one (10%) person gave a 60 point for retention (Figure 3).Kapur's retention score showed an increased value in retention from the first week to the third month post insertion. Three (30%) of the acrylic dentures showed moderate retention and 70% had good retention at one week, while at one month one (10%) showed moderate retention and nine (90%) of the acrylic dentures showed

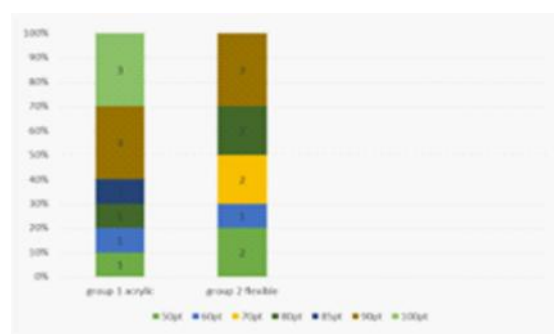


Figure 3: Patient's assessment of retention on the VAS scale

Pt= point rating on the VAS scale

Mean retention of acrylic denture (84.6 ± 16.88) mean retention of flexible denture (73.0 ± 15.67) P value=0.157

good retention. At the third month all the acrylic dentures (100%) had good retention. The Kapur's retention score of flexible dentures showed that one (10%) had minimum retention, six (60%) had moderate retention and three (30%) had good retention at the first week review. However, at 1 month, five (50%) of the flexible dentures had moderate retention and

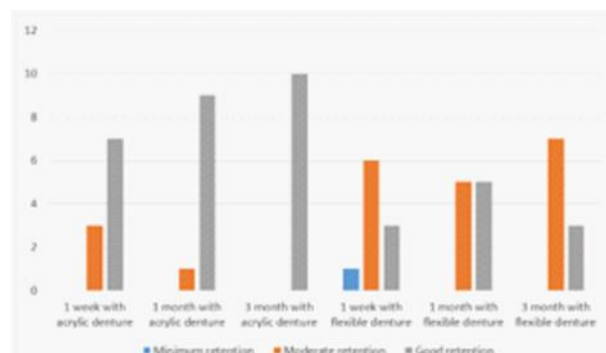


Figure 4: Subjective assessment of retention of acrylic and flexible dentures using the Kapurs scoring system

Table 4: Test of normality

Parameters	Shapiro - Wilk Statistics (W)	df	P value
Retention of acrylic denture at 3 month	0.938	10	0.530
Retention of flexible denture at 3 month	0.923	10	0.380
Anterior highest point ridge height	0.815	10	0.022
Anterior lowest point ridge height	0.815	10	0.022
Posterior highest point ridge height	0.884	10	0.147
Posterior lowest point ridge height	0.815	10	0.022

the remaining five (50%) had good retention. At the third month, seven (70%) of the flexible dentures had moderate retention and the remaining three (30%) patients had good retention (Figure 4).

The retentive force of acrylic and flexible upper dentures using digital force gauge showed that the amount of force required to dislodge the acrylic dentures was 12.5 - 62N at one-week, 12 – 63 N at one- month and 12.5 - 65N at three-month. While the amount of force required to dislodge the flexible dentures was 10 - 48N at the first week, 10.8 – 50 N at one- month and 10- 50N at three- month post insertion of the dentures (Table 3).

The test of normality for digital retention force in Newton at 3 months and ridge height in millimetre was done using the Shapiro-Wilk test due to the small

sample size in this study. This showed that the distribution of retention force for acrylic and flexible dentures may be normally distributed with W = 0.938 and 0.923 while the P value = 0.53 and 0.38 respectively. However, the result for the ridge height showed that the data may not be normally distributed, this could be as a result of repeated data and small sample size, base on this fact parametric test was used (Table 4).

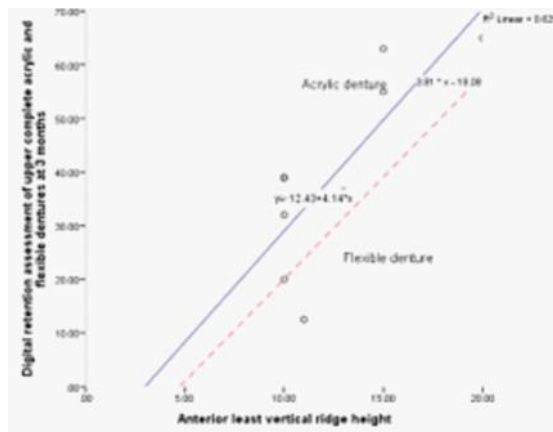
The comparison of the retentive force of acrylic and flexible upper dentures, showed statistically significant differences between the retentive forces for acrylic and flexible dentures at one month and three-month review periods. At one week, the mean retentive force for acrylic and flexible dentures were 34.17 ± 17.76 (N) and 27.39 ± 14.5 (N) respectively ($t = 2.268, P = 0.05$). Also, at one month the mean retentive force was higher for acrylic than for flexible dentures; 37.24 ± 18.16 (N)

Table 5: Comparison of the force of retention for acrylic and flexible dentures

Digital Retention at	Acrylic Mean (SD)	Flexible Mean (SD)	T – test	P value
1 week	34.17 (17.76)	27.39 (14.50)	2.268	0.050
1 month	37.24 (18.16)	28.64 (13.34)	2.959	0.016*
3 months	39.70 (17.09)	29.88 (14.36)	4.153	0.002*

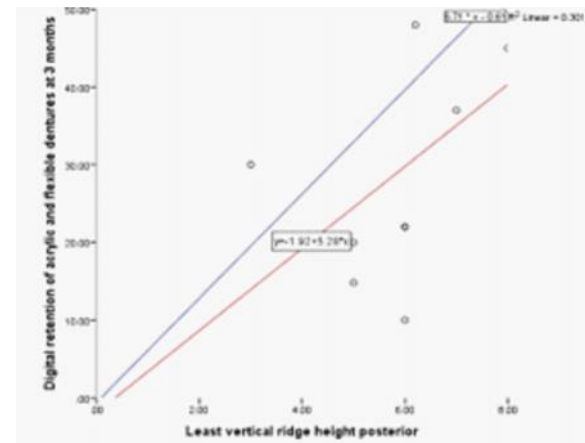
*Statistically significant

Figure 5: Comparing the effect of anterior ridge height on retention of acrylic and flexible dentures



Acrylic denture ($P = 0.006, S = 0.793, R^2 = 0.629$), Flexible denture ($P = 0.001, S = 0.867, R^2 = 0.752$)

Figure 6: Comparing the effect of posterior ridge height on retention of acrylic and flexible dentures



Acrylic denture ($P = 0.0075, S = 0.586, R^2 = 0.261$), Flexible denture ($P = 0.1, S = 0.549, R^2 = 0.241$)

and $28.64 \pm 13.34(N)$ respectively ($t = 2.959$, $P = 0.016$). Similarly, at three months the mean retentive scores were [acrylic: $39.7 \pm 17.09(N)$, flexible: $29.88 \pm 14.36(N)$] ($t = 4.153$, $P = 0.002$) (Table 5).

The anterior ridge height of 3.00mm or less showed no retention (0N) for acrylic denture, while a ridge height of 5.4mm and 15.1mm gave a value of 10 and 50N respectively. Similarly, the anterior ridge height of 4.75mm or less gave no retention (0N) for flexible denture, while a ridge height of 7.3 and 17.9mm gave a retention force value of 10 and 50N respectively, with a statistically significant difference (Figure 5). A posterior ridge height of 0.09 mm or less showed no retention (0N) for acrylic denture, while 0.36mm or less gave no retention (0N) for flexible denture (Figure 6).

DISCUSSION

Dental prosthesis is aimed at restoring oral functions, and this will be possible only if the denture is well retained when in use.²⁷ Dentists usually evaluate denture performance using pre-determined criteria for success. These criteria are based on technical standards, which usually do not take into consideration the individual needs, attitudes and expectations of the patients about their dentures.²⁷ Dubravka and Asja²⁸ claimed that the dentist's assessment has a better and reliable result and discredited the patients' reviews, while De Lucena *et al.*²⁹ showed no difference in the outcome of the assessment by the dentist and/or the patient.

Objective assessment of the retention of complete dentures is logical and reproducible.²⁸ However, it has been mentioned that the patients' assessment is also important and should not be overlooked. As a result, this study assessed the retention of complete maxillary acrylic and flexible dentures subjectively and objectively not omitting the patients' contribution. The retention of maxillary complete denture is influenced by several parameters. Anatomical structures such as: the rugae, the height and width of the alveolar ridge, the shape and depth of palatal vault and the presence of undercut have been shown to affect retention of maxillary complete dentures.³⁰ In addition, the quality and quantity of saliva aid retention; though its contribution depends on the effectiveness and adhesion of the saliva.

According to the patients' perception, the acrylic denture was more retentive than flexible denture in this study. Similarly, the subjective assessment of retention using Kapurs's scoring system showed that acrylic denture was more retentive compared to flexible denture at all the review periods, most especially at the third month review. This could be as a result of the fact that retention improves as the patients adapt

to the use of denture. A study by Gehan.²⁴ showed that it takes up to 10 weeks for patients to fully adapt to the use of denture, this is in agreement with this study that showed improved retention during the third month of denture use. Contrary to this, another study by Gaito *et al.*,³¹ showed that it takes up to 42 weeks for patients to get well adapted to denture use.

The objective assessment of retention using the digital force gauge, showed that acrylic complete denture had a better retention, compared to flexible complete denture, during the review periods. The finding is similar to those of previous study²⁴ that showed a better retention of conventional acrylic denture over soft acrylic type. This could be attributed to the elasticity of flexible denture that increases its tendency to flex under functional load and in turn break the peripheral seal, hence compromising the retention.¹⁹ This is in contrast to a study¹⁷ that reported that flexible denture has a better retention, they argue that the elastic property of flexible denture could enhance its ability to engage tissue undercut with ease.^{16,17}

Furthermore, the effect of ridge height on retention of acrylic denture considering the least vertical ridge height, showed that acrylic denture required a ridge height greater than 3mm for the anterior ridge and more than 0.09mm for the posterior ridge height to be retentive, while flexible denture required more than 4.7mm ridge height in the anterior ridge and greater than 0.36mm in the posterior. The effect of the posterior ridge height on retention in particular the hamular notch is of utmost importance for the posterior seal which also corroborate with the anterior and in turn influence the retention of complete denture. This result is in agreement with previous studies^{16,22} that prescribe flexible denture materials, as an alternative denture base material for the restoration of edentulous jaw(s) with optimum ridge height. However, the outcome of this study showed that flexible denture performed better in several other parameters such as speech, aesthetic, comfort during denture use and chewing efficiency with soft food. This could be as a result of flexible denture's texture that is tissue friendly, with light weight that have little or no interference with phonation. In addition, it gives better comfort during use and easier to clean compared to acrylic dentures which is in agreement with previous studies.^{32,33,34} On the other hand it was also shown that flexible dentures start showing colour changes from a clear transparent pink to carton brown afterward. Some of the participants also complained of difficulty in inserting the flexible dentures, this was corrected by inserting the flexible in hot water and adapted it on the cast before reinsertion in the patient mouth, trimming was avoided as much as possible.

This study showed that acrylic denture showed better retention in the objective and subjective assessment and performed better in cases of lower ridge height. Hence the alternate hypothesis is considered, and the null hypothesis was not accepted.

CONCLUSION

Within the purview of this study, it was gathered that there was coherence in both subjective and objective assessment of retention for complete flexible and acrylic dentures, more so, acrylic denture possesses better retention compared to the flexible type and far better in situation with lower ridge heights.

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