CINERADIOGRAPHY IN PROSTHETIC SPEECH APPLIANCE CONSTRUCTION

MOHAMMAD MAZAHERI, D.D.S., M.Sc.
and
F. ALLAN HOFMANN
Lancaster, Pa.

Reprinted from

THE JOURNAL OF PROSTHETIC DENTISTRY
St. Louis

Vol. 12, No. 3, Pages 571-575, May-June, 1962

CINERADIOGRAPHY IN PROSTHETIC SPEECH APPLIANCE CONSTRUCTION

MOHAMMAD MAZAHERI, D.D.S., M.Sc.
and
F. ALLAN HOFMANN
Lancaster, Pa.

Reprinted from

THE JOURNAL OF PROSTHETIC DENTISTRY
St. Louis

Vol. 12, No. 3, Pages 571-575, May-June, 1962

CINERADIOGRAPHY IN PROSTHETIC SPEECH APPLIANCE CONSTRUCTION

MOHAMMAD MAZAHERI, D.D.S., M.Sc.,* AND F. ALLAN HOFMANN**
Lancaster, Pa.

THE PROSTHETIC SPEECH appliance is recommended as a primary or secondary treatment procedure on some cleft palate patients. Its construction and design have changed much in the last 20 years because of the improved materials and the increasing interest of professional men. The optimal position of the pharyngeal section of the prosthetic speech appliance may now be determined by the use of cineradiography.[1] This article presents the clinical use of this electronic instrumentation in prosthetic dentistry.

OBJECTIVES OF CONSTRUCTION OF SPEECH APPLIANCES

Four main objectives must be kept in mind in the construction of the prosthetic speech appliance:

All techniques and disciplines in removable partial and complete dentures must be followed in designing the maxillary part of the speech appliance. The preservation of the remaining dentition and surrounding soft and hard tissue in cleft palate patients is one of the main objectives.[2] Often, the proper design of the maxillary part of the prosthesis is neglected by the dentist, and the premature loss of the hard and soft tissue further complicates prosthetic rehabilitation.

The soft tissue of the velar and nasopharyngeal regions must not be displaced by the prosthesis. A proper impression technique eliminates such displacement.

The velar and pharyngeal section of the prosthesis must not be displaced at any time by the velum, the muscle activity of the lateral and posterior pharyngeal wall, or tongue movement during swallowing and speech production. Direct visual examination has not been satisfactory in locating prosthetic displacement. However, the cause of unnecessary displacement of the prosthesis can be determined through cineradiographic recordings. The relationship of the velar and pharyngeal section

---

Read before the American Academy of Maxillofacial Prosthetics in Philadelphia, Pa.
This investigation was supported in part by Research Grant D-539 from the National Institute of Dental Research and Gustavus and Louise Pfeiffer Research Foundation.
*Chief of Dental Services, Lancaster Cleft Palate Clinic.
**Director of Technical Research, Lancaster Cleft Palate Clinic.

of the prosthesis to the tongue, soft palate, and posterior pharyngeal wall during swallowing, speech sounds, and blowing is recorded in a sound on film cineradiographic study. Adjustments are made if any movement of the prosthetic speech appliance is revealed by this roentgenographic motion picture study.

The pharyngeal section of the prosthesis must be placed properly. Cineradiographic films of velopharyngeal closure of normal individuals suggest that there is a significant difference in the elevation of the soft palate for different sounds.[3] We would like to apply these data directly to prosthetic speech appliance construction. However, the fixed prosthesis, by its very nature, cannot alter its position or shape to duplicate the normal changing configuration of the soft palate.

The speech mechanism within the oral and nasal pharyngeal regions has a compensatory action in patients wearing prosthetic speech appliances. The posterior and lateral pharyngeal wall, the tongue, and remnants of the soft palate contribute to this total compensatory action.

IMPRESSION PROCEDURES FOR PHARYNGEAL SECTION

The impression for the pharyngeal section of the prosthetic speech appliance is molded when the patient moves the head to extreme positions as well as during speech exercises and swallowing. These exercises displace the impression material and create a space between the pharyngeal section and the lateral and posterior pharyngeal walls while the muscles in these regions are relaxed.

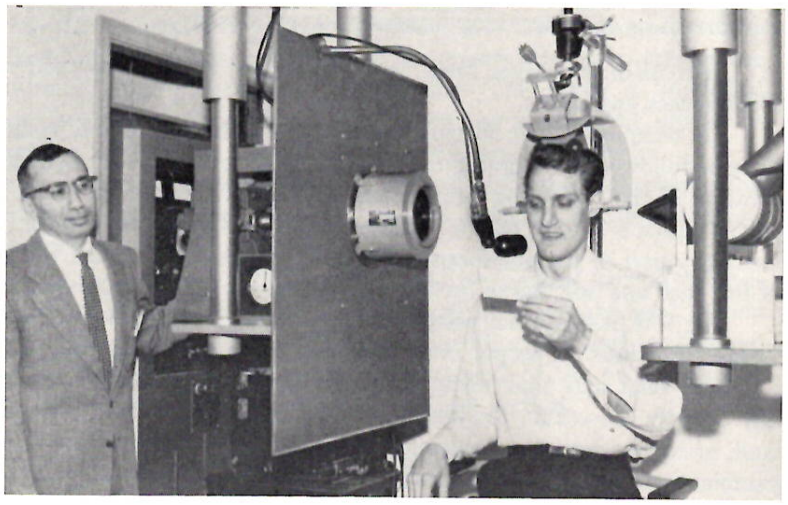

Fig. 1.—The cineradiographic unit records both roentgenographic motion pictures and the speech of the patient. The Lancaster Cleft Palate Clinic Research Department designed this ceiling-mounted roentgenographic apparatus that supports the roentgen tube, cameras, radiation timer, and image intensifier. The intensifier reduces the radiation to the patient while increasing picture screen brillance 1,000 times. This unit is used to study the dynamics of the soft palate, tongue, and throat wall function during speech. The unit is a valuable aid to surgical techniques in locating the pharyngeal section of a prosthetic speech appliance and in diagnosis and treatment planning.

Fig. 2.

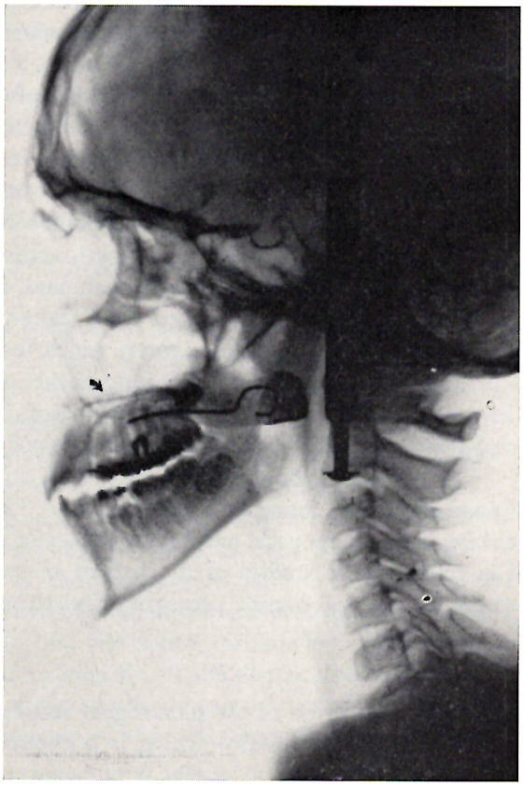

Fig. 3.

Fig. 2.—The arrow indicates the palatal plane. Note that velopharyngeal closure takes place superiorly to the palatal plane.

Fig. 3.—The arrow indicates the palatal plane. Note the position of the pharyngeal section in relation to the palatal plane.

A functional impression for the pharyngeal section has two great benefits: (1) The pharyngeal section does not touch the throat walls while the muscles in this region are relaxed. The pharyngeal section only contacts, rather than displaces, the nasal pharyngeal tissues when the patient performs speech and swallowing exercises. (2) By developing muscle activity around the pharyngeal section from speech exercises, the patient controls the seepage of air around the pharyngeal section for the production of speech sounds in a manner similar to the action of the normal soft palate. The denasalization of speech, often noted in oversized pharyngeal sections, is prevented by a functional registration for the pharyngeal section.

The objectives of our research are to observe and analyze by the use of cineradiography the movements of the speech mechanism of unoperated and operated cleft palate patients who wear prosthetic speech appliances and to determine the best location of these speech aids to produce optimal voice quality (Fig. 1). Studies of soft palates reveal that velopharyngeal closure takes place on or above the level of the palatal plane in approximately 90 per cent of people with a normal palate (Fig. 2).[3] Based on these studies, we place the superior surface of the pharyngeal section of the prosthesis above the palatal plane (Fig. 3). However, the anatomic and physiologic differences on some patients might alter this placement procedure. The speech results are very encouraging when the palatal plane is used as the point of reference.

We have used the anterior tubercle of the atlas bone as a reference point. However, our investigations reveal that the anterior tubercle of the atlas bone is varied in position in different individuals. We also have observed a change of position of the atlas bone as the individual moves his head. Therefore, the atlas bone is no longer employed as a directional point for positioning of the pharyngeal section.

A low placement of the pharyngeal section of the prosthesis causes interference with tongue movement during speech and swallowing. The width of the nasal pharynx becomes greater inferiorly. Therefore, when the pharyngeal section is placed low, it must be made larger, which increases leverage and weight.

A high placement of the pharyngeal section must not block the Eustachian tube. In the high position, the pharyngeal section is smaller in width, has less leverage, and does not interfere with the tongue motion.

In patients with postpharyngeal wall activity, the pharyngeal section is positioned above the constricted muscle area.[4] This location of the pharyngeal section eliminates undue muscle pressure against the section during speech and swallowing. Cineradiographic studies of the patient reveal displacement of the prosthesis due to postpharyngeal muscle pressure against the pharyngeal section.

SUMMARY

Proper location of the pharyngeal section of a prosthetic speech appliance reduces the nasal resonance which is a common problem in individuals with cleft palate. Cineradiographic studies with sound are used to evaluate the location of the pharyngeal section because they reveal the function of surrounding tissues in relation to the prosthesis and speech results after prosthetic treatment. Both the movement of the parts of the prosthesis and the speech sounds are recorded on roentgeno-

graphic motion picture films. The radiation hazard is very greatly reduced because the cineradiographic system utilizes the image intensifier.

The rapid movement of the soft palate during speech creates difficulty in extracting dynamic information from isolated static roentgenograms exposed at uncertain times during the speech exercise.[5] Cineradiography is a valuable adjunct in diagnosis and treatment evaluation of patients with cleft palate who require prosthetic speech appliances.

REFERENCES

1. Cooper, H. K.: Cinefluorography With Image Intensification as an Aid in Treatment Planning for Some Cleft Lip and/or Cleft Palate Cases, Am. J. Orthodontics **42**:815-826, 1956.
2. Mazaheri, M.: Prosthetic Treatment of Closed Vertical Dimension in the Cleft Palate Patient, J. Pros. Den. **11**:187-191, 1961.
3. Warren, D. W., Hofmann, F. A., and Miller, R. M.: A Study of Velopharyngeal Closure Using Cineradiography With Image Intensification (Abst.), J. D. Res. **40**:733-734, 1961.
4. Cooper, H. K., Long, R. E., Cooper, J. A., Mazaheri, M., and Millard, R. T.: Psychological, Orthodontic and Prosthetic Approaches in Rehabilitation of Cleft Palate Patient, D. Clin. N. America, pp. 381-393, 1961.
5. Hofmann, F. A.: Cineradiographic Data Reduction of Soft Palate Movement, *in* Prazansky, S., editor: Congenital Anomalies of the Face and Associated Structures, Springfield, Ill., 1961, Charles C Thomas, Publisher, pp. 337-344.

Lancaster Cleft Palate Clinic
24-26 North Lime St.
Lancaster, Pa.