Dynamic hoop tensile tests of electrospun small diameter vascular grafts

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Background: Electrospinning is a promising method to create small diameter vascular grafts. For good functionality mesh structure and mechanical behaviour are essential. Fiber orientation and mesh density influence tensile strength, elasticity and cell growth. Due to different structural requirements between inside (cell attachment) and outside (cell in-growth), grafts with defined fiber networks are favourable. In this work, the effect of fiber orientation in mechanical behaviour was investigated by dynamic tensile tests.

Methods: Four types of electrospun vascular grafts were investigated: Fibers oriented randomly, in circumferential, longitudinal and in crosswise direction. In hoop tensile measurements rings of 2 mm length were loaded sinusoidal for 1000 cycles at 10 Hz between 0.03 and 0.06 N, corresponding to a blood pressure of 80 to 120 mmHg. Finally a quasistatic tensile test until rupture was performed.

Results: Circumferential oriented fibers showed highest tensile force but lowest compliance with 6.1±0.9 %/100mmHg. The other types had significant lower tensile force but enhanced compliance with best performance in longitudinal oriented types (15.6±3.2 %/mmHg). However, continuous creeping was seen in longitudinal oriented type by a diameter change of 8.8% after 1000 cycles compared to 3.4% in circumferential oriented type.

Conclusions: The orientation of the fiber network allows the adjustment of biomechanical properties in electrospun vascular grafts. Dynamic measurements are essential to predict the in-vivo behaviour of blood vessel substitutes.