How to Cite:
Parihar, N., Vyas, A., Srivastava, R., Razdan, R. A., Jaiswal, T., & Patel, V. (2022). Comparative evaluation of sulcus/ vestibular depth by intraoral examination and on master cast/denture in completely edentulous cases. *International Journal of Health Sciences*, *6*(S2), 12361–12372. https://doi.org/10.53730/ijhs.v6nS2.8275

Comparative evaluation of sulcus/ vestibular depth by intraoral examination and on master cast/denture in completely edentulous cases

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***Abstract*---**Context: Residual ridge resorption(RRR) affect the patient's satisfaction with complete denture by decreasing the sulcus / vestibular depth, Aims: The aim of this study is to find the correlation between difference in sulcus / vestibular depth by intraoral examination and on master cast/ old denture with patient's satisfaction from complete denture. Settings and Design: The study

included old denture wearer and complete denture prosthesis made by different operators in the college. Methods and Material: The vestibular sulcus depths at 7 different sites in edentulous maxilla and 12 different sites in edentulous mandible and respective flange height in maxillary and mandibular denture were measured. Prevalidated questionnaire was used to measure the satisfaction of patients with denture. Statistical analysis used: Pearson correlation was done to find the correlation between satisfaction score and difference in sulcus / vestibular depth. Results: The difference in sulcus depth in maxilla with maxillary cast and mandible with mandibular master cast/ denture showed medium to large negative correlation with p value 0.01. The increase in difference will lead to decrease in satisfaction score of patients. Conclusions: The difference in sulcus depth in maxilla and in maxillary master cast/ denture as well as the difference in sulcus depth in mandible and mandibular master cast/ denture were negatively correlated with the overall satisfaction of patient with complete denture.

***Keywords*---**denture satisfaction, complete denture, sulcus depth, flange height.

Introduction

The success of any complete denture depends upon the recognition, understanding and incorporation of certain mechanical, biologic and physical factors. These factors are the determinants that promote the properties of retention, stability, esthetics and preservation of what is remaining in good health in the finished prosthesis.[1] According to GPT 9 "Retention is defined as that quality inherent in the dental prosthesis acting to resist the forces of dislodgement along the path of placement."[2]

Denture retention is the result of the collective influence of a number of different physical and biomechanical factors. The most significant are: adhesion, cohesion, intimate tissue contact, neuro muscular control, hydrostatic pressure gradient, and border seal.[3] During fabricating of complete denture, the labial and buccal flange of the denture should fit into and fill the vestibular space. An accurate fit will enhance the border seal of the denture and increase retention of complete denture.[4]

Overextension of denture borders can cause ulceration and pain and may impair retention. Retention and stability are also negatively influenced by short denture borders. Extension of posterior borders can result in excessive pressure, swallowing difficulties etc. These short or long borders are often caused by inadequate molding of the periphery at the impression making stage.[5] Another factor which greatly affects the success of complete denture is residual ridge resorption. Residual ridge resorption (RRR) can be defined as the alveolar atrophy which occurs after extraction of the teeth, is a complex and multifactorial process.[6] The size of the residual ridge is reduced most rapidly in the first six months, but the bone resorption activity of the residual ridge continues

throughout life at a slower rate. Residual ridge remodelling affects the function of complete Denture.[7]

There are many study concluded that had found that residual ridge resorption depends on various factors and is continuously progressing in nature but neither of them showed that residual ridge resorption affect the patient's satisfaction with complete denture and also the fabrication of complete denture.[3,8,9] The aim of this study is to find the corealtion between difference in sulcus / vestibular depth by intraoral examination and on master cast/ old denture with patient's satisfaction from complete denture.

Subjects and Methods

The present descriptive study was conducted in the department of Prosthodontics after taking approval from the institutional ethical committee of Dental College (IEC no). The study was conducted for a period of six months and included completely edentulous patients who are old denture wearer and complete denture prosthesis made by different operators in the College. Minimum sample size calculated was 76 therefore total 77 patients were evaluated for the study. Written informed consent was taken from the study participants.

The following measurements were recorded from the patients.

1. Measurement of vestibular sulcus depth in edentulous maxilla.
2. Measurement of vestibular sulcus depth in edentulous mandible.
3. Measurement of respective flange height in maxillary denture.
4. Measurement of respective flange height in mandibular denture.

Implant depth probe advanced is a depth measuring gauge used in the present study to measure various parameters. It is a rod like instrument calibrated in millimeters with a round tip on both ends. It is also termed as vestibular depth measuring gauge. Both ends of the probe are calibrated from 4 mm to 14 mm with markings at 4 mm, 6 mm, 8 mm , 10 mm , 12 mm , and 14 mm distance. The round tip at one end is 2 mm in diameter while at another end it has a diameter of 3 mm. (Figure 1)

Figure 1: Implant Depth Probe

The vestibular sulcus depths at 7 different sites in edentulous maxilla were measured namely Labial Frenum Upper (LFU), Left Labial Vestibule Upper (LL_bVU), left buccal frenum upper (LBFU), Left Buccal Vestibule Upper (LBVU), Right Labial Vestibule Upper (RL_bVU), Right Buccal Frenum Upper (RBFU) and Right Buccal Vestibule Upper (RBVU). These are compared with 7 different landmarks in maxillary complete denture namely labial notch upper (LNU), left labial flange upper (LLF_lU), Left Buccal Notch Upper (LBNU) , Left Buccal Flange Upper (LBF_lU), Right Labial Flange Upper (RLF_lU), Right Buccal Notch Upper (RBNU) and Right Buccal Flange Upper (RBFU). (Figure 2 & 3)

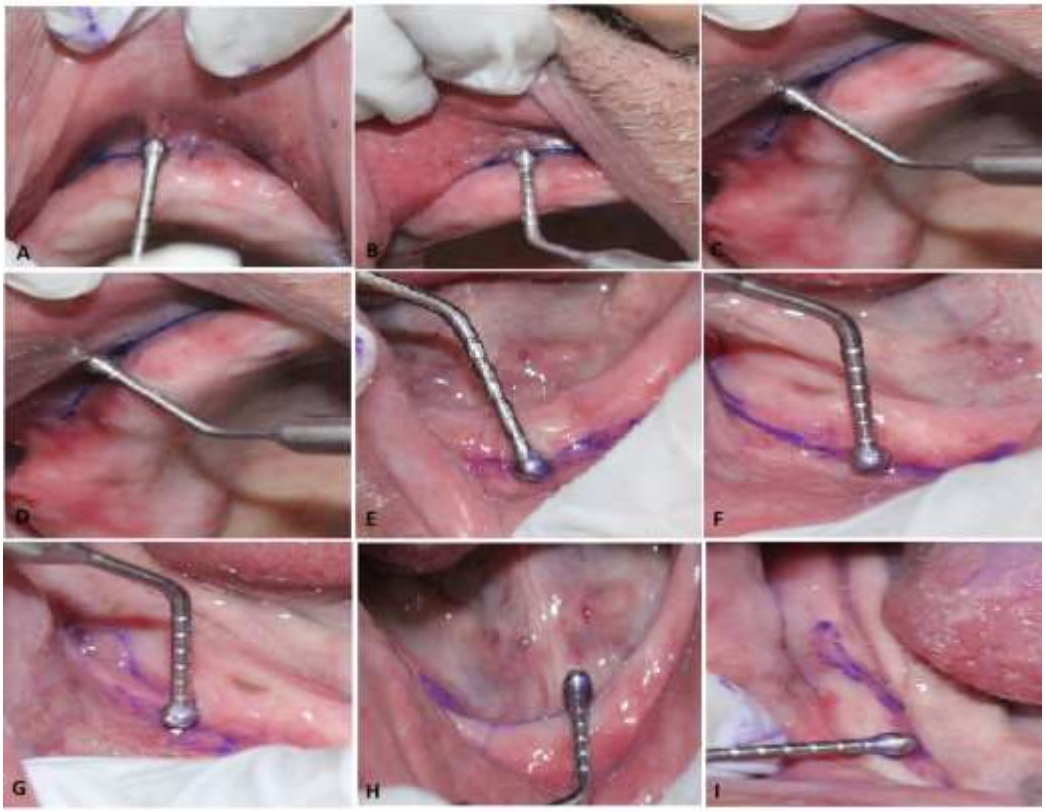

Figure 2: Measurement of vestibular sulcus depth at (A) labial frenum upper region (B) Labial vestibule upper region (C) Buccal frenum upper region (D) Buccal vestibule upper region (E) Labial frenum lower region (F) Labial vestibule lower region (G) Buccal frenum lower region (H) mandibular lingual frenum region (I) anterior mylohyoid ridge region

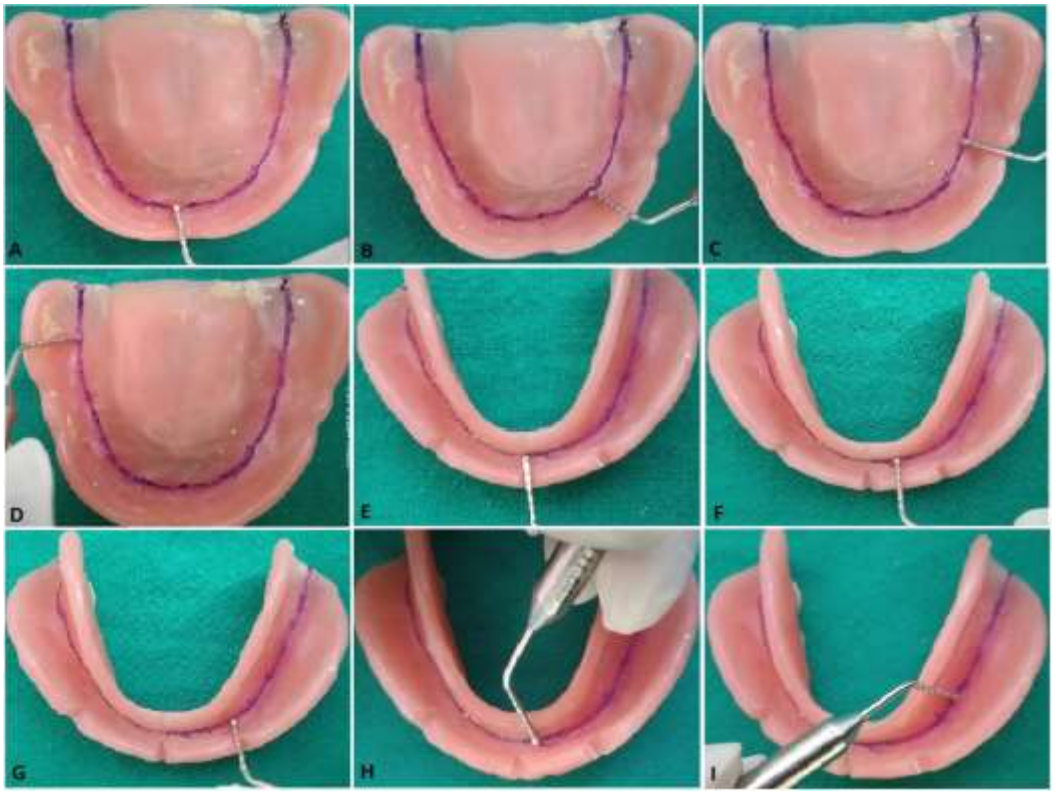

Figure 3: Measurement of height of flange at (A) Labial notch upper region (B) labial flange upper region (C) buccal notch upper region (D) Buccal flange upper region (E) Labial notch lower region (E) labial flange lower region (F) buccal notch lower region (G) Buccal flange lower region (H) mandibular lingual notch region (I) anterior mylohyoid groove region

The vestibular sulcus depths in edentulous mandible were measured at 12 different sites namely Labial Frenum Lower (LFL), Left Labial Vestibule Lower (LL_bVL), Left Buccal Frenum Lower (LBFL), Left Buccal Vestibule Lower (LBVL), Right Labial Vestibule Lower (RL_bVL), Right Buccal Frenum Lower (RBFL), Right Buccal Vestibule Lower (RBVL), Lingual Frenum (LiF), Left Anterior Mylohyoid Ridge (LAMR), Left Posterior Mylohyoid Ridge (LPMR), Right Anterior Mylohyoid Ridge (RAMR), Right Posterior Mylohyoid Ridge (RPMR). (Figure 2)

These measurements were compared with 12 different landmarks in mandibular complete denture namely Labial Notch Lower (LNL), Left Labial Flange Lower (LLF_lL), Left Buccal Notch Lower (LBNL), Left Buccal Flange Lower (LBF_lL), Right Labial Flange Lower (RLFL), Right Buccal Notch Lower (RBNL), Right Buccal Flange Lower (RBF_lL), Lingual Notch (LiN), Left Anterior Mylohyoid Groove (LAMG), Left Posterior Mylohyoid Groove (LPMG), Right Anterior Mylohyoid Groove(RAMG), Right Posterior Mylohyoid Groove (RPMG). (Figure 3)

Denture satisfaction survey was performed in all patients. This was done to evaluate the effect of difference between functional sulcus depths that is height of residual ridge intraorally at various border landmarks and flange height of

denture at respective areas and patient's satisfaction with complete denture. Pre validated questionnaire was used based on the scale of 1 to 5. Score 1 describes patient is not at all satisfied and score 5 describes patient was fully satisfied with denture.

The job of data entry, validity checks, and formation of desired results were done using the SPSS version 22.0 (IBM Corporation, Statistical Package for the Social Sciences. N.Y., USA). Student T test was applied to determine difference between mean value between males and females. Pearson correlation was done to find the correlation between satisfaction score and difference in sulcus / vestibular depth by intraoral examination and on master cast/ old denture. The level of statistical significance was set at $P \leq 0.05$.

Results

The study included 77 patients after obtaining written informed consent form the patients. The mean age of the patients included in the study was 61.88±10.45 years. Among the sample there were 34 females (44.20%) and 43 males (55.80%). The sulcus depths were measured at 7 different places in edentulous maxilla. The mean and Standard deviation at LFU () was 7.05±1.99 mm, LL_bVU was 8.80 ±2.12 mm, LBFU was 6.84 ± 2.07 mm, LBVU was 9.51 ± 2.02 mm, RL_bVU was 8.68 ± 2.15 mm, RBFU was 6.90 ± 2.02 mm and RBVU was 9.51 ± 2.16 mm. The curresponding sulcus depth at 7 different sites on maxillary master cast/ denture includes LNU was 7.64 ± 2.17 mm, LLF_lU was 8.98±1.89 mm, LBNU was 7.28 ±1.81 mm, LBF_lU was 9.71 ± 2.17 mm, RLF_lU was 8.97 ±1.91 mm, RBNU was 7.28± 1.81 mm and RBF_lU was 9.71± 2.28 mm. (Table 1)

Table 1: Measurement of Sulcus Depth in Maxillary and Corresponding Mandibular master Cast/ denture

Sulcus Depth in Maxilla		Flange height in maxillary Denture	
Site of Measurement	Mean±SD	Site of Measurement	Mean±SD
LFU – Labial Frenum Upper	7.05±1.99	LNU – Labial Notch Upper	7.64±2.17
LL_BVU – Left Labial Vestibule Upper	8.80±2.12	LLF_lU– Left Labial Flange Upper	8.98±1.89
LBFU – Left Buccal Frenum Upper	6.84±2.07	LBNU – Left Buccal Notch Upper	7.28±1.81
LBVU – Left Buccal Vestibule Upper	9.51±2.02	LBF_lU – Left Buccal Flange Upper	9.71±2.17
RL_BVU –Right Labial Vestibule Upper	8.68±2.16	RLF_lU – Right Labial Flange Upper	8.97±1.91
RBFU – Right Buccal Frenum Upper	6.90±2.02	RBNU – Right Buccal Notch Upper	7.28±1.81
RBVU – Right Buccal Vestibule Upper	9.51±2.16	RBF_lU – Right Buccal Flange Upper	9.71±2.17

The sulcus depths were measured at 12 different places in edentulous mandible. The mean and SD at LFL was 6.38 ± 2.41 mm, LL_bVL was 8.12 ± 1.98 mm, LBFL was 6.66 ± 1.72 mm, LBVL was 8.12 ± 1.98 mm, RL_bVL was 7.51 ± 1.96 mm, RBFL was 6.55 ± 1.96 mm, RBVL was 8.19 ± 1.90 mm, LiF was 5.66 ± 1.57 mm, LAMR was 5.36 ± 1.01 mm, LPMR was 5.53 ± 1.16 mm, RAMR was 5.41 ± 1.10

mm, RPMR was 5.55 ± 1.27 mm. The sulcus depth at curresponding 12 different sites on mandibular master cast/ denture includes LNU- 6.84 ± 2.18 mm ,LLF_lL– 8.49 ± 1.89 mm, LBNU 7.09 ± 1.67 mm, LBF_lL 8.49 ± 1.89 mm, RLF_lL 7.77 ± 1.88 mm, RBNL 6.89 ± 1.74 mm, RBF_lL 8.53 ± 1.78 mm, LiN 5.83 ± 1.57 mm, LAMG 5.36 ± 1.01 mm, LPMG 5.54 ± 1.16 mm, RAMG 5.41 ± 1.10 mm, RPMG 5.83 ± 1.57 mm. (Table 2)

Table 2: Measurement of Sulcus Depth in Mandible and Corresponding Mandibular master Cast/ denture

Sulcus Depth in Mandible		Flange height in maxillary Denture	
Site of Measurement	Mean±SD	Site of Measurement	Mean±SD
LFL – Labial Frenum Lower	6.38±2.41	LNL – Labial Notch Lower	6.84±2.18
LL_bVL – Left Labial Vestibule Lower	7.36±2.02	LLF_lL– Left Labial Flange Lower	7.77±1.88
LBFL – Left Buccal Frenum Lower	6.66±1.72	LBNL – Left Buccal Notch Lower	7.09±1.67
LBVL – Left Buccal Vestibule Lower	8.12±1.98	LBF_lL – Left Buccal Flange Lower	8.49±1.89
RL_bVL –Right Labial Vestibule Lower	7.51±1.96	RLF_lL – Right Labial Flange Lower	7.76±1.93
RBFL – Right Buccal Frenum Lower	6.55±1.72	RBNL – Right Buccal Notch Lower	6.89±1.74
RBVL – Right Buccal Vestibule Lower	8.19±1.90	RBF_lL – Right Buccal Flange Lower	7.76±1.93
LiF – Lingual Frenum	5.66±1.57	LiN – Lingual Notch	5.83±1.57
LAMR – Left Anterior Mylohoid Ridge	5.36±1.01	LAMG – Left Anterior Mylohoid Groove	5.36±1.01
LPMR – Left Posterior Mylohyoid Ridge	5.53±1.16	LPMG– Left Posterior Mylohyoid Groove	5.54±1.16
RAMR – Right Anterior Mylohoid Ridge	5.41±1.10	RAMG – Right Anterior Mylohoid Groove	5.41±1.10
RPMR – Right Posterior Mylohoid Ridge	5.55±1.27	RPMG– Right Posterior Mylohoid Groove	5.55±1.27

The complete denture satisfaction among the study patients for upper complete denture overall was 3.44 ± .71.The retention of upper CD was 3.44 ± .73, Stability of upper CD was 3.44 ± .73, comfort from upper CD was 3.42 ± .75, Esthetics was 3.51 ± .64. The satisfaction with lower complete denture overall was lower as compared to the upper denture3.02 ± .95. The retention of lower CD was 3.00 ± .98, Stability of lower CD was 3.00 ± .98, comfort from lower CD was 3.01 ± .99, and esthetics from lower CD was 3.51 ± .64. The satisfaction from the chewing efficiency was 3.05 ± 0.98 and the patient ability to speak with the complete denture was 3.12 ± 1.12. (Table 3)

Table 3: Measurement of Satisfaction from Complete Denture of study subjects

S. No	Variable	Minimum	Maximum	Mean±SD
1.	Complete Upper denture overall	1.00	4.00	3.44±0.71

2.	Complete lower denture overall	1.00	4.00	3.02±0.95
3.	Retention of upper CD	1.00	4.00	3.44±0.73
4.	Retention of lower CD	1.00	4.00	3.00±0.98
5.	Stability of upper CD	1.00	4.00	3.44±0.73
6.	Stability of lower CD	1.00	4.00	3.00±0.98
7.	Comfort of upper CD	1.00	4.00	3.42±0.75
8.	Comfort of lower CD	1.00	4.00	3.01±0.99
9.	Chewing efficiency	1.00	4.00	3.05±0.98
10.	Esthetics of upper complete denture	2.00	4.00	3.51±0.64
11.	Esthetics of lower complete denture	2.00	4.00	3.51±0.64
12.	Ability to speak	1.00	4.00	3.12±1.03
	Patient satisfaction Overall	15.00	48.00	39.07±9.48

The scale was compared on the basis of gender. There was no significant difference between the male and female regarding the satisfaction score of different variable. (Table 4) The difference in sulcus depth in mandible and mandibular master cast/ denture was correlated with the overall satisfaction of patient with complete denture by using pearson correlation. The result shows medium to large negative correlation with p value 0.01. The increase in difference will lead to decrease in satisfaction score of patients. (Table 5 & 6)

Table 4: Comparison of Satisfaction on the basis of Gender

Question	Male (N=43)	Female (N=34)	T value	P value
Complete Upper denture overall	3.41±0.79	3.47±0.61	0.32	0.75
Complete Lower denture overall	3.09±0.89	2.94±1.02	0.68	0.49
Retention of upper CD	3.44±0.79	3.44±0.66	0.004	0.99
Retention of lower CD	3.06±0.93	2.91±1.05	0.69	0.48
Stability of upper CD	3.44±0.79	3.44±0.66	0.004	0.99
Stability of lower CD	3.06±0.93	2.91±1.05	0.69	0.48
Comfort of upper CD	3.44±0.79	3.41±0.70	0.17	0.86
Comfort of lower CD	3.09±0.944	2.91±1.05	0.79	0.43
Chewing Efficiency	3.04±0.97	3.05±1.01	0.05	0.98
Esthetics of Upper CD	3.51±0.70	3.52±0.56	0.12	0.90
Esthetics of Lower CD	3.51±0.70	3.52±0.56	0.12	0.90
Ability to speak	3.16±1.02	3.08±1.05	0.31	0.75
Total	39.39±9.71	38.67±9.31	0.32	0.74

Table 5: Correlation between Difference in sulcus depth in maxilla and maxillary master cast/ denture and satisfaction level of patient from Complete Denture

Maxilla	Maxillary Cast	Pearson correlation coefficient ρ (rho)	P value
LFU – Labial Frenum Upper	LNU – Labial Notch Upper	-0.52	0.01*
LL_bVU – Left Labial	LLF_lU– Left Labial	-0.58	0.01*

Vestibule Upper	Flange Upper		
LBFU – Left Buccal Frenum Upper	LBNU – Left Buccal Notch Upper	-0.52	0.01*
LBVU – Left Buccal Vestibule Upper	LBF_lU – Left Buccal Flange Upper	-0.65	0.01*
RL_bVU –Right Labial Vestibule Upper	RLF_lU – Right Labial Flange Upper	-0.60	0.01*
RBFU – Right Buccal Frenum Upper	RBNU – Right Buccal Notch Upper	-0.50	0.01*
RBVU – Right Buccal Vestibule Upper	RBF_lU – Right Buccal Flange Upper	- 0.58	0.01*

Table 6: Correlation between Difference in sulcus depth in mandible and mandibular master cast/ denture and satisfaction level of patient from Complete Denture

Mandible	Mandibular cast	Pearson correlation coefficient ρ (rho)	P value
LFL – Labial Frenum Lower	LNL – Labial Notch Lower	0.60	0.01*
LL_bVL – Left Labial Vestibule Lower	LLF_lL– Left Labial Flange Lower	0.71	0.01*
LBFL – Left Buccal Frenum Lower	LBNL – Left Buccal Notch Lower	0.65	0.01*
LBVL – Left Buccal Vestibule Lower	LBF_lL – Left Buccal Flange Lower	0.67	0.01*
RL_bVL –Right Labial Vestibule Lower	RLF_lL – Right Labial Flange Lower	0.67	0.01*
RBFL – Right Buccal Frenum Lower	RBNL – Right Buccal Notch Lower	0.73	0.01*
RBVL – Right Buccal Vestibule Lower	RBF_lL – Right Buccal Flange Lower	0.67	0.01*
LiF – Lingual Frenum	LiN – Lingual Notch	0.62	0.01*
LAMR – Left Anterior Mylohoid Ridge	LAMG – Left Anterior Mylohoid Groove	0.60	0.01*
LPMR – Left Posterior Mylohyoid Ridge	LPMG– Left Posterior Mylohyoid Groove	0.65	0.01*
RAMR – Right Anterior Mylohoid Ridge	RAMG – Right Anterior Mylohoid Groove	0.58	0.01*
RPMR – Right Posterior Mylohoid Ridge	RPMG– Right Posterior Mylohoid Groove	0.71	0.01*

Discussion

Tooth loss impairs oral function, esthetics and phonetics. Prosthodontic treatment can be performed to improve patient function and oral health. Quality

of life is influenced by the quality prosthodontic treatment.[5]The success of any prosthesis depends upon the certain mechanical, biological and physical factors.[3]These factors promote the properties of retention, stability, support, comfort, esthetics and preservation of what is remaining in good health in any prosthesis. Incorporation of these properties in the complete denture make it a success and makes it comfortable for the patient and hence quality prosthodontic treatment is achieved.[1]

When a complete denture is fabricated, the labial and buccal flange should be such that they should fit into and fill the vestibular space. An accurate fit enhances the border seal which increases the retention of the complete denture. Hence the proper length and thickness is important to achieve the good retention and if they are not proper, the complete denture will lose its peripheral seal and retention gets compromised.[3] The success of the complete denture is also greatly influenced by residual ridge resorption, which can be defined as the alveolar atrophy which occurs after extraction of the teeth and is a complex multifactorial process that continues throughout the life.[6]

The current study is done to evaluate the height of maxillary and mandibular residual ridges at different areas. This will be done by measuring the functional sulcus depth at various border areas. The study also determined the correlation between Difference in sulcus depth in mandible and mandibular master cast/ denture and satisfaction level of patient from Complete Denture. The current study the vestibular sulcus depth was measured by "Vestibular Sulcus Depth Measuring Gauge." Vestibular sulcus depth measuring gauge has calibrations on both ends ranging from 4 mm to 14 mm. It has round end tip on both sides, one end has a round tip of 2 mm diameter and another end has a round tip of 3 mm. There is a 2 mm gap in between the calibrations. This instrument can be used to measure the vestibular sulcus depth as round end tip is safe than the sharp end probes.

The measurements of the edentulous maxilla and mandible were correlated with the maxillary and mandibular denture with the help of Pearson correlation. The results showed the large negative correlations which were statistically significant. The increase in difference will lead to decrease in satisfaction score of patients with both maxillary and mandibular dentures. The scale was also compared on the basis of gender. There was no significant difference found between male and female regarding the satisfaction score of different variables. Douglas A. Atwood et al.,[10] V. J. Ward.,[11] Bhuma Jayaram et al.,[12] Venkatesan N et al.,[13] S. Huumonen et al.,[14] Eijiro Yamaga et al.,[15] concluded that there was low correlation between the rate of residual ridge resorption is a chronic, progressive disease which continues throughout life even after healing of extraction sockets and it increases with the increase in age, also residual ridge resorption was associated with major problems related with complete denture wearer.

Sara A. Alfadda[16], Y. Komagamine et al.,[17]conducted a questionnaire based study for assessing the satisfaction of complete denture wearer by using Pearson correlation. They revealed that a clinically stable mandibular denture was the most important determinant of patient's satisfaction and sufficient retention of

lower dentures and appropriate appearance may lead to improved Oral health quality in edentulous patients.

Edward V. Kluth[18] stated that measurement of vestibular sulcus depth is a positive method of evaluating the border extensions of the tray. They checked the border extensions of the tray only. Hence they did not given any correlation of vestibular sulcus depth with the patient's satisfaction with complete denture. Other studies concluded by Douglas A. Atwoodet al.,[10] Mario Traxler et al.,[19] Bhuma Jayaram et al.,[12] had found that residual ridge resorption depends on various factors and is continuously progressing in nature but neither of them showed that residual ridge resorption affect the patient's satisfaction with complete denture and also the fabrication of complete denture.

Conclusion

The difference in sulcus depth in maxilla and in maxillary master cast/ denture as well as the difference in sulcus depth in mandible and mandibular master cast/ denture were negatively correlated with the overall satisfaction of patient with complete denture. There was no significant difference found between the male and female regarding overall satisfaction score.

References

1. Jacobson TE, Krol AJ. A contemporary review of the factors involved in complete denture retention, stability, and support. Part I: retention. The Journal of prosthetic dentistry. 1983 Jan 1;49(1):5-15.
2. Glossary of Prosthodontic Terms 9–The Academy of Prosthodontics . JPD 2017;117(5):1-105.
3. Chen J , Erlee H , Huey J , Hsuing F , Sen H , Mauchou T , HuiWeng C. Investigating the maxillary buccal vestibule. J Dent Sci 2014;9:2:125-9.
4. Patel J, Jablonski RY, Morrow LA. Complete dentures: an update on clinical assessment and management: part 1. British dental journal. 2018 Oct;225(8):707.
5. Zarb GA, Hobkirk J, Eckert S, Jacob R. Prosthodontic treatment for edentulous patients-e-book: complete dentures and implant-supported prostheses. Elsevier Health Sciences; 2013 Nov 21.
6. McCord JF, Grant AA. Prosthetics: Identification of complete denture problems: a summary. British dental journal. 2000 Aug;189(3):128.
7. Bilhan H , Geckili O, Ates G. Evaluation of satisfaction and complications in patients with existing complete dentures. J Oral Sci. 2013;55(1):29-37.
8. Humphries S, Devlin H, Worthington H. A radiographic investigation into bone resorption of mandibular alveolar bone in elderly edentulous adults. Journal of dentistry. 1989 Apr 1;17(2):94-6.
9. Jagadeesh MS, Patil RA, Kattimani PT. Clinical evaluation of mandibular ridge height in relation to aging and length of edentulism. IOSR J Dent Med Sci. 2013;3:44-7.
10. Atwood DA, Coy WA. Clinical, cephalometric, and densitometric study of reduction of residual ridges. The Journal of prosthetic dentistry. 1971 Sep 1;26(3):280-95.

11. Ward VJ. A technique of measurement of the depth of the vestibular fornix in the mandibular anterior region. J Periodontal. 1976 Sep;47(9):525-30.
12. Jayaram B, Shenoy KK. Analysis of mandibular ridge resorption in completely edentulous patients using digital panoramic radiography. J. Dent. Med. Sci. 2017;16:66-73.
13. Venkatesan NK, Thenmozhi N, Udhayan A, Raghunathan J. Analysing the residual ridge morphology and resorption for treatment of edentulous patient with complete denture in Melmaruvathur population. Int. J Rec Sci Res. 2018;9:25529-32.
14. Huumonen S, Haikola B, Oikarinen K, Söderholm AL, Remes-Lyly T, Sipilä K. Residual ridge resorption, lower denture stability and subjective complaints among edentulous individuals. Journal of oral rehabilitation. 2012 May;39(5):384-90.
15. Yamaga E, Sato Y, Minakuchi S. A structural equation model relating oral condition, denture quality, chewing ability, satisfaction, and oral health-related quality of life in complete denture wearers. Journal of dentistry. 2013 Aug 1;41(8):710-7.
16. Alfadda SA. The relationship between various parameters of complete denture quality and patients' satisfaction. The Journal of the American Dental Association. 2014 Sep 1;145(9):941-8.
17. Komagamine Y, Kanazawa M, Kaiba Y, Sato Y, Minakuchi S, Sasaki Y. Association between self-assessment of complete dentures and oral health-related quality of life. Journal of oral rehabilitation. 2012 Nov;39(11):847-57.
18. Kluth EV. Use of the periodontal probe to determine border extensions of impression trays. Journal of Prosthetic Dentistry. 1986 Dec 1;56(6):746-7.
19. Traxler M, Ulm C, Solar P, Lill W. Sonographic measurement versus mapping for determination of residual ridge width. The Journal of prosthetic dentistry. 1992 Mar 1;67(3):358-61.