

Functional Anatomy of the Limbs and Back

*A Text for Students of the
Locomotor Apparatus*

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W. B. SAUNDERS COMPANY Philadelphia London Toronto

W. B. Saunders Company: West Washington Square
Philadelphia, PA 19105

1 St. Anne's Road
Eastbourne, East Sussex BN21 3UN, England

1 Goldthorne Avenue
Toronto, Ontario M8Z 5T9, Canada

Library of Congress Cataloging in Publication Data

Hollinshead, William Henry, 1906–

Functional anatomy of the limbs and back.

Includes index.

1. Extremities (Anatomy) 2. Anatomy, Human.
3. Muscles. I. Title.

QM531.H7 1976 611'.98 75-19844
ISBN 0-7216-4757-X

Listed here is the latest translated edition of this book, together with the language of the translation and the publisher:

Japanese (*2nd Edition*)—Kyodo Isho Shuppan Sha, Tokyo, Japan

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ISBN 0-7216-4757-X

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Last digit is the print number: 9 8 7 6 5

Preface to the Fourth Edition

This fourth edition of *Functional Anatomy of the Limbs and Back* follows the format of former editions. The chief emphasis, therefore, is on the muscles of the limbs and back and their actions, with special regard to the needs of the student of physical therapy. The skeletal, nervous, and vascular systems are described and discussed primarily as they pertain to the muscular system. In addition, various fundamental facts and concepts that should be understood before beginning a study of the limbs are presented in the first section, and the last section deals briefly with some features of the head, neck, and trunk of which the physical therapist should be aware.

The text has been thoroughly revised and, where it seemed advantageous, rearranged or rewritten to make it as clear and concise as possible. Discussion of the physiology and innervation of voluntary muscle has been improved but only slightly expanded; descriptions of the origins of various muscles have been made more complete when it appeared that this might be helpful in the dissecting laboratory; information obtained from electromyographic studies that has become available since the last edition has been inserted; and 14 new figures have been added. The terminology is that of the latest or third edition of the *Nomina Anatomica* (NA).

Although it is impossible in a book of this size to discuss controversial questions in any detail, beginning students should be aware that there are still, even in the very old science of anatomy, differences of opinion and gaps in our knowledge. They should therefore not be surprised if their instructor sometimes disagrees with statements in this book.

My thanks are due to Mr. Gordon K. Branes, Educational Director, Mayo Foundation School of Physical Therapy and long-time associate, for suggestions that have helped improve the present edition; to my colleagues at the University of North Carolina, Dr. Mary C. Singleton and Dr. Charles W. Hooker, for their criticism and suggestions;

and to the Medical Department, Harper & Row, for permission to use figures from my *Anatomy for Surgeons* and *Textbook of Anatomy*. Finally, I am especially indebted, as always, to my publisher, the W. B. Saunders Company.

Chapel Hill, North Carolina

W. HENRY HOLLINSHEAD

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I

THE ORGANIZATION OF THE BODY

Anatomic Terminology

The beginning student of anatomy is confronted with the necessity of mastering a largely new, cumbersome and complicated vocabulary. The difficulties are increased by the fact that, in common with most scientific terminology, anatomic names are given a Latin form. It is now agreed that each language group may use the vernacular as it deems proper, therefore we depart from the strict Latin by anglicizing many expressions or using a direct English translation; however, the Latin terminology is the foundation upon which our scientific vocabulary is built. The problem is further complicated for most of us through the fact that, regardless of their endings, most anatomic terms have Greek or Latin roots. As most of them convey very definite meanings it is well worth the effort to consult a medical dictionary, when necessary, to discover the original meaning of the word and thus translate it in one's mind from a term that must be merely memorized to one that is understood. If the student will make a conscientious effort to understand the terminology of anatomy, he will find it much easier to learn the facts and concepts of anatomy.

A further difficulty in anatomic terminology is the abundance of synonyms that have accumulated for generations. The international anatomic terminology (NA, or *Nomina Anatomica*, adopted in 1955) recognizes practically no synonyms, but even anatomists, because they are used to an older terminology, have difficulty in eliminating synonyms from their talking and writing. Certainly, many of the clinicians with whom the therapist will come in contact will use the synonyms with which they are most familiar, and it is impossible to eliminate synonyms from older texts and figures that the student

may consult. In this book the use of synonyms has been reduced to an approximate minimum. Only where it seemed obvious that the student might be handicapped through ignorance of another commonly employed although officially outdated term has that term been given as a synonym.

The major subdivisions of the body are the head, neck, trunk, and limbs. Although it is perfectly proper to use these English names, they also have Latin names that are used in many terms that the student will meet. Thus the head is “caput,” and “capitis” therefore means “of the head.” The neck is “collum”; cervix also means neck, especially its anterior part, and nucha means its posterior part. Thus “colli” means “of the neck,” and we also find the terms “cervical” and “nuchal” or “nuchae” used in referring to structures in the neck.

Our word “trunk” is obviously the same as the Latin “truncus,” but we have no particular reason to use the latter word. However, the subdivisions of the trunk need to be understood. The Latin word for chest is thorax, and this word will be met often both in this form, in its possessive “thoracis,” which means “of the chest,” and in its adjectival form “thoracic.” The abdomen is the part of the trunk with muscular walls that lies below the thorax. It is most easily translated into our word “belly,” but since this is considered inelegant we are left with no acceptable translation, and therefore use the words “abdomen” and “abdominal.” (“Stomach,” commonly used and understood to mean the abdomen, means no such thing; the stomach is one of many organs in the abdominal cavity.) The lowest part of the trunk is the pelvis (meaning “basin”), and the Latin term is always used for this; “pelvic” is the adjective pertaining to the pelvis.

The Latin for the limbs is “membra” (member), but has no common usage. “Appendage” is a term long used by zoologists to describe limbs in general, and sometimes appears in human anatomy in the adjectival form “appendicular.” Names of smaller subdivisions of the limbs are best reserved for the times when the limbs are studied.

Since anatomy is a descriptive science, many anatomic terms are in themselves descriptive, referring to shape, size, location or function of a part, or its fancied resemblance to some nonanatomic structure. Muscles, especially, are usually so named, but since many muscles may have a given shape or a given function it is usual to use more than one descriptive adjective in naming a muscle. Thus there are two muscles called biceps, or muscles with two heads of origin, so we distinguish one as the biceps brachii, or two-headed muscle of the arm, the other as the biceps femoris, or two-headed muscle of the thigh. Similarly, the pronator quadratus is a quadrilateral muscle that pronates or turns the palm of the horizontally held hand downward, the quadratus lumborum is a quadrilateral muscle located in the lumbar region; the rectus abdominis is a muscle running vertically (rectus

means straight) in the abdominal wall, the rectus capitis anterior is an anteriorly situated muscle running vertically to attach to the caput, or head, and so forth.

In addition to the various technical names of structures in the body there are also certain general terms describing surfaces of the body, planes through the body, relative positions of one structure to another, and so forth, that must be understood from the very beginning. The surfaces of the trunk may be conveniently described as the dorsum, or back, the ventral or belly surface, and the two sides, or lateral surfaces. The cranium is the skull, and cephalon is the Greek word for head, so cranial and cephalic both mean toward the head; similarly, caudal means toward the tail, or in man toward where the tail would be had it persisted from embryonic life.

The above-defined terms are all understandable regardless of the position of the body, but there are others that require agreement as to what position of the body we are referring to before they can be understood. For instance, superior, meaning up or upward, implies a relation to gravity, and therefore might differ entirely in meaning according to whether one was erect, lying upon one's back, or standing upon one's head. For this reason, anatomists have agreed that such terms of relative position should always be used in relation to a fixed position of the body termed the anatomic position; the anatomic position is the erect one, with the heels together and the feet pointing somewhat outward, the arms by the sides and the palms facing forward. With reference, then, to the anatomic position, superior always means toward the head, and is therefore used interchangeably with cephalic or cranial; similarly, inferior means toward the feet, and is usually synonymous with caudal. Anterior, referring to the part of the body habitually carried forward in progression, is thus synonymous with ventral in the human being, and posterior and dorsal are also synonymous. Even in the new anatomic terminology there is some inconsistency in the use of the terms "anterior" and "ventral," and similarly in "posterior" and "dorsal"; in essence, however, dorsal and ventral are used in human anatomy only in referring to parts of spinal nerves and of the hand and foot (compare our English "back of the hand"). Elsewhere anterior and posterior are preferred, so what was once, for example, the dorsal interosseous artery is now the posterior interosseous artery. The term "ventral" was rarely used in regard to the limbs (except in developmental stages), the more common term here being "volar" (vola = the palm or sole); this has now been abandoned as the antithesis of posterior, so what was once the volar interosseous artery is now called the anterior interosseous artery.

Other terms of relative position are medial and lateral, that is, toward the midline or toward a side. In the case of the limbs, however, some confusion might exist as to whether these terms refer to the body

a whole, and its relation to the body in the anatomic position; if relative mediolateral relationships of structures within the limb are to be described, radial and ulnar, and tibial and fibular are the terms best employed. These terms refer to the paired bones of the limbs. In the upper limb, the radius is on the thumb side, the ulna on the little finger side, and in the lower limb the tibia is on the side of the big toe

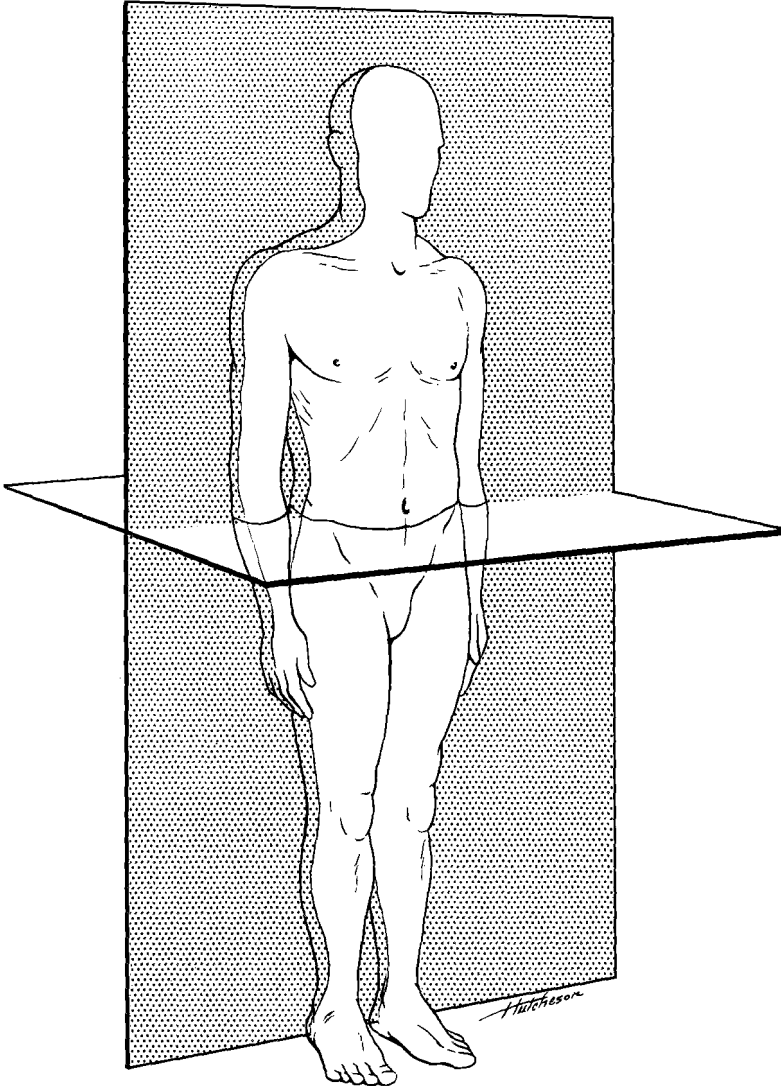


Figure 1-1. Continued. Coronal and transverse planes.

while the fibula is on that of the little toe; the sides of the limbs are thus named from the positions of these bones. Additional terms especially useful in regard to the limbs are proximal, meaning toward the attachment of the limb to the trunk; distal, or away from the base of the limb; palmar, referring to the palm of the hand; and plantar, referring to the sole of the foot.

In regard to the planes of the body (fig. 1-1), the sagittal plane is either one passing through the midline of the body so as to divide it into right and left halves or one (often called parasagittal) parallel to but to one side of it. A coronal or frontal plane is one dividing the body into an anterior and a posterior (ventral and dorsal) portion, thus running roughly parallel with the front of the body and with a suture of the skull called the coronal suture. A horizontal or transverse plane divides the body or limbs into upper and lower parts, in relation to gravity and the anatomic position.

In describing movements we may refer to them as being toward or away from a given plane, or we may find it convenient to speak of the axis of motion. For any given movement the axis of motion is an imaginary line about which a part describes a rotatory movement. These axes of motion typically make angles with one of the chief planes of the body. For instance, the axis for bringing the forearm up against the arm ("bending" the arm) is a line passing through the elbow region from lateral to medial sides, and is therefore at approximate right angles to the sagittal plane, and correspondingly approximately parallel to the frontal plane.

In addition to the terms of position, we must also agree in general upon the meaning of terms describing movement. As a rule, bending of the trunk or the limbs occurs most freely toward the original ventral surfaces, therefore flexion, which means bending, is usually a bending in the ventral direction; if we want to designate a bending as being in the dorsal direction, it is proper to say dorsiflexion. Extension, the straightening out of a bent part, is a movement opposed to that of flexion, and therefore occurs typically in the dorsal direction; if, at the joints where this is possible, we continue the movement of extension beyond that necessary to straighten the part, we can designate it as hyperextension. Dorsiflexion and hyperextension are plainly synonymous, as they both designate movement in the same direction. From these terms of movement we have acquired terms of position that are frequently used colloquially, although not a part of official terminology. Thus we may speak of the flexor or extensor surfaces of a limb, and these correspond to the original ventral and dorsal surfaces of the developing limb.

Abduction means moving apart, or away from the midline, and adduction, the reverse, is moving together, or toward the midline; both of these are particularly useful in describing movements of the

limbs. Protraction is moving a part forward, retraction moving it back; elevation is lifting a part, that is, moving it superiorly, while depression is moving it inferiorly. Rotation is the twisting of a part around its longitudinal axis, and is described as lateral or external rotation if the anterior surface of the part is turned laterally, and medial or internal rotation if it is turned medially. Circumduction is a combination of successive movements of flexion, abduction, extension and adduction in such a fashion that the distal end of the part being moved describes a circle.

In relation to the limbs, especially, some of the terms defined above are apt to be confusing in their specific applications. For this reason an effort has been made in the following chapters of this book to so define terms of relation and movement, as they apply specifically to the part being considered, that there can be no ambiguity as to what is meant. With the proper use of the dictionary, and with due regard to the correct usage of anatomic terms as displayed by your instructor and in textbooks, the bugaboo of anatomic terminology can be largely overcome, and what may seem at first an almost incomprehensible jargon will become a useful part of your scientific language.