A New Model to Facilitate Palpation of the Level of the Transverse Processes of the Thoracic Spine

Geelhoed MA, McGaugh J, Brewer PA, Murphy D

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Objectives

嗓子 Explain the results, relevance, and clinical implications of the present study on determining thoracic vertebral level.

嗓子 Information, demonstration, and explanation of the “Rule of Threes.”

嗓子 Review the evidence concerning the validity of the rule of threes, reliability of spinal palpation, and coupling behavior of the thoracic spine.
To test a proposed model to locate the level of the transverse processes (TPs) of the thoracic spine through surface palpation.

Clinical Importance

- Currently accepted palpation technique ("Rule of Three's") has not been validated
- Importance of accurately locating spinal segments for:
  - Diagnostic tests
  - Mobility Assessment
  - Treatment techniques
“Rule of Threes”

- Described by Mitchell in 1979
- Attempted to locate TPs relative to corresponding SPs
- Based on changing caudal angulation of SPs
- Has not been validated in research

<table>
<thead>
<tr>
<th>TABLE 1. The rule of threes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The upper 3 thoracic vertebrae (T1-T3) have spinous processes (SPs) that project directly posterior and therefore the tip of the SP is in the same plane as the transverse processes (TPs) of that same vertebra.</td>
</tr>
<tr>
<td>The next 3 vertebrae (T4-T6) have SPs that project slightly downward and therefore the tip of the SP is in a plane that is halfway between its own TPs and that of the TPs of the caudal vertebrae.</td>
</tr>
<tr>
<td>The next 3 vertebrae (T7-T9) have SPs that project moderately downward and therefore the tip of the SP is in a plane with the TPs of the caudal vertebrae.</td>
</tr>
<tr>
<td>The last 3 vertebrae (T10-T12) have SPs that project from a position similar to T9 and rapidly regress until T12 is more like T1 (i.e., T10 SP is in the plane of the TPs of the caudal vertebra, T11 SP is halfway between its own TPs and that of the caudal vertebra, and T12 SP is in the plane of its own TPs).</td>
</tr>
</tbody>
</table>
Proposed Method

- Predicts location of thoracic TP’s
- Thoracic TPs are lateral to the most prominent SP of vertebrae 1 level above

Subjects

- Dissected to clearly visualize and palpate the SPs and TPs of the thoracic spine

FIGURE. Dissected cadaver showing pins inserted in thoracic spine transverse processes (TPs) and spinous process (SP) of the adjacent cranial vertebra.
Methods

- Palpated the most prominent points of the SPs and TPs
- Established a transverse plane
- Used a digital caliper to measure:
  - Vertical distance between the transverse plane and SP of the above vertebrae

Data Analysis

<table>
<thead>
<tr>
<th>Thoracic Spine Level</th>
<th>Mean</th>
<th>SD</th>
<th>Effect Size (6-mm mean)/SD</th>
<th>Minimum Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 SP to T2 TPs</td>
<td>2.9</td>
<td>1.9</td>
<td>1.7</td>
<td>5</td>
</tr>
<tr>
<td>T2 SP to T3 TPs</td>
<td>2.3</td>
<td>1.8</td>
<td>2.1</td>
<td>3</td>
</tr>
<tr>
<td>T3 SP to T4 TPs</td>
<td>2.2</td>
<td>1.2</td>
<td>3.2</td>
<td>2</td>
</tr>
<tr>
<td>T4 SP to T5 TPs</td>
<td>2.0</td>
<td>1.8</td>
<td>2.3</td>
<td>3</td>
</tr>
<tr>
<td>T5 SP to T6 TPs</td>
<td>2.3</td>
<td>1.7</td>
<td>2.2</td>
<td>3</td>
</tr>
<tr>
<td>T6 SP to T7 TPs</td>
<td>3.6</td>
<td>2.2</td>
<td>1.1</td>
<td>10</td>
</tr>
<tr>
<td>T7 SP to T8 TPs</td>
<td>3.2</td>
<td>2.1</td>
<td>1.3</td>
<td>7</td>
</tr>
<tr>
<td>T8 SP to T9 TPs</td>
<td>2.5</td>
<td>1.4</td>
<td>2.6</td>
<td>2</td>
</tr>
<tr>
<td>T9 SP to T10 TPs</td>
<td>2.0</td>
<td>1.9</td>
<td>2.1</td>
<td>3</td>
</tr>
<tr>
<td>T10 SP to T11 TPs</td>
<td>3.0</td>
<td>2.5</td>
<td>1.2</td>
<td>8</td>
</tr>
<tr>
<td>T11 SP to T12 TPs</td>
<td>3.8</td>
<td>4.3</td>
<td>0.5</td>
<td>44</td>
</tr>
<tr>
<td>T12 SP to L1 TPs</td>
<td>4.0</td>
<td>4.2</td>
<td>0.3</td>
<td>53</td>
</tr>
</tbody>
</table>

Abbreviations: SP, spinous process; TP, transverse process.
Results

<table>
<thead>
<tr>
<th>Thoracic Spine Level</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>99% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 SP to T2 TPs</td>
<td>2.9</td>
<td>1.9</td>
<td>.48</td>
<td>1.42-4.30</td>
</tr>
<tr>
<td>T2 SP to T3 TPs</td>
<td>2.3</td>
<td>1.6</td>
<td>.46</td>
<td>0.96-3.68</td>
</tr>
<tr>
<td>T3 SP to T4 TPs</td>
<td>2.2</td>
<td>1.2</td>
<td>.31</td>
<td>1.26-3.09</td>
</tr>
<tr>
<td>T4 SP to T5 TPs</td>
<td>2.0</td>
<td>1.8</td>
<td>.45</td>
<td>0.70-3.38</td>
</tr>
<tr>
<td>T5 SP to T6 TPs</td>
<td>2.3</td>
<td>1.7</td>
<td>.43</td>
<td>1.03-3.56</td>
</tr>
<tr>
<td>T6 SP to T7 TPs</td>
<td>3.6</td>
<td>2.2</td>
<td>.50</td>
<td>1.83-5.26</td>
</tr>
<tr>
<td>T7 SP to T8 TPs</td>
<td>3.2</td>
<td>2.1</td>
<td>.53</td>
<td>1.65-4.81</td>
</tr>
<tr>
<td>T8 SP to T9 TPs</td>
<td>2.5</td>
<td>1.4</td>
<td>.35</td>
<td>1.45-3.53</td>
</tr>
<tr>
<td>T9 SP to T10 TPs</td>
<td>2.0</td>
<td>1.9</td>
<td>.50</td>
<td>0.51-3.49</td>
</tr>
<tr>
<td>T10 SP to T11 TPs</td>
<td>3.0</td>
<td>2.5</td>
<td>.64</td>
<td>1.09-4.87</td>
</tr>
</tbody>
</table>

Discussion

- Vertical distances averaged less than 6 mm
- Research supports the hypothesis
- The results of this study suggest that the potential changes in dorsal angulation may not significantly affect the anatomical relationship between the SP and the TPs of the vertebral level below.
Discussion

- Relationship between the TPs and the SP of the adjacent cranial vertebra is similar and consistent throughout the thoracic spine.

- More variability at the 2 caudal thoracic levels making accurate palpation more difficult.

Limitations

- Intervertebral disc height, spinal alignment, and other factors seen in cadavers may not be consistent with living subjects
  - Ability to generalize to the clinical setting remains unclear.

- Did not assess the effect of age on the anatomical relationships in the thoracic spine
Limitations

- Reproducibility is limited
- No repeated measures
- 1 examiner palpated
- Did not assess the reliability of palpation of spinal landmarks.

Future Research

- Investigate the clinical reliability and validity of locating the level of the TPs through palpation using the proposed model.
- Include investigation of living subjects using imaging technology
TPs in the thoracic spine are anatomically located at the level of the most prominent point of the SP of the above vertebrae.

More difficult to predict TP’s of T11 and T12.

Clinical Application

Allows clinicians to:

- Precisely locate level of TPs
- Improve accuracy of examination, differential diagnosis, and intervention.
A pilot study to investigate the validity of the rule of threes of the thoracic spine

Michael A. Geelhoed, PT, DPT, OCS, MTC, James A. Viti, DPT, OCS, FAAOMPT, Patricia A. Brewer, PhD

Study: Determine the accuracy of the rule of threes at locating the TPs relative to their corresponding SPs

Methods: Pinned the midpoint of the SPs and TPs and measured the vertical distance between the transverse plane of the TPs and superior SP
**Results:**

- Mean distance $\leq 4\text{mm}$
- TPs in lower thoracic spine are generally in a plane near the SP of the superior vertebra.

**Conclusion:**

- Not consistent with the rule of threes
- Rule of threes is not an accurate predictor of the location of the TPs.

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**Hierarchy of Evidence**

1. Large RCT with good power, Systematic Literature Review
2. Cohort Design, Single-Case Design, Small RCTs with low power
4. Case Reports, Opinion of Clinical Experts
A cadaver study to investigate the lateral distances of the transverse and spinous processes of the thoracic spine

Geelhoed MA, Brewer PA, Ortega C, Cervantes G, Cockrum M, Robbins SA; University of Texas Health Science Center at San Antonio, Department of Physical Therapy, San Antonio, TX.

Study (unpublished): Provide clinicians with a more complete model for locating the TPs of the thoracic spine using surface palpation.

Methods: Palpated and pinned the most prominent points of the TPs and SP’s in 12 cadavers then measured the lateral distance between the TP and above SP

Results:

• Mean distances = 25.3mm - 32.4mm
• Overall mean = 28.9mm
• Standard deviations = 3.8 - 10.5mm.

Conclusions:

• Most prominent points of the TPs are 3cm lateral to the most prominent point of the above SP
• High variability limits generalization
Spinal Motion Palpation: A Review of Reliability Studies
Peter A. Huijbregts, DPT, OCS, FAAOMPT

Study: Analysis of the research into the intra- and interrater reliability of spinal motion palpation.

Methods: The MEDLINE and CINAHL databases and the computerized index to the holdings of Western State Chiropractic College (WSCC) and hand search of the reference lists of the retrieved articles.

Conclusions:

• Moderate to substantial intrarater agreement
• Poor to fair interrater agreement
Clinical Relevance:

- Lack of reliability when determining the spinal level could explain the higher intrarater reliability.

- Correctly identify the presence of the same segmental motion abnormality but incorrectly name the segmental level.

- Clinically less important to correctly identify the segmental level than the presence of an abnormality which makes the decision to treat.

Further Research:

- Appropriate patients as subjects

- Raters with different experience levels and post graduate qualifications

- Clinically usable rating scales.

- Done in the clinical setting
• Research into motion palpation reliability would benefit from good operant definitions of the dimensions of spinal stiffness for use in mobility rating scales.

### Other Literature: #3

Table 5. Factors affecting perceived PA stiffness.

- Loading frequency
- Direction of force
- Type of grip used (pinch or thumb grip)
- Visual feedback
- Patient position
- Plinth padding
- Series and contrast effects
- Use of reference stimuli

### Hierarchy of Evidence

- Large RCT with good power, Systematic Literature Review
- Cohort Design, Single-Case Design, Small RCTs with low power
- Before-After Design, Case-Control Design, Cross-Sectional Design
- Case Reports, Opinion of Clinical Experts
Reliability of Joint Mobility and Pain Assessment of the Thoracic Spine and Rib cage in Asymptomatic Individuals

Heiderscheit B., Boissonnault W.

Study: Determine the inter- and intra-reliability of thoracic spine and rib cage joint mobility assessment between two experienced PT’s

Methods: The TP and rib cage mobility of nine subjects without history of mid/low LBP were assessed twice by each of 2 experienced examiners

Results:

- Intra-reliability; Strict Definition = Slight to Fair
  Expanded Definition = Good
- Inter-reliability; Strict Definition = Slight
  Expanded Definition = Moderate

Conclusion: Based on the expanded definition (± 1 segment), we can be more accurate with identifying a specific SP.
Coupling behavior of the thoracic spine: a systematic review of the literature

Sizer PS Jr.; Brismee J; Cook C

Study: To examine the coupling directional pattern of the thoracic spine by systemic review

Methods: A systematic review of studies examining in vivo and in vitro thoracic spine coupled motion using PubMed and Cumulative Index to Nursing and Allied Health Literature searches (1960-2006), as well as a separate band-search.
**Results:**

- Of 21 citations, 8 met the inclusion criteria and were fully reviewed.
- No consistent coupling pattern was observed across the 8 studies, where they exhibited ipsilateral, contralateral, or mixed coupling behaviors.

**Conclusion:**

- Differences in study design, measurement method, and tissue preparation contributed to differences between studies.
- More quality, in vivo investigations are needed to evaluate thoracic coupling in symptomatic subjects in both a flexed and extended position.

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Summary

- Rule of threes is inaccurate
- Proposed method is more accurate
- Better intra than inter-rater agreement in spinal motion palpation
- More research needs to be done in spinal palpation and motion using similar methods

References


