

ANATOMIC GUIDE FOR THE ELECTROMYOGRAPHER

THE LIMBS

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Second Edition by

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"... an excellent anatomic guide which clearly illustrates and precisely describes proper needle electrode placement during clinical electromyography. This book should be of value to the clinical electromyographer and to all who teach electrodiagnosis."

— *Archives of Physical Medicine and Rehabilitation*, in a review of the First Edition

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**ANATOMIC GUIDE FOR THE
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FOREWORD

Electromyography has been developing as an increasingly useful diagnostic tool for only the past thirty years. An abundance of literature has given the clinician an opportunity to become more and more sophisticated in its use. Unfortunately, understanding the tool as a diagnostic aid rather than as a diagnosis maker has not always been evident. It is the knowledgeable and thorough clinician who is best fitted to realize the great power of the procedure. On the other hand, having a detailed knowledge of electromyography by itself does not necessarily make one a good clinician. The reason for this is quite simple. *Whether, when and where* the procedure should be done are based on knowledge, experience and judgment—these are the hallmarks of the clinician. If done, the findings must be interpreted in light of the patient's problem as previously elicited from history, physical examination and other diagnostic tests.

This book is largely concerned with the question of *where* to insert electrodes in order to elicit maximum useful information. The more experienced the electromyographer becomes, the more he realizes the need for precision in the placement of needle electrodes. After all, there are very many anatomically distinct skeletal muscles in the human body. Each of them, whether large or small, superficial or deep, is innervated by axones traversing roots, plexuses and nerve trunks. In addition, innervations are often aberrant. One example of the diagnostic power of this procedure is the ability to localize discrete axonal lesions within reasonably narrow zones. This depends upon eliciting electromyographic abnormalities in distinctive combinations of a number of individual muscles. This example illustrates the need for the clinician to be a good anatomist. Unfortunately this is not always the hallmark of even the exceptional clinician, and the modern deempha-

sis of detailed anatomical study in our medical schools is of no help. This poses no problem since the authors have done the job for us. This simple book, almost in the nature of a cookbook, is the product of painstaking detailed and repeated dissections by the authors. It is a labor of love—but who could have carved out the long hours from busy professional and academic lives except those in love with their field.

Segments of this work had been presented at seminars in national meetings. These presentations had been received with enthusiasm and with appeals for a more complete and tangible presentation of the material. For the clinician who wishes to make better syntheses of his patients' problems, this book is offered as an aid to a diagnostic aid.

Arthur S. Abramson, M.D.

PREFACE TO SECOND EDITION

In revising this manual we have tried to take into consideration the many constructive criticisms offered by our readers. These suggestions fell into three main categories:

The first was for a clearer exposition of the innervation of the muscles presented. We attempt to do this by giving the course of each innervation from the periphery through the peripheral nerves, cords, division, trunks and spinal segments. Where more than one spinal segment contributes to the innervation, we have italicized the segment or segments making the major contribution.

Another suggestion we thought worthy of attention was to have cross-sectional diagrams of some of the deep muscles in order to aid in the orientation of the reader in placing the electrode. We have added such diagram for the pronator quadratus, the flexor pollicis longus, the extensor digitorum longus, the tibialis posterior, the adductor brevis and the vastus intermedius.

Finally, we were asked to be more specific in listing our literary sources than stated in the first edition. To fulfill this request we add the following sources:

- (1) Gross, Charles M. (Ed.): *Gray's Anatomy of the Human Body*, 29th American ed. Lea & Febiger, Philadelphia,, 1973.
- (2) Baker-Cohen, Frances: *A Study Guide and Laboratory Manual for Human Anatomy*, corrected and expanded edition, Albert Einstein College of Medicine, New York, 1971.
- (3) Haymaker, Webb, and Woodhall, Barnes: *Peripheral Nerve Injuries*, 2nd ed. Saunders, Philadelphia, 1953.
- (4) Hollinshead, Henry: *Functional Anatomy of Limbs and Back*, 2nd ed. Saunders, Philadelphia, 1960.
- (5) Sunderland, Sydney: *Nerve and Nerve Injuries*. Williams & Wilkins, Baltimore, 1968.
- (6) Crenshaw, A.H. (Ed.): *Campbell's Operative Orthopaedics*, 4th ed. Mosby, St. Louis, 1963.
- (7) Spinner, Morton: *Injuries to the Major Branches of Peripheral Nerves of the Forearm*. Saunders, Philadelphia, 1972.

- (8) Lockhart, R.D., Hamilton, G.F., and Fyfe, F.W.: *Anatomy of the Human Body*. Lippincott, Philadelphia, 1965.
- (9) Kakamo, Kenneth: The Entrapment Neuropathies. *Muscle and Nerves*, 1:264-279, July-Aug 1978.
- (10) Lampe, Ernest W.L.: Surgical anatomy of the hand. *Clinical Symposia—Ciba*, 21(3): July-Aug-Sept 1969.
- (11) Koppel, Harvey and Thompson, Walder A.L.: *Peripheral Entrapment Neuropathies*. Krieger, Huntington, 1976.

E.F.D.

A.O.P.

INTRODUCTION

Development in electronic instrumentation has made it possible for electrophysiological observations, formerly only possible in the laboratory, to become commonplace clinical diagnostic procedures. With this advance in technology, a new demand is put upon the diagnostician, not only to become acquainted with the technical aspects of the new instrumentation but to reorganize the more traditional areas of his knowledge so that they better serve this new approach.

In order to perform the now common electrodiagnostic procedures of electromyography and nerve conduction studies, a knowledge of anatomy of the muscle, nerve and skeletal systems is essential.

This book represents an attempt to supply the electrodiagnostician with anatomical information concerning the limbs, organized for easy utilization in the clinical practice of his discipline.

In normal subjects it is usually possible to use kinesiological maneuvers to identify the muscle and localize the electrode. However, in certain movements where synergistic muscles cannot be activated discreetly, this is not possible. It is also not possible to use this method of localization in patients with complete paralysis or with neurological conditions that make it impossible to perform controlled or discreet movements.

Other methods previously described include using the electrode as a means of stimulating the muscle, radiological localization with or without the injection of carbon dioxide through the electrode, or using the motor points as the area for electrode insertion.

Although these methods are quite suitable in certain circumstances, they require special apparatus and are solely methods of

localization not answering the problems of initial placement of the electrode.

The muscles accessible to the examiner have been placed in regional categories in order to facilitate clinical study. A brief anatomical description and a diagram is given for each muscle and the special requirements for the procedure as follows:

1. Segmental and peripheral innervation and origin and insertion.
2. Position of patient or limb.
3. Point of electrode insertion determined by visual and/or palpable landmarks.
4. Test maneuver to insure proper localization of electrodes after insertion.
5. Pitfalls or possible sources of error.

The above is based on a systematic anatomical study of cadaver material, normal subjects, patients and standard anatomy texts and manuals.

Although this manual is based on data derived from the anatomy of adult subjects of the usual body configuration found in patients and anatomical specimens in east coast urban centers, it is possible by interpolation to accomodate for extremes of anatomical variation in the adult and the, as yet, incomplete development of the child or infant.

There is rarely a problem when the point of insertion is given as a proportion between two boney landmarks. However, when measurements are given in terms of "fingerbreadths" and there is great disparity between the stature of the subject and examiner, it has been suggested that the fingerbreadths used should be those of the subject and not of the examiner.

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This book was made possible by many people; unfortunately only a few can be named.

Our department chairman, Doctor Arthur Abramson was most helpful, not only in guiding and encouraging us, but in finding the necessary material support for production of the manuscript.

Doctor Frances Baker-Cohen, of the department of anatomy, gave freely of her vast knowledge of the subject and made available the essential anatomical material.

Ms. Sylvia Golod cheerfully worked through the many revisions of the manuscript made necessary by the editorial ineptitudes of the authors.

Among the nameless are the numerous medical students whose dissections were used in this study and to whom we owe many apologies for disturbing their studies to foster our own. And finally, the nameless host that made the ultimate contribution; that of their earthly remains to become the “anatomical material.”

To all those named and the nameless, we give profound thanks and acknowledge our debt.

The Authors

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