Chapter 1

Enhanced tendon repair through adhesive-coated sutures

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1.1 Abstract

PBS	Phosphate buffered saline	x	position along suture
$\tau(x)$	shear stress in the adhesive layer	τ_{ave}	average shear stress
τ_{fail}	failure shear stress of adhesive-coated suture	$\bar{\sigma}_s(x)$	normal stress in suture normalized by normal stress at $x = 0$
E_s	suture elastic modulus	E_s^*	suture elastic modulus normalized by tendon elastic modulus
E_t	tendon elastic modulus	G_a	adhesive shear modulus
G_a^*	adhesive shear modulus normalized by tendon elastic modulus		
L	suture purchase length	$L_{intersect}$	suture length where asymptotic limits for load transfer intersect
P_s	normal force in suture at the interface, $x = 0$	P_k	resultant normal force in suture at the anchor point
r_s	suture radius	r_t^*	tendon radius normalized by suture radius
r_t	tendon radius	ρ_t^*	effective radius of tendon, normalized by suture radius
t_a	adhesive thickness	t_a^*	adhesive thickness normalized by suture radius
β_s	characteristic (inverse) length scale related to geometry and material properties	χ	variable related to geometry and material properties

Table 1.1: Abbreviations and variables used throughout Chapter 2.

1.2 Introduction

1.3 Theory

$$I(X,Y) = -\sum_{x \in X} \sum_{y \in Y} \frac{P(x,y)}{P(x)P(y)}$$

1.4 Methods

1.5 Results

1.6 Discussion

1.7 Conclusion

Strengthening surgical repairs should lead to improved healing outcomes for mechanically sensitive tissues, such as tendon. Our models and proof-of-concept experiments suggest that coating sutures with adhesives that are appropriately designed hold promise for achieving repairs that have higher levels of resistance to gap formation and catastrophic failure. While Loctite 4903 shows promising results that would be valuable clinically, it is far from an ideal adhesive according to the model due to its high shear modulus. We intend to develop biocompatible adhesives with optimized mechanical and chemical properties to further increase load transfer and improve clinical repairs for tendon, ligament, and other tissue injuries.

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1.9 Author contributions

SWL derived the shear lag model with help from VB and GMG. SWL designed and performed all experiments with guidance from ST, RHG, VB, and GMG. IK performed the surgeries and provided input into how to apply adhesives to sutures during surgeries. UGKW provided input and data comparing model results to real material properties. SWL wrote the manuscript, and ST, GMG, IK, RHG, VB, and UGKW provided edits.

1.10 Supplemental material