FUNCTIONAL ANATOMY for Occupational Therapy

Nathan Short
Joel Vilensky
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Free **Goniometry** and **MMT** eTextbook included

DISCOVER
Books of Discovery

What educators are saying about *Functional Anatomy for Occupational Therapy*

At last, a textbook written by an OT, for OT education at every level. Throughout, this textbook guides the student's thought process towards occupation-based reasoning in every chapter. Anatomy has become functional and certainly more relevant to the entry-level OT and OTA student.

ADA HOERL, MA, BS, AS IN OCCUPATIONAL THERAPY
Professor, Occupational Therapy Assistant Program,
Sacramento City College, Sacramento, CA

This is the first anatomy textbook that focuses on the specific requirements of the occupational therapy curriculum.

JOYDEEP CHAUDHURI, MD
Professor, School of Occupational Therapy, Husson University, Bangor, ME

Functional Anatomy for Occupational Therapy is an occupation-centered text where all the topics relate back to occupation and function. Embedding this meaning into the text will improve student learning and application of the knowledge.

GABE BYARS, MS, OTR/L, LSVT-BIG, MSCS
Assistant Professor, Occupational Therapy Assistant Program,
Salt Lake Community College, Salt Lake City, UT

Excellent book to provide the foundations of functional anatomy for students and a great refresher for clinicians and academicians!

CARRIE CIRO, PHD, OTR/L, FAOTA
Associate Professor of Occupational Therapy,
University of Oklahoma Health Sciences Center

This book is definitely needed and will hopefully become a staple in all OT programs.

BETH ROROS, CHT
Assistant Professor, Delaware Technical Community College, Georgetown, DE

This well-designed and beautifully illustrated textbook of functional anatomy will be an excellent resource for entry-level OT students.

PATRICIA HENTON, OTD, OTR/L, ICA, CEIM
Assistant Professor, OTD Program, Huntington University, Huntington, IN

Functional Anatomy for Occupational Therapy is the "just right challenge" to optimize learning for occupational therapy students. It includes the correct amount of depth with adequate detail, yet it does not oversimplify things. It is written specifically for occupational therapy students and puts occupation in the forefront. As always with Books of Discovery textbooks, the exceptional images add to the clarity of the concepts. I think occupational therapy students will engage with this text and enjoy learning the important foundational content.

SUSANNE HIGGINS, OTD, OTR/L, CHT
Associate Professor, Occupational Therapy Program,
Midwestern University, Downers Grove, IL

Getting Oriented

If you are reading this book, you are likely beginning your journey as an occupational therapist (OT) or occupational therapy assistant (OTA). Like many OTs or OTAs, you may feel a sense of calling or higher purpose to serve others and see them achieve their full potential. Perhaps you want to work with children, using play-based interventions to help them reach developmental milestones. Or your journey could lead to a rehabilitation setting, helping individuals recover the ability to complete their **activities of daily living (ADLs)** and **instrumental activities of daily living (IADLs)**.

Regardless of the setting or population, you will be part of a distinct profession with the common goal of helping people do the things they love and live their lives to the fullest.

What purposeful activities are most meaningful to you? As a full-time professor and parent, I enjoy recreational cycling as an opportunity to be outdoors and exercise. Biking to work on a nice day combines several occupations—leisure, community mobility, and health management—and it saves gas money! While the physical act of cycling involves muscle coordination, strength, and balance, the personal meaning and intrinsic motivation are what get me out of bed early to ride, distinguishing *occupation* from merely physical function.

The Language of Occupation

As an occupation-based student and future clinician, you will need to be familiar with some language specific to the profession. While you might not use these exact terms when talking to a patient, having a shared understanding of these words and concepts is key to facilitating professional discussion. The definitions that follow are adapted from the *Occupational Therapy Practice Framework*, fourth edition (OTPF-4).[1]

Occupations, or everyday activities that people do to bring meaning and purpose to life, include ADLs, IADLs, rest and sleep, education, work, play, leisure, health management, and social participation (**1.1**).[2] **Occupational performance** is the act of completing these meaningful activities by a person (such as an individual patient or caregiver), group(s) (several individuals with shared characteristics, such as a support group), or population(s) (an entire community of persons, such as all employees of a business). **Performance skills** are goal-directed actions that contribute to occupational . . .

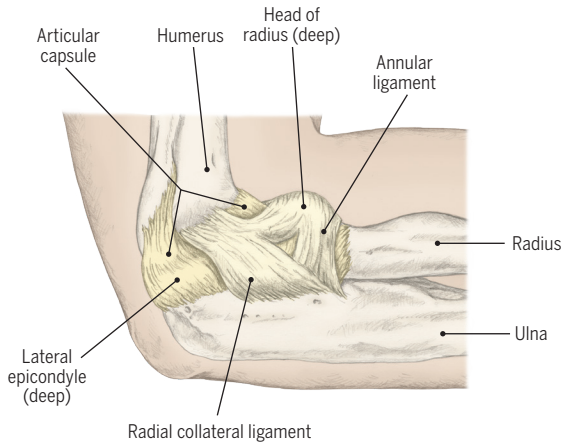
Proximal Radioulnar Joint

Structural classification: pivot
Functional (mechanical) classification: uniaxial
Movements: pronation, supination

The **proximal radioulnar joint (PRUJ)** is a pivot joint, permitting only axial rotation. This motion results in pronation and supination of the forearm and hand, which is carried along with rotation of the radius around the ulna.

The radial head, a component of the PRUJ, is held in the radial notch of the ulna by the **annular ligament** of the radius (**6.15**). This ligament wraps around the circumference of the radial head.

The annular ligament has an inferior rim that is important for preventing a distal dislocation of the



Lateral view of right elbow, showing humeroulnar and proximal radioulnar joints

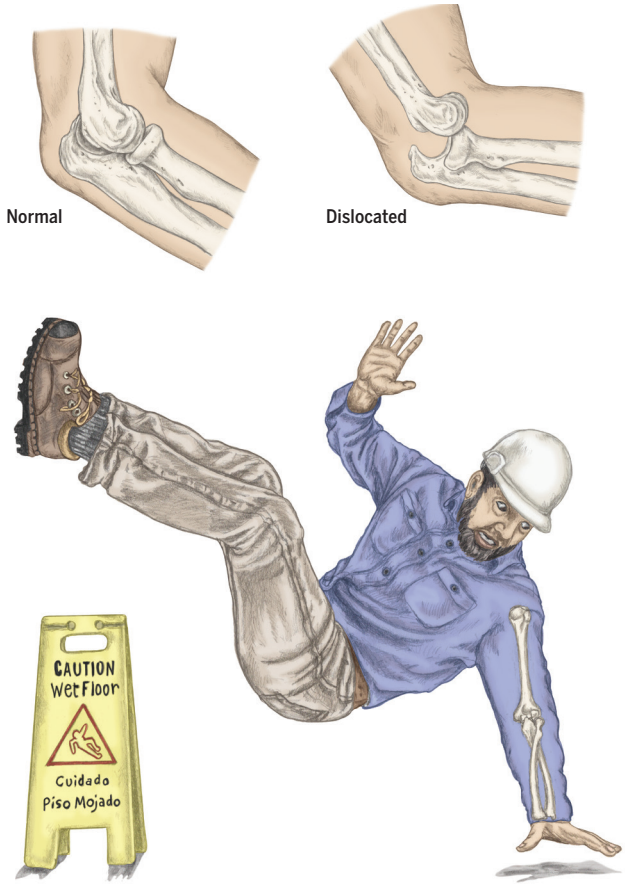
6.15 Ligaments of the elbow

CLINICAL APPLICATION
Elbow Dislocation

Many patient injuries to the upper extremity that you may encounter as a future clinician occur as a result of a fall. Elbow dislocations are frequently related to a fall-on-outstretched-hands (FOOSH) injury or other trauma that forces the ulna posterior relative to the distal humerus (**6.16**).

Elbow joint dislocation is almost always posterior. This injury is a clinical emergency because of the many neurovascular structures that cross the joint. Nerves and blood vessels move relatively freely in the soft tissues of the upper arm. However, the upper arm narrows as it moves toward the elbow, creating an anatomical choke point for these neurovascular structures as they pass through to the forearm. Dislocation disrupts these tightly engineered spaces and can place damaging tension or compression on the ulnar, radial, or median nerves, with potentially long-term functional consequences. Closed reduction or surgical repair attempts to restore the anatomical position and stability of the elbow while preserving neurovascular function.

Rehabilitation often involves a period of immobilization to encourage stability of the joint, followed by interventions to safely restore motion, strength, and function. What functional limitations would an individual experience with stiffness of the elbow and forearm after immobilization? What compensatory or adaptive techniques might be beneficial?



6.16 Fall on outstretched hands (FOOSH) resulting in a posterior elbow dislocation

PRUJ, or the radius being displaced distally. However, in young children, the head of the radius is still largely cartilaginous and, consequently, deformable. If a child's muscles are relaxed, a strong distal pull on the forearm can result in a partial descent of the radial head through the inferior opening in the annular ligament. This condition is traditionally called "nursemaid's elbow" because it often arose from an impatient caregiver yanking on a child's hand in an upward motion or swinging the child around by the arms, creating traction of the radius.

Limitations of individual or multiple joints involved in forearm rotation—the humeroradial joint, PRUJ, and distal radioulnar joint (DRUJ) (see Chapter 7)—may limit functional motion of the entire forearm. Functional rotation of the forearm and associated compensatory patterns are described later in this chapter.

TRY IT

Let's explore self-feeding as an ADL that requires simultaneous elbow and forearm motion. First, find an apple or other piece of fruit. What motions are involved with simply picking up the fruit and taking a bite? Mimic these actions as you conceptualize them.

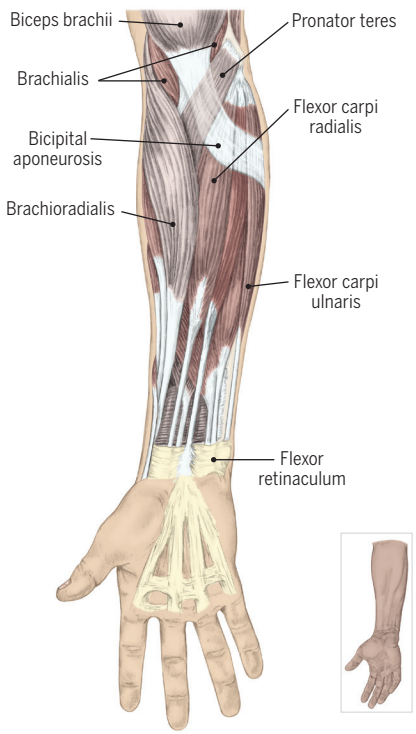
Now consider a patient who has sustained an injury with significant limitations in forearm rotation. Try to pick up the fruit and take a bite while keeping your forearm in a neutral position without rotating it (thumbs up). What happens?

Did you notice your shoulder naturally begin to compensate? What shoulder motions might compensate for a loss of forearm pronation or supination?

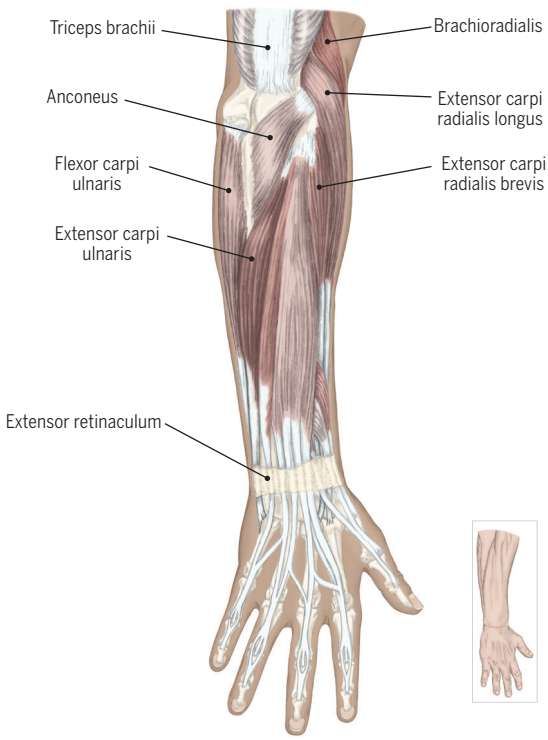
In your future practice, if you are working with a patient to restore true forearm rotation, you may want to prevent this compensatory pattern of shoulder motion. For someone with more permanent loss of forearm mobility, how might this substitute movement serve as a beneficial compensatory strategy?

Musculature and Movement

The muscles of the elbow and forearm (**6.17**–**6.19**) relate to occupational performance beyond simply lifting or carrying objects. Consider their broader capabilities: How might these muscle groups enable the motor performance skills involved in ADLs or IADLs as well as functional mobility? As you work through this section, think of additional functional examples.



6.17 Anterior view of right forearm

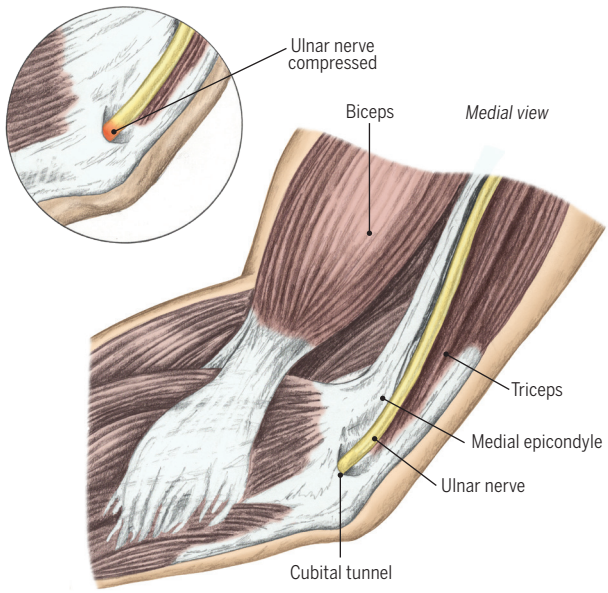


6.18 Posterior view of right forearm

CLINICAL APPLICATION
Cubital Tunnel Syndrome

Refer to Figure **6.26** and take a close look at the ulnar nerve pathway. Do you notice how it disappears from view once it enters the elbow? The **cubital tunnel** is a bony passageway posterior to the medial epicondyle of the elbow. The roof of this tunnel is elastic and formed by a retinaculum called the **ligament of Osborne**. Chronic compression or tension on the ulnar nerve within the tunnel is known as **cubital tunnel syndrome**.

This syndrome is generally considered a cumulative trauma disorder (CTD). Daily habits or routines involving prolonged elbow flexion, such as texting while lying in bed, may increase internal pressure within the cubital tunnel and can place tension on the nerve, leading to distinct paresthesia (tingling) in the ring and small fingers. How might you modify an individual's habits or routines to prevent these symptoms?



6.26 Cubital tunnel syndrome

Primary Rotators of the Forearm

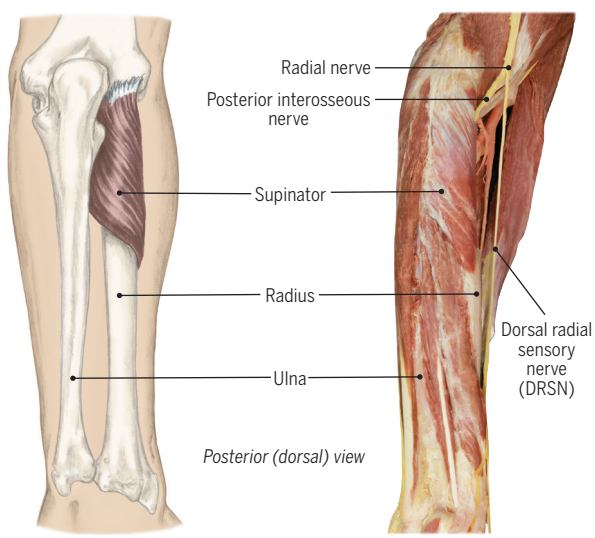
Biceps brachii (see flexors of the elbow)
Supinator
Pronator teres
Pronator quadratus

The primary rotator muscles supply the forces to specifically rotate the forearm for object manipulation, such as when turning a smartphone faceup to read a text message or opening a letter.

Supinator

The **supinator** lies deep to the extensor muscles. Take a close look at the way its fibers are arranged on the dorsolateral forearm (**6.27**).

Do you notice how the supinator crosses the forearm diagonally from the lateral epicondyle of the humerus to the proximal radius? This arrangement is a clear example of structure determining function: the diagonal, or oblique, alignment of the supinator fibers allows



6.27 Supinator

JAMIE ROBBINS | Review Jamie's case so far, along with the Clinical Application feature on cubital tunnel syndrome. Jamie is now complaining of occasional numbness and tingling, mainly in her ring and small fingers. How might these symptoms be related to her daily roles, habits, and routines?

the muscle to rotate the forearm. These motions often occur simultaneously, such as when you use your smartphone to respond to the text message you just received.

The forearm can generate considerably more strength for supination than it can for pronation due to the force generated by the biceps brachii. This is the reason, along with the preponderance of right-handedness, that screws are designed to be tightened by supination as opposed to pronation.

Refer again to the cadaver figure (**6.27**, right). Do you see the nerve that passes beneath the proximal edge of the supinator? This is the deep branch of the radial nerve, which becomes the posterior interosseous nerve (PIN), or motor branch of the radial nerve. As it passes beneath the supinator, the PIN may become compressed, leading to pain and eventual weakness of the extensor muscles of the wrist and fingers. This condition is known as PIN syndrome and may be caused by repetitive forearm rotation with resistance. Can you think of specific work or leisure activities that might increase the risk of PIN syndrome? The superficial branch of the radial nerve, also referred to as the dorsal radial sensory nerve (DRSN), splits off of the main radial pathway. This nerve provides sensory innervation to the radial aspect of the dorsal wrist and thumb.

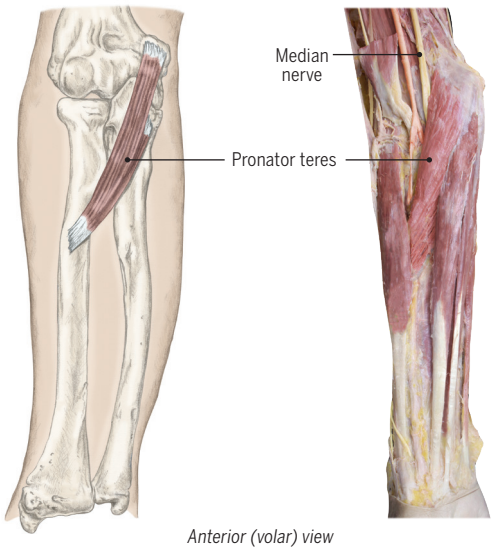
SUPINATOR	
Purposeful Activity	
P	**Using a screwdriver, turning a doorknob**
A	**Supinate** the forearm (radioulnar joints)
O	Lateral epicondyle of humerus, radial collateral ligament, annular ligament, and supinator crest of the ulna
I	Anterior, lateral surface of proximal one-third of radial shaft
N	Radial C5 to C7

Pronator Teres

The **pronator teres** originates primarily from the medial supracondylar ridge of the humerus (**6.28**).

Notice that, similar to the supinator, the **pronator teres** has fibers that are oriented diagonally (oblique), attaching to the radius. However, this muscle is positioned on the anterior forearm and, unlike the supinator, originates on the medial epicondyle. As a result—and as you probably guessed from its name—this muscle pronates the forearm, as when throwing an object into a wastebasket.

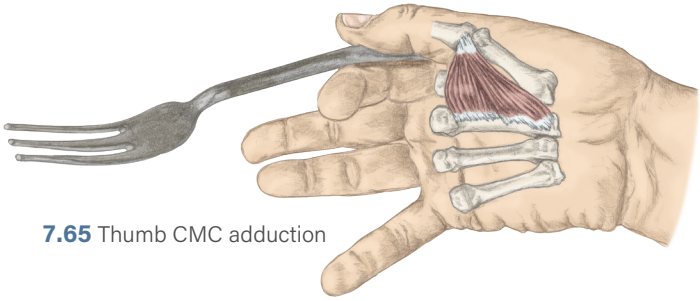
Notice on the cadaver figure how the median nerve enters the forearm between the two heads of this muscle (**6.28**, right). Compression of the median nerve beneath these muscle fibers describes a condition known as **pronator teres syndrome**, which may cause a similar pattern of numbness and tingling in the hand as carpal tunnel syndrome.



Anterior (volar) view

6.28 Pronator teres

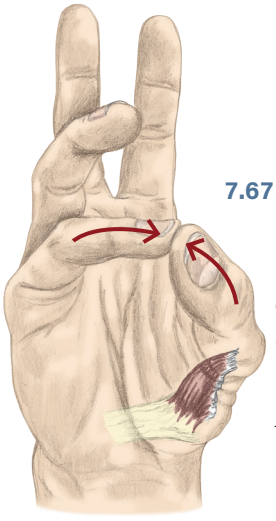
PRONATOR TERES	
Purposeful Activity	
P	**Knitting, pouring coffee**
A	**Pronate** the forearm (radioulnar joints) Assist to **flex** the elbow (humeroulnar joint)
O	Common flexor tendon from medial epicondyle of humerus and coronoid process of the ulna
I	Middle of lateral surface of the radius
N	Median C6 and C7



7.65 Thumb CMC adduction

Thumb CMC Adduction

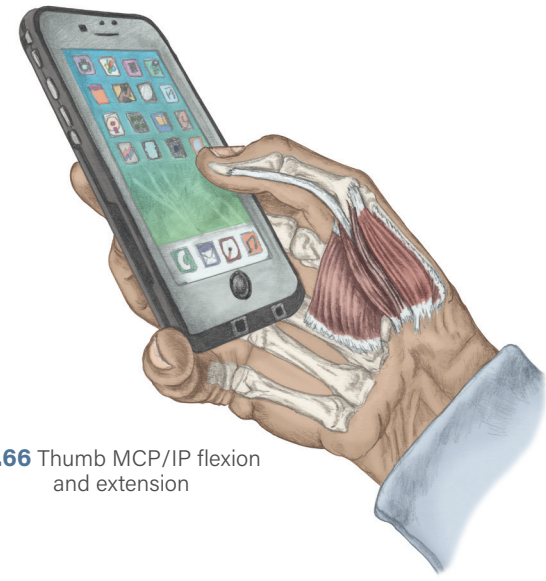
Adductor pollicis
Flexor pollicis brevis*
Flexor pollicis longus (assists)*



7.67 Opposition of the thumb

Opposition

Opponens pollicis
Flexor pollicis brevis (assists)*
Abductor pollicis brevis (assists)*



7.66 Thumb MCP/IP flexion and extension

Thumb MCP/IP Flexion and Extension

Flexor pollicis longus (IP)
Flexor pollicis brevis (MCP)
Adductor pollicis (assists MCP)
Palmar interossei (1st, assists MCP)*

MMT OT Guide to Goniometry & MMT: Wrist and Hand

The musculoskeletal structures that animate the hand are complicated. It takes time and clinical experience to develop familiarity, and there is always something new to learn. To build on the foundational knowledge you have developed, let's practice goniometry and MMT of the wrist, fingers, and thumb using the *OT Guide to Goniometry & MMT* eTextbook. These joints are much smaller and require a higher level of precision to obtain accurate measurements.

Also consider the length-tension relationship we discussed in Chapter 1. It is important to keep the joints that are proximal to the one being measured in a neutral position to prevent passive or active insufficiency from limiting joint motion.

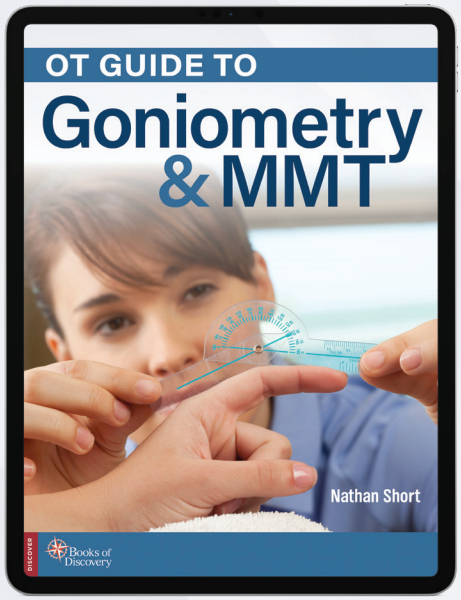
Sometimes a quick approximate measurement of hand motion is needed. In these instances, measuring the distance from the fingertips or thumb to specific landmarks on the palm may be the best option. In other scenarios, using a goniometer is important to measure the exact motion of each individual joint.

Assessing the strength of individual joints of the hand using MMT is also necessary. Sometimes a specific pattern of weakness indicates a particular injury. Overall grip and pinch strength are essential components of object manipulation and grasp. Occupational therapists, along with other health care practitioners, use **dynamometry** to measure grip and pinch strength. A **dynamometer** is a device that measures force production and can be used to assess various grasp and pinch patterns. Similar to range-of-motion measurements, grip and pinch strength values can be compared to the nonaffected hand or with norms for age groups among males and females to identify baseline strength, set goals, and assess progress. The *OT Guide to Goniometry & MMT* eTextbook features detailed descriptions of assessment techniques for the wrist and hand, including dynamometry. Practice these techniques on a variety of individuals—females, males, children, adults, older adults—and note the differences in motion and strength.

Also make it a habit to narrate the underlying anatomy and functional purpose for various motions. Describe the extrinsic and intrinsic forces as well as the patterns of weakness that might be present with a specific nerve injury. Think about the motion and strength required for different occupations. Describing the anatomical and functional perspectives will help solidify your knowledge on multiple levels and get you thinking like an OT or OTA. For example, you might measure PIP flexion and describe the FDS and FDP muscles as contributing to the movement and strength at this joint as a contribution to gripping a steering wheel when driving.

OT Guide to Goniometry & MMT: Your free companion eTextbook

Goniometry and MMT are fundamental skills for occupational therapy students to learn. Measuring purposeful movement and strength with these common clinical assessments supplies key information for evaluating occupational performance and tracking progress in many practice settings.



OT Guide to Goniometry & MMT puts this core knowledge at your fingertips, as near as your tablet or computer. And, it is available with your *Functional Anatomy for Occupational Therapy* (FAOT) textbook at no additional charge. When you register online for access to FAOT's digital resources, you will be prompted to redeem this free eTextbook.

OT Guide to Goniometry & MMT brings you:

- Detailed video and photographic instruction of goniometry and MMT, covering more than 50 common movements
- Functional examples to link anatomy to occupational performance
- In-depth orientation and step-by-step demonstrations for practicing and developing skills
- Examples of occupation-based goals, case studies, documentation templates, and quizzes for building and enhancing your clinical skills

Chapter 8

KNEE

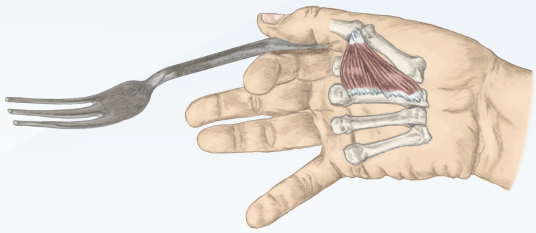
Purposeful Movement of the Knee

The primary functional purpose of the knee is to shorten and lengthen the lower extremity to facilitate sitting, standing, and ambulation (walking or running)—essential components of functional mobility for occupational performance. The knee is capable of rapidly shifting from closed-chain weight-bearing—for example, the stance phase of gait—to open-chain function, as when kicking a soccer ball (8.1). The knee is a modified hinge joint that demonstrates flexion, extension, and rotation; this resource focuses on goniometry and MMT for flexion and extension, primary purposeful movements of functional mobility.

8.1 The knee shortens and lengthens the lower extremity for functional mobility and operates in both closed and open kinetic chains.

Finally . . . an OT Approach to Functional Anatomy

Functional Anatomy for Occupational Therapy provides students with a solid foundation for understanding the science of purposeful movement. Lead author Nathan Short, a practicing OT, presents functional anatomy across the human life span through an occupation-based lens, in the context of clinical practice.



***Functional Anatomy for Occupational Therapy* provides:**

- A comprehensive, occupation-based approach to functional anatomy, goniometry, and manual muscle testing (MMT)
- An "OT voice" that frames functional anatomy in the context of purposeful movement
- Anatomical illustrations and cadaver-dissection images for unrivalled visual instruction
- Instruction aligned with ACOTE standards and OTPF-4 concepts and terminology
- Great preparation for licensure exams and clinical practice

FREE Goniometry and MMT eTextbook

The companion eTextbook, *OT Guide to Goniometry & MMT*, presents detailed video and photographic instruction for more than 50 common functional movements. The in-depth orientation and step-by-step demonstrations help students develop these vital assessment skills. Sample goals and review questions solidify students' knowledge and strengthen the application of their clinical skills.

One Comprehensive Resource

Written as a set, *Functional Anatomy for Occupational Therapy* and *OT Guide to Goniometry & MMT* deliver the advancement OT educators have been waiting for—a comprehensive pairing written from the OT perspective.

". . . by framing anatomical content in the context of occupational therapy practice, students will gain a clearer perspective on the importance of this core knowledge to their future profession."

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Nathan (Nate) Short, PhD, OTD, OTR/L, CHT, is an associate professor of occupational therapy at Huntington University in Fort Wayne, Indiana. He is clinically active, primarily in occupation-based hand and upper extremity rehabilitation. His research interests include cross-cultural practice and, more recently, a novel goniometric technique to measure scapular mobility, featured exclusively in this text.

Joel Vilensky, PhD, taught medical gross anatomy at Indiana University for 34 years. He now teaches anatomy within the OTD program at Huntington University.

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