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Review Article

Speech in phonetics: A review

Kunal K Kohle^{1,*}, Deepak Vikhe¹, Vijaysingh Tanpure², Sanyukta Ingale³

¹Dept. of Prosthodontics, Rural Dental College, Loni, Maharashtra, India

²Dept. of Orthodontics, Rural Dental College, Loni, Maharashtra, India

³MGM Dental College, Navi Mumbai, Maharashtra, India



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ABSTRACT

The proper knowledge of speech production and phonetic parameters will enable the clinician in fabrication of dentures with good phonetic capabilities. In achieving the optimum phonetic potential by providing correlation among three key objectives i.e. (mechanics, aesthetics and phonetics) of dentistry is the eventual goal of every dentist. This article provides a correlation between occlusion and speech, since the time these two factors are mostly not considered related to each other. But during phonation, the lower teeth function independently and there remains no contact with upper teeth. This article also highlights the basic utilization of phonation as an indispensable part in placement of upper anterior teeth in complete and partial denture rehabilitation. This is basically because, while restoring natural teeth, we may have to depend on pre-extraction records in order to achieve necessary objectives. And if these records are missing, it is difficult to determine the position of artificial teeth. Hence here, we use phonetics as a guideline for proper placement of artificial teeth.

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1. Introduction

Phonetics is the science of sounds used in speech.¹ Speech articulation is defined as the movement and placement during speech of the organs that serve to interrupt or modify the voice or unvoiced air stream into meaningful sounds.²

Speech in a matured person is a learned habitual neuromuscular pattern.³ This review presents the articles and studies under the following headings.

1. Physiology and analysis of speech.
2. Speech as used for designing of dentures.
3. Studies to evaluate the standards for the construction of dentures.

2. Review of Literature

2.1. Physiology and analysis of speech

Martone AL and Black JW (1962)³ have considered some speech science research that has prosthodontics import. They have determined the rate of movement of the various articulatory structures and concluded that the tip of the tongue is the fastest articulator followed by the jaw, back of the tongue, lips and the velum. They have discussed the sensitivity of the speech mechanism to pressure and concluded that the pressure of the tongue against the posterior portion of the palate is considerably higher than the anterior portion.

Bond EK, Lawson WA.(1968)² have discussed the different aspects of speech, like its components (voice, language, articulation and rhythm), its development and the causes and types of speech defects. They have described

* Corresponding author.

E-mail address: dr.ortho.aj@gmail.com (K. K. Kohle).

the speech sounds and also the effects on speech caused by changes in the vocal tract like that caused by placement of dentures or orthodontic appliances. They have described that the changes within the oral cavity may affect the speech that can be produced. Infact, be responsible for the development of certain speech defects.

Kestenberg JM.(1983)⁴ has divided the types of speech samples that can be used for assessment in dentistry into spontaneous samples, imitative samples, samples by reading and deep samples. The author stresses that, what is needed is a prepared speech articulation test which tests all the consonants and vowel phonemes. It should be quick, easy to administer and require little or no equipment. The author has proposed a speech articulation test consisting of a set of twelve questions.

2.2. Speech as used for designing of dentures

Pound E. (1951)⁵ presented a method of treating the problem of phonetics based on the opinion that phonetics is controlled 100 percent by esthetics. Esthetics is not only placing the teeth in their correct positions but also reproducing the supporting structures to the correct form of the interdental papillae. He states that the “Dentures with a new look – that speak – by themselves” can be achieved by accurately reproducing the esthetic principles in nature. This he achieved by considering three phases.

1. Natural setting of teeth.
2. Development of an entirely new concept of denture form.
3. Reproduction of natural colors of living tissues.

Silverman MM.(1952)⁶ the author has discussed the speaking method of determining the vertical dimension as the scientific, accurate and practical method without the need for expensive equipment or instruments. He calls this method a physiologic method substantiated by the “all or none” law of muscle physiology. He has briefly discussed the disadvantages of increased vertical dimension and also cited the clinical situations that are exceptions to the general rule that vertical dimension must not be increased.

Martone AL.(1963)⁷ has discussed the clinical applications of speech science to the registration of maxillomandibular relations. He has suggested that certain speech sounds like ‘m’ may serve as an aid in recording the physiologic rest position. The patient is instructed to say a series of ‘m’ sounds until he experiences fatigue and at this time a measurement can be made. The patient should be asked to count rapidly from 45 to 70. Special attention should be given to the ‘s’ sounds. He suggests that the occlusion rims should be reduced in height until there is a slight clearance when the ‘s’ sounds are produced to obtain an optimum vertical dimension.

Silverman MM. (1967)⁸ discusses the common abnormal sounds in denture patients such as the whistle

and swishing sounds, the cause of these sounds and the alterations in the dentures that are done to prevent these sounds. The author also discusses the palatal changes that are done to correct phonetics.

Lawson WA and Bond EK. (1968)⁹ have discussed in detail the relationship between certain intra oral structures and speech with particular reference to their articulation. They say that certain factors of the dentures that affect the production of a lateral seal, produced by the sides of the dorsum of the tongue making contact with the upper posterior teeth or alveolar ridges, factors affecting the resting position of the tongue, factors affecting the level of the occlusal plane, the buccolingual positioning of teeth and the vertical dimension, all affect the speech production.

Lawson WA and Bond EK (1969)¹⁰ have described how the dentures and the changes in their designs affect speech and how the patients may attempt to compensate for these changes. The authors have grouped the changes in design of dentures and discussed in detail each of these changes as they affect speech production.

Pound E et al (1971)¹¹ have introduced the branching concept for construction of dentures. They propose that incisal guidance be restored first. The six upper anterior teeth are set up first to fulfill esthetic and phonetic requirements. The four lower teeth are set up in normal ‘s’ relation to upper teeth. The patient is then asked to comfortably retrude the mandible and close until the four lower anterior teeth contact the upper teeth or properly contoured wax of the denture base. This method is used to establish the correct vertical dimension and centric occlusion.

Murrell GA.(1974)¹² has reviewed the positioning of anterior teeth for esthetics and phonetics. The production of the ‘f’ sound is used to determine the positions of the upper anteriors. The procedure of using speaking wax placed on stabilized lower base as used for the diagnosis of anterior occlusion is explained. Using the established anterior stop, a procedure is described to record the occlusal vertical relation and centric relation. The article also provides a brief review of the atypical ‘s’ sounds produced under classes I, II and III of occlusion. Methods to overcome these obstacles in recording the occlusal vertical and centric relations.

Goyal BK and Greenstein P. (1982)¹³ have described a method to functionally contour the palatal vault to improve speech with complete dentures. The procedure can be carried out either at the try in stage or during insertion of dentures. The palatal vault is roughened and painted with impression wax. The denture is inserted and the patient is asked to produce the various sounds. The contact patterns of the tongue are registered in the impression wax. The denture is then processed to incorporate these patterns into the final denture.

McCord JF, Firestone HJ and Grant AA (1994)¹⁴ have highlighted the use of phonetics as a guide to designing the

complete dentures. They have discussed the positioning of anterior teeth, the determination of vertical dimension, the level of the occlusal plane and the designing of the palatal vault as factors that can be determined using phonetics.

2.3. Studies to evaluate the standards for the construction of dentures

Martone AL, Black JW. (1962)³ conducted a study to measure quantitatively, by electronic means, under predetermined vertical dimensions of occlusion, the palatal pressures of the tongue in the pronunciation of select palatolingual speech sounds and that during the act of swallowing. Spectrographs were used to detect changes in phonetic values in which the vertical dimension of occlusion was altered. A palatogram was constructed for a old maxillary single denture wearer to determine the regions of strain gauge placement. Test maxillary dentures were made one with increased vertical dimension and one with decreased vertical dimension. The results obtained from the experimental dentures were compared with that obtained from the denture that the patient had worn successfully for one year. The study concluded that in speech and in swallowing, the compensatory tongue changes resulted not only in changes of the magnitude of palatal pressures, but also in the time interval in which those pressures were applied. Optimum pressures were obtained with the correct vertical dimension of occlusion.

Sherman H (1970)¹⁵ conducted a study using dynamic palatography to

1. Investigate areas of the palate contacted by the tongue during speech.
2. To record evidence of lingual laterality.
3. To observe if a characteristic pattern linguopalatal temporal sequencing exists.

The speech material selected included the consonants /t /, /d /, /l /, /n /, /s/ and /k/ as control. The apparatus used for the study consisted of artificial resin palates of uniform thickness (1.9 mm), which had twelve electrodes, embedded into the lingual surface. It recorded the areas contacted by the tongue during speech.

The results of the study showed that the lateral aspects of the palate plus the incisive papilla are the areas most commonly frequented by the tongue. The tongue appears to function in a bilaterally symmetrical manner during speech and the dynamic manner in which the tongue contacts and releases from the palate depends on whether an "initial" or "final" consonant is being articulated.

Tanaka H (1973)¹⁶ studied the changes in speech patterns of patients with new complete dentures before and at various times after insertion of the new dentures and any relationship between speech production and the palatal contour of the denture. After comparing the casts

of dentulous and denture wearing patients, he concluded that the greatest difference between the two conditions was in the region immediately adjacent to the teeth. It was convex in the dentulous condition whereas concave in the dentures. The height of teeth was also more in the dentulous condition. The conclusions drawn from the study were

1. Most of the patients showed speech improvement when the dentures were first inserted.
2. With increased length of time of wearing the new dentures, the speech intelligibility was improved.
3. The speech of patients can be improved by experience with their new dentures
4. Individual sounds showed different levels of speech intelligibility, and this level improves with the length of denture usage.
5. Acoustic distortions occurred more frequently in the s, sh, ch, zh, and j sounds than in z, t, n, d and l sounds.
6. The 's' sound is a poor prognostic sound for intelligibility of speech
7. The palatal ridge formation (palatal contour) of complete dentures will affect the acoustic distortion of affricate and fricative sounds.

Petrovic A.(1985)¹⁷ conducted a study on a group of edentulous patients who had been wearing dentures. Three speech sample recordings were taken-

1. With the set of complete dentures which had been worn for a period of time long enough to permit the adaptation of the denture wearer.
2. Without the dentures.
3. With dentures of different morphology.

The three dimensional spectrograms were drawn from the set of data obtained from analysis of the voice signal on the digital computer.

The author concluded that

1. There is persistent correlation between denture morphology and speech quality.
2. Small alterations in the position and relationship of the incisors had a strong influence on speech.
3. Speech distortion alters with the thickness of the denture palatal plate and increases rapidly after 1mm thickness.
4. The alterations of the relative time duration of sounds in the test word (ivica) were small and alterations were inside the standard deviation of measurement.
5. Patient's adaptation to the new set of dentures was completed during the first 30 days after denture insertion.

Ichikawa, Komoda J, Horiuchi M, Matsumoto N.(1995)¹⁸ used two experimental manipulations,

1. Palatal augmentation – provided by 1 mm thick acrylic artificial palate with the posterior tooth position palatally greater than original dentition by 4mm; and
2. Increased vertical dimension – provided by an acrylic bite block that increased vertical dimension of occlusion by 8 mm at incisor position, as the alterations in the oral environment, in subjects with natural dentition.

Analysis focused on the consonant and vowel /si /, /ki / and /ci / which were reported to be disturbed syllables for denture wearers. Speech signal processing was carried out with the **MITSYN-** a digital acoustic analyzing system. The parameters that were measured and compared were the voice onset time, consonant duration and aspiration time.

The authors concluded that the voice onset time for /ki / and /ci / was influenced more by the palatal augmentation than the aspiration time.

Consonant duration for /s / was also influenced by palatal augmentation.

Significant influence of increasing vertical dimension on the timing was not observed. The authors observed that speech disorders caused by prosthesis seem to be singly related to orosensory feedback.

Alexander J Hassel and Dr. Thomas Holste (2006)¹⁹ in their pilot study suggested that sand blasting can improve speech function in maxillary complete denture wearer patients.

3. Discussion

Speech is a very sophisticated autonomous and unconscious activity. Speech in matured man is a learned habitual neuromuscular pattern, which makes use of anatomical structures, designed primarily for respiration and deglutition. Because oro-dental morphological features also may influence an individual speech, the dentist should therefore recognize the possible role of prosthetic treatment on speech activity.

The loss of teeth and supporting structures alters the main articulatory cavity and produces a marked effect on the speech pattern proportionate to the location and magnitude of alterations. An empiric approach to the phonetic factor in denture construction frequently places the burden for compensating for speech changes for the adaptability of the tongue. Additionally significant is the fact that the speech mechanism is highly susceptible to degenerative diseases. If dentures are to contribute effectively to the functions of speech, dentists should utilize studies in the speech science field to augment their clinical knowledge of the phonetic factor in denture construction.

Therefore in this study we are selecting specially edentulous patients who are wearing dentures for at least last one year, so that they are habituated to denture use. We are attempting to improve speech function in these patients by

sand blasting in pre maxillary area because this area give proprioceptive response for sound production.

Pre- extraction records²⁰ when available are one of the easiest ways for the selection and positioning of teeth. In the absence of these records, incisive papilla^{21,22} the nasal width²³ and anthropometric measurements²⁴ have been used as determinants of selection and positioning of the maxillary anterior teeth in the construction of complete dentures. There have also been suggestions for the use of swallow and relax method,²⁵ cephalometric method,²⁶ measurement of electrical activity of muscles²⁷ as techniques for determination of vertical dimension of rest and occlusion. Further, many authors have found phonetic method for determining the vertical dimension and the positioning of anterior teeth^{28,29} as one of the reproducible and reliable methods.

It appears that adaptation to complete dentures may be explained by feedback mechanical related to speech motor programming. Initially, a complete denture wearer attempts to overcome problems related to the new prosthesis by the helps of auditory and oro-sensory feedback during function. After a while, only the patient will be aware of remaining articulating difficulties, which often are related to certain specific sounds. The listener (dentist) is, however, not able to detect any speech production disturbances. At this stage, there are still sensory stimulations from orofacial afferents to central areas. Finally, if the process of adaptation proceeds, the patient will not be aware of any articulatory difficulties or distortional sounds due to the prosthesis.

New speech production central engrams have been established, and adaptation and / or habituation to the complete dentures occur.

4. Articulation

Amplified, resonated sound is formulated into meaningful speech by the articulators, namely, the lips, tongue, cheek, teeth and palate, by changing the relative spatial relationship of these structures. The tongue is considered to be the single most important articulator of speech because of its ability to affect rapid changes in movement and shape. The tongue may impede, selectively restrict, and channel the air stream with precise contact against the teeth and palatal areas, thus articulating the basic laryngeal sound, or the non-phonated air stream, into recognizable speech. If oral structures such as the tongue, adjacent soft tissues, jaws or lips, are altered surgically and / or neurologically, articulation may be compromised.

The production of consonants involve six valves below:-

1. Bilabial
2. Labiodental
3. Linguodental
4. Lingeoalveolar

5. Linguopalatal
6. Linguoalveolar
7. Out of the above six valves five valves are affected by teeth position:-Here we are more concerned about valves related to lingual and palatal position and their contact while sound production
8. Alveolar sounds (eg. t, d, s, z, v & l) are made with the valve formed by contact of the tip of the tongue with the most anterior part of the palate (the pre maxillary area) or the palatal sides of the anterior teeth (as shown in Fig. 9). The sibilants (sharp sounds) s, z, sh, ch & j (with ch & j being affricatives) are alveolar sounds, because the tongue and alveolus forms the controlling valve. The important observations when these sounds are produced are the relationship of the anterior teeth to each other. The upper and lower incisors should approach end to end but not touch. A phrase such as “I went to church to see the judge” will cause the patient to use these critical sounds, and the relative position of the incisal edges will provide a check on the total length of the upper and lower anterior teeth (including their vertical overlap).
9. A failure of the incisal edge to approach exactly end to end indicates a possible error in the anterior of horizontal overlap of the anterior teeth. In pronouncing the word “t”, “d” and “th” the tip of the tongue is in contact of the pre maxillary area. If it is to make more close to nature like duplication of rugae. The sand blasting in this area it is for better change in the pronunciation of these sounds.

In this study speech therapist reported that the word “t” at initial, middle and final position shows intermediate better improvement after sand blasting. The word “d” at initial and middle position shows intermediate better improvement after sand blasting while “d” at final position shows low better improvement after sand blasting. The word “th” at initial and final position shows intermediate better improvement after sand blasting while “th” at middle position shows low better improvement after sand blasting. Overall we can conclude that after sand blasting there is intermediate better improvement in pronouncing the sounds.

For some patients speech samples after sand blasting gave negative scoring which shows that speech quality decreases after sand blasting. 82.35% patients shows better improvement in their speech samples after sand blasting. 16.07% patients shows no difference in their speech samples after sand blasting, while 1.56% patients shows worst improvement in their speech samples after sand blasting. From these results we can conclude that there is definite better improvement in larger percentage in speech samples after sand blasting that means sand blasting in pre maxillary area of prosthesis can really improve the speech quality. But 16% patients also shows no improvement and 1.5% patients shows worst improvement after sand blasting. This can suggest for correction for procedure by repeating

speech recordings and if it doesn't work then polishing the sand blasted area. There have been attempts in the past to describe the factors influencing speech function, and efforts have been made to improve the speech function of maxillary complete dentures. The anterior and molar reverse curves of the resin body,³⁰ a thin palatal resin^{31,32} the correct vertical dimension,³²⁻³⁴ and frontal overbite are thought to be important factor for the speech function and correct pronunciation of sound. Attempts to rebuilt rugae palatinae are controversial.^{5,35}

Alexander J Hassel, Dr. Thomas Holste (2006) in their article suggested that sand blasting can improve speech function in maxillary complete denture wearer patients.

5. Conclusion

“We can conclude that sand blasting in pre maxillary area can improve the speech function in complete denture wearer patients.”

6. Future perspective

1. There is a need for further studies with a larger sample size to investigate the effect of alterations in dentures on other parameters.
2. There is a necessity to evaluate the effects of a longer duration of adaptation on all parameters.
3. There is a need for further studies to evaluate the effects of degree of sand blasting.
4. There is a need for further studies to evaluate the area of degree of sand blasting.

7. Conflict of Interest

The authors declare that there are no conflicts of interest in this paper.

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None.

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Author biography

Kunal K Kohle, Senior Lecturer

Deepak Vikhe, Reader

Vijaysingh Tanpure, Senior Lecturer

Sanyukta Ingale, Post Graduate Student

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