



# Does Anatomic Knowledge Correlate with Surgical Competency? A Multi-Center Pilot Study of Orthopaedic Surgery Trainees

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**Duke Orthopaedics**

# Background

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- Resident competency traditionally measured by certifying opinion of program director after completion of specified number of years in training
    - Supplemented by required examinations in training
    - Successful completion of specialty board examinations
  - Recent emphasis on competency assessment of resident physicians
    - ACGME core competencies
    - Next Accreditation System Milestone guidelines
  - Limitations of current evaluation methods of competency
    - Remain primarily subjective by design (faculty / peer evaluations)
    - Difficulties in accurately capturing application of knowledge
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# Background

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- Human anatomy is foundation of all medical and surgical specialties
  - Appreciation of human anatomy guides multiple clinical abilities
    - Clinical evaluation skills
    - Observations through diagnostic testing
    - Technical proficiency in operative theatre
  - Can application of anatomic knowledge in the operative theatre be used as an objective measure of competency?
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# Goals

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- Evaluate anatomic knowledge base of orthopaedic surgery trainees in performance of two common upper extremity procedures
  - Establish competency targets by training level for anatomical knowledge in two common upper extremity procedures
  - Examine improvements in anatomic knowledge base for two common upper extremity procedures over the course of one academic year
  - Evaluate correlation between anatomic knowledge and clinical competencies as guided by the ACGME Milestone project
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# Methods

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- Participating medical institutions
    - Duke University, Department of Orthopaedic Surgery, Durham, NC
    - Harvard University, Department of Orthopaedic Surgery, Boston, MA
  - All orthopaedic surgery trainees invited to participate
  - Institutional review board exemption received from host institution
  - Partial funding received from the American Board of Orthopaedic Surgeons and the American Board of Medical Specialties
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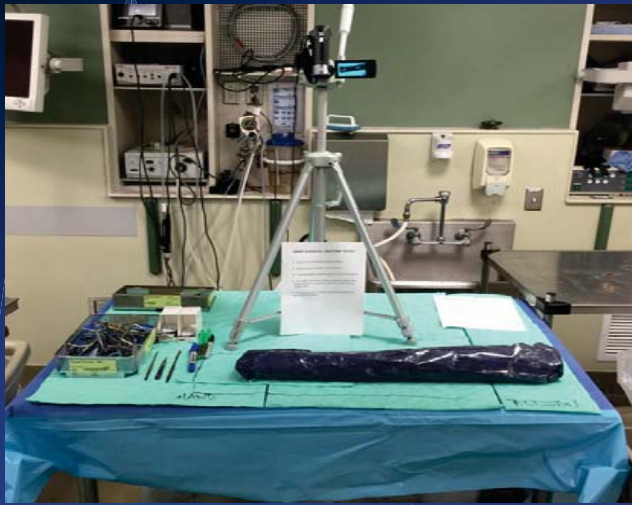
# Methods

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- Data collection at beginning and end of the academic year
  - Expectations for dissections outlined in pre-participation video
    - Unrelated common approach to the upper extremity
    - Performed by board certified orthopaedic hand surgeon
  - Dissections on cadavers video-taped in mock OR without an audience
    - Carpal tunnel release (CTR) and volar approach to the distal radius (VDR)
  - Residents asked to vocalize pertinent anatomy in greatest detail possible specific to successful completion of approach
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# Methods

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Example of mock OR and resident performing VDR on a cadaver

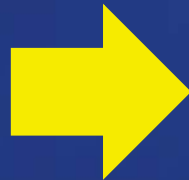
# Methods

- Surveys regarding anatomic knowledge expectations by training level sent to all hand surgery fellowship directors

**Carpal Tunnel Release**

| Anatomic Detail / Relationship               | POI TWR        | POI TWR        |
|--|----------------|----------------|
| Detail                                       | OR             | OR             |
| Skin surface landmarks (Raynor's line, etc.) | Please select* | Please select* |
| Carpal tunnel - boundaries                   | Please select* | Please select* |
| Superficial carpal ligament (TCL) insertions | Please select* | Please select* |
| Median nerve course - flexion                | Please select* | Please select* |
| Median nerve at PICA / DCS interval          | Please select* | Please select* |
| Palmar cutaneous branch (MC) origin / course | Please select* | Please select* |
| Median nerve course - carpal tunnel          | Please select* | Please select* |
| Thenar motor branch - origin / types         | Please select* | Please select* |
| Thenar motor branch - nerve innervation      | Please select* | Please select* |
| Thenar motor branch - variations             | Please select* | Please select* |
| Median nerve - divisions                     | Please select* | Please select* |
| Sensitization - Common digital nerve         | Please select* | Please select* |
| Superficial palmar arterial arch             | Please select* | Please select* |
| Deep palmar arterial arch                    | Please select* | Please select* |
| Common digital artery / nerve relationship   | Please select* | Please select* |
| Ulnar / thenar tunnel - boundaries           | Please select* | Please select* |
| Ulnar nerve / artery relationship            | Please select* | Please select* |
| Ulnar nerve branching - OSAIN                | Please select* | Please select* |
| Ulnar nerve - deep / superficial branches    | Please select* | Please select* |
| Ulnar nerve - motor in course                | Please select* | Please select* |
| Median-Ulnar interconnection                 | Please select* | Please select* |
| Wrist-Carpus interconnection                 | Please select* | Please select* |
| Palmar fascia / thenar fascia                | Please select* | Please select* |
| Wrist carpal ligament insertions (MC, TC)    | Please select* | Please select* |

Please list any additional relevant or pertinent anatomic details or relationships which were not mentioned above that should be included and the minimum POI level that this should be expected:



**Detailed Checklist Carpal Tunnel Release Score Sheet**

Resident Number: \_\_\_\_\_ Resident Number: \_\_\_\_\_ Time: \_\_\_\_\_

Resident Detail / Institution: \_\_\_\_\_ Specialty: \_\_\_\_\_ Months in specialty: \_\_\_\_\_

| Essential Anatomic Landmarks  | Yes | No |
|---|-----|----|
| <b>General</b>  | 10  | 0  |
| <b>Neurovascular</b>  |     |    |
| Median nerve course - flexion (depth of pronation)                                      | 10  | 0  |
| Median nerve course - carpal tunnel (depth to PICA, ulnar to PICA)                      | 10  | 0  |
| Palmar cutaneous branch MC origin / course (PICA - Most hand classes, 100% MC interval) | 10  | 0  |
| Recurrent motor branch - origin / types (nerve course off median in 1/2 of 3 branches)  | 10  | 0  |
| Recurrent motor branch - innervation (thenar musculature, 100% MC)                      | 10  | 0  |
| Recurrent motor branch - variations (anatomical/physiological)                          | 10  | 0  |
| Median nerve - divisions (distal - common digital to 1st/2nd and 3rd/4th)               | 10  | 0  |
| Ulnar nerve / artery relationship (osseal dorsal and prior to ulnar)                    | 10  | 0  |
| Ulnar nerve branching - OSAIN   | 10  | 0  |
| Ulnar nerve - deep / superficial branches   | 10  | 0  |
| Ulnar nerve - motor in course   | 10  | 0  |
| Median-Ulnar interconnection (MC in other nerve in 100%)                                | 10  | 0  |
| Wrist-Carpus interconnection (median in other nerve in 100%)                            | 10  | 0  |
| <b>Musculoskeletal</b>  |     |    |
| Superficial palmar arterial arch course, primarily ulnar                                | 10  | 0  |
| Deep palmar arterial arch course, primarily ulnar                                       | 10  | 0  |
| Common digital artery / nerve relationship  | 10  | 0  |
| <b>All TWR Approaches</b>   |     |    |
| Palmar tunnel - ligamentous boundaries  | 10  | 0  |
| Distal tunnel releases  | 10  | 0  |
| Transverse carpal ligament (TCL) variations   | 10  | 0  |
| Common digital artery / nerve relationship  | 10  | 0  |
| Ulnar-Ulnar tunnel - ligamentous boundaries   | 10  | 0  |
| Median-Ulnar / thenar tunnel  | 10  | 0  |
| Wrist carpal ligament insertions (MC, TC)   | 10  | 0  |
| <b>Medical/Anatomy</b>  |     |    |
| Common digital - common branches (superficial/median & deep/proximal/median)            | 10  | 0  |
| Distal ulnar tunnel - osseal boundaries   | 10  | 0  |

Errors: \_\_\_\_\_ (Incorrect statements / merge/s identification)

| Technique | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|-----------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
| 1         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| 2         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| 3         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| 4         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |
| 5         |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |

Grading Scale: \_\_\_\_\_

- Itemized checklists for each approach created from survey data to quantitatively assess participant knowledge base



# Methods

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- Videos reviewed independently by authors in blinded fashion
  - Points given for correctly mentioning and/or identifying pertinent anatomic structures
  - Checklist scores summed and divided by total number of options to calculate percentage of structures identified per approach
  - Resident Milestone and case log data obtained from residency program director of host institution
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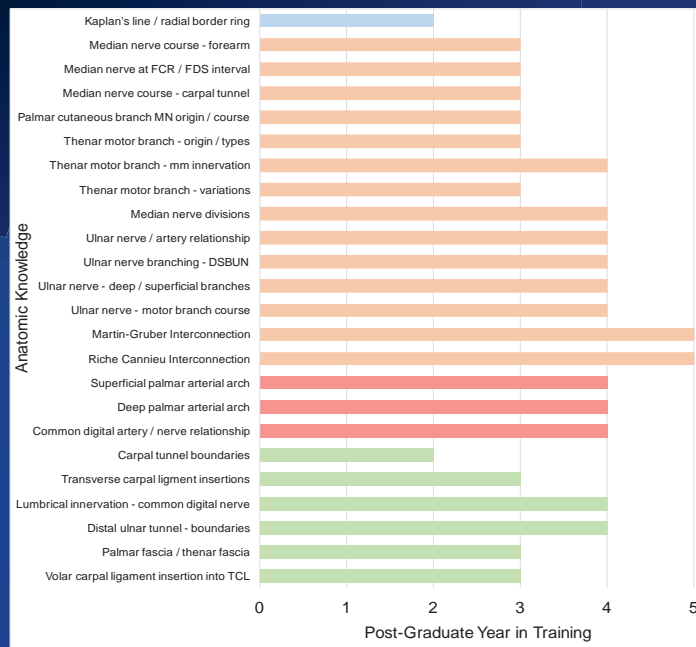
# Statistical Analysis

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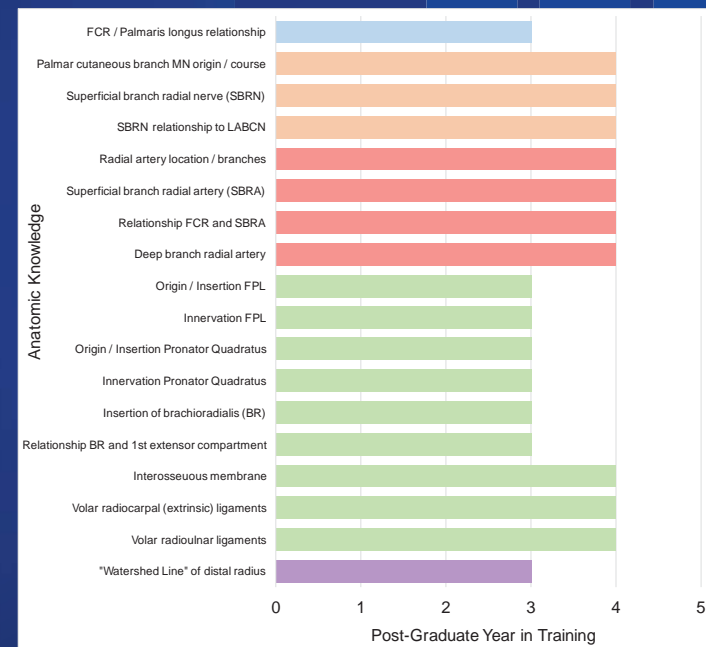
- Mean checklist scores for each approach were calculated from reviewer evaluations
  - Differences in anatomic knowledge scores analyzed using one-way analysis of variance (ANOVA) with PGY level as between-subjects factor
  - Improvements in anatomic knowledge scores of individual residents after one year analyzed with paired students T-test
  - Threshold for significance set at  $p \leq 0.05$  for all tests
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# Results

## Fellowship Director Surveys



Carpal Tunnel Release

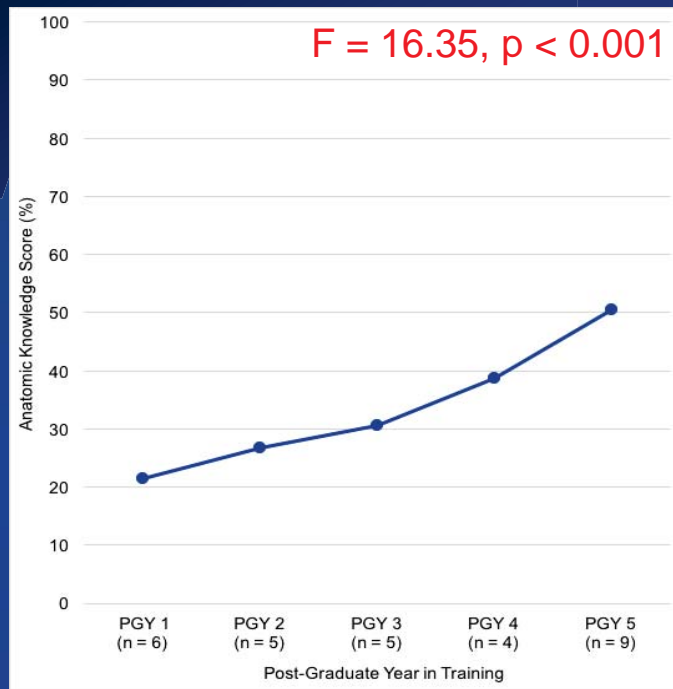


Volar Approach to Distal Radius

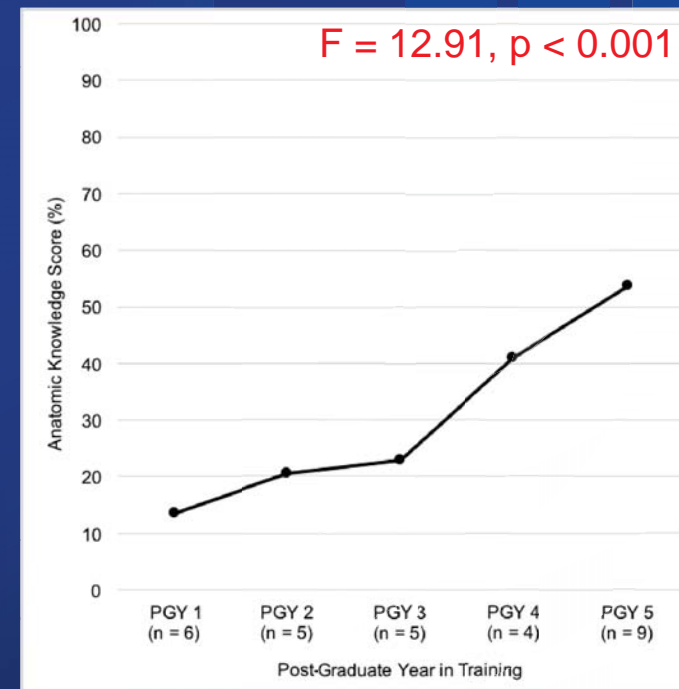
**>37% of facts for CTR and > 55% facts for VDR expected to be known by PGY 3**

# Results

## Mean Anatomic Knowledge Scores by Resident Year in Training



Carpal Tunnel Release



Volar Approach to Distal Radius

# Results

## Comparisons Between Resident Year in Training, Carpal Tunnel Score, Previous Surgical Experience, and ACGME Milestone Score

| Resident Year in Training | CTR Score (%) <sup>*</sup> | Total No. CTR Cases Observed Per Resident <sup>§</sup> <sup>¶</sup> | CTR Medical Knowledge ACGME Milestone Score <sup>§</sup> | CTR Patient Care ACGME Milestone Score <sup>§</sup> |
|---------------------------|----------------------------|---|--|---|
| PGY 1 (n = 6)             | 21.43 ± 7.22               | 1   | 4.2  | 4.3   |
| PGY 2 (n = 5)             | 26.67 ± 6.16               | 13  | 4.2  | 4.3   |
| PGY 3 (n = 5)             | 30.48 ± 9.28               | 13  | 4.3  | 4.4   |
| PGY 4 (n = 4)             | 38.69 ± 17.58              | 22  | 4.4  | 4.5   |
| PGY 5 (n = 9)             | 50.74 ± 4.07               | 28  | 4.5  | 4.5   |

<sup>\*</sup>Data presented as the mean and the standard deviation. <sup>§</sup> Data presented as the mean for 2014 - 2015 academic year. <sup>¶</sup> Case totals based off CPT code 64721.

# Results

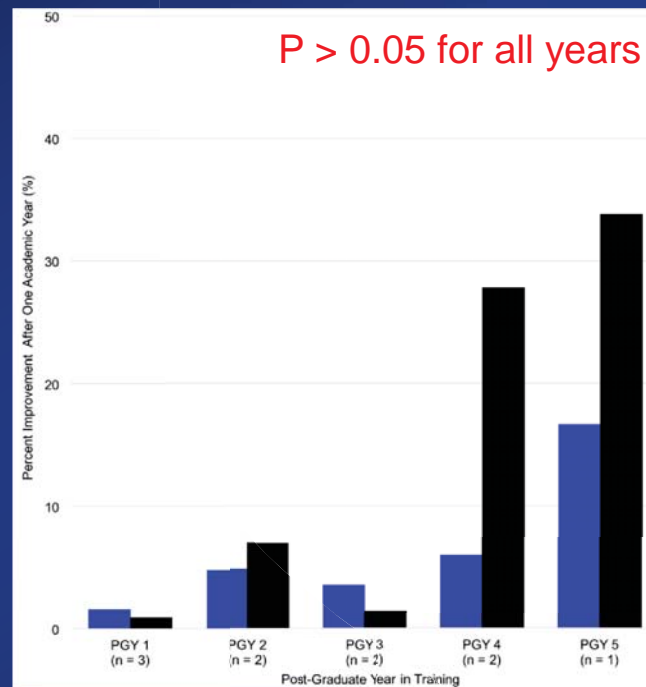
## Comparisons Between Resident Year in Training, Distal Radius Score, Previous Surgical Experience, and ACGME Milestone Score

| Resident Year in Training | VDR Score (%)* | Total No. VDR Cases Observed Per Resident § ¶ | VDR Medical Knowledge ACGME Milestone Score § | VDR Patient Care ACGME Milestone Score § |
|---------------------------|----------------|---|---|--|
| PGY 1 (n = 6)             | 13.43 ± 10.16  | 1   | 4.2   | 4.2                                      |
| PGY 2 (n = 5)             | 20.56 ± 4.56   | 5   | 4.2   | 4.2                                      |
| PGY 3 (n = 5)             | 22.78 ± 5.34   | 6   | 4.3   | 4.4                                      |
| PGY 4 (n = 4)             | 40.97 ± 20.26  | 10  | 4.4   | 4.5                                      |
| PGY 5 (n = 9)             | 59.72 ± 25.80  | 12  | 4.5   | 4.6                                      |

\*Data presented as the mean and the standard deviation. § The values given as the mean for 2014 - 2015 academic year. ¶ Case totals based off CPT codes 25607, 25608, 25609

# Results

Mean improvement in anatomic knowledge score over one academic year



CTR (blue) VDR (black)

# Conclusions

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- Progression of anatomic knowledge each year was found using an objective assessment tool
    - Increased exposure to procedures throughout residency
    - Relevant education during formal clinical rotations
  - Despite improvement in Milestone scores each year, variation between levels was small and all training levels scores above 4 (out of 5)
    - Milestone scores may not accurately reflect surgical competency
    - Influenced by subjective nature of faculty evaluations?
  - Standardized, procedure-based assessment of pertinent clinical anatomy may facilitate identification of educational deficiencies
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# Future

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- Standardized curriculum and technique guides for testing
  - Expansion of resident testing with inclusion of hand surgery fellows
  - Longitudinal evaluation of individual trainees throughout residency
  - Comparison to validated methods of competency assessment
  - Application to other surgical and non-surgical specialties
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# Acknowledgments

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- The American Board of Orthopaedic Surgery
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- Orthopaedic surgery residents at Duke and Harvard University



## Duke Orthopaedic Surgery

Moving forward. Climbing higher.