ALARYNGEAL SPEECH

Third Printing

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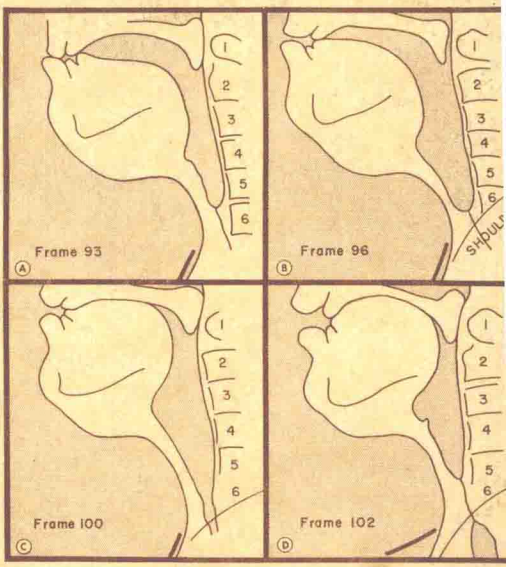

For all those concerned with the complex dynamics of esophageal speech . . . an extensive research report, clinical observations, and rehabilitation procedures. Specifically, the research project is a radiographic study of alaryngeal speech. Cinefluorography with simultaneous synchronous recording of sound on film is the principal instrument. Air intake and speech are illustrated through frame by frame tracings of cinefluorograms.

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ALARYNGEAL SPEECH

PREFACE

THIS WORK HAS GONE THROUGH two fundamental stages. The first was the research investigation (project #337) which was sponsored by the Vocational Rehabilitation Administration, Department of Health, Education, and Welfare, from 1958 to 1962. A project report was submitted to that office in September, 1962, and with some revisions comprises Chapters I-IV. The research study was a collaboration of the principal investigator (WMD) and the associate investigator (KY). The second stage (Chapters V and VI) evolved as additional data were collected and new concepts were formulated regarding air intake, air expulsion, and methods for teaching esophageal speech. The senior author (WMD) is primarily responsible for these efforts.

The research report (Chapters I-IV), other data (Chapter V), and the rehabilitation section (Chapter VI) may be read as separate entities and cross-references have been provided within the text for certain topics (e.g., air intake) which may be discussed in different chapters. For an appreciation of the authors' bias in terminology it may be helpful for the reader to study the nomenclature section of Chapter VI before reading any other chapter.

Alaryngeal speech is a unique form of human adaptive behavior. The process has intrigued many investigators for more than a century. Over the years each new technical advance in instrumentation has provided the wherewithal for better understanding of the complex dynamics of esophageal speech. We disagree with those who believe that "everything there is to know about esophageal speech is known." We trust that this book represents a further step in our comprehension of speech after laryngectomy.

W. M. D.
K. Y.

ACKNOWLEDGMENTS

IT IS DIFFICULT to personally acknowledge all of those who have contributed to this work. The ideas and concepts expressed herein are the result of interaction with many people over a long period of time. If the writers have forgotten to mention anyone, forgive our delinquent memories.

As a graduate student, one of us (WMD) was introduced to the area of alaryngeal speech under the tutelage of Dr. Warren H. Gardner. Dr. Gardner has pioneered in the problems of the laryngectomee. He also wishes to express his appreciation to Dr. June Miller, Educational Director of the Hearing and Speech Department, who started esophageal speech training at the Medical Center and kept a constant interest in this project.

Dr. Kenneth L. Moll was extremely helpful in formulating the procedures necessary for judging speech skill. Mrs. Dale Bellerose generously provided her time in statistical assistance. Dr. Harris Winitz and Dr. Ralph L. Shelton, Jr. made constructive suggestions on the first four chapters, Dr. Willard F. Goff, Dr. Fernando R. Kirchner, and Dr. Charles I. Berlin on Chapter VI. Other colleagues and students, too numerous to mention, made thoughtful suggestions about Chapters V and VI. Professor Margaret Anderson is thanked warmly for her assistance in clarity of expression in Chapters V and VI. Any errors which remain are the responsibility of the authors.

We wish to thank the personnel from the Department of Medical Communication, Mrs. H. J. Clifford, Mrs. R. E. Brewster, and Mr. John L. Jensen for illustrations; Mr. Burton W. Johnson, Mr. Barton E. Lavine, and Mr. Fred DeGreef for photography; and Mr. Wes Heisey for the adaptations to the equipment.

The following persons provided the translations for the many foreign articles: the late Dr. Eugene Mueller (German and French), Mrs. Aldo Vigliano (German), the late Dr. Aldo Vigliano (Italian), Dr. Danuta Oktawiec (Polish), and Mr. Dale Bellerose (French).

A personal word of appreciation goes to Mr. Robert S. Brooks and Mrs. Robert D. Brooks who served as research assistants during part of the research project. Mr. Brooks was responsible for much of the ground work which was accomplished in the early pilot studies. Mrs. Brooks had the toilsome burden of film marking and graphic analysis. To Mrs. Robert D. Packham who served as typist and proofread the manuscript, we give a special word of thanks.

The Vocational Rehabilitation Administration, Department of Health, Education, and Welfare, provided the major source of financial assistance for the research (project #337). They were generous in their support and whenever a supplemental request was made they were quick to respond with the necessary aid.

Finally, this project could not have been carried out without the unstinting support of the subjects who willingly participated in all the procedures. As a result of their efforts, we trust that this study has achieved some advancement in knowledge about alaryngeal speech.

W. M. D.
K. Y.

CONTENTS

ALARYNGEAL SPEECH

Chapter I

INTRODUCTION

THE NUMBER OF LARYNGECTOMIZED patients increases each year. The American Cancer Society has estimated that there are approximately 25,000 laryngectomized persons in the United States and between 2,500 and 4,000 new patients are added yearly (93). The incidence of cancer of the larynx is believed to be between three and four per 100,000 in the general population (50). A report by the National Cancer Institute showed a 42 per cent increase in the mortality and a 75 per cent increase in the incidence of carcinoma of the larynx during a recent ten-year period (50). As a result, many more patients are being seen for speech rehabilitation. In addition, the increased life span of our population makes it more probable that these people will continue to function in society. A recent survey of 3,366 laryngectomized patients by the American Cancer Society (44) has shown that 64 per cent speak entirely with esophageal speech, the remaining use artificial devices or do not speak at all. A more intensive and integrated research program is needed to develop improved procedures for the rehabilitation of these patients.

The purpose of this project was to study, through the use of cinefluorography, the physiological movements involved in esophageal speech. Study of the laryngectomized patient by cinefluorography has not been extensive, especially in the United States. Image intensification permits the visualization of the speech mechanism with minimal radiation dosage to the patient.

This tool has unique application to the study of speech after laryngectomy because of the obstacles encountered by other procedures, e.g., indirect laryngoscopy. With cinefluorography, there is the distinct advantage of being able to observe the dynamic movement patterns in alaryngeal speech which is not possible with routine lateral spot films. Rapid serial radiographs are not adequate in speed for observing the movement phenomena which occur during alaryngeal speech.

Although the concepts and procedures for developing alaryngeal speech are not new, it is very apparent when one attempts to find out more about this process that there are still many basic questions to be answered. There is a need for detailed information concerning the functional morphology and physiology of voice and speech production in the post-laryngectomized patient. Questions regarding the basic processes of air intake and production of sound are still in dispute.

STATEMENT OF THE PROBLEM

The primary purpose of this project was to investigate by cinefluorography and simultaneous synchronous recording of sound the morphological movement patterns of the lips, tongue, palate, pharynx, and esophagus during post-laryngectomized speech. Additional observations were taken from speech recordings, lateral spot films, audiological evaluations, oral air pressure measurements, and surgical information. A detailed description of the observed speech behavior and a statistical assessment of the inter-relationships among the above factors was done.

Some of the more specific research questions which this study attempted to answer are as follows:

1. What relationships exist between speech skill and the morphology of the hypopharynx, pharyngo-esophageal (P-E) segment, and esophagus?
2. What are the morphological characteristics (site, shape, size) of the P-E segment during different physiological states (rest, modified Valsalva, blowing, and phonation)?
3. What changes occur in the process of air intake when it is followed by different phonetic utterances (vowels and selected consonant-vowel combinations)?
4. What differences of the speech mechanism are observed in persons who trap air by the process of swallow, inhalation, or injection?
5. What relationships are noted between the morphology of the P-E segment and speech skill when surgical factors are evaluated?
6. What relationships exist between speech skill and audiological factors, oral air pressure, and chronological age?

Chapter II

PROCEDURE

SUBJECTS

TWENTY SUBJECTS were evaluated in a pilot study which employed a five-inch cinefluorographic image intensifier and observations from that study were reported earlier (29, 30, 103). After a nine-inch intensifier had been installed, twenty-seven esophageal speakers were filmed and they composed the group used in this study.*

All of these subjects had received extensive group and individual speech training. The chronological age ranged from forty-two through seventy-five years with a mean of 60.7 years. There were twenty-three males and four females who had been laryngectomized for seven months or more. The range of time from the surgery to participation in this study was from seven to 161 months with a mean of forty-eight months.

All of the subjects except four were operated upon by twelve different surgeons in the greater Kansas City area. The majority of the laryngectomies were a widefield type of operation. Seven subjects had all or part of their hyoid bone remaining, eight subjects had unilateral neck dissection, and seven subjects had pre- or postoperative x-ray treatment. The subjects represented a wide range of occupational levels from laborer to professional worker. See Appendix D for a detailed description of medical and occupational status of each subject.

EQUIPMENT

A Philips, nine-inch, one-thousand brightness, image intensifier was utilized with a 16 mm Cinephonic magnetic sound recording camera operated at twenty-four frames per second (Fig. 1). Shellburst linagraph film with magnetic sound striping was used. The films were made with 100

* Other alaryngeal speakers, including one who used pharyngeal speech and users of the artificial larynx, were also filmed and recorded. For purposes of this study, the criteria for esophageal and pharyngeal speech determined from cinefluorograms were as follows: the source of air supply was located only in the region named and the site of vibration was cephalad to the vicarious air chamber. For esophageal speech, the air was in the esophagus and some part of the pharyngo-esophageal junction served as a vibrator. For pharyngeal speech, the air was trapped in the hypopharynx and no air was noted to be in the esophagus. The vibrator appeared to be the tongue against the pharyngeal wall, soft palate, and/or pillars of fauces. Only one speaker was found who used pharyngeal speech and he did not have speech instruction. The pharyngeal speaker was included in several computations (Tables 4, 7, 11 and 23). See Appendix A for a description of the subjects used to assess speech skill from the audio tape recordings.

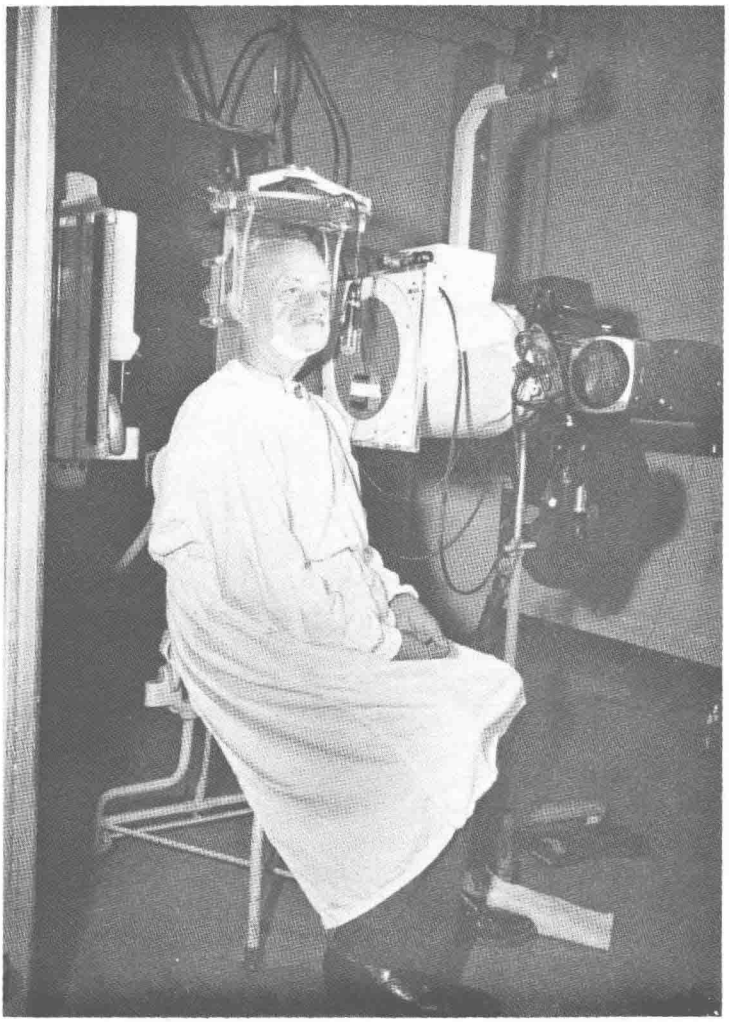

Figure 1. Equipment and position of subject for cinefluorography.

KVP, six to eighteen MA, continuous x ray, and no grid. Target-to-intensifier distance was fifty inches. The factors were varied with the size of the subject. Roentgen dosage to the neck of the subject was 1.0 r/ma/minute. The films were developed in D76 Kodak developer for eight minutes at 68° F. to maximum contrast.

The radiographic data included ten-by-twelve-inch lateral spot films (Fig. 2). They were made at 90 KVP, one-twentieth of a second, 150 MA with the moving grid of 6½ : 1 ratio, forty inch target-film distance, on

standard x-ray film in cassettes with high-speed double screens. The films were developed for one and a half minutes at 68° F. in standard x-ray developer or in a Pako automatic processor.

A Precision Sound Reader (Optical-Magnetic) (87) was used to mark beginning and end of phonation on the film (Fig. 3). The cinefluorograms were analyzed visually for frame by frame analysis on a variable speed forward and reverse, Perceptoscope projector (83). A specially designed cabinet (Fig. 4) adapted from Fletcher (32) was used for these studies.

Figure 2. Equipment and position of subject for lateral spot films.