Docket #: S13-014

Injectable Tendon Hydrogel: A Scaffold for Tissue Regeneration

Stanford researchers have developed an injectable, biocompatible hydrogel consisting of extracellular matrix (ECM) from human cadaveric tendons as a potential scaffold for guided tissue regeneration and tissue engineering purposes. This injectable material can potentially direct a collagen matrix of tendon directly to the injury site, thus stimulating cell migration and healing. It can promote faster healing of a variety of tendon injuries, thus allowing earlier return to work or sports activities after common orthopedic injuries.

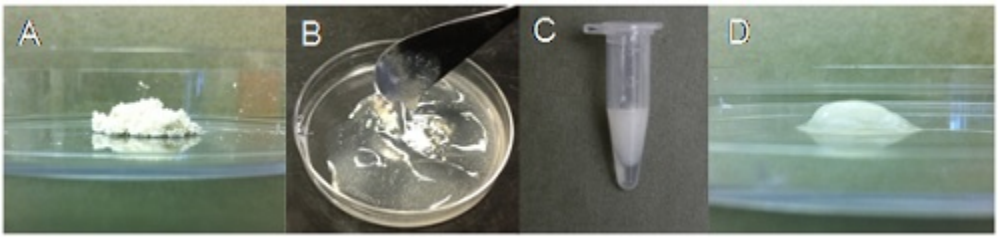

Figure description - Fabrication of ECM solution and gel. (A) Decellularized tendon in powder form, (B) powder digested by pepsin at low pH forms liquid ECM solution that is injectable through 25G cannula, (C) gel formed after 20 min incubation in 37°C chamber, (D) gel poured on petri dish showing polymerization

Stage of Research:

- Protocol from human tendon decellularization to gel production has been established
- Studies show in vivo biocompatibility in an animal model
- Application of the gel in an animal model of partial Achilles tendon injury shows improved healing

Applications

- **Therapeutic applications for ligament and tendon injuries**

- These injuries are most commonly seen in the rotator cuff, Achilles tendon, quadriceps tendon, and patella tendon
- Ligamentous injuries such as medial and lateral epicondylitis of the elbow, and other chronic enthesopathie also involve similar mechanisms of injury

Advantages

- **Simple, non-invasive, easily produced and stored**
- **Biocompatible**
- **Promotes faster healing of a variety of tendon injuries**
- **Clinical benefits:**
  - Can be delivered non-invasively into a zone of injury
  - Polymerizes in vivo at body temperature
  - Carrier of cells or growth factors to injury
  - Conforms to injured tissue space/defect
  - Provides a supportive nanostructure of collagen fibers

Publications

- PCT Patent Application Serial No. PCT/US2014/02825
- Colin Y.L. Woon, Simon Farnebo, Taliah Schmitt, Armin Kraus, Kai Megerle, Hung Pham, Xinrui Yan, Sanjiv S. Gambhir, and James Chang. "Human Flexor Tendon Tissue Engineering: Revitalization of Biostatic Allograft Scaffolds", Tissue Engineering Part A. December 2012, 18(23-24): 2406-2417.
- Shyam S. Raghavan, Colin Y.L. Woon, Armin Kraus, Kai Megerle, Matthew S.S. Choi, Brian C. Pridgen, Hung Pham, and James Chang. "Human Flexor Tendon Tissue Engineering: Decellularization of Human Flexor Tendons Reduces Immunogenicity In Vivo", Tissue Engineering Part A. April 2012, 18(7-8): 796-805.
- Poster Presentation "Decellularized Tendon?Bone Composite Grafts are Less Immunogenic and Stronger than Untreated Grafts – an In Vivo Experimental Study in Rat"
- Farnebo S, Woon CY, Schmitt LM, Joubert M, Kim M, Pham H, Chang J. Design and Characterization of an Injectable Tendon Hydrogel: A Scaffold for Guided Tissue Regeneration in the Musculoskeletal System, *Tissue Engineering*, Volume: 20 Issue 9-10: May 2, 2014

- Kim M, Farnebo S, Woon C, Pham J, Chang J. Tendon Hydrogel Improves Healing in a Rat Achilles Tendon Injury Model, Plastic & Reconstructive Surgery, submitted.

Patents

- Published Application: WO2014144215
- Published Application: 20160166735
- Published Application: 20180133369
- Issued: 9,925,308 (USA)
- Issued: 10,857,265 (USA)

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