Distance of the Posterior Interosseous Nerve (PIN) from the Bicipital Tuberosity at Varying Degrees of Forearm Rotation: A Magnetic Resonance Imaging (MRI) Study with Clinical Implications

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Disclosures may be found at the AAOS Organization Website.
Objective

- Posterior interosseous nerve (PIN) injury is a feared complication of distal biceps tendon repair.

- Cadaveric studies recommend forearm supination and proximal-ulnar trajectory of cortical button instrumentation to protect the PIN during the single-incision approach.

- This study uses MRI to (1) analyze the distances between the PIN, bicipital tuberosity, and cortical button instrumentation in varying positions of forearm rotation, and (2) uses MRI to validate existing recommendations from cadaveric studies.
Methods

- N = 13 patients indicated for MRI Elbow
- Standardized non-contrast, non-fat suppressed T1-weighted MRI (3 Tesla) were obtained with the forearm in:
  - Maximal Supination
  - Neutral Rotation
  - Maximal Pronation
- Achievable position of simulated drill pin instrumentation defined by senior surgeon (RJM) with reference to:
  - Arm position on MRI (Operative) Table
  - Intermuscular planes
- 3-part measurement analysis by two fellowship-trained MSK Radiologists
  - Blinded to clinical & demographic information

<table>
<thead>
<tr>
<th>PATIENT VARIABLE</th>
<th>MEAN</th>
<th>SD / %</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE (YRS)</td>
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<tr>
<td>BMI</td>
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</tr>
<tr>
<td>SEX (FEMALE)</td>
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<td>38.5%</td>
</tr>
<tr>
<td>LATERALITY (LEFT)</td>
<td>5</td>
<td>38.5%</td>
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</table>
Measurements – Part 1

“Simulated Single-Incision Technique”

**Definition of Measurement:**

- **GWE-PIN:** distance measured from the PIN to the simulated path of an entering guide wire (GWE) achievable from an anterior, single-incision approach.
- **CSP-PIN:** distance from the PIN to the cortical start point (CSP) on the bicpital tuberosity.

**Performed in Forearm Position:**

- Maximal Supination
- Neutral Rotation
- Maximal Pronation
Results – Part 1

“Simulated Single-Incision Technique”

- **GWE-PIN** distance was significantly greater in supination than both neutral ($p = 0.004$) and pronation ($p < 0.001$), however this difference was small (1-3mm)

- **CSP-PIN** distance was significantly greater in supination than both neutral ($p = 0.002$) and pronation ($p < 0.001$), however this difference was small (1-2mm)
Measurements – Part 2

“Reference to Anatomic Landmarks”

Definition of Measurement:

- **BTP-PIN**: distance measured from the PIN to the prominent-most point of the bicipital tuberosity (BTP)
- **PPT-PIN**: distance between the PIN and a perpendicular plane trajectory (PPT) entering at 90-deg to the bicipital tuberosity and exiting out the opposing radial cortex

Performed in Forearm Position:

- Maximal Supination
- Neutral Rotation
- Maximal Pronation
Results – Part 2

“Reference to Anatomic Landmarks”

• **BTP-PIN** distances did not significantly differ between forearm positions of supination, neutral, and pronation.

• **PPT-PIN** distance was significantly greater in supination than both neutral (p < 0.001) and pronation (p < 0.001), by a mean of 5mm and 7mm, respectively.

• Note: **PPT** in the prone position closely approximates the trajectory of the drill pin used for bicortical suspensory button fixation utilizing the two-incision technique; the results therefore should raise caution against the use of bicortical button fixation via this approach.

*All measurements reported in millimeters (mm)*

<table>
<thead>
<tr>
<th></th>
<th>BTP-PIN (SUPINATION)</th>
<th>BTP-PIN (NEUTRAL)</th>
<th>BTP-PIN (PRONATION)</th>
<th>PPT-PIN (SUPINATION)</th>
<th>PPT-PIN (NEUTRAL)</th>
<th>PPT-PIN (PRONATION)</th>
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<tbody>
<tr>
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<td>15.00</td>
<td>3.50</td>
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<tr>
<td><strong>MAXIMUM</strong></td>
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<td>26.50</td>
<td>12.50</td>
<td>9.50</td>
<td>3.50</td>
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</table>
Measurements – Part 3

“Axial Course of PIN Relative to Bicipital Tuberosity”

**Measurements – Part 3**

**“Axial Course of PIN Relative to Bicipital Tuberosity”**

**Definition of Measurement:**

- **BTP-PIN:** distance measured from the PIN to the prominent-most point of the bicipital tuberosity (BTP)
- **PPT-PIN:** distance between the PIN and a perpendicular plane trajectory (PPT) entering at 90-deg to the bicipital tuberosity and exiting out the opposing radial cortex
- Measurements made at 3 sequential axial levels to assess course of PIN:
  - 1cm Proximal to BT Prominence
  - @ Level of BT Prominence
  - 1cm Distal to BT Prominence

**Performed in Forearm Position:**

- Maximal Supination ONLY
Results – Part 3

“Axial Course of PIN Relative to Bicipital Tuberosity”

- **BTP-PIN** distances did not significantly differ when measured 1cm proximal to, at the mid-portion of, or 1cm distal to the BT with the forearm in supination.

- **PPT-PIN** distance was significantly shorter when measured 1cm distal to the BT mid-portion, compared to the BT mid-portion itself, or 1cm proximal (p < 0.001).

- Results suggest that distal drill pin trajectory or re-insertion of the biceps tendon at the distal portion of the BT using bicortical suspensory button may increase risk of PIN injury.

<table>
<thead>
<tr>
<th></th>
<th>BTP-PIN (PROXIMAL)</th>
<th>BTP-PIN (MID-PORTION)</th>
<th>BTP-PIN (DISTAL)</th>
<th>PPT-PIN (PROXIMAL)</th>
<th>PPT-PIN (MID-PORTION)</th>
<th>PPT-PIN (DISTAL)</th>
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<tbody>
<tr>
<td><strong>MEAN</strong></td>
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<td>0.00</td>
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<tr>
<td><strong>MAXIMUM</strong></td>
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<td>24.00</td>
<td>15.00</td>
<td>12.00</td>
<td>8.00</td>
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*All measurements reported in millimeters (mm)*
Limitations

- **Small Sample Size (n=13)**
  - However, n=13 is consistent with the quantity of specimens evaluated in the existing anatomic studies in the literature
  - Measurements demonstrated consistency with low standard deviation, which suggests the sample size is sufficient for the purposes of the study

- **MRIs were indicated for subjects with a variety of elbow complaints**
  - Inability to maintain forearm rotation secondary to pain was cause for exclusion, and may limit the feasibility of forearm rotation-specific elbow MRI in some acutely injured patients

- **Risk of observer bias and measurement error**
  - However, our reliability analysis demonstrated a high correlation and minimal bias between observers for all measurements.
Conclusions

- First study to use MRI to confirm the dynamic position of the PIN relative to the BT in varying degrees of forearm rotation, as well as the relationship between the PIN and radius along the course of the nerve.

- MRI findings are consistent with cadaveric studies, supporting that forearm supination and proximal-ulnar guidewire trajectory safeguards against PIN injury inflicted by cortical button instrumentation with the single-incision approach.

- However, retractor placement deep to the radial neck likely poses significant risk to the PIN, and should be avoided (especially distal to the BT*).

- Caution should be raised against two-incision, bicortical suspensory button repair due to proximity of the PIN to BT in pronation.

- Forearm rotation-specific MRI may provide important anatomical information regarding PIN position to guide safe selection of surgical approach, instrumentation and technique for distal biceps tendon repair.