

# Improved orthopaedic repairs through mechanically optimized, adhesive biomaterials

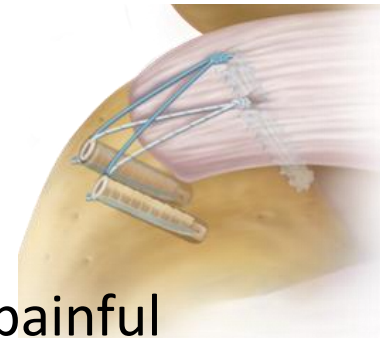
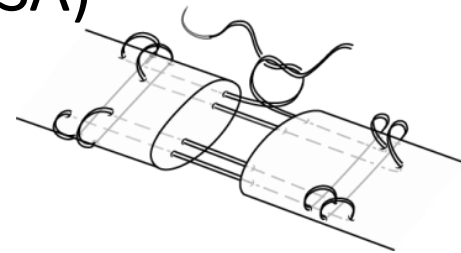
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# Motivation

- Flexor Tendon – 10,000 repairs annually (USA)
  - Elongation rate: 48%      Rupture rate: 6-10%
  - Most failures happen within first 6 weeks
- Rotator cuff – 600,000 repairs annually (USA)
  - Failure rate 20% in young, 60% in old
  - 50% of adults > 60 y/o have tear
  - Half of asymptomatic tears enlarge, half become painful
  - ~ \$500 million/year spent on repairs that rupture
- MSK repairs require high strength and resilience to avoid rupture



*\*Figures adapted from Osei et al. 2013 (flexor tendon), Arthrex.com (rotator cuff)*

# Current Solutions: Sutures

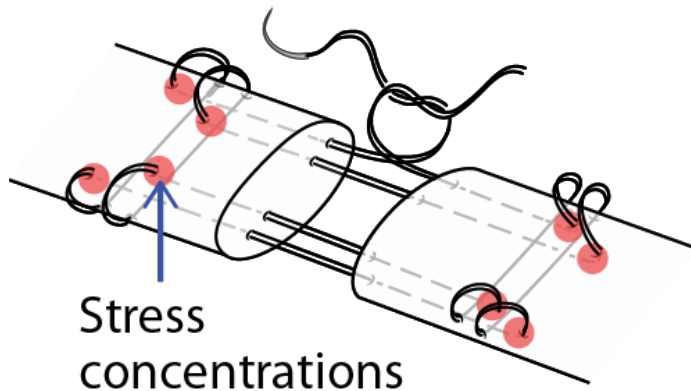


Figure: Core suture repair technique for human flexor tendon repair.\*

- Sutures used since Ancient Egypt
- Crude mechanical solution
  - Tension transferred to tissue at anchor points
  - Does not use length of suture effectively
  - Suture breaks or tears through surrounding tissue

*\*Figures adapted from Osei et al. 2013 (flexor tendon)*

# Current Solutions: Adhesives



- Adhesives used to close wounds
- Not used in tendon / ligament
- Use limited to interface between aligned tissues
- Some considerations:
  - Biocompatibility
  - Interfacial and bulk strength
  - Modulus
  - Swelling
  - Shelf life

*\*Figure from <http://www.cryolife.com/products/bioglue-surgical-adhesive>*

# Current Repairs

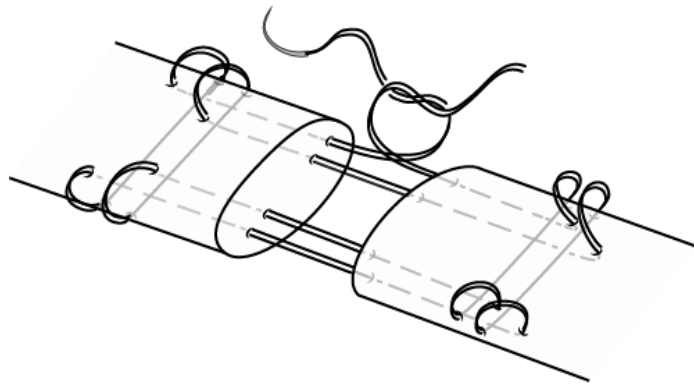


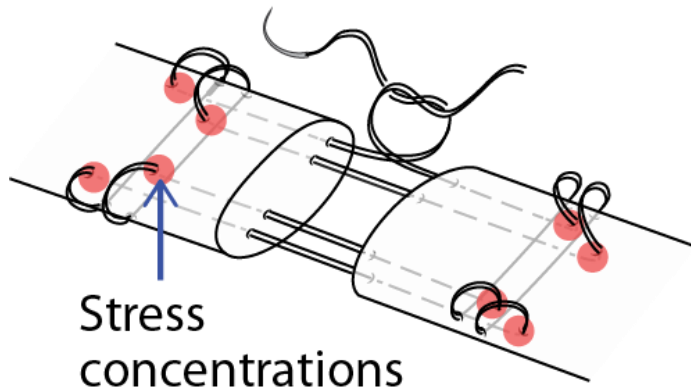
Figure: Core suture repair technique for human flexor tendon repair.\*

- Critical period for tendon repair = first 6 weeks
- Implication: mechanical solution = adequate
  - Need to hold tendon ends together for long enough (about 6 weeks) for body to heal sufficiently
  - “Buying time until biology kicks in”

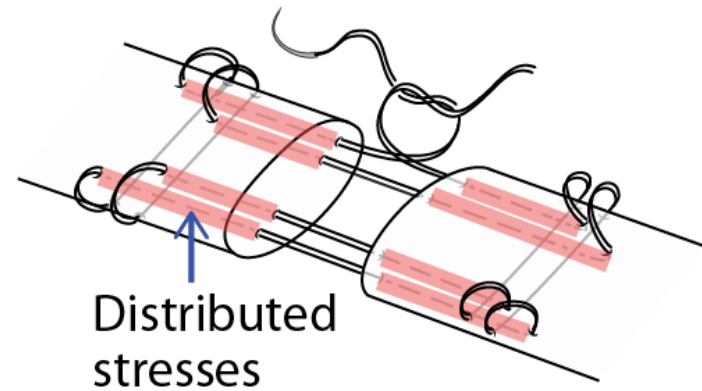
*\*Figure adapted from Osei et al. 2013*

# Mechanical Solutions

## Standard repair (no adhesive)



## Adhesive-coated suture



- Suture = crude mechanical solution
  - Does not utilize the length of the suture
- *Paradigm shift:*
  - Use same technique
  - Implant modified suture with a collagen-binding adhesive
  - Activate adhesive after suture is sewn into position
- Goals:
  - *Shift load from anchor points to shear along the suture's length*
  - Minimize stress concentrations at the repair site