A Biomechanical Comparison of Three Allografts Tissues for Reconstruction About the Knee

Albert W. Pearsall, IV, MD
J. Marcus Hollis, PhD
George V. Russell, Jr., MD
David A. Stokes, MD

Department of Orthopaedic Surgery
University of South Alabama Medical Center
Mobile, Alabama
This research was supported in part by a grant from Research Technology, Inc., Alachua, Florida
Introduction

- Functional significance of knee cruciate and collaterals well established
- Reconstruction of both common
- Critical factor – graft material*

* [Blevins et al, AJSM, 1994]
Introduction

- Common autologous graft sources*
  - B-PT-B
  - Double-looped ST/G
  - Quadriceps tendon

*Angliettti et al., AJSM, 1994
[Fulkerson et al, Arthroscopy, 1995]
Introduction

- Allograft Advantages
  - Decreased morbidity
  - Decreased operative time
  - Diminished post-op pain
  - Availability for multiple ligament surgery
Purpose

- Biomechanically evaluate 3 allograft tissues for use in ligamentous reconstruction
  - Tibialis anterior
  - Tibialis posterior
  - Peroneus longus
Materials & Methods - Specimens

- 16 FF cadaveric limbs
- Ages: >69 years
- Specimens frozen at –20º C
  Thawed day of harvest
- TA, TP, PL tendons
  harvested from
  musculotendinous junction
to insertion
Materials & Methods - Testing

- CSA measured @ 3 locations / average taken
- CSA measured in single and double configuration
- Tendon ends placed in dry ice clamps
- Testing performed in custom hydraulic testing machine
Materials & Methods - Testing

- Tendons tested in single and double strand configuration
- Elongated to failure at rate of 1 mm/sec
- Load / displacement recorded
  - Analog-digital interface board
- Stiffness, stress, strain modulus of elasticity calculated
Statistical Analysis

- 1 way analysis of variance (ANOVA)
- Paired t-test between groups
Results

- 16 Tendon groups (48 tendons) tested
- Average cross sectional area (doubled tendon)*
  - TA 38 mm²
  - TP 48 mm²
  - PL 37 mm²
* Not statistically different
Results

- **Average Ultimate Load to Failure** *(doubled tendons)*
  - **TA**: 3412 N
  - **TP**: 3391 N
  - **PL**: 2484 N

* Statistical difference between:
  - TA & PL (p<.04)
  - TP & PL (p<.05)
Results

- **Average Stiffness*** (doubled tendons)
  - TA: 344 N/mm
  - TP: 302 N/mm
  - PL: 244 N/mm

* Statistical difference between: TA & PL (p<.04), TP & PL (p<.05)
Results

- Modulus of Elasticity*
  (doubled tendons)
  - TA  453 kpa
  - TP  208 kpa
  - PL  243 kpa

* Statistical difference
  between: TA & PL (p<.01)
  TA & TP (p<.03)
Results

- **Ultimate Strain*** (doubled tendons)
  - TA: 39%
  - TP: 68%
  - PL: 48%

* Statistical difference between: TA & TP (p<.05)
Discussion

- Last 15 yrs
  B-PT-B considered premier graft for ACL reconstruction
  - High initial strength
  - Bone-bone healing
  - Predictable success
Discussion

- Problems Reported with B-PT-B Graft for ACL Reconstruction
  - Morbidity after harvest
  - Patellar pain
  - Quadriceps weakness
  - Patellar fracture / ligament rupture
  - ROM loss
Discussion

- Other ACL Graft Sources
  Developed
  - Doubled ST / G
  - Central 1/3 Quad tendon
  - Allograft
    - B-PT-B
    - Achilles tendon
    - Other tendons?
Discussion

- Excellent Results Reported with Allografts
  - Improved sterilization techniques
    - Virtually eliminated disease transmission
    - Diminished osteolytic reaction
    - Improved initial tensile strength
  
  [Harner et al, Pitt School of Med, 1992]
Discussion

- Recent Increased Demand for Allograft Tissue
- Diminished supply of adequate donor tissue
- Investigate new allogenic sources of tissue
Numerous studies have documented the biomechanical strength of ACL and other graft sources.

Recent grafts compare favorably.
Discussion

Failure Load of Different Grafts

- Native
- 14mm
- 10mm
- ST-G
- TA
- TP
- PL

Newton
Discussion

Stiffness of Different Grafts

N/mm

Grafts

Native*, 10mm*, ST-G*, TA, TP, PL
Discussion - Limitations

- Evaluated only initial biomechanical properties
- Pullout strength not evaluated
- Specimen age [>69 years]
- Historically TP can demonstrate degeneration in elderly
Conclusions

- Doubled TA, TP, and PL tendons demonstrated excellent UTS, stiffness, and CSA compared to currently used grafts for ligamentous knee reconstruction
Conclusions

- Excellent biomechanical properties noted even with elderly donors
- Improved strength and stiffness possible with younger donors
- Greater allogenic tissue available for ligamentous reconstruction
THANK - YOU

Department of Orthopaedic Surgery
University of South Alabama Medical Center
Mobile, Alabama