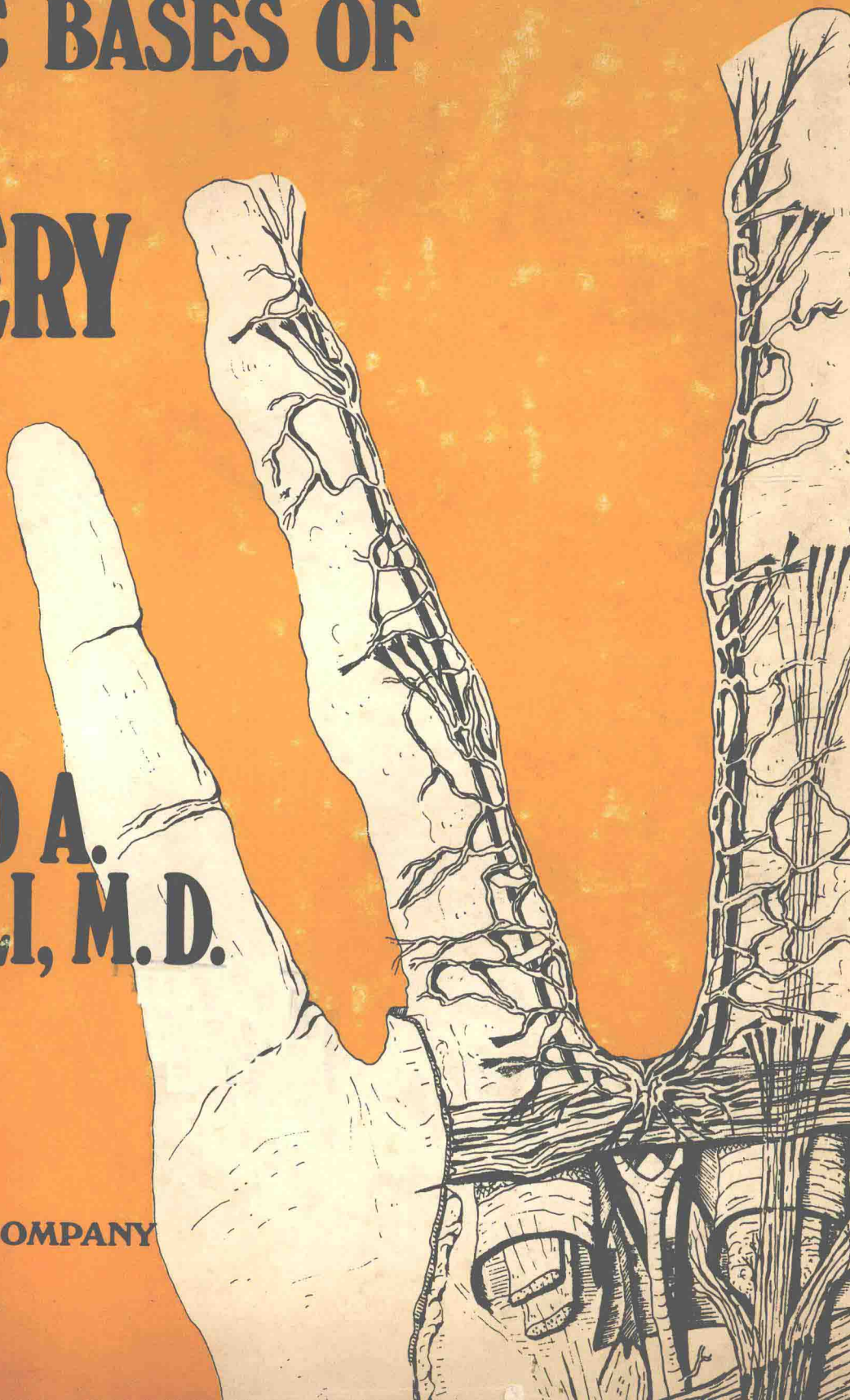
STRUCTURAL AND DYNAMIC BASES OF HAND SURGERY

2ND EDITION

EDUARDO A. ZANCOLLI, M.D.



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Structural and Dynamic Bases of HAND SURGERY

Second Edition

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With a Foreword by

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Structural and Dynamic Bases of

HAND SURGERY

Second Edition

To Aurora

Foreword

In the decade since the first edition of his book, Professor Zancolli has continued his studies of the anatomical structures of the hand and the manner in which various forces act on these parts to produce normal and abnormal patterns of motion. The results of these anatomical studies and the results of his extensive experience in the use of methods to restore essential motions are described in this volume; it is called the second edition, but actually it is a complete revision. All the illustrations are new and demonstrate well the points he emphasizes.

This is a book to be studied and to be read carefully, for Professor Zancolli has explained in great detail the static and dynamic anatomy of the structures of the various systems and then developed logically a plan of treatment for the disabilities that occur. A reader will find it difficult to accept the reasons and the plan of treatment unless the anatomical discussion is thoroughly understood. In a most detailed way the author tells us what the older anatomists described and how some of the signs and tests we think were discovered recently were known long ago. It is this comprehensive review of the anatomic literature that makes this book doubly valuable even though Zancolli's penchant for naming anatomical structures demands an exercise of memory. Were it not for his drawings which illustrate the structures and forces so clearly, one could easily be confused by the terminology.

In this work we find complete studies of the extensor apparatus of the finger, the movements of the thumb, and of the forces involved in intrinsic paralysis and in ischemic contractures.

From a practical standpoint, this book should enable a surgeon to understand better the pathophysiology of the claw hand, the boutonnière, the mallet finger, the hand with Volkmann's contracture, and the hand of the patient with rheumatoid arthritis. With this clearer understanding, surgical treatment can then be carried out on a logical basis.

There are other aspects of the hand which can well be studied with this approach and examples of this method applied to problems in the elbow are well described.

Professor Zancolli's work demonstrates clearly the intimate association of anatomy and surgery and points out the need to develop our surgical skill on a firm base of anatomical knowledge, so that the results of our work will be of optimal benefit to our patients.

JOSEPH H. BOYES

Preface

This edition constitutes an almost complete revision of each of the subjects treated in the first edition; some new chapters have been added, too.

In the development of each subject special importance is given to the study of its morphological, functional, and clinical aspects, in order to select the most appropriate method of treatment.

In the selection of the methods of treatment special preference is given to those most simple and also to those which serve to reproduce with the greatest precision the normal anatomy and function of the hand; given a choice among several procedures of equal efficacy the most simple in its application should be considered the best. Therefore, reproduction of the normal anatomy (insofar as this is possible) and simplicity are an excellent basis for selection.

The first chapter is devoted to the anatomy and mechanics of the extensor apparatus of the fingers. Here several cadaveric experiments are shown which demonstrate the function of its different structures. The extensor apparatus is formed by two main types of structures: the terminal tendons and the retention ligaments. These ligaments are basically represented by the sagittal bands (here called metacarpophalangeal fibrous girdle), the triangular ligament, and Landsmeer's retinacular ligament. These tendinous retaining ligaments should be considered separately from those structures that retain and stabilize the skin of the hand to favor its prehension functions. The structures that form the retaining system of the skin are: the palmar fascia with its deep and digital prolongations, the natatory or interdigital ligament and the so-called Cleland's ligament. Considering the function of these structures we found very logical its grouping under the general denomination of "retinaculum cutis" of the hand.

In spite of this clear separation between the retaining ligaments of the extensor tendons and the skin of the hand, the reader will find that, in the first chapter, these structures are described not separately but as a whole, forming different retaining apparatus at the level of the finger joints. In this chapter, elementary anatomic concepts are not mentioned, since they can be found in texts of basic anatomy.

In Chapter 2 the pathology and treatment of the different deformations and dysfunctions of the extensor apparatus are described.

The anatomy and function of the first carpometacarpal joint is extensively described and illustrated by findings from cadaveric investigations and surgical observations, pointing out the importance of its study in relation to the normal mechanics of the thumb and to the different surgical procedures which act over it.

In the chapters devoted to definitive paralysis of the intrinsic muscles of the hand I refer particularly to the surgical procedures I prefer. The classical claw-hand deformity is corrected basically by two procedures: (1) the metacarpophalangeal capsuloplasty with bony fixation and (2) the "lasso" operation, a tendon transfer in which the tendons used as transfers are fixed at the vaginal ligament of the fibrous sheath of the flexor tendons. This last technique creates a powerful primary flexor of the proximal phalanx for the grasping functions of the hand and stabilizes the proximal phalanx during finger extension. It is pointed out that in ulnar nerve palsy it is very important to correct, as much as possible, the functional deficit, depending on Froment's sign. For restoring the opposition movement, tendon transfers must be planned in relation to the severity of muscular paralysis. Thus in isolated median nerve paralysis a single tendon transfer is indicated, to produce a marked antepulsion. In median-ulnar nerve paralysis opposition and pinch grip are restored by one or two tendon transfers. When two tendons are employed, which represents the best indication, one is used as antepulsor and the other as adductor. Two tendon transfers will reproduce with greatest fidelity the

thumb function impaired by extensive intrinsic paralysis.

Functional restoration of the upper limbs in quadriplegic patients is described in the light of our experience at the Rehabilitation Center of Buenos Aires. Surgical procedures are described in relation to the most distal motor function preserved. The importance of restoring elbow extension in high lesions of the spinal cord is discussed in accordance with Moberg's ideas. Level of sensation is relevant to the functional capability of the hand after reconstructive procedures but is not considered as a determining factor in the surgical indications. The surgical procedures described are those whose value has been demonstrated through the years.

Chapters devoted to the spastic hand in infantile hemiplegia, Volkmann's ischemic contracture, and ulnar drift of the fingers in rheumatoid arthritis have been completely revised and enlarged.

Ischemic contracture of the intrinsic muscles of the hand is identified as Finochietto's deformity since this author described for the first time its pathophysiology, clinical picture, and surgical treatment.

We wish to give our thanks to the hand surgeons of my Surgical Service at the Rehabilitation Center, Drs. S. Fazzini and F. Aponte for their close collaboration in the daily surgical work which has been the basis for many of the conclusions in this monograph. I thank particularly Dr. E. Cozzi for his very valuable contribution of much of the anatomical work here presented.

I deeply appreciate the wonderful cooperation of my wife, as well as her constant support. I thank also Mrs. Flora de Bergamalli for her cooperation in the translation to English.

EDUARDO ZANCOLLI

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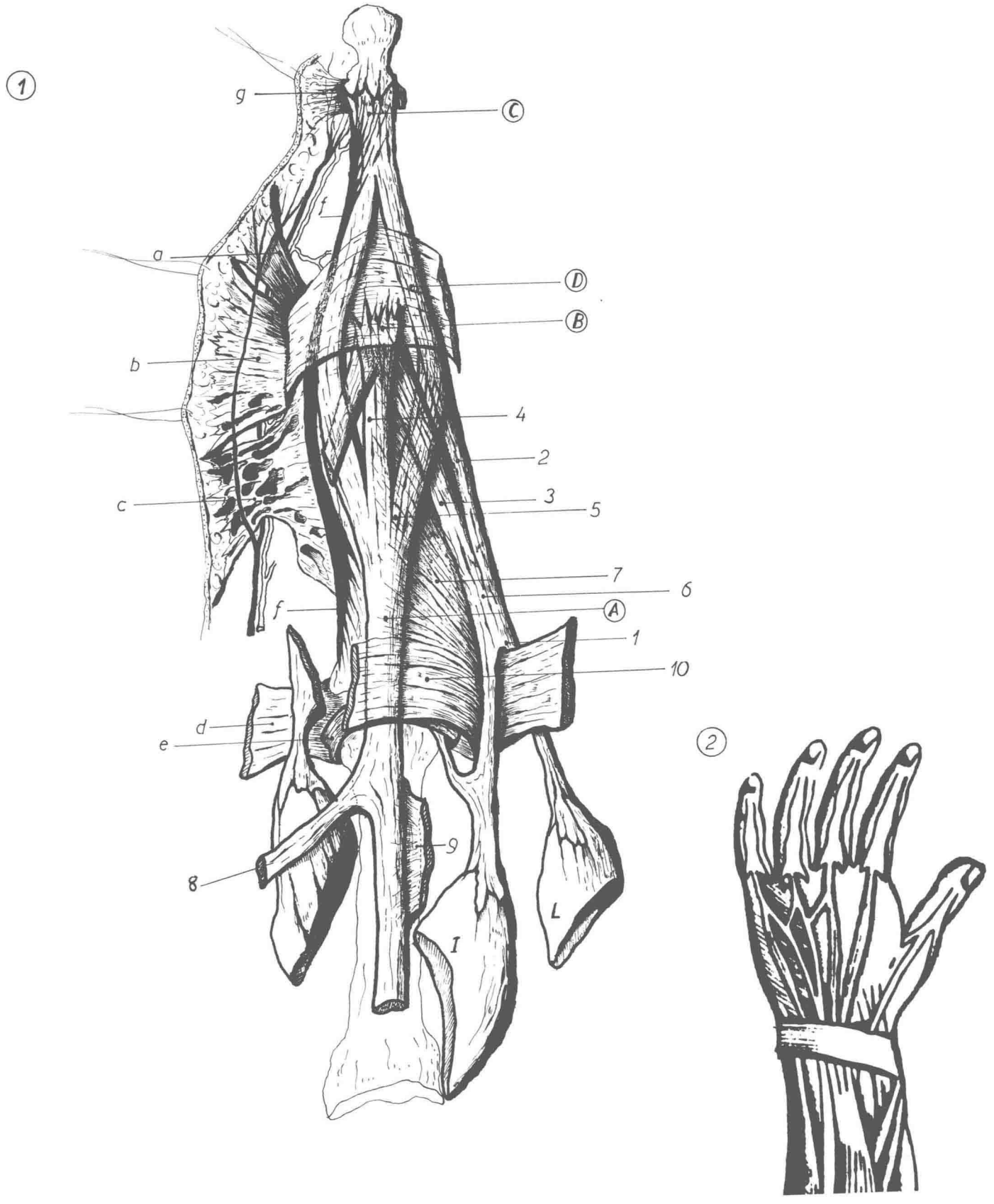
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1 Anatomy and Mechanics of the Extensor Apparatus of the Fingers

The *extensor apparatus* of the fingers, because of its anatomic and functional complexity, and because of its abundant pathology, has in recent years been of particular interest to those surgeons specialized in the reconstructive surgery of the hand. This interest is due to the fact that surgical methods employed to correct digital deformities, whether consecutive to lesions or dysfunction of the extensor mechanism, demand a thorough knowledge of the characteristics of the extensor apparatus so as to enable the reproduction of its morphological and functional structure with the greatest similitude to normal.

Our intention in this chapter is to study the *structure and function* of the extensor apparatus, which represents a true tendinous plexus where the terminal tendons of the extrinsic and intrinsic muscles mix with the fibers of the digital retinacular system.

In its *mechanics* the extensor apparatus basically produces the *extension of the digital joints*, but also determines *some of the characteristics of digital flexion* (simultaneous digital flexion) and intervenes in the *production of special digital positions as the intrinsic-plus and hook flexion.*

Fig. 1-1. 1. The extensor apparatus here represented is of the middle finger of the left hand.

The tendinous system: (*A*) Long digital extensor tendon. (*B*) proximal conjoint extensor tendon. (C) Distal conjoint extensor tendon. (*D*) Lateral conjoint extensor tendon.

(*1*) Interosseous-lumbrical tendon. (*2*) Poirier's lateral fibers. (*3*) Poirier's medial fibers or "spinal fibers." (*4*) Middle or central band of the extensor tendon. (*5*) Extrinsic lateral band. (*6*) Intrinsic lateral band. (*7*) Fan fibers or interosseous triangular lamina. (*8*) Intertendinous band between the middle and ring fingers. (*9*) Intertendinous fascia between the long extensor tendons of the middle and index fingers. (*10*) Metacarpophalangeal or extensor hood formed by the interosseous hood and the metacarpophalangeal girdle or saggital bands. (*L*) Lumbrical muscle. (*I*) Second dorsal interosseous muscle.

The retinacular system: (*a*, *b*, and *c*) Distal, middle and proximal parts of the cutaneous ligament at the level of the middle digital joint. (*d*) Deep transverse intermetacarpal ligament. (*e*) Metacarpophalangeal fibrous girdle. (*f*) Longitudinal cords of the lateral retinacular ligament (Landsmeer's oblique band). (*g*) Cleland's cutaneous ligament at the level of the distal interphalangeal joint. In this figure are not represented the distal fibers of the interdigital ligament and midpalmar fascia that mix with Cleland's cutaneous ligament (Figs. 1-13 and 1-14).

2. The original drawing of the extensor mechanism by Bartolomeo Eustachio (16th century). We observe the correct anatomy of the extensor tendons of the fingers and the prolongations of the thenar intrinsic muscles to the extensor pollicis longus.

ANATOMY

According to our interpretation the extensor apparatus or extensor mechanism of the fingers is not only represented by the extrinsic and intrinsic terminal tendons but also by the different ligamentous structures that constitute the so-called retinacular system of the digits. Therefore in describing the extensor apparatus we shall consider two types of structural systems: the *tendinous system* and the *retinacular system* (Fig. 1-1).

The description presented here is based on the classical knowledge on the subject and also on our investigations of cadaveric dissections and surgical observations. Several anatomical experiments have been carried out with the intention of demonstrating the functional significance of the different components of the extensor apparatus.

THE TENDINOUS SYSTEM

The tendinous system is represented by the terminal tendons of the extrinsic and intrinsic muscles.

(Text continues on p. 6)

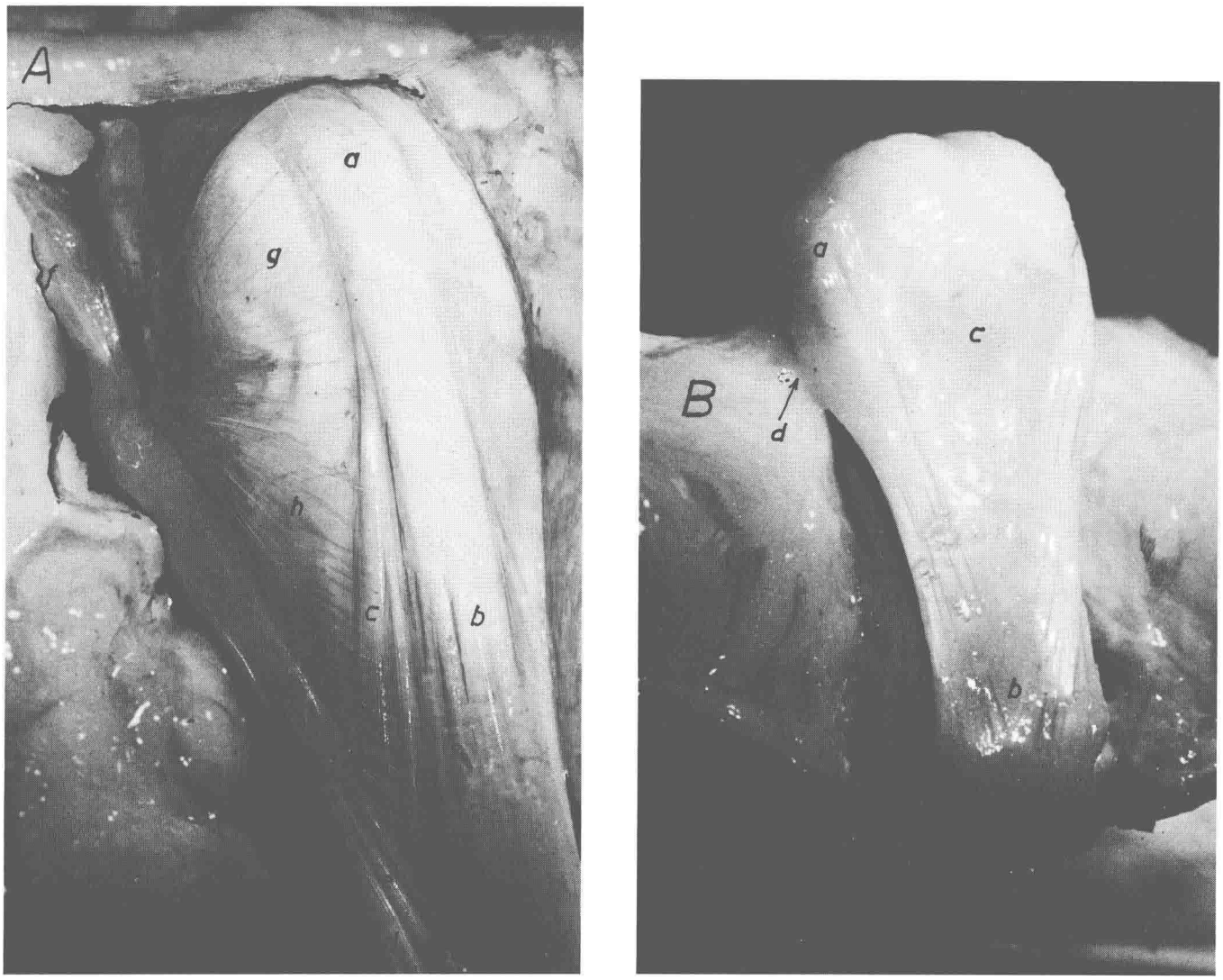
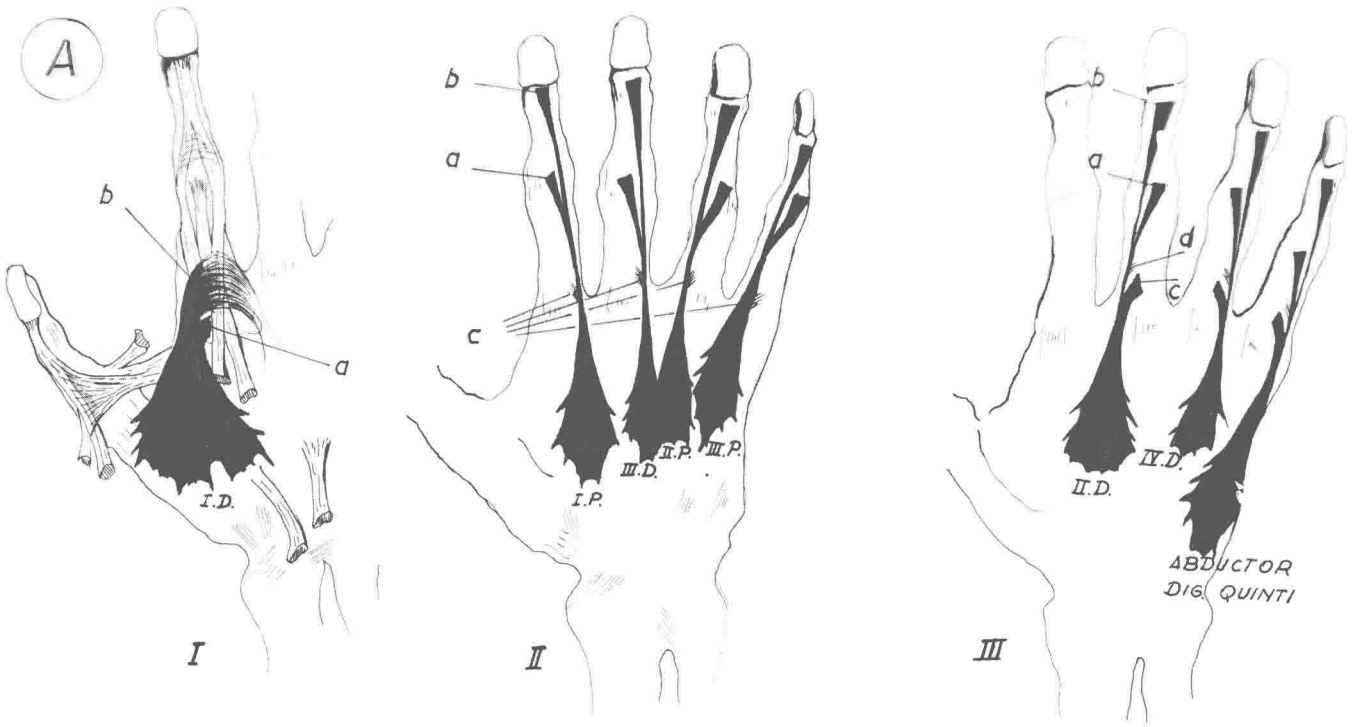


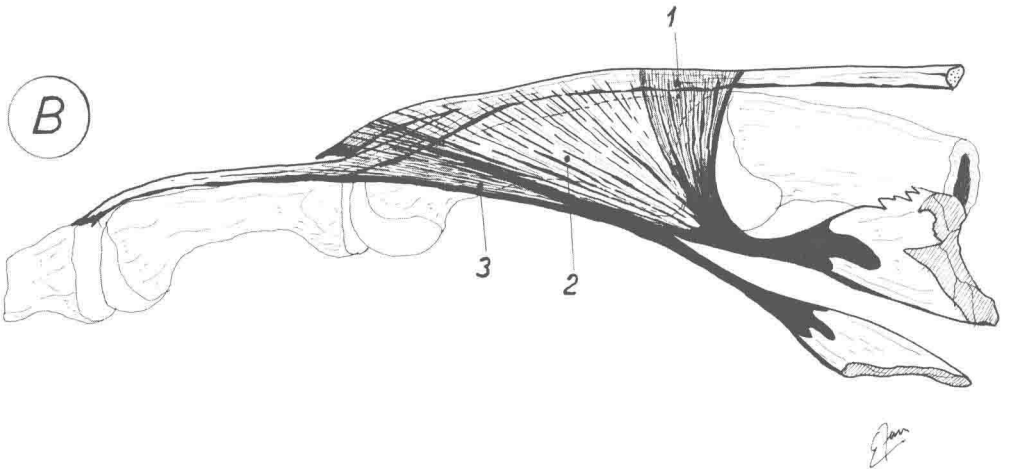
Fig. 1-2. A. The extensor apparatus over the dorsum of the proximal phalanx with the proximal and middle joints flexed. (*a*) Long extensor tendon. (*b*) Central band. (*c*) Extrinsic lateral band formed by various tendinous strips. (*d*) Poirier's lateral fibers. (*e*) Poirier's medial fibers. (*f*) Interosseous muscle. (*g*) Interosseous hood. (*h*) Fan fibers or interosseous triangular lamina.

B. The extensor apparatus over the dorsum of the two last phalanges. (*a*) Lateral conjoint extensor tendons. (*b*) Distal conjoint extensor tendon. (*c*) Triangular ligament. (*d*) Cleland's cutaneous ligament adherent to the skin.

Fig. 1-3. A. Grouping of the interosseous muscles according to their most common digital insertions. *Type I, or proximal.* This type is represented by the first dorsal interosseous muscle with its profound insertion (*a*) at the radial tubercle of the first phalanx base, and its wide and powerful superficial insertion (*b*) in the long extensor tendons of the index. *Type II, or distal.* These are formed by the palmar interosseous muscles: first, second, and third, and by the third dorsal. All of them fundamentally lead toward the middle (*a*) and distal phalanges (*b*), but have a weak proximal insertion (*c*) in the distal part of the metacarpophalangeal volar plate (capsular insertion). *Type III, or mixed.* These are formed by the second and fourth dorsal interosseous muscles. The abductor digiti quinti muscle has been included in the drawing because of its similarity of digital insertion with respect to the interossei of the mixed type. These muscles insert in the base of the middle (*a*) and distal phalanges (*b*), and also proximally at the metacarpophalangeal level. At this level they have a bony insertion (*c*) dependent on its profundus fascicles and an insertion in the volar plate (*d*) dependent on the superficial fascicles.

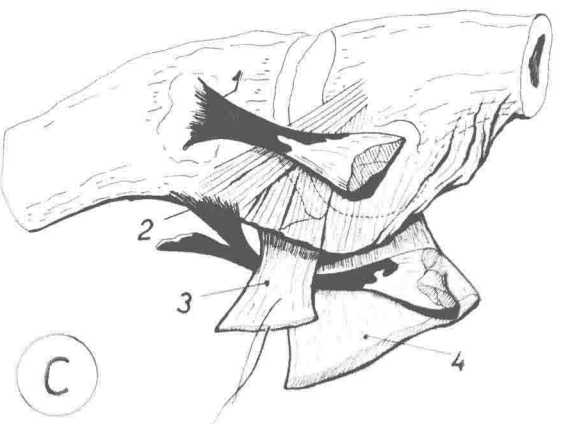
B. Superficial insertions of the interosseous muscles. (*1*) Proximal or transverse fibers (interosseous hood). (*2*) me-





dian or oblique, or fan fibers. (3) Distal or very oblique fibers which form the medial and lateral divisions of Poirier. These insertions fundamentally depend on the distal interossei and the superficial fascicles of the mixed interossei. The first dorsal interosseous only forms the transverse fibers of the interosseous hood.

C. Profound insertions (schematic drawing). (*1*) Insertion at the lateral tubercle of the proximal phalanx, dependent on the profundus fascicle of the dorsal interossei of the proximal and mixed types. (*2*) Insertion in the distal part of the metacarpophalangeal volar plate dependent on the distal-type interossei and on the superficial fascicle of the mixed interossei. (*3*) Metacarpophalangeal fibrous girdle. (*4*) Deep transverse intermetacarpal ligament.



Terminal Extrinsic Extensor Tendons

The terminal extrinsic extensor tendons are represented by the extensor digitorum communis tendons and the extensor proprius of the index and the little fingers, which are connected by the intertendinous bands (juncturae tendinum). These tendinous connections have been identified since the time of the studies of the initial anatomists of the sixteenth century (Figs. 1-1 and 1-34).[73, 248] As we observe in Chapter 4 (Fig. 4-10), the more developed intertendinous band is the one between the extensor tendons of the middle and ring fingers. This band, studied with the fingers extended, runs obliquely, distally from the extensor tendon of the ring finger to the middle finger tendon. The intertendinous band between the ring and little finger tendons is formed by the division of the extensor digitorum communis tendon of the little finger which runs very closely to the long extensor tendon of the ring finger. Between the index and the middle fingers, the intertendinous union is usually represented by a thin and wide fascia, condensed at times in its distal part, which joins their extensor digitorum communis tendons. The extensor indicis proprius runs profoundly to this fascia and by the ulnar side of the corresponding extensor digitorum communis tendon. All of the long extensor tendons, on reaching the metacarpophalangeal joint, are fixed by their profound and central aspect, throughout a long and lax fibrous expansion to the capsule and by it to the base of the proximal phalanx (Figs. 1-5 and 1-10). This fibrous expansion was mentioned by Horner[118] and later described in detail by Cruveilhier in the first edition of his *Traite d'Anatomie Descriptive* (1837).[56] In our description, this insertion will be called *deep central expansion of the long extensor tendon* of the fingers. Its great laxity allows the complete excursion of the extensor mechanism during digital flexion and extension, and it only obtains complete tension when the metacarpophalangeal joint totally hyperextends (Figs. 1-24 and 1-32). Also, at the metacarpophalangeal level, the long digital extensor tendons are joined at their lateral borders to the interosseous muscles, through the so-called *interosseous hood* ("dossier des interosseux" by Montant and Baumann),[174] and to the deep transverse intermetacarpal ligament and capsular joint by means of the structure usually known as the *sagittal band*,[240] but which we shall henceforth call the *metacarpophalangeal fibrous girdle*. Both structures, the interosseous hood and the metacarpophalangeal fibrous girdle, shall be identified as the *metacarpophalangeal extensor hood*. (The interosseous hood as well as the metacarpophalangeal fibrous girdle shall later be described in detail, not only their anatomy but also their functions.)

Following the long extensor tendon of the digits throughout its course distally, it is observed that at the level of the proximal phalangeal diaphysis it divides into a *middle band* (extrinsic middle or central band) that inserts at the base of the middle phalanx and *two lateral bands* (extrinsic lateral bands) which, joining with the fibers coming from the intrinsic muscles, form the *conjoint lateral extensor tendons* (Fig. 1-1).

We agree with Kaplan[134] that the extrinsic lateral bands are not neatly formed compact structures, but that they are made up of a real "fan" of fibers, as it is possible to observe in Fig. 1-2. The lateral bands of the long extensor tendon were initially described by Winslow (*Exposition Anatomique de la Structure du Corps Humaine*).[256] According to Winslow the two extrinsic lateral bands form a *tendinous rhombus* between themselves on the dorsum of the fingers which is held from its sides by the ending of the interosseous and lumbrical tendons. This formation shall be identified in our descriptions as the *Winslow's tendinous rhombus* (Fig. 1-32).

Terminal Tendons of the Intrinsic Muscles

The tendons of the interosseous and lumbrical muscles end at the level of the fingers in different structures of the extensor mechanism and at the bones themselves, producing, through these insertions, their specific functions. We shall here describe in particular the anatomy of the tendons of the interosseous muscles, given their greater functional and pathologic significance. The lumbrical muscles placed normally at the radial side of the fingers meet the more distal fibers of the interosseous, forming the *intrinsic lateral bands* of the extensor mechanism.

The importance of the description of the different *insertions of the interosseous muscles* in the fingers lies in the great significance these insertions have for the different functions of the hand. This study will allow us to classify these muscles according to the anatomy of their digital insertions.

Albinus (1734) initially classified the interosseous muscles into *dorsal* and *palmar* according to their proximal insertions at the metacarpal level (*metacarpal insertions*). This nomenclature is still important in relation to the laterality movement of the fingers, since the dorsal interossei produce abduction whereas the palmar interossei produce adduction. These laterality movements can be produced by each interosseous muscle, independently from the rest, or produced by the simultaneous action of all the interossei which form each group.

Another way to classify the interosseous muscles has been based on their distal insertions at the level

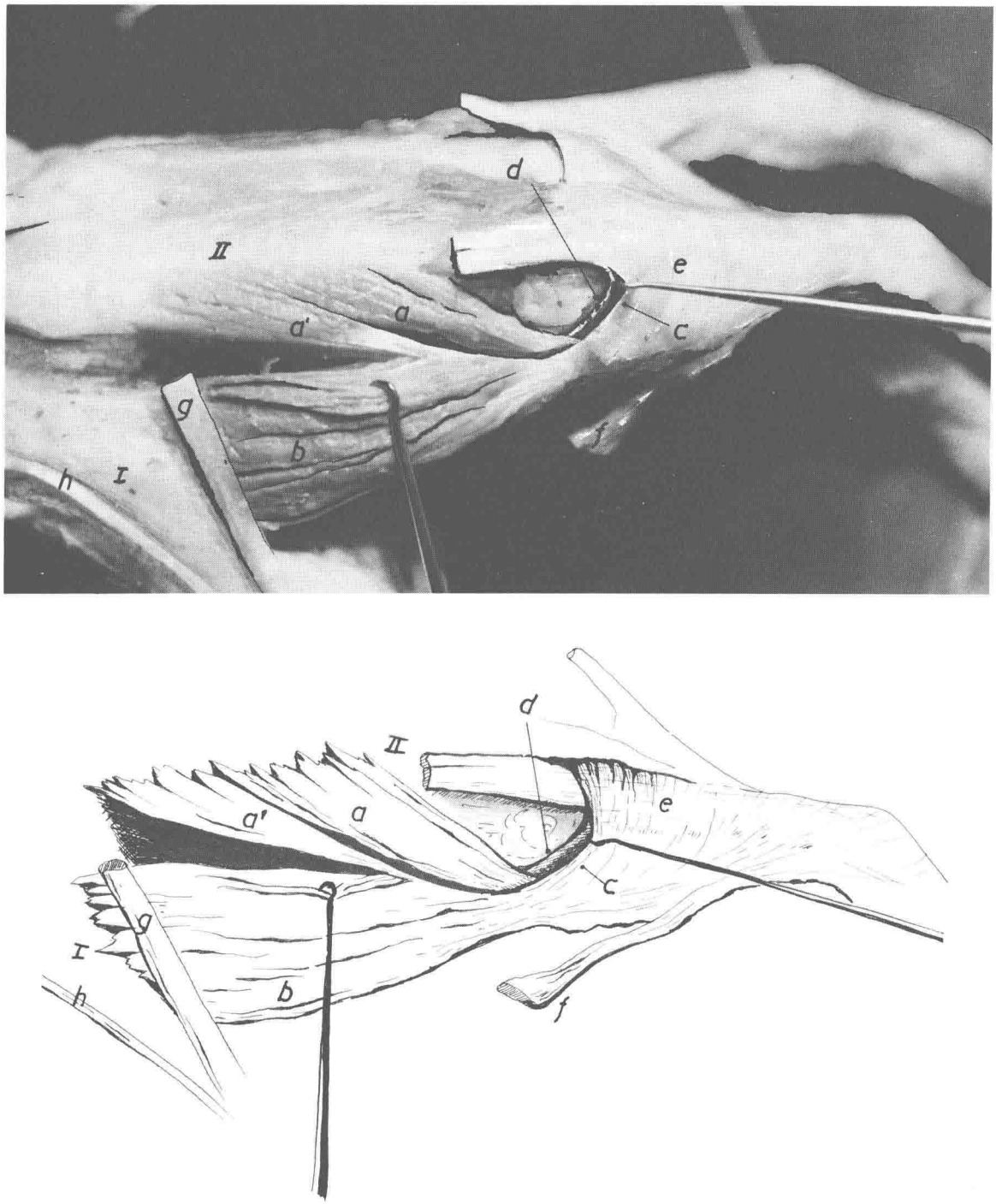


Fig. 1-4. First interosseous dorsal muscle, with (*a*, *a'*) profundus parts; (*b*) superficial part; and (*c*) interosseous hood which has been lifted with a hook to reveal the metacarpophalangeal fibrous girdle (*d*). The interosseous hood and the fibrous girdle join together next to the lateral border of the long extensor tendon. Both structures, with didactic aim, can be called the *metacarpophalangeal extensor hood.* (*e*) Extensor communis tendon. (*f*) Lumbrical muscle. (*g*) Extensor pollicis longus. (*h*) Extensor pollicis brevis. (*I*) First metacarpal. (*II*) Second metacarpal.