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

Benjamin M. Wooster MD¹, Nathan L. Grimm MD¹, George S. Dyer MD², Fraser J. Leversedge MD¹

¹Department of Orthopaedic Surgery, Duke University Medical Center, Durham, NC
²Department of Orthopaedic Surgery, Harvard University Medical Center, Boston, MA
Background

- 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
Background

- Human anatomy is foundation of all medial 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?
Goals

- 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
Methods

- 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
Methods

- 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
Methods

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

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

- 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
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.
Results

Fellowship Director Surveys

Carpal Tunnel Release

>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

F = 16.35, p < 0.001

F = 12.91, p < 0.001
## Results

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

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

*Data presented as the mean and the standard deviation. ‡ Data presented as the mean for 2014 - 2015 academic year. ‡‡ Case totals based off CPT code 64721.
## Results

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

<table>
<thead>
<tr>
<th>Resident Year in Training</th>
<th>VDR Score (%)*</th>
<th>Total No. VDR Cases Observed Per Resident $\dagger$ $\ddagger$</th>
<th>VDR Medical Knowledge ACGME Milestone Score $\dagger$</th>
<th>VDR Patient Care ACGME Milestone Score $\dagger$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGY 1 (n = 6)</td>
<td>13.43 ± 10.16</td>
<td>1</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>PGY 2 (n = 5)</td>
<td>20.56 ± 4.56</td>
<td>5</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>PGY 3 (n = 5)</td>
<td>22.78 ± 5.34</td>
<td>6</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>PGY 4 (n = 4)</td>
<td>40.97 ± 20.26</td>
<td>10</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td>PGY 5 (n = 9)</td>
<td>59.72 ± 25.80</td>
<td>12</td>
<td>4.5</td>
<td>4.6</td>
</tr>
</tbody>
</table>

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

Mean improvement in anatomic knowledge score over one academic year

P > 0.05 for all years
Conclusions

- 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
Future

- 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
Acknowledgments

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- My fellow ABMS visiting scholars
- Orthopaedic surgery residents at Duke and Harvard University
Moving forward. Climbing higher.