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SPEECH PATTERN CHANGES DURING EDENTULOUS AND DENTURE CONDITIONS

I. PALATOGRAPHIC STUDY

by

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INTRODUCTION

The phonetic changes that occur in patients with complete dentures have shown that the patient sometimes adapts his speech pattern to the new appliance (*Allen*, 1958). Presently, there is discussion about the degree and type of speech adaptation, whether the adaptation, is associated with particular speech sounds.

One of the paramount decisions for the prosthodontist concerning the prosthetic treatment is the size and shape of the — denture and its relationship to an acceptable speech pattern. The relationship between the vertical dimension at denture construction and speech sounds have been discussed (*Silverman*, 1956). He verified by palatographic measures this relationship. Also, studies by phoneticians (*Fant*, 1959; *Jassem*, 1962) have established the relationship between oral cavity, size and shape as related to the various speech sounds. The vocal mechanism is, however, a highly adaptable structure. Speech patterns are undergoing change as a function of age, milieu, education. The degree of changes are dependent upon individual differences based on psychological and physiological features of the speech mechanism.

Hopkin and *McEwen* (1955) studied speech defects in patients with extreme malocclusion conditions by palatographic recordings. *Ylppö* and

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Sovijärvi (1962) report that formant regions are lowered when dentures are not present during speech production and rise when dentures are inserted. They reported also that maxillary dentures facilitate the (*s*) and the (*r*) sound whereas (*t*) is enhanced by the mandibular dentures.

When a denture is inserted in the oral cavity the speech characteristics are noted to be different from the edentulous speech pattern. The purpose of this study was to test these speech changes that occur during the process of going from edentulous to denture conditions. Palatographic measures were obtained at periodic intervals from edentulous to denture conditions.

MATERIAL AND METHODS

Five male patients and four female patients served as subjects in this study. Their ages ranged from 40 to 68 years. All of these patients were completely edentulous for a minimum of six months. All subjects live in the Buffalo, New York State area since 25 years. However, subjects displayed a variety of regional social dialects not generally associated with Western New York speech. The experimental design was so constructed that a given subject's speech was only compared against his own speech pattern. Thus the individual speaker variation was not a factor in this study.

The patients, who never had worn denture before received complete upper and lower denture treatment. The intermaxillary relations were normal so the setting of the denture teeth could be done in an equivalent order.

Palatographic recordings. The subject pronounced the four sequence of syllables [*s(o)*, *t(o)* *th(e)* *sh(e)*] on four different occasions. The four recordings were obtained in the following sequence:

1. One week before insertion of the dentures.
2. The day of the insertion of the dentures.
3. Two weeks after the insertion of the dentures.
4. Twelve weeks after the insertion of the dentures.

A palatography method of measurement was devised which assesses the predominant tongue-palate contact during speech.

Palatographic recordings have been used in order to describe the position and size of the contact surface between the tongue and the palatal area. By changing the shape and volume of the oral cavity it is possible to alter the quality of phonemes (*Allen*, 1958). This is especially true in the denture patient, where almost a completely new oral cavity is constructed. The palatographic medium used in previous studies has consisted of different

types of powder (talcum, chalk, and charcoal). When the tongue is in contact with the palate the powder is removed and the contact area is noted. If the tongue is making contact with the palate during non-speech this will influence the palatogram and yield an erroneous measure believed to be associated with speech. In speech production the tongue has a predominate contact area during the utterance of certain phonemes. This contact area is a composite of the formation stage of muscle groups and functional stage of articulatory movements. The powder technique is questioned as a valid measure of tongue-palate contact when studying the behavior of the articulators.

By using a 2 mm. layer of recording material of viscous type, Coe-Comfort, it was possible to obtain a permanent record of the »functional contact area». This tissueconditioner material was found to be usable for this study. The material was mixed thinner than recommended by the manufacturer. The palatal surface of the upper appliance was covered by approximately 2 mm. layer of this material. In the edentulous condition (I), a special thin acrylic plate covering the whole denture palate area was used as a base for the material; in stages II, III, and IV, the upper denture was used as the base for the material that yielded the palatograms.

The patient pronounced each of the four syllables [*sh(e)*, *th(e)*, *t(o)* *s(o)*] 20 times. Because of the viscosity of the recording material, it was found that twenty repetitions yielded an average impression of the contact surface associated with a given syllable. After the impression was obtained, the acrylic appliance or the denture was removed from the mouth.

Photographic recording. The palatogram contours and a scale indicator were then photographed with a Land Camera M43 connected to a light table. The camera equipment consisted of a Rodonstock-Ysaron lens 1:4.9, *f*=127 mm. The film used was Ektacolor »L» (4"×5" Eastman-Kodak). The film was then transferred to a colorprint.

Measuring the contact area. The location and area of the tongue to alveolar contact surface was determined by measuring the area with a planimeter (OTT-planimeter, Type 31). Repeated measures from the photographs of the palatograms were obtained from eight randomly selected cases at different points of time. By recording the palatogram and measuring the area twice, it was possible to calculate the error of the methods. The error was estimated according to the formula $\sqrt{\frac{\sum d^2}{2n}}$, where *d* is the difference in area between the two repeated measures and *n* is the number of differences. The error from the repeated measures obtained from the palatogram was calculated to be 55.2 mm² and the error of the planimeter measurements was calculated to be 6.9 mm².

The palatal height (the vault) differs from one subject to another, and this could influence the palatogram area measured on the two-dimensional photographs. A calculated factor was obtained for each subject as an indicator of the palatal height. The palatal height was measured on a plaster cast as a vertical difference from three defined points in the median line to corresponding predefined points on the alveolar ridge. From the three measured distances a mean value was calculated as a correction factor for each subjects palatographic measure.

The palatogram areas reported in this study are recalculated according to the correction factor for palatal height. In this way the standard two-dimensional palatogram was now reflexed by a third dimension which yielded a value of the palatal-contact area associated with a three dimensional plane.

RESULTS

The four words studied showed a different characteristic pattern. It was also possible to note the differences between the consonants from observing, form and position of the contact surface. Without dentures the palatographic pattern of the s-sound showed the medial side of the ridge from the vibrating line to the cuspid and lateral incisive region as being the predominate contact region. When the denture was inserted the contact surface increased in area and also showed the utilization of the denture teeth as contact surface (Fig. 1). The sh-sounds indicated a similar pattern as the s-sounds but a shorter and broader shape of the contact area. The anterior border of the contact surface stops at the first or second premolar region in the edentulous condition and can, after increasing habit of the denture, involve the cuspid area (Fig. 2). For t- and th-sound production, the tongue constriction was at a more palatal-lingual region of the maxillary alveolar ridge, not only on the molar and premolar region but also in the anterior region.

A significant increase contact area could be observed between the edentulous and the denture condition. Most tongue to palate contact was facilitated by the dentures. During the adaptation period (Recording II—IV): an increased contact area could also be observed (Table I).

DISCUSSION

The purpose of the palatographic method was to assess the tongue palate contact surface in edentulous and denture conditions during the utterance of the sounds in *sh(e)*, *s(o)*, *t(o)*, *th(e)*. The palatograms showed some

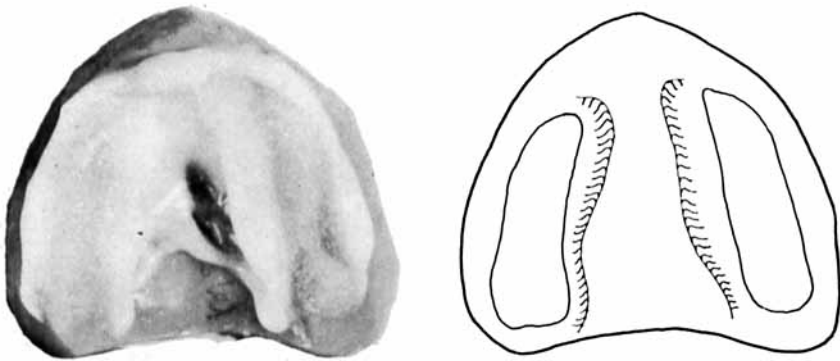


Fig. 1 A

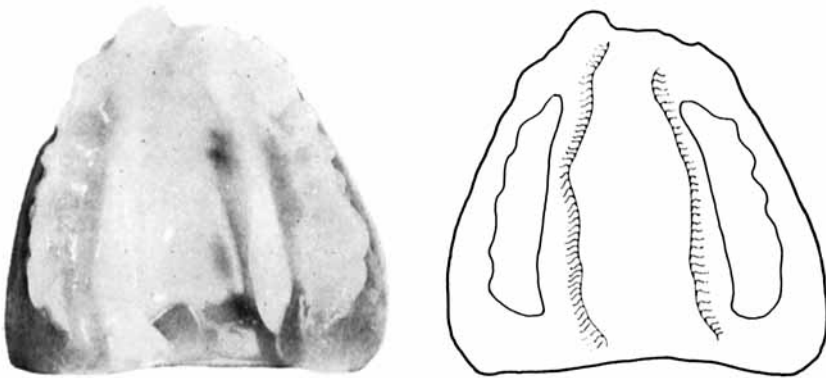


Fig. 1 B

Fig. 1. Palatograms and drawings showing the tongue-palate contact area of S-sound (continuous line). The shade-lines in the drawing indicate the functional impression of the tongue medially of the contact area.

- A. before the insertion of the denture, acrylic plate.
- B. 3 months after insertion of the denture.

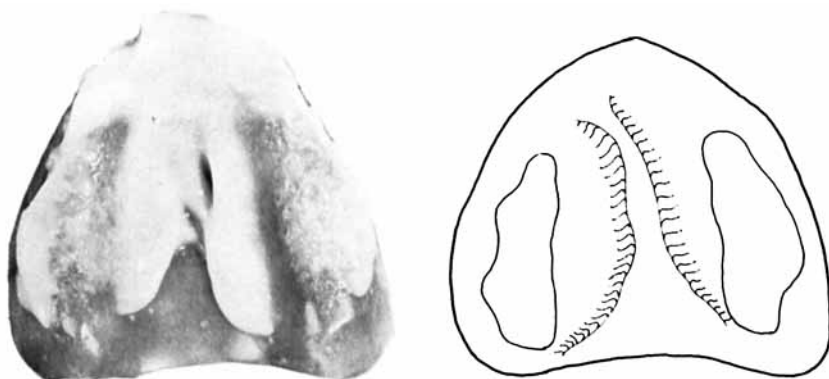


Fig. 2 A

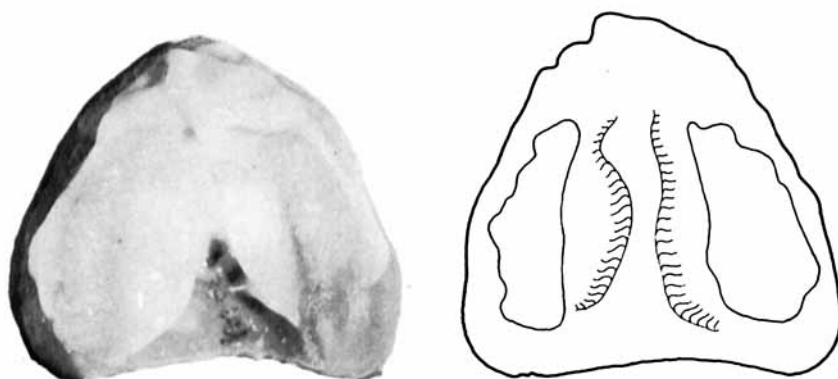


Fig. 2 B

Fig. 2. Palatograms and drawings showing the tongue-palate contact area of Sh-sound (continuous line). The shade-lines in the drawing indicate the functional impression of the tongue medially of the contact area.

- A. before the insertion of the denture, acrylic plate.
- B. 3 months after insertion of the denture.

Table I

Mean values of the contact areas measured (vernier units) in the palatograms

Recording	Sound			
	S	Sh	T	Th
1	164.5	172.4	155.7	127.6
2	215.9	234.2	225.4	214.4
3	247.0	215.4	260.6	232.2
4	251.4	278.1	287.0	256.7

characteristic pattern for each syllable studied. The increasing contact area between edentulous and denture condition described in the results can be clarified by the reduced volume of the oral cavity, whereby the tongue makes earlier contact with the palatal area.

An increase of the contact area during the adaptation period (Recording II—IV) was observed. It seems that this increase may depend on an adaptation of the tongue to the new palatal surface during articulation.

The borders of the contact surface was more well defined and sharp at the end of three months for certain cases. The position of the contact surface was more anterior after wearing the denture for three months. The place of articulation was predominately in a posterior position in the edentulous condition and progressed toward the anterior palate in the denture condition. This corresponds with earlier experience that edentulous patients tried to compensate their lack of teeth by using the posterior part of the oral cavity for the articulation or point of constriction.

However, these findings of adaption are not to transfer directly to improvement of speech. A psychometric study using the same spoken words and the same subjects was performed (*Agnello & Wictorin*, 1970). When a comparison was done between the psychometric data and the palatographic data there was a correlation for certain sounds [*sh(e)* and *t(o)*]. That is, the palatographic observations was followed by a speech improvement as judged by trained phoneticians. However, this relationship could not be found concerning the sounds *s(o)* and *th(e)*. These contradictory results may depend on the quality or perceptibility of certain sounds which cannot be inferred by palatographic measures. *Hopkin and McEwen* (1955) have found similar discrepancies between speech disorders and malocclusion when using palatography as a criteria measure. It is therefore questionable

if palatography alone can give the information needed to assess speech improvement. Any anatomical or physiological data must be in conjunction with a speech evaluation method where the sounds can be analyzed from the stand point of intelligibility and/or comprehension.

SUMMARY

The speech changes of nine patients supplied with full upper and lower denture are studied by a palatographic method. The palatographic pattern is recorded on four different occasions by using the syllables »s(o)«, »t(o)«, »sh(e)« and »th(e)«. The contact area of the tongue-palatal ridge was photographed and measured. The form and position of the contact area was studied and compared within each individual but not between different individuals. An increasing contact area could be observed during the observation period. This increasing contact area may depend on an adaptation of the tongue to the palatal surface. It is suggested that the palatographic method alone cannot give true observation of adaptation and speech improvement. However the palatographic method can give an anatomical and physiological explanation to a speech disorder.

RÉSUMÉ

MODIFICATIONS DE L'ÉMISSION DE LA PAROLE DANS LES CAS D'ÉDENTATION ET DE PORT DE PROTHÈSES. I. ÉTUDE PALATOGRAPHIQUE

Les modifications de l'émission de la parole chez neuf patients ayant reçu des prothèses complètes haut et bas ont été étudiées par une méthode palatographique. L'enregistrement palatographique a été fait en quatre occasions différentes, en utilisant les syllabes »s(o)«, »t(o)«, »sh(e)« et »th(e)«. La surface de contact langue/crête palatine a été photographiée et mesurée. Les formes et les position de la surface de contact ont été étudiées et comparées pour chaque individu, mais non d'un individu à l'autre. Une augmentation de la surface de contact pouvait être constatée au cours de la période d'observation. Cette augmentation peut être liée à une adaptation de la langue à la surface palatine. Il semblerait que la méthode palatographique à elle seule ne peut rendre véritablement compte de l'adaptation et de l'amélioration de la parole. Cependant, la méthode palatographique peut donner une explication anatomique et physiologique de cas de troubles de la parole.

ZUSAMMENFASSUNG

SPRACHEVERÄNDERUNGEN BEI ZAHNLOSEN PATIENTEN UND PATIENTEN MIT
 OBER- UND UNTERKIEFERPROTHESEN
 EINE PALATHOGRAPHISCHE STUDIE

Die Spracheveränderungen von neun Patienten mit totalen Ober- und Unterkieferprothesen wurden mit einer palathographischen Methode studiert. Das palathographische Munster wurde bei vier verschiedenen Gelegenheiten registriert durch Anwendung der Silben »s(o)«, »t(o)«, »sh(e)« und »th(e)«. Das Kontaktgebiet des Zunge-Gaumenrandes wurde photographiert und gemessen. Die Form und Lage des Kontaktgebietes wurde studiert und verglichen innerhalb jedes Individuums, aber nicht zwischen verschiedenen Individuen. Eine zunehmende Kontaktfläche konnte während der Observationsperiode beobachtet werden. Diese zunehmende Kontaktfläche kann auf einer Adaption der Zunge an die Gaumenoberfläche beruhen.

Es ist anzunehmen, dass die palathographische Methode allein keine echte beobachtung der Adaption und der Sprachverbesserung geben kann. Indessen kann die palathographische Methode eine anatomische und physiologische Erklärung für eine Sprachstörung geben.

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