Linear Braiding Technology for the Realization of Biomimetic Implant Structures

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Abstract

Tendon and ligament injuries are among the most common musculoskeletal disorders and are becoming increasingly relevant due to an ageing yet physically active population. For larger defects, autologous tissue remains the gold standard, but its availability is limited and harvesting is associated with additional donor-site morbidity. Biological and synthetic substitutes provide alternatives, but they are still unable to adequately reproduce the complex structural and mechanical properties of native tendons and ligaments. In particular, locally adapted geometries and stiffness gradients, which are essential for load-appropriate force transmission between muscle, tendon and bone, are lacking.
Textile manufacturing technologies such as weaving, knitting and braiding offer great potential for fiber-based implants due to their adaptable yarn architectures. However, conventional braiding technologies are limited in enabling controlled changes in geometry and braid pattern along the implant length and in generating defined stiffness gradients.

Linear braiding technology offers a novel approach to overcome these limitations. In contrast to conventional circular braids, the yarns are guided in a star-shaped arrangement through the central braid axis. This enables compact structures with a high degree of axial fiber orientation. Furthermore, the technology allows the cross-sectional geometry as well as braid geometry and pattern to be varied within a continuous manufacturing process.
The presentation introduces the technological advancement of linear braiding for the development of a biomimetic tendon implant. The focus is on scaling the braided structure, integrating axial yarns, and tailoring geometric, structural and stiffness gradients along the implant length. The aim is to reproduce different functional regions of native tendons, particularly the supraspinatus tendon, using textile manufacturing principles and thereby establish a basis for implant structures adapted to anatomical and mechanical requirements.

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