

# The effects of Synapse microcurrent on the alignment, proliferation, biomechanics and gene profile of tendon cells

## Background

Chronic degenerative tendon pathology is one of the hidden problems in medicine; treatments are generally repeatedly ineffective and the condition affects a wide range of the population including elite sports competitors, racehorses and the 'everyday' ageing population. The search for a scientifically robust treatment continues with literally hundreds of projects undertaken annually with the aim of better understanding the aetiology of the condition which hopefully will result in a more reliable treatment regime.

Synapse Microcurrent Ltd is an ISO 9001 (2008) accredited company producing a small range of medical devices (ISO 13485) focusing on regenerative medicine. Two key areas of medicine are targeted: tendon pathology and complicated non-healing venous leg ulcers.

Synapse produces a product using their patented microcurrent technology which is designed to improve tendon healing specifically applicable for use with human tissue. A director of Synapse and the developer of the technology, Dr David Chapman-Jones has adopted this human clinical application for use with the biologically very similar equine tendon tissue. Dr Chapman-Jones has an exclusive licence for this work. Tendonology is the company through which that David Chapman-Jones administers the equine work.

Professor Karl Kadler, PhD, is an expert in tendon development and structure, and has developed ex-vivo and in vivo models of tendon development and healing. He is responsible for the Tendon Research Unit at The University of Manchester, England.

## The Research

A programme of research has been designed to test the following hypothesis:

*'Synapse microcurrent improves tendon healing by enhancing the process of cell alignment and extracellular matrix organisation, thereby improving tendon biomechanics'.*

This project will use of the cell and animal tendon models in Kadler's laboratory, at the Tendon Research Unit, The University of Manchester to obtain a mechanistic insight into the effects of Synapse microcurrent.

The aims of the project are:

1. To determine the effects of Synapse microcurrent on the alignment, proliferation, gene profile, and migration of tendon cells.
2. To determine the effects of Synapse microcurrent on the biomechanics, assembly and turnover of the tendon extracellular matrix.
3. To use the knowledge obtained from Aims 1 and 2, in combination with microcurrent and pharmaceuticals, to improve tendon healing beyond what is currently achievable.



The experimental system will apply a microcurrent across a living tendon construct, which has been developed by Kadler's group as a cell-based model for studying tendon development and healing (Kapacee et al., Matrix Biology, 2008; Kapacee et al. Matrix Biology 2010; Kalson et al., Matrix Biology 2010; Bayer et al., Biomaterials 2010).

The tendon constructs comprise cells (e.g. human mesenchymal stem cells (hMSCs) or adult tendon cells) grown in fixed-length fibrin gels that are anchored to metal posts. The cells replace the fibrin with ordered arrays of collagen fibrils during seven days in culture and have cellular, ultrastructural, and biomechanical properties similar to tendon.

The availability of metal posts at each end of the construct is ideal for making electrical connections. Using available Instron microtensometer, electron microscopes, spinning disc confocal light microscopes for live-cell imaging, microarray, molecular biology and biochemistry approaches, we will be able to investigate the effects of microcurrent on cell migration, cell proliferation, ultrastructure, gene profiling and biomechanical properties of the constructs.

A variety of microcurrent loading regimes will be correlated with mechanical properties, gene expression, signaling pathways and cell behaviour.

The proposed study will use stem cells, adult tendon cells and equine tendon cells. The stem cells are hMSCs, which are already available in Kadler's laboratory. Adult cells isolated from human patellar tendon and Achilles tendon will be used after we have identified volunteers and obtained ethical permission to isolate the cells.

The study will compare the cellular responses of human and equine cells to microcurrent, as these are the two species in which tendon pathology is clinically relevant.

The expected outcomes are to identify the mechanism of how Synapse microcurrent works and to provide new insights into how to improve functional outcomes in affected patients.

The final target outcome aims to devise a new and improved method of using Synapse microcurrent in combination with pharmaceuticals to accelerate and improve tendon tissue repair and evaluate if the application has resonance with other similar conditions.

**David Chapman-Jones**  
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