# Bridging Suture Makes Consistent And Secure Fixation In Double-Row Rotator Cuff Repair

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# Introduction

- Many studies have shown that the integrity of the postoperative rotator cuff is correlated with functional outcome.

- Rotator cuff tendons repaired by using double-row techniques that incorporate suture bridges have lower re-tear rates and better biomechanical properties than those repaired through conventional techniques.

# Introduction

- But poor distribution of suture tension in a double-row repair can excessively concentrate stress at a few sutures, thus potentially increasing the risk of re-tear of the repaired tendon.

- Distributing tension equally among all sutures in the repair is key to secure fixation and to maintaining cuff integrity after surgery.

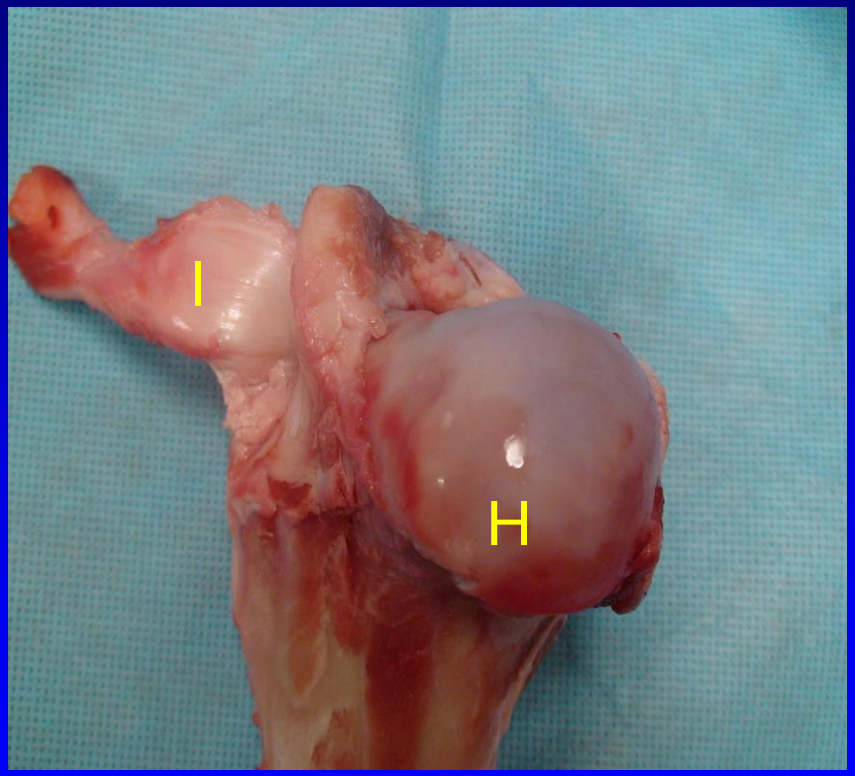
# Purpose

- To compare the tension distribution along the repaired rotator cuff tendon among three double-row repair techniques.

# Materials and Methods

- Fresh-frozen shoulders from 42 pigs (age, 6 mo)

- Extraneous tissue was dissected from the scapula and proximal humerus to isolate the infraspinatus tendon to create a rotator cuff tear model.




H:humeral head
I:infraspinatus tendon¥

# Materials and Methods

## Repair techniques

The simulated rotator cuff tear was repaired with three types of double-row repair technique:

- conventional double-row repair (double-row without bridging sutures, DR)
- transosseous-equivalent repair (bridging suture alone, TE)
- compression double-row repair (which combined conventional double-row and bridging sutures, CDR)

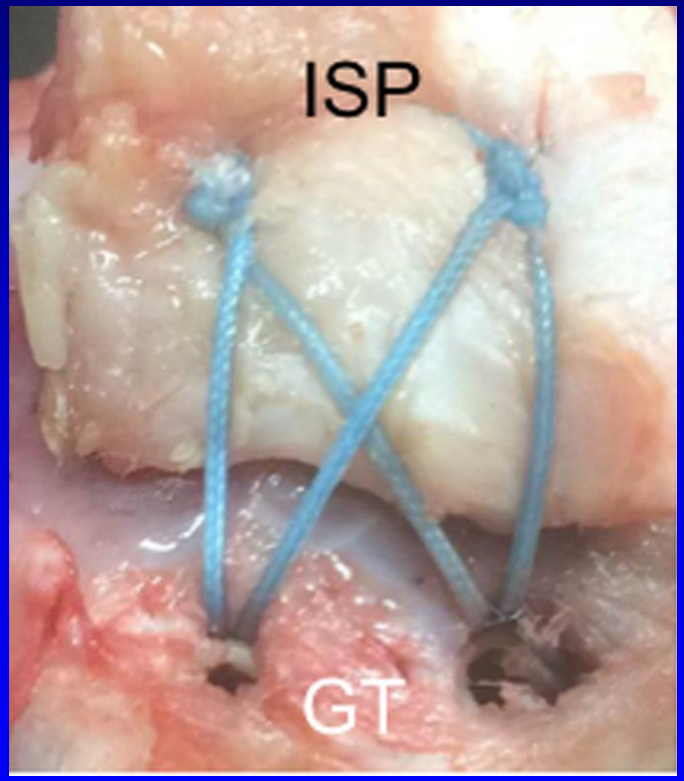
# Materials and Methods

## conventional double-row repair (DR)


The medial 2 anchors were placed just along the articular margin, 10mm apart from the superior-inferior dimension. And the lateral anchors were placed 10 mm apart laterally from the medial anchors. The medial sutures were tied in a horizontal mattress configuration with 5mm tissue captured. And the lateral sutures were tied in simple sutures with 5mm tissue captured from lateral edges.

# Materials and Methods

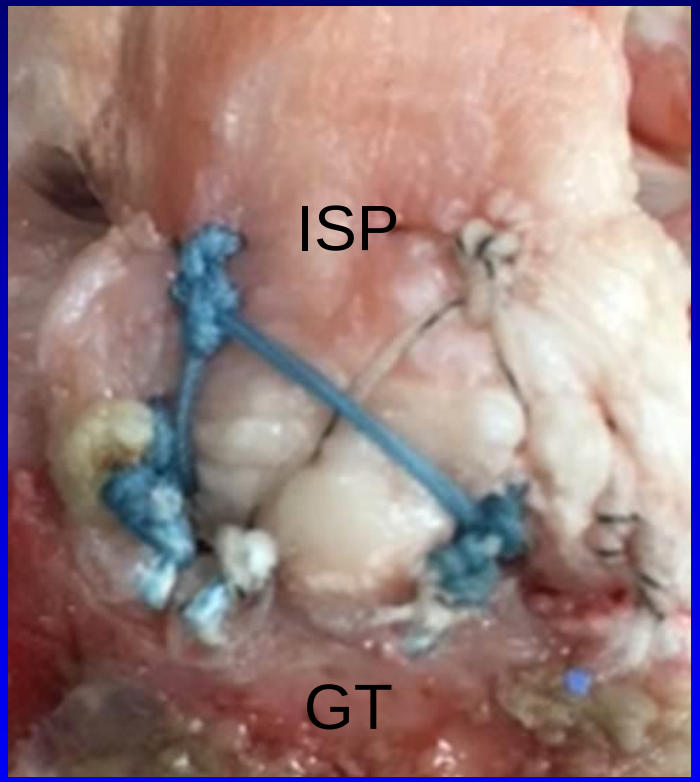
## Transosseous-equivalent repair (TE)




The medial anchors were placed and tied as DR repair and the suture limbs were bridged over the footprint and fixed laterally with Pushlock (Arthrex, Naples, FL).

# Materials and Methods

## Compression double-row repair (conventional double-row repair with bridging sutures)



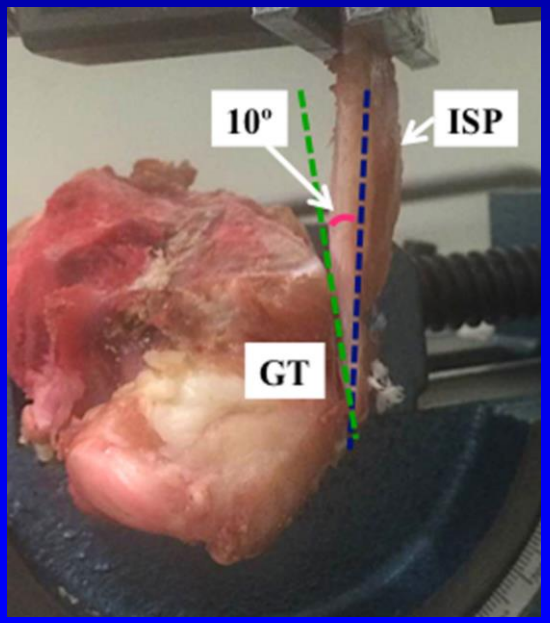

: The suture limbs from each of the medial anchors were bridged over the footprint and tied laterally through the loop that was formed with a suture limb of each lateral anchor..

# Materials and Methods

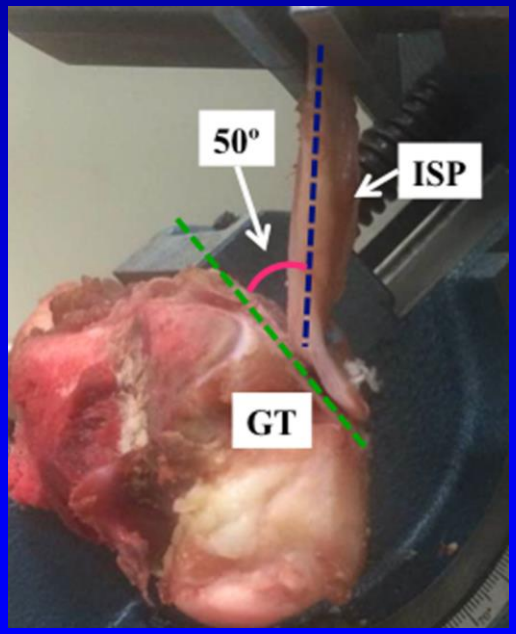
material testing machine

- AUTOGRAPH$^{TM}$ (Shimadzu AG-1)

- Each specimen underwent cyclic testing at a simulated shoulder abduction angle of 0˚ or 40˚ on a material-testing machine.



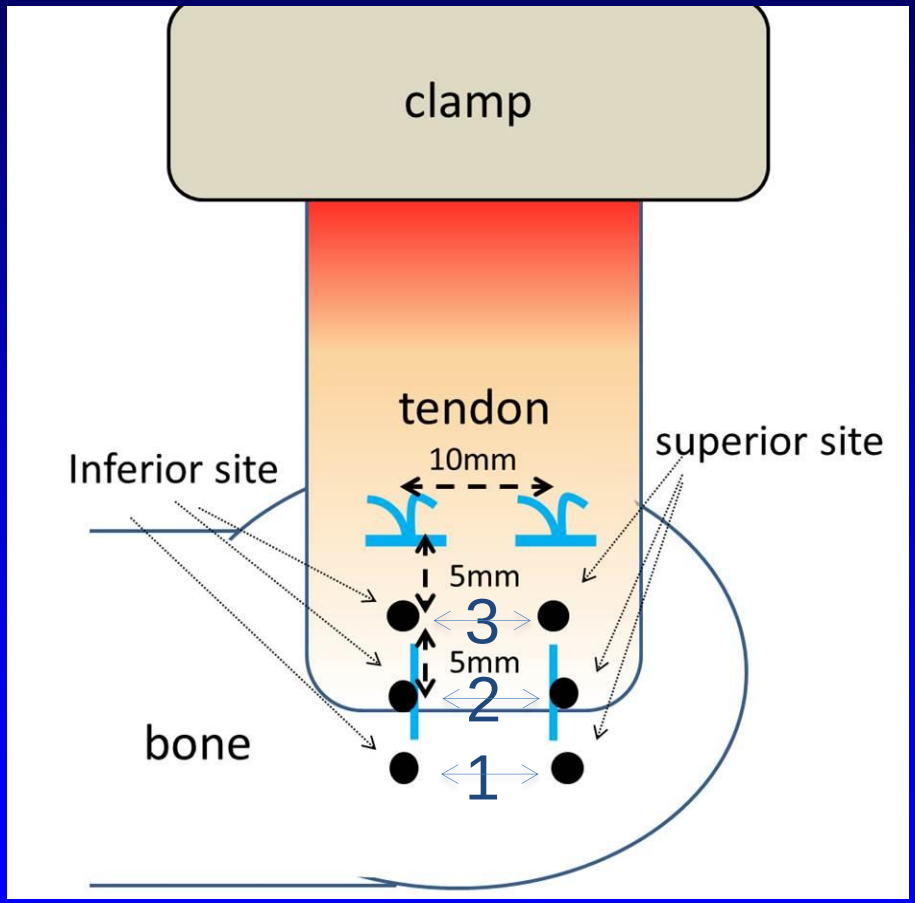

abduction angle of 0˚




abduction angle of 40˚

# Materials and Methods

- Cyclically loaded from 5 to 30 N at a rate of 20mm/min for 30 cycles.
- Both superior and inferior gap formation ( between bone:1 and tendon edge:2 ) and tendon strain (between tendonedge:2 and tendon:3) were measured during the 1st and 30th cycles.



# Materials and Methods

- All measurements and calculations were made by using motion analysis software (WINanalyze, Mikromak, Berlin, Germany) to evaluate video-recordings (model HDR-SR8 Digital Camcorder, Sony, Japan)

- To evaluate tension distribution after cuff repair, difference in gap and tendon strain between the superior and inferior fixations were compared among three double-row techniques.

# Materials and Methods

## Statistical analysis

- One-way analysis of variance followed by Fisher's post hoc test（among the three repair techniques.）
- Student's t-test（between the two abduction angles.）
- All statistical analyses were performed by using Statistica software (version 6, StatSoft, Tulsa, OK)
- The level of significance was set at $P < .05$. Data are shown as means ± 1 standard deviation.

# Results

## Gap Formations in the Superior and Inferior Side of Infraspinatus Tendon (mean ± 1 SD)

| Difference in Longitudinal strain between Superior and Inferior , % | Conventional Double-row | Transosseous-Equivalent | Compression Double-row |
|---|---|---|---|
| 0º abduction | | | |
| 1st cycle | 3.3±3.8 | 2.3±2.5 | 1.9±1.5 |
| 30th cycle | 8.6±5.5 [a] | 5.1±4.9 | 2.7±2.4 |
| 40º abduction | | | |
| 1st cycle | 1.5±0.9 | 1.1±0.5 | 2.0±1.1 |
| 30th cycle | 5.2±6.3 | 4.2±2.4 | 2.9±2.4 |

[a] Value significantly ($P < .05$) higher than that with the transosseous-equivalent technique
[b] Value significantly higher than that with the compression double-row technique ($P < .05$)
[c] Significantly higher values than value at 40º abduction ($P < .05$)

# Results

## Difference in Gap Formation between the Superior and Inferior Sides of the Infraspinatus Tendon (mean ± 1 SD)

| Difference in Gap Formation between Superior and Inferior , mm | Conventional Double-row | Transosseous-equivalent | Compression Double-row |
|---|---|---|---|
| 0º abduction | | | |
| 1st cycle | 0.3±0.3 [a] | 0.1±0.1 | 0.1±0.1 |
| 30th cycle | 0.5±0.4 [a,b] | 0.1±0.1 | 0.1±0.1 |
| 40º abduction | | | |
| 1st cycle | 0.1±0.1 | 0.1±0.1 | 0.1±0.1 |
| 30th cycle | 0.2±0.2 | 0.1±0.1 | 0.2±0.1 |

[a] Value significantly ($P < .05$) higher than that with the transosseous-equivalent technique
[b] Values significantly ($P < .05$) than that with the compression double-row technique

# Result

## Longitudinal Strain of the Superior and Inferior Sides of the Infraspinatus Tendon (mean ± 1 SD)

| | Conventional Double-row | | Transosseous- equivalent | | Compression Double-row | |
|---|---|---|---|---|---|---|
| Strain, % | Superior | Inferior | Superior | Inferior | Superior | Inferior |
| 0º abduction | | | | | | |
| 1st cycle | 0.5±2.7 | 0.1±5.0 | 1.7±1.9 | 1.9±3.3 | 0.2±1.3 | 0.2±1.4 |
| 30th cycle | 1.1±4.1 | -0.3±10.4 | 2.9±3.4 | 4.6±8.9 | 0.1±2.2 | -0.6±2.1 |
| 40º abduction | | | | | | |
| 1st cycle | -0.9±1.9 | -0.1±1.2 | 0.3±1.4 | 0.8±1.5 | 0.3±2.8 | 0.9±1.2 |
| 30th cycle | -4.4±5.3 | -0.6±4.8 | 0.8±7.0 | 2.5±2.5 | -2.0±3.1 | -0.1±1.2 |

# Result

## Difference in Longitudinal Strain between the Superior and Inferior Sides of the Infraspinatus Tendon (mean ± 1 SD)

| Difference in Longitudinal strain between Superior and Inferior , % | Conventional Double-row | Transosseous-equivalent | Compression Double-row |
|---|---|---|---|
| 0º abduction | | | |
| 1st cycle | 3.3±3.8 | 2.3±2.5 | 1.9±1.5 |
| 30th cycle | 8.6±5.5 [a] | 5.1±4.9 | 2.7±2.4 |
| 40º abduction | | | |
| 1st cycle | 1.5±0.9 | 1.1±0.5 | 2.0±1.1 |
| 30th cycle | 5.2±6.3 | 4.2±2.4 | 2.9±2.4 |

[a] Value significantly ($P < .05$) higher than that with the compression double-row technique

# Discussion

- The double-row rotator cuff repair techniques that included bridging sutures (that is, transosseous-equivalent and compression techniques) had smaller differences in gap formation between the superior and inferior fixation sites and less tendon strain than did conventional double-row repair.

- These results suggest that bridging sutures promote balanced fixation in double-row rotator cuff repairs and may be beneficial for distributing stress evenly when rotator cuff repairs require 4 or more suture anchors, as for medium or large tears.