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The Effect of Changing Vertical Dimension of Complete Denture Within its Normal Range on Sound Production With The Presence or Absence of Palatal Rugae.

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ABSTRACT

Purpose: To investigate the effect of changing vertical dimension of complete denture within its normal range on phonation with the presence or absence of palatal rugae, using Computerized speech lab (CSL).**Material and Methods**: Ten completely edentulous patients (aged 50-60 years) were selected for reading some sentences. Each patient had two maxillary and two mandibular dentures with an adaptation period between each denture. The patients' speech records were divided into four groups,Group I: Maxillary acrylic denture had polished anterior palatal surface without rugae reproduction and a free-way space of 2 mm.Group II: Maxillary acrylic denture with rugae reproduction on its polished surface and a free-way space of 2 mm.Group III: Maxillary acrylic denture had polished anterior palatal surface without rugae reproduction and a free-way space of 4 mm.Group IV: Maxillary acrylic denture with rugae reproduction on its polished surface and a free-way space of 4 mm, the samples selected were s/sh/t sounds**. Results**: There is no significant difference was recorded in mean value of first formant frequency in dentures with and without Ruge using freeway of 4 and 2 mm for S and Sh sounds and in the voice onset time (VOT) of T sound. **Conclusion**: Any change in the normal cross section of the oral cavity by a removable prosthesis will affect the properties of normal human voice, so it is not recommended to construct thick areas in the anterior region of denture even if it contains palatal rugae so that it will not affect palatolingual sounds.

KEYWORDS

Complete Denture, Range, Sound, phonation.

INTRODUCTION

Speech is a unique, complex, dynamic motor activity through which we express our thoughts and respond to control our environment. It is most powerful tool possessed by human species, and the degree to which we employ it effectively contributes to character and quality of our life.

- A paper extracted from Master thesis titled "The Effect Of Changing Vertical Dimension Of Complete Denture Within Its Normal Range On Sound Production With The Presence Or Absence Of Palatal Rugae"

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The air that we breathe out comes out of lungs before it gets out into the outer atmosphere; various organs in our body convert it into speech sounds. These organs are called the organs of speech. These organs fall into three groups or systems Respiratory system in which the lungs generate air stream, Phonatory system which includes larynx and vocal folds, Articulatory system which includs hard and soft palate, tongue, lip, teeth, nasal cavity.It is concluded that speech does not start in the lungs, It starts in the brain and it is, then, studied by Psycholinguistics. After the creation of the message in our mind, we need a representation of the sound sequence and a number of commands which will be executed by our speech organs to produce the utterance. So, we need a phonetic plan and a motor plan [1]

The speech sounds are produced by controlled air source from lungs. Amount of air flow is variable; the controls of various articulations are valves in pharynx, oral and nasal cavities. The valves are used for modifying the flow of air to produce speech sounds which are classified as; Labial Sounds, Labio-dental Sound, Linguo-dental Sound, Linguo-palatal (anterior), Linguo-palatal (posterior), Linguo-palatal (soft palate), Truly Palatal, Nasal[2].

Palatal rugae is asymmetrical and irregular elevations of the mucosa, it is also called transverse palatine folds which are located in the anterior third of the hard palate, it is formed from the lateral membrane of incisive papilla and arranged in transverse direction from palatine raphe located in mid-sagittal plane[3] . It is formed in the third month intrauterin from the hard connective tissue covering the bone. It is formed around 12th to 14th week of prenatal life and remains stable until the oral mucosa degenerates after death. Physiologically palatal rugae helps in swallowing of food, taste perception, speech and suction in children; and also in the medico-legal identification process [4].

It is observed that the defective speech is most frequently associated with increased vertical dimension which may result in difficulty in pronouncing sound like b, m, p, f, v. various phonetic tests to determine proper vertical dimension using such sound as s, c, z. It is important to obtain the correct vertical dimension of occlusion especially in speech since the compensatory tongue changes resulted not only in changes of the magnitude of palatal pressures, but also the time interval in which those pressures were applied. The optimum pressures were obtained with the correct vertical dimension of occlusion, the occlusal vertical dimension can alter the inter occlussal distance needed to speech /m/ and /s/ sounds [5].

As a result of instrument evolution, acoustic analysis was the way to objectively assess voice; the advantages of this method are increase in diagnostic precision, identification and documentation of short and long-term treatment efficacy and possibility of providing visual feedback to the patient. Through this analysis it is possible to obtain concrete values of acoustic characteristics of the voice [6].

The aim of this study was to investigate the effect of changing vertical dimension of complete denture within its normal range on phonation with the presence or absence of palatal rugae.

MATERIAL AND METHOD

Ten completely edentolous patients were selected from the Outpatient Clinic Prosthodontics Department, Faculty of dental medicine, AL-Azhar University, Girls' Branch.

Each patient had two maxillary and two mandibular dentures with an adaptation period between each denture. The patients' speech records were divided into four groups,

Group I: Maxillary acrylic denture had polished anterior palatal surface without rugae reproduction and a free-way space of 2 mm.

Group II: Maxillary acrylic denture with rugae reproduction on its polished surface and a free-way space of 2 mm.

Group III: Maxillary acrylic denture had polished anterior palatal surface without rugae reproduction and a free-way space of 4 mm.

Group IV: Maxillary acrylic denture with rugae reproduction on its polished surface and a free-way space of 4 mm.

Dentures in Group I were complete dentures with freeway of 2mm fabricated as usual way, GroupII were denures duplication of group I with addition of Palatal rugae Group III were maxillary denture of group I with new mandibular denture with free way of 4mm, Group IV maxillary denture with rugae reproduction were used with mandibular denture with a free-way space of 4 mm.

Steps of reproduction of the Rugae area using alginate impression and soft wax [7] .One of the impressions that was taken before was used to duplicate the rugae area by pouring soften wax to these impressions at the area of palatal rugae. The part of the Acrylic trial denture base that contains the rugae area was removed by fissure carbide bur. The wax pattern of the rugae area was removed from the impression and placed into position on the area that was removed from the trial denture base. The wax pattern of rugae was then sealed to the trial denture base, Midline and incisive papilla were used as the guide for proper orientation and adaptation. The rest of steps of denture were completed as usual.

Method of analysis:

It was done in the speech research laboratory of Cairo University. It was carried out using speech lab CSL 3400B. The set unit of Computerized Speech Lab (CSL) consists of external module with high speed dual channel, the plug-in board with 2 high speed digital signal processing integrated circuits, high quality microphone, and software version 3.1 and all patients were subjected to analysis of their signal after it was captured using sampling rate of 20 KHz and bandwidth is 300. The continuous electric signal can be converted to a digital representation suitable for manipulation by a computer. Computers equipped with the proper hardware can convert the analog voltage variations into digital sound waveforms by a process called analog-to-digital conversion. All recordings were made in sound proof room and the patient was seated in the chair in the upright position and was allowed to read a passage in comfortable amplitude and pitch using a high quality dynamic microphone at chest level 20 cm in front of the patient's mouth.

Each sound was inserted in the key words and each target word was embedded in the carrier sentence to divert the patient's attention away from the phoneme in the carrier phrase. These sounds were selected in a paragraph containing the required constant sound between two vowels such as "asa", "asha", "ata"; to avoid the patient's trials to adjust himself for optimum utterance. The spectral analysis was not done on the whole word of the paragraph but only on word fragments that permit perception of these alterations as /s/ sh / and t sounds. Breaking the words into sounds was performed for each patient in order to achieve more profound study of individual phonetic characteristics and a higher quality of studied phenomena.

The patient was then asked to read each sentence three times with every denture with normal speech intensity and speed, The computerized data of various acoustic parameters was obtained and spectral analysis of collected data was made with multi speech program-spectrogram analysis software, Speech samples Palatolingual sound such as: /S/ unvoiced linguodental fricative; /Sh/ unvoiced linguoalveolar fricative for both sounds the first formant frequency F1 (in Hz) were examined and the Voice Onset Time (VOT) of /t / sound unvoiced linguoalveolar stop, sound production (in millisecond).

Each patient was evaluated four times with 2 week interval between each group.

Statistical analysis

Statistical analysis was performed using a commercially available software program (SPSS 19; SPSS, Chicago, IL, USA). As data was parametric, significance of the difference between dentures with or without Rugae, as well as difference between dentures with 2 or 4mm freeway spaces were evaluated using independent t test.

All denture types were compared using one way analysis of variance (ANOVA) test.

The level of significance was set at $P < 0.05$.

RESULTS

There was no significant defference recorded in mean value of first formant frequency dentures with and without Rugae using freeway of 4and 2 mm. T test revealed that the difference was not statistically significant between groups of dentures with and without Rugae for S and Sh sounds . Regarding voice onset time (VOT) of t sound there was no significant difference in the mean value recorded in denture without Rugae at 4 and 2 mm freeway space (table1 and fig. 1).

Table (1) *Comparison of speech sounds using dentures with or without rugae area (t test)*

Speech sounds \ Groups		V4		V2	
		With Rugae	Without Rugae	With Rugae	Without Rugae
S (HZ)	**Mean**	715.523	766.328	665.815	726.218
	SD	71.829	144.738	60.046	138.158
	T	0.077		0.982	
	P	**0.4590 NS**		**0.3492 NS**	
Sh (Hz)	**Mean**	679.973	757.705	647.847	751.752
	SD	109.301	192.587	59.705	278.477
	T	0.8598		0.893	
	P	**0.41NS**		**0.393 NS**	
VOT (m/s)	**Mean**	0.024	0.030	0.024	0.035
T	**SD**	0.006	0.013	0.006	0.009
	T	1.8819		1.3587	
	P	**0.089 NS**		**0.204 NS**	

Significance level P<0.05, NS=non-significant V4 (freeway space of 4mm) , V2 (freeway space of 2mm).

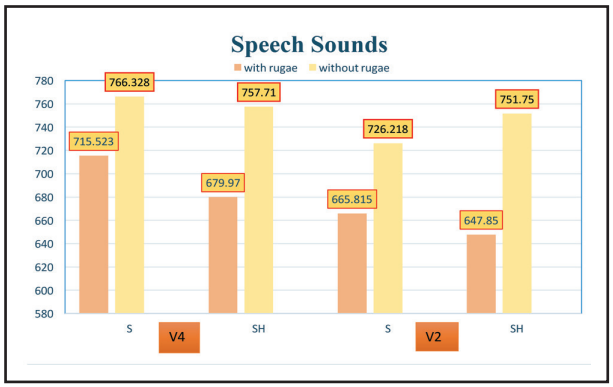

Fig. (1) Column chart showing mean value of F1of speech sounds with or without rugae area using 2 and 4mm free way space

DISCUSSION

The selected patients were free from any disorder or pathologic condition that may affect any organ related to vocal tract which may affect sound production [8].

The use of this technique of duplicating dentures has several advantages. It is a simple method when compared to other methods. Another advantage of these techniques are the use of stock teeth which have superior properties to those made in cold-cure resin [9].

In this study, heat-cured acrylic resin was used instead of self- cured acrylic in fabrication of duplication denture to protect the patient from its biological harmful effect of the residual monomer [10].

Duplication of upper denture was done to eliminate any effects that may result from changing the dimensions or morphology of complete denture except palatal rugae [11]. Speech is an acquired complex process[12]. After removable denture insertion, the oral cavities volumetric parameter alters and as a result, transitory speech distortion occurs duplicating decrease these alteration and accelerate adaptation [13].

In comparison between 2 and 4 mm freeway space, dentures without Rugae had a higher mean value of first formant frequency F1 in (s, sh) sounds than dentures with Ruge. Regarding s sound results, it may be explained as that this sound was not produced by contact between the tongue and rugae but it was formed by the formation of groove by the tongue which laterally sealed the air flow and this groove was affected by changing the thickness of the denture base [14],so denture with Rugae may add additional thickness that may decrease the cross section of the groove of the air that was formed between the tongue and palate and this cross section has direct proportional value to frequency so when this cross section decrease the first formant frequency will also decrease according to Helmholtz resonance formula which stated that the vocal tract is considered as resonance cavity and is subjected to this quation Since all rest variable are constant [15].

In this study there was no significant difference in the mean frequency after adding palatal Rugae because the small increase in the thickness of maxillary denture not large enough to make a difference in the frequency.

Both of S and SH sounds are produced in the same way except in that in SH sound the tongue groove is broader than that in S sound [15].

Regarding VOT of t sound, the higher mean value was recorded in denture without Rugae. This may be explained by that t sound is palatolingual sound and during pronounciation of this letter the tip of the tongue must be placed firmly against the teeth and the anterior part and sides of the palate for correct pronunciation of t sound [16], so that the duration of production of this sound might increase in case of polished denture without rugae since the tongue takes time to locate this land mark [17] ,however in the results of this study there was no difference in time onset duration between the presence or absence of palatal rugae dentures. This may be due to the adaptation of the patient who is used to locate the tounge in the same position either in the presence or absence of palatal rugae [18].

Regarding the comparison between dentures with and without Rugae, the 4mm freeway space was the higher in (s,sh) sounds than 2mm frequency space. During the pronounciation of s sound higher mean value of first formant frequency was observed in denture with higher freeway space, which leads to decrease the cross section between dorsum of tongue and palate. The area behind the palatal constriction means that decrease the volume or capacity of air in this area, and this agrees with Helmholtz resonance formula which is inversely related to the volume of this area , as rest of variable are constant[19]. However this difference is not significant, and this may be due to the fact that during functional modifications, an immediate speech compensation and a potential contribution of sensory information in the adaptive process may occur [20].

Each of s and sh sounds are silibiant sounds (teeth sounds). These sibiliants are high –frequency sounds produced by a stream of air directed through a minimal incisal separation [21]. So for the same reason, sh sound has no significant difference before and after changing the vertical dimension. In comparison between dentures with and without Rugae, the 2mm freeway space was the higher mean value of t sound than 4mm frequency space. The higher

mean value was recorded with 2 mm freeway space. This may be due to facilitation of tongue elevation by narrowing vertical dimension [22] which leads to decrease time to form the sound. The same value was recorded in dentures with 2 and 4 mm freeway space in case of denture with rugae.

CONCLUSION

Any change in the normal cross section or normal distance between two points in the oral cavity by a removable prosthesis will affect the properties of normal human voice, so it is not recommended to construct thick areas in the anterior region of denture even if it contains palatal rugae so that it will not affect palatolingual sounds.

REFERENCESS:

1. Seiichi N, Kiyohiro S, Yoh'ichi T. Speech, Hearing and Neural Network Models.1st ed (IOS) press North America .1995; 73-111.
2. McCord F, Firestone J, Grant A. Phonetic determinants of tooth placement in complete dentures. Quintessence Int 1994;25:341-345.
3. Gondivkar S, Patel S, Gadbail A, Gaikwad R, Chole R . Morphological study of the palatal rugae in western Indian population. J Forensic Leg Med 2011;18:310–2.
4. Petrovic A. Use of spectrographs for speech analysis in full denture wearer. J Oral Rehabil 1974;1:353-360.
5. Fry B. Acoustic Phonetics: A Course of Basic Readings.1st ed Cambridge Universal Press. Cambridge 1976;113: 467.
6. Supryia M, anil A. Simplest technique for duplicating palatal rugae the palatal rugae in the maxillary complete denture.WJD 2012; 4: 96-95.
7. Anand S, Saldanha Sh, Thilak B, Sujatha D.Duplication of Dentures: How well Dentures can be copied using different techniques. IDJSR 2015;2:4.
8. Winkler, S. Essential of complete denture prosthodontics.2nd ed. PSG.London publishing co.INC London .1988;1-9.
9. Duthie N, Lyon F, Sturrock K.C , and Yemm R. A copying technique for replacement of complete dentures. Brit Dent J 1978; 144: 248-252.
10. 10-Kelly EN. Rapid polymerization and cementation in denture construction . J Prosthet Dent 1952; 2:491-512,
11. Sweeney BM, Hastions JW. Rhythmic cell division in populations of Gonyaulax polyedra, J Protozool 1958; 5: 217.
12. Jindra P, Eber M, Pešak J. The spectral analysis of syllables in patients using dentures . Biomed Papers 2002; 146(2):91-94
13. Ichiwak AJ. Influence of alteration in the oral environment on speech production . J Oral Rehabil 1995; 22:295-299.
14. Kenneth N, Stevens S. Acoustic Phonetics.1sted MIT Press London 1998; 261-266.
15. William T. Dynamic palatography-Astudy of linguopalatal contacts during the production of selected consonant sounds. J P journal 1983;59:277-348.
16. Hansen CA. phonetic consideration of chromium alloy plates for complete dentures. J Prosthetic Dent 1975; 34:620-624.
17. Palmer, J.M.: analysis of speech in prosthetic practice J prosthet Dent 1974;31 :605-614.
18. 18-Masuda K . Pronunciation Practice Support System for Children who have Difficulty Correctly Pronouncing Words in Inter speech ISCA Dagstuhle 2014; 2144-2145.
19. Nick C, Coauthors K. Features in phonology and phonetics. 1sted. Library of Congress Ctaloging in Publication Data Berlin .2015;108-112.
20. Ozbek M, Tulunoğlu I, Ozkan S, Oktemer M. Evaluation of articulation of Turkish phonemes after removable partial denture application. Braz Dent J 2003; 14:125–131.
21. West R, Kennedy L, Carr A. The rehabilitation of speech. Rev .1st ed Harper & Brothers New York.1947; 630.
22. Mary E, Gordon B, Curtis EW. Clinical Management of Articulatory and Phonologic Disorders 3rd ed.Lippincott Williams & Wilkins. Philadelphia 2007; 44-361.