Chapter

Introductory Chapter: Tendons – Trauma, Inflammation, Degeneration, and Treatment

Nahum Rosenberg

1. Introduction

> *"When a joint becomes painful, swollen, and inflamed, it is impossible not to consider the ligaments and tendons, as they are the immediate cause of these symptoms."*
> *Citation attributed to Hippocrates.*

Tendons are specialized connective tissues essential for transferring forces from muscle contraction to the bones, enabling joint movement and mobility. Due to the semi-stiff nature of the tendons, forces may be effectively transferred from the muscle to the bone. Tendons' mechanical strength makes it possible to withstand mechanical forces.

The collagen fibers within the tendon have a very well-organized structure, which accounts for their strength. On the other hand, tendons display some viscoelastic activity that is dependent on the rate and length of loading. This characteristic enables tendons to adjust over time to variations in mechanical loading. As a result, tendons resist structural failure even under repeated strain. Its resistance to fatigue results from the tendon cells' capacity to repair and remodel the tendon according to its stress–strain characteristics, expressed by the stress–strain curve (**Figure 1**) [1, 2]. This curve determines the tendon's stiffness and toughness and present the maximum force the tendon can withstand before failing. A tendon's structural and mechanical characteristics may alter over time due to degeneration or damage, according to changes in the stress–strain curve.

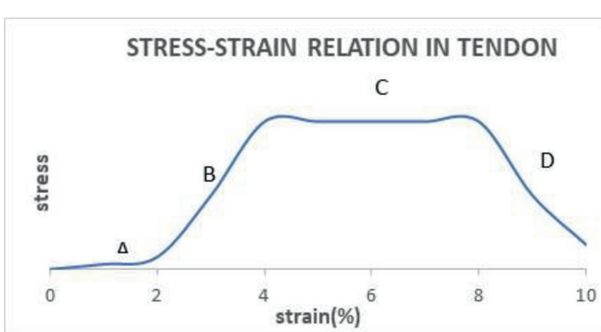

Figure 1.
The stress–strain curve of a tendon – A simplified schematic representation.

These biomechanical features are made possible by the peculiar structure of tendons. A sheath of connective tissue (such as the endotenon) surrounds the collagen fiber bundles that make up tendons at the microscopic level, where they are arranged into fascicles. The endotenon has a vascular and nerve supply that allows the tendon to receive nutrients and react to external stimuli.

The basic structural element of tendons is collagen fibers (the primary type is type I collagen). The parallel bundles they form give the tendon its strength and stiffness. Moreover, tendons include elastin fibers that provide some semi-flexibility and allow them to stretch slightly in response to stress (toe region on the stress–strain curve). Tenocytes, which are fibroblasts in the tendon tissue, is crucial to preserving the tendon's form and functionality. The collagen and elastic fibers of the tendon are produced and maintained by these cells. In addition, tenocytes can adapt the tendon to changes prompted by the stresses of a contracting muscle because of their mechanosensing characteristics.

A. Toe region – the tendon can withstand stress of low magnitude with minimal strain (up to ~2%). This region is due to the straightening and reorientation of the crimped collagen fibers within the tendon. B: Linear region – elastic deformation (a strain of ~2–4%) when the tendon returns to its original shape once the stress is removed. This region is due to the stretching of the collagen fibers within the tendon. C: Microscopic failure region- the tendon beyond the plastic deformation (a strain of ~4–8%) and incapable of returning to its original shape once the stress is removed. This region is due to the rupture of the collagen fibers within the tendon. D: Total structural rupture of the tendon (a strain above ~8%).

The distinctive structure of tendons is created by type I collagen, which makes long, thin fibers grouped in parallel bundles. Other forms of collagen, such as type III collagen, are also in minor quantities in the tendon tissue. The tendon's structure and function are supported by type III collagen, which is present in lesser levels and is less rigid than type I collagen.

As a result, the tendon is made up of fascicles that are packed with multiple parallel collagen fibers. A matrix of proteoglycans and glycosaminoglycans holds these fibers together while also acting as a shock absorber and lubricant thanks to the presence of synovia-like material. Collagen molecules repeating units are arranged staggered to form the collagen fibers. The tensile strength of the tendon is provided by this arrangement [3, 4].

The myotendinous junction is created at the tendon-muscle interface, where the collagen fibers of the tendon are continuous with the muscle fibers.

The fibrocartilaginous enthesis is created at the tendon–bone junction, where the collagen fibers of the bone and the tendon are continuous. The enthesis is a unique area with numerous discrete zones with various compositions and architecture. A highly organized structure called the fibrocartilaginous enthesis enables effective force transmission from the tendon to the bone. The multiple zones of the enthesis are designed to withstand the various mechanical stresses at the interface, such as compressive forces in the highly mineralized fibrocartilage zone and tensile forces in the tendon zone due to the well-aligned collagen fibers.

Tendon collagen content varies according to environmental and endogenous factors, such as age, systemic conditions, and specific anatomical location.

Thus tendon is a complex structure dependent on material and biochemical factors; therefore, it might be susceptible to mechanical failure, acute or degenerative, and pathological inflammatory conditions of connective tissue disorders. This makes

DOI: http://dx.doi.org/10.5772/intechopen.110708

the tendon a source of numerous disabling conditions expressed by pain and movement disorders [5].

This book addresses and discusses several unique and clinically important tendons-related issues. This text should be an important information source for clinicians treating musculoskeletal pathology.

Author details

Nahum Rosenberg
Specialists Center, National Insurance Institute, Haifa, Israel

*Address all correspondence to: nahumrosenebrg@hotmail.com

References

[1] Robi K, Jakob N, Matevz K, Matjaz V. Chapter 2. The physiology of sports injuries and repair processes. In: Hamlin M, Draper N, Kathiravel Y, editors. Current Issues in Sports and Exercise Medicine. London, UK: Intech Open; 2013. pp. 43-86. DOI: 10.5772/54234

[2] Maganaris CN, Chatzistergos P, Reeves ND, Narici MV. Sec. Exercise Physiology. Frontiers in Physiology. 28 Feb 2017;**8**:1-11. DOI: 10.3389/fphys.2017.00091

[3] Thorpe CT, Screen HRC. Tendon structure and composition. In: Ackermann P, Hart D, editors. Metabolic Influences on Risk for Tendon Disorders. Advances in Experimental Medicine and Biology. Vol. 920. Cham: Springer; 2016. DOI: 10.1007/978-3-319-33943-6_1

[4] Kannus P. Structure of the tendon connective tissue. Scandinavian Journal of Medicine & Science in Sports. 2000;**10**(6):312-320. DOI: 10.1034/j.1600-0838.2000.010006312.x

[5] Zabrzyński J, Łapaj Ł, Paczesny Ł, Zabrzyńska A, Grzanka D. Tendon - function-related structure, simple healing process and mysterious ageing. Folia Morphologica. 2018;**77**(3):416-427. DOI: 10.5603/FM.a2018.0006. Epub 2018 Jan 18