

# FEMORAL FIXATION STRENGTH AS A FUNCTION OF BONE PLUG LENGTH IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION UTILIZING INTERFERENCE SCREWS

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# Disclosures

- I (and/or my coauthors) have disclosures directly relevant to this study. One author has disclosures relevant to the field of Orthopaedics, listed as follows:
  - Jonathan Light, Amanda Firoved, Vanna Rocchi, & Laurie Wellman: None
  - Kevin Bonner: Arthroscopy: Editorial or governing board, Arthroscopy Association of North America: Board or committee member. COVR Medical: Stock or stock Options. DePuy, A Johnson & Johnson Company: IP royalties; Paid consultant; Paid presenter or speaker. Embody: Paid consultant. LifeNet Health: Board or committee member; Paid consultant. Orthofix, Inc.: Research support. Wolters Kluwer Health - Lippincott Williams & Wilkins: Publishing royalties, financial or material support. Zimmer: IP royalties; Stock or stock Options.

# Introduction

- ❑ The anterior cruciate ligament (ACL) is the most common knee ligament treated by orthopaedic surgeons<sup>1</sup>
- ❑ ACL tears and reconstruction rates have increased over the past two decades<sup>2</sup>
- ❑ Various ACL autograft options exist, including bone-patellar-tendon-bone (BPTB), multi-strand hamstring, or quadriceps tendon are available to surgeons<sup>3</sup>
- ❑ The BPTB has been extremely popular for young pivoting athletes and even coined the "gold standard" by some<sup>4,5</sup>
- ❑ BPTB autograft advantages<sup>4,6</sup>
  - ❑ Decreased rupture rates in young athletes
  - ❑ Less residual laxity in some patients related to other options
  - ❑ Bone-to-bone healing

## How short is too short?

- Smaller plugs can be harvested inadvertently
- There is a trend in arthroscopy to go smaller with respect to plug length, especially in smaller statured pts
  - Intercondylar notch width
    - Anteromedial/accessory anteromedial femoral approach
  - Decrease patella morbidity?

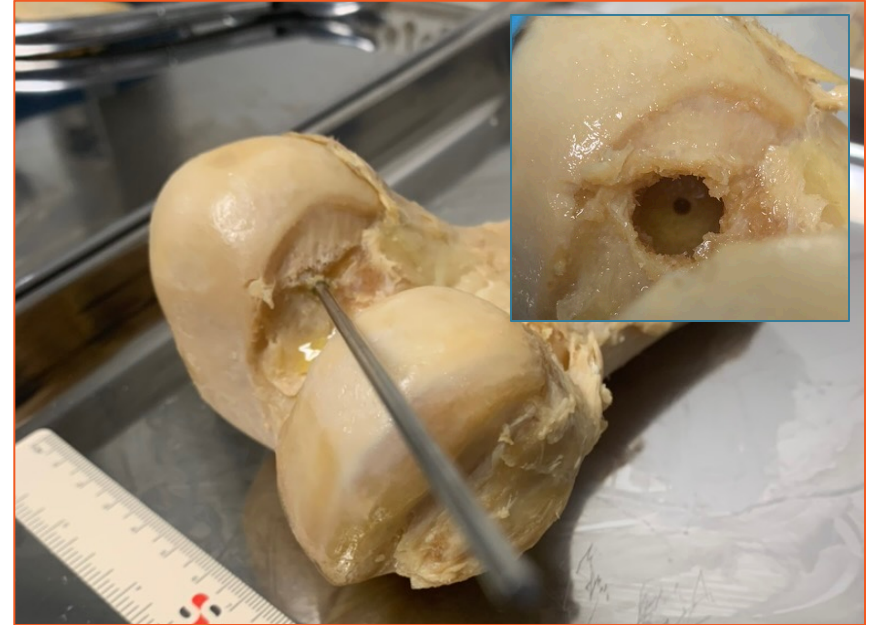


## Purpose and Hypothesis

- To determine femoral construct fixation strength as bone plug length decreases in anterior cruciate ligament reconstruction (ACLR)
- Fixation strength will decrease as bone plug length decreases, with a significant difference in stability between  $\geq 15\text{mm}$  plugs vs  $10\text{mm}$  plugs within the femoral tunnel

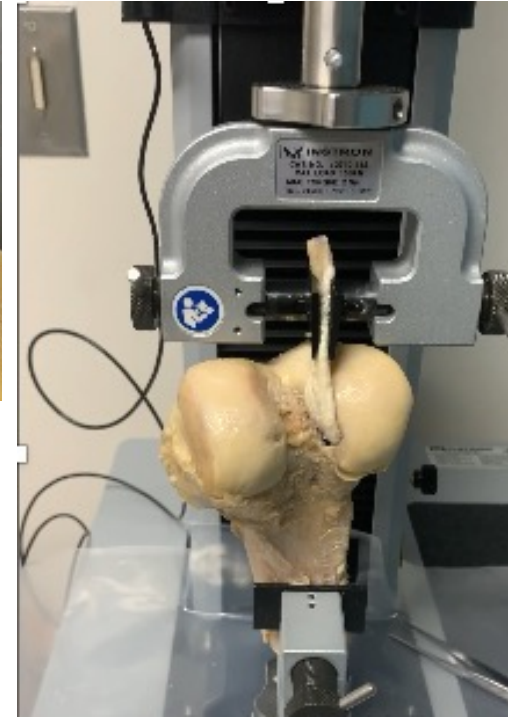
# Materials and Methods

- Sixty fresh frozen bone-patellar-tendon-bone allografts were divided into 20-, 15- and 10-mm length bone plug groups
  - Half utilized the patella side (P) for testing and half used the tibial side (T), e.g. P20, T20, P15, T15, P10, T10
- Ten mm diameter recipient tunnels were created within the anatomic ACL footprint of 60 cadaveric femurs; All bone plugs were 10 mm in diameter



# Data Collection

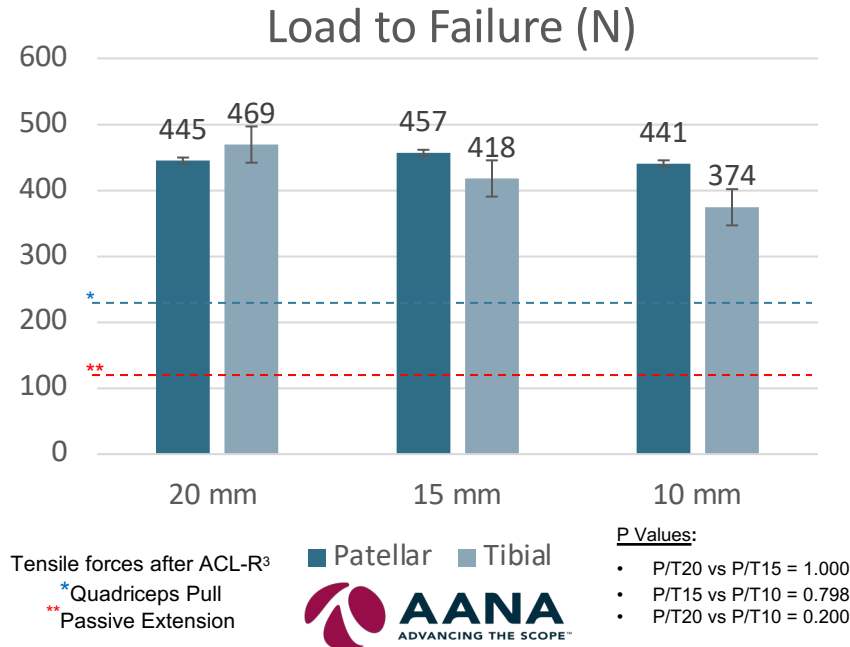
- ❑ Grafts were fixed using a 7X23mm metal interference screw
- ❑ An Instron was used to determine the load to failure of each group
- ❑ A one-way multivariate analysis of variance (MANOVA) was conducted to test the hypothesis that there would be one or more mean differences between P+T or P vs. T groups and subgroups, respectively



## Results: P+T groups

- The mean load to failures of 20-, 15- and 10 mm plugs:
  - 20 mm plugs (20 P+T) =  $457 \pm 66$  N
  - 15 mm plugs (15 P+T) was  $437 \pm 74$  N
  - 10 mm plugs (10 P+T) was  $407 \pm 107$  N
- There was no significant difference between P+T groups:
  - 20 mm vs. 15 mm (P=1.000)
  - 15 mm vs. 10 mm (P=.798)
  - 20 mm vs. 10 mm (P=.200); P+T MANOVA (P=.291)
- There was no significant difference between patella and tibial bone plug subgroups

**Figure 1.** Fixation Strengths (N) of Patellar and Tibial Bone Plugs





**Table 1. Bone Plug Length and Fixation Strength Cross Comparison**

Bone Plug (Patellar and Tibial) Length	Cross-Comparison	P Value
20 mm (Groups 1 and 4)	15 mm plugs (Groups 2 and 5)	1.000
	10 mm plugs (Groups 3 and 6)	.200
15 mm (Groups 2 and 5)	20 mm plugs (Groups 1 and 4)	1.000
	10 mm plugs (Groups 3 and 6)	.798
10 mm (Groups 3 and 6)	20 mm plugs (Groups 1 and 4)	.200
	15 mm plugs (Groups 2 and 5)	.798

**Table 2. Patellar and Tibial Bone Plug Cross-Comparisons for Groups 1, 2, 3, 4, 5 and 6**

Patella Groups	Cross-Comparison	P Value	Tibia Groups	Cross-Comparison	P Value
<b>Group 1</b>	Group 2	1.000	<b>Group 4</b>	Group 1	1.000
	Group 3	1.000		Group 2	1.000
	Group 4	1.000		Group 3	1.000
	Group 5	1.000		Group 5	1.000
	Group 6	.924		Group 6	.194
<b>Group 2</b>	Group 1	1.000	<b>Group 5</b>	Group 1	1.000
	Group 3	1.000		Group 2	1.000
	Group 4	1.000		Group 3	1.000
	Group 5	1.000		Group 4	1.000
	Group 6	.452		Group 6	1.000
<b>Group 3</b>	Group 1	1.000	<b>Group 6</b>	Group 1	.924
	Group 2	1.000		Group 2	.452
	Group 4	1.000		Group 3	1.000
	Group 5	1.000		Group 4	.194
	Group 6	1.000		Group 5	1.000

## Results: Failure Modes

- P/T20 grafts failed by:
  - pullout > tendon failure > bone block fracture
- P/T15 grafts failed by:
  - pullout > tendon failure > bone block fracture
- P/T10 grafts failed by:
  - pullout > bone block fracture, with no tendon failures
- Two condylar fractures in different femurs with our P20 group

**Fracture (T20)**



**Condylar fracture (P20)**



**Pullout (P10)**



## Conclusions

- Fixation strength did trend down when from 20- to 15- to 10 mm bone plugs; however, this was not statistically significant
- No difference in construct failure between 20-, 15- and 10mm bone plugs when fixed with an interference screw within a femoral tunnel
- Utilizing shorter plugs with interference screw fixation is likely acceptable on the femoral side (at least down to 15 mm)
- This study supports utilizing interference screws on the femoral side if grafts are under 20 mm in length

## Significance of the Findings

- There is a balance between optimal bone plug length on the femoral side for achieving adequate fixation as well as minimizing donor site morbidity and facilitating graft passage in ACL reconstruction. This study reveals utilizing shorter plugs with interference screw fixation is likely acceptable on the femoral side if shorter plugs are harvested.

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