DEGRADABLE WARP-KNITTED SPACER FABRICS FOR MUSCLE TISSUE ENGINEERING.

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Introduction

Extensive muscle defects cannot be structurally and functionally recovered by the body, these lead to a loss of strength and functionality of the affected muscle. The range of motion is decreased and there are permanent defects visible on the body of the patient. [1]

Conservative treatment options such as physical therapy and exo-prothesis only offer modest improvement [2]. A surgical approach is the transplantation of functional muscle tissue, which comes with the drawbacks of limited availability and a second operation site [3].

Great possibilities are seen in Tissue Engineering. Important components include both the structural replacement of the extracellular matrix (ECM), and the colonization of this replacement with cells (myocytes) [4]. Another factor is the macroscopic hierarchical structure of natural muscle tissue. To provide potential for hierarchical growth, different cell lines can be printed precisely using the drop on demand technology. Highly biocompatible and bioactive hydrogels can be used as an ECM that is printable. They offer a positive environment for cell growth and proliferation but lack the mechanical stability necessary to cultivate voluminous tissue. Warp-knitted spacer fabrics can be used as a stabilizing scaffold for the hydrogel. They consist of two cover-layers and a pile-system, connecting both layers.

Methods

This study aims to investigate the potential of degradable warp-knitted spacer fabrics as scaffold material for the use in Tissue Engineered Muscle Repair. The spacer fabrics were produced with biodegradable poly-ε-caprolactone yarns on a doublebar-Raschel-warpknitting machine. For the cover-layers a 55 dtex f8 multifilament and for the pile yarn a 100 dtex monofilament was used. Spacer fabrics with two different cover-layers and with two different stitch densities were produced. They were evaluated mechanically using uniaxial tensile tests measuring the Youngs modulus and tensile strength. The morphological evaluation contains the pore size of the upper cover area as well as the porosity of the warp-knitted spacer fabric.

Results

The morphological characterization shows significantly larger pores in samples with an atlas-mesh as a cover-layer (Figure 1). Additionally, the share of pores larger than 600 µm is higher in atlas-mesh samples. In contrast, the stitch density does not affect the pore size significantly in the evaluated interval of 10 to 16 stitches/cm.

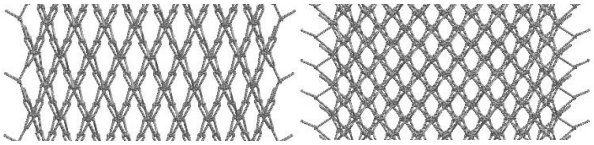

Figure 1: Upper cover layer of spacer textile. Left: Atlas-Mesh (AF), right: 1x2 Mesh (TF)

The mechanical properties of the spacer fabrics also differ significantly regarding the cover-layers (Table 1).

Sample	Young's modulus [N/mm²]	Tensile strength [N/mm²]
AF-10	16.7 (0.4)	4.9 (1.7)
AF-16	10.7 (0.1)	7.0 (0.5)
TF-10	15.8 (0.3)	10.3 (1.3)
TF-16	9.2 (0.2)	7.4 (0.5)
Muscle tissue	1.58	0,9

Table 1: Young's modulus and tensile strength of the analyzed spacer fabrics. Results are given in mean and 95% confidence level. Reference muscle tissue from [5] and [6].

Discussion

Warp-knitted spacer fabrics offer great potential in the field of Tissue Engineering, because of their variable mechanical and morphological properties. The larger pore size of the atlas-mesh cover-layer allows for different filling methods, including the precise printing of hydrogels using the drop on demand technology enabling hierarchically structured cell cultures.
The mechanical properties of all evaluated spacer fabrics exceed those of human muscle tissue, therefore during the degradation enough stability can be provided for a cell-laden hydrogel filling. It was shown, that degradable warp-knitted spacer fabrics have high potential as scaffold materials in muscle tissue engineering.

References

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