



## EVALUATION OF SPEECH AND EFFECT OF CUSTOMIZATION OF PALATAL RUGAE IN COMPLETE DENTURE REHABILITATION"

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**KEYWORDS** : Spectrographic analysis of speech, Conventional Complete denture, Customized Complete denture, Duplicated denture.

**Introduction:** Speech has always been the most significant medium for the transmission of ideas and throughout the centuries it has been one of the main forces for the human progress. Speech is a critical activity of the stomatognathic system, which utilizes the oral cavity as an instrument. A significant part of speech articulation happens inside the oral cavity and any modification of the structures in that will unfavorably influence speech proportionate to the area and magnitude of change. Inability to form the palatal contours to suit ordinary tongue contact as a rule brings about poor speech. Therefore, for the success or coming to nothing of dental rehabilitation, speech production quality is a vital criterion.

### Aim:

The aim of this study was to assess and correlate the speech pronunciation (linguopalatal sounds) of subjects with customized palatine rugae duplicated on upper complete denture and subjects with conventional upper complete denture and subjects with the natural dentition upto a duration of 4 weeks after denture insertion

### OBJECTIVES:

1. To assess and correlate the linguo-palatal sounds with complete dentures rehabilitation from the edentulousness up to a duration of 4 weeks after denture insertion.
2. To assess and correlate the speech pronunciation of customized palatine rugae duplication on upper complete denture up to a duration of 4 weeks after denture insertion.
3. To correlate the articulation of linguo-palatal sounds of customized palatine rugae duplicated on upper complete denture with conventional upper complete denture up to a duration of 4 weeks after denture insertion.
4. To correlate the speech pronunciation of completely edentulous subjects with the natural dentition subjects.

### METHODOLOGY:

The clinical study was done in the Dept. of Prosthodontics, TAMIL NADU GOVERNMENT DENTAL COLLEGE AND HOSPITAL, CHENNAI and INSTITUTE FOR SPEECH REHABILITATION AND HEARING HANDICAPPED MADRAS MEDICAL COLLEGE GOVERNMENT GENERAL HOSPITAL,CHENNAI.

Source of data 18 subjects (12 completely edentulous and 6 dentulous) were selected from the outpatients in the Dept. of Prosthodontics, TAMIL NADU GOVERNMENT DENTAL COLLEGE AND HOSPITAL, CHENNAI, including 6 male and 6 female patient for the study group and 3 male and 3 female for the control group.

Control group: 6 subjects (3 male and 3 female), with natural complete dentition with the age group of 45-60 years as considered for study group.

Study group: 12 subjects (6 male and 6 female), who were completely edentulous, further divided into two Groups: A and B.

Group A: were rehabilitated with conventional complete dentures with the palatine rugae duplicated on maxillary dentures.

Group B: were rehabilitated with duplicated complete dentures without the palatine rugae duplicated on maxillary dentures.

Duplication was done to preserve the same occlusal plane, tooth position, vertical dimension and thickness of denture base for comparison.

S.No	MATERIAL	COMMERCIAL NAME
1.	Stock trays	Jabbar & Co.,India
2.	Impression Compound Hiflex,	Provest dent, India
3.	Self cure PMMA resin DPI RR Cold cure,	Dent. products of India
4.	Dental plaster Asian chemicals, India	
5.	Greenstick compound	
6.	Zinc Oxide Eugenol DPI Impression paste,	Dent. products of India
7.	Hard Wax Cavex Set Up Hard	Cavex Holland BV.
8.	Dental Stone KALSTONE,	kalabhai, India
9.	Cold mold seal DPI Cold mold seal ,	Dent. products of India
10.	Articulator Dentatus type	ARH, Sweden
11.	Teeth set Acry Rock	Ruthinium Dental Prod. Pvt Ltd
12.	Heat cure PMMA resin DPI heat cure	Dent. products of India

### For Replication of Palatal rugae:

- Dental floss - Thermoseal waxed dental floss, ICPA Health Products Ltd, India.
- Inlay wax - Kronenwachs, BEGO, Made in Germany.

For Denture Duplication:		
S.No.	MATERIAL	COMMERCIAL NAME
1.	Teeth set Acry Rock	Ruthinium Dental Prod. Pvt Ltd
2.	Lab Putty Unisil Lab Putty	Delta products
3.	Hard wax Cavex Set Up Hard	Cavex Holland BV
4.	Heat cure PMMA resin DPI heat cure	Dent. products of India
5.	Denture Flasks and Clamps	Varsity flasks, Jabbar & Company

**For speech recording and analysis:**

- Philips SBCMD110/01 Corded Microphone - frequency range of 20Hz - 44100Hz.
- Speech recording and evaluation software - PRAAT (Version 5.1.43) - generated by School of London.

**Inclusion criteria:****Inclusion criteria for control group**

In the age range of 45-60 years Who were native speakers of Tamil Language Who were completely dentulous wearers and were completely With no neurological and no hearing Deficits With good general health condition.

**Inclusion criteria for study group**

In the age range of 45-60 years Who were native speakers of Tamil language Who were new/first complete denture edentulous from past min. 1 to 3 months. With no neurological and no hearing deficits With good general health condition.

**Exclusion criteria for both the groups:**

- Subjects below 45 years and above 60 years of age.
- Who were not the native speakers of Tamil language.
- Subjects with neurological and hearing deficits.
- Who were previous complete denture wearers.

Those who agreed to participate voluntarily, written consent was taken and ethical clearance for conducting this study was obtained from the ethical committee of TamilNadu Government Dental College and Hospital.

**Methodology:****For Control Group:**

Materials and Methodology A total of 6 subjects (3 male and 3 female), with natural complete dentition were selected based on the inclusion and exclusion criteria. Ling's test was done to assess the hearing capabilities. The speech samples for each subject were recorded.

**For Study Group:****Preparation of the subjects:**

A total of 12 subjects (6 male and 6 female), who were completely edentulous were selected based on the inclusion and exclusion criteria. Ling's test was done to assess the hearing capabilities for the selected subjects. The speech sample for each subject was recorded before the processing of complete denture.

Preliminary impressions were recorded with stock edentulous trays and impression compound, and poured with Type II dental plaster, primary casts were obtained.

Special trays were fabricated with the autopolymerizing acrylic resin and 2 mm border reduction was done.

Border molding was done using tracing compound material and final impression were made using Zinc- oxide eugenol impression paste, then poured with Type III gypsum product and master casts were obtained.

Fabrication of record bases were made on the master cast with autopolymerizing acrylic resin. Occlusal rims were made with hard wax and bite fork was attached anteriorly 3 mm above the occlusal plane to the maxillary occlusal rim. Face bow recording was done, and mounted to the Dentatus articulator after the zeroing of articulator. Vertical jaw relation was established with physiologic method before recording horizontal relation.

Horizontal relation was established with gothic arch tracing method. Extraoral tracers were attached and patient was guided for the centric and eccentric movements. Tracing was recorded and quick setting plaster was injected between the rims allowed to harden, thus the record obtained and transferred to the articulator.

Teeth arrangement was done with conventional norms and evaluated in patient mouth.

**Replication of the palatal rugae:**

After patient acceptance for the trial dentures, replication of palatal rugae was processed. Rugae was marked in the master cast with permanent marker. Rugae portion in the trial denture was cut-off and made with clear autopolymerizing acrylic resin using sprinkle on method.

Dental floss [ICPA waxed interdental floss] was cut as per the required length and luted over the rugae markings which were seen through the transparent acrylic resin in the cast using inlay casting wax. Two or more floss threads were luted together for variations in the thickness of palatal rugae 1.

The waxed up trial dentures were dewaxed and the maxillary denture base kept for the duplication of the denture. Processing was done conventionally with the heat cure acrylic resin, finished and polished.

**Duplication of the Maxillary Denture 2:**

Duplication was done to preserve the same occlusal plane, tooth position, vertical dimension and thickness of denture base for comparison.

Lab putty was adapted to the entire tissue surface of the denture and bended wire loops were inserted before the material sets. Approximately 2mm border of the denture was exposed with scalpel knife blade.

Rectangular box bigger than the denture was made with baseplate wax and was poured with the mixture of dental plaster and stone and the same mix was poured on to the putty material. Denture was inverted onto it and four keys were made before the mix was set.

Roll of baseplate wax was waxed to form sprues on the either side of the posterior region of 2nd molar. Again lab putty was adapted on the entire denture teeth and the palatal surface, and bended wire loops were inserted before the material sets. Whole assembly was boxed with baseplate wax and poured with the dental stone. After the stone sets, wax box was removed and both halves was trimmed so the sides are continuous and parallel. Two halves of the mold were separated and denture with sprues were removed. Impression of the tissue surface of the denture was in one half and the teeth imprints were in the other half, and both were in lab putty. Identical teeth were placed in the teeth imprints and denture base was placed on the impression surface, which was taken out after dewaxing of the original denture and halves were closed.

Molten hard wax was poured into one of the sprue holes until it was exuded through the second sprue hole. Wax was allowed to harden and both halves of the mold were separated, and the waxed denture was recovered.

Duplicated waxed maxillary denture was placed on the master cast and, occlusion and vertical dimension were checked from the lab remounting procedure with the original mandibular denture.

Wax tryin of the duplicated maxillary denture was evaluated in patient mouth also, minor occlusion corrections were made and denture was processed conventionally with the heat cure acrylic resin, finished and polished.

**Preparation for the speech recording:**

Tamil Articulation Test [(USHA.D (1986))] was regulated to each subject (control and study group) and recorded. 3 Linguo-palatal phonemes in Tamil [d, th, ja] were selected for this study.

The target phonemes were recognized in the medial and initial position of words like for /d/: dappa, veedu; /th/: thatha, patthtu; /ja/: jannal, manjal which are part of Tamil Articulation Test. A

standard Tamil passage was executed to both the groups and for the study group at each stages of the study. The samples with target phonemes were evaluated using Acoustic analysis by Speech Pathologists. In acoustic analysis, both the Temporal and Spectral parameters were evaluated and analyzed.

The recordings were executed at the INSTITUTE FOR SPEECH REHABILITATION AND HEARING HANDICAPPED MADRAS MEDICAL COLLEGE GOVERNMENT GENERAL HOSPITAL, CHENNAI in a soundproof room for both the control and study groups.

For the control group recordings were done only once but for study groups (Group A and B) recordings were done under the accompanying stages-

- Edentulous stage – STAGE 1
- Immediately after post insertion - STAGE 2
- 10 days after denture insertion - STAGE 3
- 4 weeks after denture insertion - STAGE 4

At each stage from stage 1 to 4, recordings were done of 6 words with 2 trials and this was administered to acoustic analysis. The recordings were taken with the distance of 10-14 cms from mouth to microphone. The speech samples were recorded by Philips SBCMD110/01 Corded Microphone into the computer with a sampling recurrence of 20 Hz - 44100 Hz and for further analysis, recordings were saved on hard disc.

To extricate the spectral and temporal parameters for both the study groups, the digital sound recordings were administered to spectrographic analysis. Likewise the control group of 6 subjects with no speech malformation were considered. Tamil articulation test was imposed comprising the target phonemes and to get the readings for the target phonemes, it was administered to spectrographic analysis.

The target phonemes were administered to acoustic analysis under two parameters:

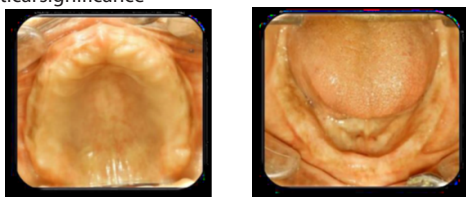
Temporal parameters (m sec) : Vowel Duration, Frication Duration, Affrication Duration, Formant frequency (F1, F2), Spectral peak energy.

Spectral parameters (Hz) : Voice Onset Time and Closure Duration.

The VOT was evaluated for the sound : /d/ in the initial position "dappa". The closure duration was evaluated for the sound : /d/ in the medial position "veedu". The duration of the fricative were evaluated for the sounds : /th/ in initial "thatha" and /th/ in medial position "pathu". The affrication duration were evaluated for the sounds : /ja/ in initial "jannaal" and /ja/ in medial "manjal". Spectral Peak energy were evaluated for the sounds : /th/ in initial "thatha" and /th/ in medial position "pathu", /ja/ in initial "jannaal" and /ja/ in medial "manjal". Vowel duration were evaluated for all the sounds and the groups.

**Method of Statistical Analysis:**

Statistical analysis was carried out using SPSS (Statistical Package for Social Science, Ver.10.0.5) package. In this study data was normally distributed and parametric test was used to compare between the groups. Comparison between the different groups was carried out using one-way Anova followed by Tukey's Post-Hoc test. In all the above test "p" value of less than 0.05 was accepted as indicating statistical significance



UPPER AND LOWER EDENTULOUS ARCH



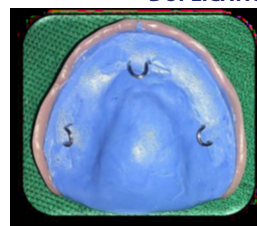
UPPER AND LOWER FINAL IMPRESSION



WAX TRY IN



DUPLICATION OF RUGAE



PUTTY INDEX SPRUE ATTACHMENT



DUPLICATED DENTURE

GROUP	S	N	Stage 1		Stage 2		Stage 3		Stage 4	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
VOT	Group A	12	39.78	6.211	68.52	10.438	65.18	9.443	70.63	10.757
	Group B	6	39.78	6.211	54.55	7.222	61.47	9.369	59.77	9.073
	Group C	6	73.20	27.248	73.20	27.248	73.20	27.248	73.20	27.248
	F value*		2.561		4.489		1.313		2.525	
	P value		0.096		0.021		0.286		0.099	
VD	Group A	12	82.08	11.898	113.07	33.327	116.21	34.899	123.10	34.578
	Group B	6	82.08	11.898	87.08	21.561	74.34	23.128	79.36	16.693
	Group C	6	116.03	53.586	116.03	53.586	116.03	53.586	116.03	53.586
	F value*		4.275		2.247		5.031		5.933	
	P value		0.024		0.125		0.014		0.010	
F1	Group A	12	595.38	59.299	607.25	65.414	618.45	54.847	631.05	51.295
	Group B	6	595.38	59.299	575.34	57.430	583.28	52.397	576.74	43.811
	Group C	6	606.58	69.866	606.58	69.866	606.58	69.866	606.58	69.866
	F value*		0.080		0.906		1.166		6.053	
	P value		0.923		0.416		0.327		0.007	
F2	Group A	12	1534.03	68.371	1556.39	71.308	1561.03	60.784	1558.25	60.472
	Group B	6	1534.03	68.371	1556.39	61.595	1558.59	54.377	1638.56	52.012
	Group C	6	1589.13	88.055	1589.13	88.055	1589.13	88.055	1589.13	88.055
	F value*		1.589		0.591		0.502		4.855	
	P value		0.267		0.561		0.611		0.016	

Table shows the descriptive statistics of the variables for the sound /d/ at initial position (dappa) with mean and standard deviation and the comparison between the groups shows the significant

difference among them at various stages.

VOT shows no statistical significance at stage 1, 3 and 4, only at stage 2 with the Mean of A=68.52, B=54.55, C=73.02, where Group B had a statistically significant decrease when compared to Control group with p value of 0.037.

VD at stage 1, the Group A and B shows statistically significant decrease compared to Control group with the Mean of A & B=82.08, C=116.03 with p value 0.033. At stage 3 and 4, Group B shows statistically significant decrease compared to Group A with the Mean of A=116.2, B=74.34 at stage 3, and p value of 0.019, and at stage 4, A=123.10, B=79.36 with the p value of 0.010.

F1 at stage 4, Group B shows statistically significant decrease compared to Group A with the Mean, A=651.05, B=576.74 and p value of 0.005.

F2 at stage 4, Group A shows statistically significant decrease with Group B with the Mean, A= 1558.25, B=1638.5 and p value of 0.012.

similarly, The VOT was evaluated for the sound : /d/ in the initial position "dappa". The closure duration was evaluated for the sound : /d/ in the medial position "veedu". The duration of the fricative were evaluated for the sounds: /th/ in initial "thatha" and /th/ in medial position "pathu". The affrication duration were evaluated for the sounds: /ja/ in initial "janna" and /ja/ in medial "manja". Spectral Peak energy were evaluated for the sounds: /th/ in initial "thatha" and /th/ in medial position "pathu", /ja/ in initial "janna" and /ja/ in medial "manja". Vowel duration were evaluated for all the sounds and the groups and Compared among the GROUP A, B & C for different parameters at various stages for the sounds by Descriptive analysis and One-way Anova test.

### Results:

All recordings were evaluated and comparison was done using one-way Anova followed by Tukey's post hoc test. At stage 1, subjects without the dentures shows statistically significant decrease in almost all the spectral and temporal parameters as compared to control group. At stage 2, Immediately after denture insertion mostly all the parameters shows improvement from stage 1, specially with the group A as compared to group B but compared to group C both A & B shows statistically significant decrease. At stage 3, denture with replicated palatal rugae shows less adaptation duration to the new dentures as compared to the conventional dentures. At stage 4, few parameters of group B still shows significance with the group A and C, like spectral peak energy, frication and affrication duration.

### Discussion:

The entire speech generation mechanism comprises of basically three functions which are displayed through the diagram 3.

Motor Control----->Articulatory Motion ----->Sound Generation

### MOTOR CONTROL FUNCTION:

The entire process is named as control function and it is further partitioned into two sections, the motor commands generation and the language processing 4.

The auditory (Broca's area) gets input in the kind of visual gestures and listening 5.

### ARTICULATORY MOTION:

The air goes through the vocal chords by means of the way from the lungs via vocal tract, vibrating them at diverse frequencies 6.

The Vocal tract: The air sections over the larynx are well known as the vocal tract.

The Pharynx: It is conventionally partitioned into three sections: the

nasopharynx, the oropharynx and the laryngopharynx.

The Glottis: Its essential function is to cover the entrance to the larynx  
The Velum: Its primary function is to isolate the nasal cavity from the oral cavity  
The Tongue: The tongue is the most movable articulator and can take up nearly limitless number of positions, both laterally and vertically. The tongue is the fundamental organ in the creation of vowel sounds.

The Teeth and Lips: The teeth, especially the different anatomy of upper teeth are imperative for the production of numerous consonants.

Larynx: Sound is produced in the larynx, and that is the organ where volume and pitch are manipulated.

### PHONEMES:

Any language spoken on the planet have 20 to 60 phonemes 7,8.  
Phonetics of any language comprises broadly two sorts of phonemes, the Vowels and the Consonants.

### Vowels:

Speech sounds generated by voiced stimulation of the open vocal tract are known as vowels. These are voiced sounds.

Vowel Duration: It can be categorized as overlong, long and short.

Formants: Among the sound of human voice, formants are especially critical in light of the fact that they are fundamental components in the coherence of speech.

Consonants Speech sound that is articulated with fractional or complete closure of the vocal tract.

### Linguo-Palatal Sounds:

Group of sounds wherein the tongue is the active articulator and the palate being static  
Articulators Voice onset time -VOT gives data with respect to duration between articulatory release of stop and the onset of vocal fold vibration.

Closure duration- closure duration is the time distinction among the onset of the closure of articulator and the articulatory discharge.

Frication duration - The turbulent airflow is called Frication which is generated by forcing air via a constricted channel  
Formant frequencies- Formant frequencies relies on the place of articulation of tongue with the palate. As the place moves forwards, frequency shows increases. F1 formant frequency associated to superior-inferior placement of tongue, F1 differs inversely with the height of tongue. F2 formant frequency for the vowels associated to tongue advancement, it increases as tongue moves forwards. The formant frequencies were evaluated for all the sounds.

As A.J. Hassel et al stated that speech problems are commonly noticed after complete denture insertion fundamentally communicated as issues with consonants, particularly linguo palatal sounds 47. Therefore, in the present study, linguo palatal sounds were evaluated.

For the control group recordings were done only once but for study groups ( Group A and B ) recordings were done under the accompanying stages-Edentulous stage - STAGE 1, Immediately after post insertion - STAGE 2, 10 days after denture insertion - STAGE 3, 4 weeks after denture insertion - STAGE 4 At each stage from stage 1 to 4, recordings were done of 6 words with 2 trials and this was administered to acoustic analysis.

### Conclusion:

It is suggested to duplicate the palatal rugae in complete denture in light of the fact that the articulation of linguo palatal sounds of complete denture with rugae replication was better than the

conventional complete denture without rugae replication.

#### REFERENCES:

1. V.Vijayaraghavan, P.Chandni. A Simple Method for Palatal Rugae Carving in Complete Dentures. *J Indian Prosthodont Soc* (Apr-June 2013) 13(2):137-138.
2. Izharul Haque Ansari. Duplicating an existing complete denture to make a replica. *The Journal of Prosthetic Dentistry*. Vol 72, no.4. October 1994.
3. Masaki Honda, "Human Speech Production Mechanism", selected papers, NTT technical review, vol.1, No.2, May 2003.
4. Edmund Blair Bolles, "Speech Circuitry", a blog on origins of speech posted at <http://www.babelsdawn.com>, Jul 2009.
5. Mc Caffrey, Patrick, CMSD 620 Neuroanatomy of speech, Swallowing and language (Neuroscience on the web, California State university, Chico, Feb 2009).
6. Fitch, W. T., "The evolution of speech: a comparative review", *Trends in Cognitive Science* 4, pp. 258-267, 2000.
7. O'Saughnessy D., *Speech Communication - Human and Machine* (Addison- Wesley, 1987).
8. Breen A., Bowers E., Welsh W., "An Investigation into the Generation of Mouth Shapes for a Talking Head", *Proceedings of ICSLP* 96 (4), 1996.