09-12-2010
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Voorstel MDO-opdracht
Opleiding Technische Geneeskunde
Universiteit Twente

A. Algemeen

1. Titel MDO-opdracht: Synthetic alternatives to tendon and ligament regeneration

2. Gegevens instelling/indiener:
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B. Faciliteiten

1. Welke faciliteiten zijn nodig voor een adequate uitvoering van de vraagstelling?

Electrospinning set-up, set-up for calcium-phosphate coating process

2. Wat zijn daarbij mogelijke risico's voor de voortgang van de opdracht?

n/a

C. Overige opmerkingen

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D. Inhoudelijke informatie MDO-opdracht

1. Omschrijving van de technisch geneeskundige vraagstelling (maximaal 400 woorden)
N.B.: zo mogelijk directe afstemming tussen medische en technische groep, anders hiervoor contact opnemen met de opleiding TG.

The wear and tear from years of activity, or from sudden acute injuries in sports, falls, or accidents, are the main causes of damage and degeneration of ligaments in teenagers and young adults. The anterior cruciate ligament (ACL), for example, is one of the most frequently injured ligaments in the knee, with over 240.000 surgeries performed annually in the US only, generating revenues of over $3.5 billion (http://www.ibridgenetwork.org/columbia/ir_2099). Damage of ACL, is however, not only a problem of younger people, but has also consequences for the well-being of our aging population. Small tears of ACL are frequently not, or late diagnosed, and with increasing age, they contribute to degeneration of ligament itself, as well as surrounding tissues, such as meniscus and cartilage in the knee. As a result, patients are greatly limited in their mobility, as the main role of the ACL is to prevent forward movement of the tibia from underneath the femur in the knee. To help patients to retain the function of the ligament and return to normal physical activities, successful reconstruction strategies are of utmost importance.

Current methods of ACL injuries either include repair of the tear by suturing the torn parts to themselves or to a natural or synthetic graft, which is only a successful approach when the tear is timely diagnosed. In the case of more severe damages and degenerated ligament, the injured ligament is removed, followed by drilling tunnels in tibial and femoral bone, and insertion of a replacement graft. Synthetic grafts are typically fabricated by non-degradable polymers (e.g. braided ultra-high molecular weight polyethylene or polyethylene terephtalate). Alternatively, grafts from autologous tissues (autografts) or cadaveric origin (allografts) are used.

The proposal idea presented here aims at developing a hybrid implant, consisting of a polymeric center, produced in such a way that it meets mechanical requirements of ACL, and gradient-wise mineralized ends, which are responsible for a firm anchoring of the implant into the surrounding bone. The design of the hybrid implants will be optimized to allow minimally invasive surgery (e.g. arthroscopy). Advanced production methods will be employed to obtain such an implant. For the polymeric part of the implant, electrospinning technique will be used to obtain micro- and nano-sized fibers which will then be bundled using textile techniques to meet mechanical properties of the native ligament, while mimicking the structure of the extracellular matrix. These polymeric bundles will then be used to gradient-wise introduce mineralization seeds in order to develop a construct that consists of pure polymer in the middle and pure mineral in the end, with gradients of compositions in between such that the mechanical properties are maintained. The choice of materials will be such that they are biocompatible and degrade in time, leading to full reconstruction of the native tissue.

The students are supposed to gather information about the advantages and disadvantages of the existing methods for ligament regeneration based on published literature and interviews with clinicians. Based on this information, a conclusion is to be drawn whether development of a synthetic alternative based on polymer/mineral constructs is potentially valuable. If so, some preliminary experiments will be performed in the lab to proof the feasibility of the combinations of polymers and techniques proposed.

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