Five-Strand Hamstring Autograft for Anterior Cruciate Ligament Reconstruction: A Systematic Review

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Disclosures

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- American Orthopaedic Society for Sports Medicine: Board or committee member
- Biomet: IP royalties; Paid consultant; Research support
- Elsevier: Publishing royalties, financial or material support
- International Society of Arthroscopy, Knee Surgery, and Orthopaedic Sports Medicine: Board or committee member
- Mitek: Research support
- Orthopedics Today: Editorial or governing board
- Orthopedics American Journal of Sports Medicine: Editorial or governing board
- Smith & Nephew: Research support
- Stryker: Research support

Armando Vidal, MD
- American Orthopaedic Society for Sports Medicine: Board or committee member
- Arthrex, Inc: Paid presenter or speaker
- Arthrocare: Paid consultant
- Ceterix: Paid presenter or speaker
- Smith & Nephew: Other financial or material support
- Stryker: Other financial or material support; Paid consultant

Jonathan Bravman, MD
- DJ Orthopaedics: Paid consultant
- Mitek: Other financial or material support
- Shukla Medical: IP royalties; Unpaid consultant
- Smith & Nephew: Other financial or material support; Paid consultant
- Stryker: Other financial or material support; Research support
- Western Orthopedic Association: Board or committee member

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This study has been accepted for publication at OJSM
Introduction

- When undergoing anterior cruciate ligament reconstruction (ACLR) using hamstring autograft, increasing the graft’s diameter has been linked to decreased rates of revision and improved clinical outcomes, particularly when the graft is greater than 8 mm in diameter (Boniello et al, 2015; Magnussen et al, 2012; Mariscalco et al, 2013).

- The five-strand hamstring (5HS) autograft technique has been used to increase the cross-sectional area of the graft when the standard four-strand hamstring autograft (4HS) technique would produce a graft less than 8 mm in diameter.

- However, it is unknown if the 5HS technique provides additional benefits when compared to a 4HS already greater than 8 mm in diameter.
Purpose

• To determine if the 5HS technique provides superior biomechanical and clinical results following ACLR, when compared to 4HS already greater than 8 mm in diameter.
Methods

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA).

Inclusion criteria:
- Studies published in the English-language
- Reporting biomechanical properties of 5HS
- Reporting clinical outcomes following primary ACLR using 5HS
- Studies with a minimum one-year follow-up

Exclusion Criteria:
- Studies not reporting clinical or biomechanical results
- Use of BTB or hybrid grafts
- Systematic reviews
- Scientific abstracts
- Studies solely reporting techniques
Methods

Outcomes Assessed

Biomechanical Outcomes
- Load to failure
- Stress-relaxation
- Stiffness
- Displacement

Clinical Outcomes
- Failure rate
- Anteroposterior (AP) laxity
- Patient Reported Outcomes (PROs)
  - Lysholm Score
  - KOOS Score
  - IKDC Score
  - SF-36
Results

Biomechanical

- Two biomechanical studies met inclusion and exclusion criteria
- One study used ovine flexor tendon graft material and the uniaxial electromechanical load system for biomechanical analysis
- The other used cadaveric gracilis and semitendinosus graft material and DVRT for biomechanical analysis
- A total of 28 hamstring graft specimens subjected to biomechanical analysis were included (4HS, n = 14; 5HS, n = 14)

Clinical

- Three clinical outcome studies met inclusion and exclusion criteria
- 115 patients were included (4HS, n = 53; 5HS, n = 62) and mean graft diameter for 4HS and 5HS grafts were 8.36 mm and 9.12 mm respectively
- Overall mean patient age at time of surgery was 28.7 years
Results - Clinical

- Of the clinical outcome studies, there were no significant differences in failure rates ($p=0.82$) or AP laxity between 4HS and 5HS grafts ($p=0.20$).
- No significant differences were found in postoperative Lysholm, IKDC, KOOS, SF-36 MCS and SF-36 PCS scores ($p>0.05$ for all).

<table>
<thead>
<tr>
<th>Study</th>
<th>Failure rate</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4HS</td>
<td>5HS</td>
</tr>
<tr>
<td>Calvo, 2017</td>
<td>3/33 (9.1%)</td>
<td>2/37 (5.4%)</td>
</tr>
<tr>
<td>Krishna, 2018</td>
<td>-</td>
<td>NR</td>
</tr>
<tr>
<td>Krishna, 2018</td>
<td>1/20 (5.0%)</td>
<td>2/25 (8.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>4/53 (7.5%)</td>
<td>4/62 (6.5%)</td>
</tr>
</tbody>
</table>

$p=0.82$
Results - Biomechanical

- No significant differences between 4HS and 5HS constructs in failure load, stress-relaxation, graft displacement, or graft stiffness (p>0.05 for all)

<table>
<thead>
<tr>
<th>Study</th>
<th>Failure load</th>
<th>Stress-relaxation</th>
<th>Graft displacement</th>
<th>Graft stiffness</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-value</td>
<td>0.46</td>
<td>0.59</td>
<td>0.29</td>
<td>0.82</td>
</tr>
</tbody>
</table>
Discussion

• The results of this systematic review suggest that patients undergoing primary ACLR using 5HS autografts do not demonstrate significantly different failure rates, clinical success, and PROs when compared to patients undergoing ACLR using 4HS autografts greater than 8 mm in diameter.

• The 5HS autografts do, however, demonstrate lower failure rates in comparison 4HS autografts less than 7.5 mm in diameter, in which revision is necessary in 13.6% of these cases (Magnussen et al, 2012).

• The biomechanical studies suggest that 5HS grafts do not differ in their biomechanical properties when compared to 4HS grafts as no significant differences were found between constructs in failure load, stress-relaxation, graft displacement, or graft stiffness.
Discussion

Limitations

- First, this study was limited by a small sample, resulting from the small number of studies included.
- Second, a patient cohort in one study was duplicated in a separate study by the same author (Krishna et al, 2018).
- Third, the overall average follow-up time was relatively short at 30.2 months.
- Fourth, not many female patients were included (14/115), a patient cohort that most likely will have grafts that do not meet the 8 mm mark and will benefit most from the 5HS graft technique.
Conclusions

• The available literature on traditional 4HS and 5HS autografts for ACLR is limited.
• This study suggests that there are no significant differences in clinical outcomes or biomechanical properties between 4HS constructs greater than 8 mm in diameter and 5HS constructs.
• Further research is necessary to determine if creating a 5HS construct is beneficial, especially in cases where the traditional 4HS graft is less than 8 mm in diameter.
References