Hand and Wrist Anatomy and Biomechanics

A Comprehensive Guide

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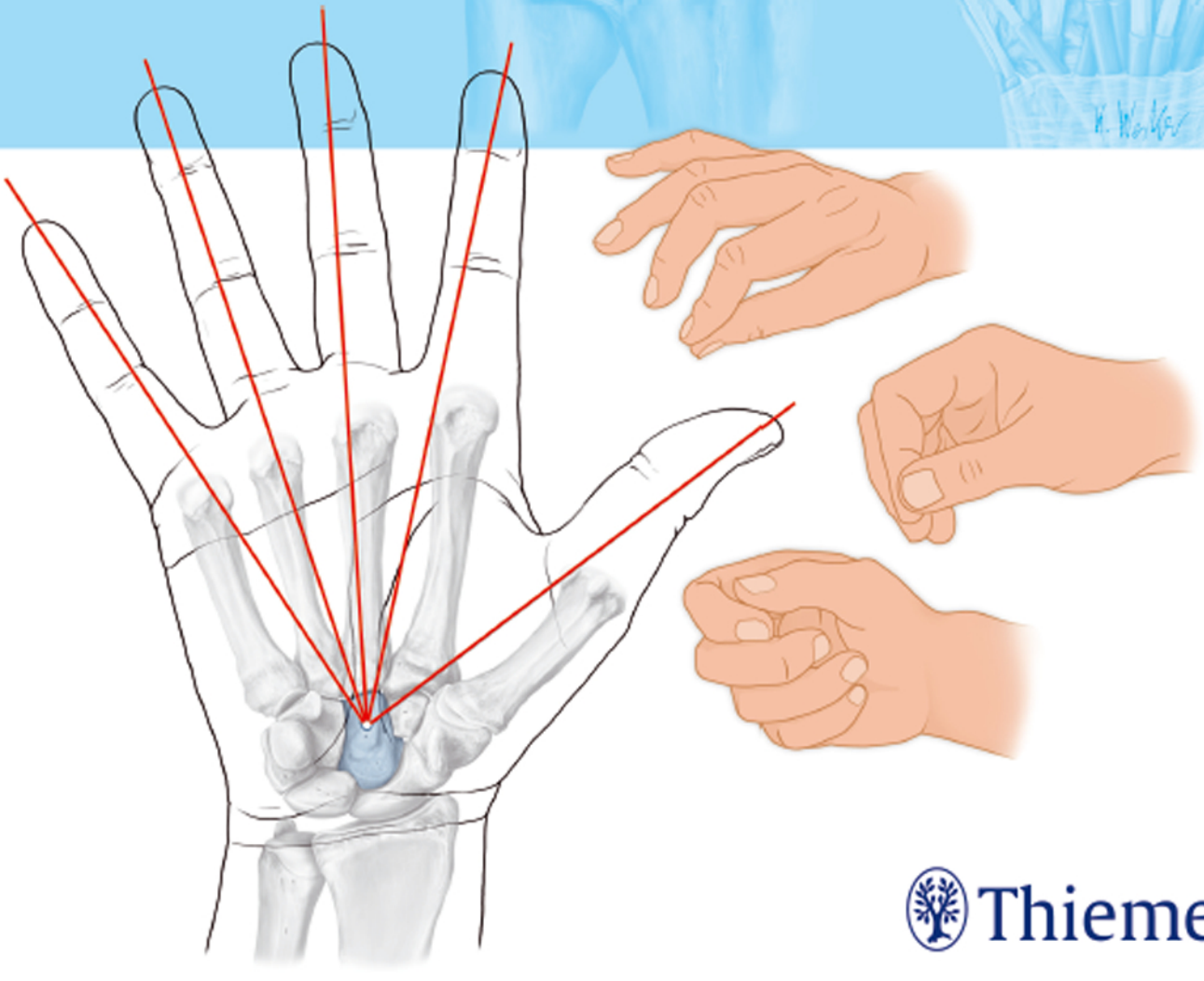

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A Comprehensive Guide

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Preface

In order to diagnose and treat hand disorders, medical professionals must be intimately familiar with the anatomical structures in question. They must also understand their specific functions in terms of biomechanics and have the practical skills needed to determine and palpate them. These skills are indispensable for physicians, occupational therapists, and physical therapists when choosing the best treatment for the patient.

While there are many books available on the anatomy, surface anatomy, and kinematics of the hand, no book to date has gathered all of these disciplines in a single volume. When practitioners work with patients, they need to address these aspects simultaneously. They are forced to consult a number of different books when treating a single patient. In many cases the particular reference needed is not in the practitioner's library—or the information in the book to hand is too detailed for a salient answer to be found in the time available. As we planned this book, we felt that several features were essential: it needed to have a convenient format; it should cover all important aspects of this broad spectrum; and can be referred to quickly and easily wherever hand injuries and conditions are diagnosed and treated.

We hope that we have met our goal in *Anatomy and Biomechanics of the Hand* with regard to both subject matter and ease of use. This book is intended to help health care professionals diagnose and treat patients more efficiently and to provide a solid foundation for interdisciplinary communication among all of the professionals involved. "If we expect to understand each other, we all need to speak the same language."

Prof. Bernhard Hirt, MD
Harun Seyhan, MD
Michael Wagner, PT
Rainer Zumhasch, OT

Acknowledgments

We would like to thank Mr. Klausch for editing the images for this book, as well as Ms. Cornelia Paries for the wealth of tips and suggestions for improving the text. We are also grateful to our family members, to whom we dedicate this book, Anatomy and Biomechanics of the Hand. They picked up the slack for us, allowing us to complete this book in a timely manner despite all of our other professional commitments. Special thanks go to the wife of Rainer Zumhasch, who exhibited a great deal of patience and understanding as she allowed us to draw the anatomical structures on her arms and hands. In so doing, she made a valuable contribution to conveying the knowledge in a way that is easy to see and understand.

Furthermore, we would like to thank all of the participants in our seminars at the Academy of Hand Rehabilitation, Bad Münder, Germany. It was their requests for information on various topics that inspired us to write this book.

We also gratefully acknowledge the entire staff of Thieme Publishers. Our cooperation was always pleasant and quickly grew into a collaboration characterized by friendship. When selecting the numerous anatomical illustrations, they respected our wishes, worked meticulously and ensured that the images underpinned the individual text passages.

Particular thanks go to the Department of Anatomy at the University of Tübingen, Germany, which assisted us in both word and deed at all times.

Finally, we would also like to thank all of the readers of this book. We thank you for choosing this publication and hope that we have been able to address your needs.

Chapter 1

Anatomy and Functional Anatomy of the Hand

1 Anatomy and Functional Anatomy of the Hand

1.1 Introduction

In their biological taxonomy and status as "higher-level mammal—homo sapiens," humans owe their distinction from primates to the miraculous structure of the hand. With its 19 degrees of freedom and its opposing thumb, the hand is a highly developed and complex grasping organ. This enables a wide range of movement combinations while simultaneously allowing adaptation of force, speed, and facileness. Moreover, the hand also features a highly specific sensory and tactile organ that human beings use to perceive and assess themselves and their surroundings. Owing to its capacity for making gestures, the hand plays an important role in interpersonal communication. In writing, music, and the visual arts, the hand acts as a means of expression for the human mind.[229] These gross and fine motor skills, along with sensory capacities, enable humans to take care of and nourish their bodies, as well as communicate and shape their environment. With all these possibilities, the hand also plays a major role in self-expression and in developing the human mind, and significantly contributes to modifying human motor capacities.[202] The mobilizing of this functionality requires exceptional interaction between the central control system and anatomical structures such as bones and joints, muscles and tendons, nerves and blood vessels, making the hand an extremely complex organ.

The distal area of the lower arm consists of the distal radioulnar joint, the thumb and finger carpometacarpal (CMC) joints, the palm, and the fingers. In total, there are 27 bones with 36 articulations and 39 active muscles. In order for the hand to translate its wide range of fine and gross motor capabilities into its complex range of motion, these structures must all be coordinated.

1.2 Structure and Function of the Proximal and Distal Radioulnar Joints

The forearm skeleton consists of two bones: the **ulna** (elbow bone) and the **radius**. These two bones form two radioulnar joints, one near the elbow (**proximal radioulnar joint**) and one near the wrist (**distal radioulnar joint**) (▶ Fig. 1.1). Pronation and supination movements are performed by these two joints with a contribution from the **shoulder joint** (▶ Fig. 1.2).[233] During this movement, the radius takes a conical path, in which the rotation axis courses from the radial head through to the distal end of the ulna.[3] In so doing, the radial head rotates around itself within the anular ligament (wide ringlike band) in the proximal radioulnar joint, while the radius simultaneously moves around the ulna (ulnar head) in the distal radioulnar joint. During **supination**, the radius and ulna are parallel, whereas these two cross during pronation, with the radius overlying the ulna. The range of the forearm's rotational motion is between 140° and 150°.[190] During **pronation**, the ulna glides more toward the dorsal aspect, and during supination it glides more toward the palmar aspect,[262] which extends the movement to 180°.[229] The range of motion from the neutral zero position for pure pronation and supination is therefore approximately 80° to 90°–0–80° to 90°, or an average of 85° supination and 90° pronation.[233] With the contribution of the shoulder joint (continued movement), this range can increase to up to 230°.[256] These possibilities of additional and substitute movements can simulate movements in the radioulnar joint by means of "pseudo-movements."[149] The hand must follow these movements, since the proximal condyloid wrist joint does not allow any compensatory movements.[149]

In functional terms, the **proximal radioulnar joint** is a **pivot joint**. It consists of the convex surface of the articular circumference of the radius and the concave surface of the radial notch of the ulna.

The **distal radioulnar joint**, also functionally a **pivot joint** (▶ Fig. 1.3), consists of the convex semicylindrical surface of the articular circumference of the ulna, which is completely covered with cartilage, and the associated concave joint surface of the ulnar notch on the distal radius. The joint is enclosed by a thin connective-tissue capsule that has no stabilizing properties.[49] Its loose

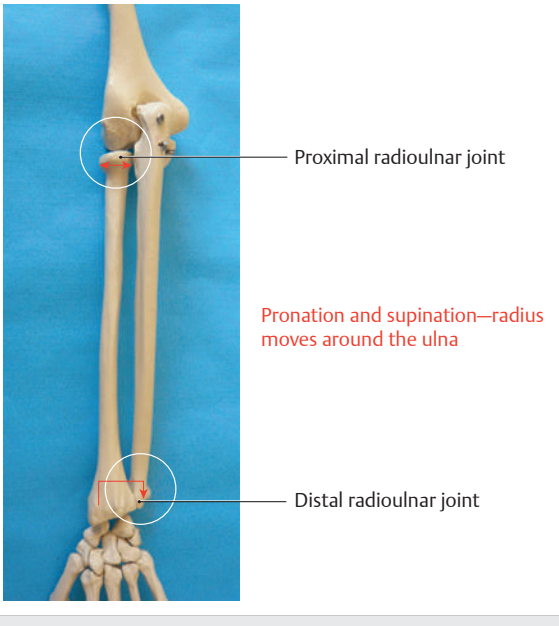

Fig. 1.1 Distal and proximal radioulnar joints.