

Tissue Tolerances of the Muscle-Tendon Unit

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ABSTRACT

CONTENT: This monograph discusses the wide ranging variables that affect the capacity of the muscle-tendon unit to facilitate human movement. A spectrum of clinically relevant content is covered, from anatomy and biomechanical considerations of normal tissue to pathologic changes with disease or injury. Current evidence regarding contemporary physical therapy and medical management of the pathologic muscle-tendon unit is presented and evaluated. Clinical reasoning related to intervention selection is also discussed. This content is intended to be useful for clinicians, researchers, educators, students, and all other stakeholders in orthopedic and sports settings. **CASE ANALYSES:** Four case studies are presented to assist in the application of knowledge in clinical practice. Specific tissue tolerance considerations are highlighted and management priorities are detailed to guide the reader through patient presentations similar to those encountered every day in the clinical setting.

Key Words: capacity, musculotendinous injury, tendinopathy

LEARNING OBJECTIVES

Upon completion of this monograph, the course participant will be able to:

1. Understand clinically relevant normal muscle and tendon tissue anatomy and biomechanics.
2. Understand physiological mechanisms and processes associated with pathologic muscle and tendon tissue.
3. Describe clinical and diagnostic tools used in identifying muscle-tendon abnormality.
4. Discuss the evidence surrounding the physical therapy management of dysfunctional muscle-tendon units.
5. Discuss the evidence related to medical and alternative management of the dysfunctional muscle-tendon unit.
6. Cite evidence related to improving muscle-tendon tissue tolerance to load, including injury prevention strategies.
7. Apply acquired information to case-based patient scenarios to enhance understanding and clinical reasoning in physical therapy management of muscle-tendon pathology.

INTRODUCTION

Human motion is a smooth coordinated process requiring a series of complex interactions of numerous body systems. An intricate relationship between muscles, tendons, and bones, and the seamless way that tissues work together so coherently allow us to perform our functional, recreational, and sport-related

activities. When any part of the neuromusculoskeletal system becomes dysfunctional, clinicians are tasked with identifying and optimizing movement dysfunction to return the patient/client/athlete to their prior level of function. In order to identify dysfunction rapidly and effectively, it is imperative that we understand how typical movement occurs.

We could not have normal movement without a functional muscle and tendon unit. When a muscle contracts, it creates pull on the tendon that anchors the muscle to a bone, allowing the bone to move as needed for a task. Impairment to the muscle-tendon unit (MTU, for the purposes of this monograph) and subsequent alteration in force production and voluntary movement can contribute to substantial disability. In 2016, the Global Burden of Disease study reported that between 20% and 33% of people across the globe live with a painful musculoskeletal condition.¹ In the United States, that number is as high as 1 in 2 adults, contributing (with indirect costs) to an economic burden of \$874 billion in 2015, or 5.7% of the gross domestic product.² While these data are not specific to MTU pathology, musculoskeletal disorders typically are accompanied by alterations in movement, which is commonly associated with MTU impairment. Therefore, it is essential for clinicians, researchers, students, and all other orthopedic and sports medicine stakeholders to understand the tissue tolerances of muscles and tendons, so they can evaluate and treat MTU dysfunction effectively.

The purpose of this monograph is to describe normal MTU architecture and function, pathologic MTU, and clinical management options for treating MTU dysfunction.

NORMAL MUSCLE-TENDON UNIT

Understanding normal muscle and tendon architecture and tissue development can be helpful in optimizing management of dysfunction. This section describes clinically relevant anatomical considerations, biomechanical principles, and clinical methods of measuring tissue capacity with the aim of allowing for more targeted treatment and enhancement.

Anatomy

Skeletal muscle tissue

Muscle is abundant in the human body, and can be responsible for up to 50% of our total body weight.³ Skeletal muscle allows the human body to achieve and sustain positioning and movement. During any functional activity, muscles shorten, elongate, or maintain activity without changing length, in order to ensure efficient, safe, and appropriate task performance. To understand normal muscle activity and capacity, it may be helpful to first review basic muscle structure.

Skeletal muscle architecture is intricate.⁴ Contractile proteins, actin and myosin, and noncontractile proteins such as titin and desmin combine to create myofilaments. Many myofilaments combine to create myofibrils. A group of myofibrils create a muscle fiber, the structural unit of a muscle, which is surrounded by a thin layer of connective tissue called the endo-