Investigation of Thoracic Muscle Morphology With Open Upright MRI


1School of Biomedical Engineering, University of British Columbia, Vancouver, Canada
2ICORD, University of British Columbia, Vancouver, Canada
3Centre for Hip Health and Mobility, University of British Columbia, Vancouver, Canada
4Department of Orthopaedics, University of British Columbia, Vancouver, Canada
5Department of Human Health and Nutritional Sciences, University of Guelph, Guelph, Canada
6Department of Mechanical Engineering, University of British Columbia, Vancouver, Canada
2. DISCLOSURES

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3. INTRODUCTION

Clinical Problems

1. Age-related Hyperkyphosis

2. Proximal Junctional Kyphosis

Objectives:

I. To quantify muscle geometric parameters, cross-sectional area (CSA) and position (radius and angle with respect to the vertebral body center) in supine and upright postures

II. To study the effect of spinal level and posture on these parameters

Literature Gap

Thoracic muscle health play an important role in sagittal balance disorders of the spine

Need for understanding of thoracic muscle morphology in upright, weight-bearing postures
4. METHODS

**Imaging**

**Equipment:** 0.5T open upright MRI scanner (Paramed Italy)

**Sequence:** T1-weighted Gradient Field Echo

**Study Design**

**6 participants:** 26±6 years, height 177 ± 9 cm, weight 75 ± 10 kg

**4 postures:**
- Supine
- Standing
- 30° flexion
- Sit upright

**3 muscles:**
- Trapezius (TZ)
- Erector Spinae (ES)
- Transversospinalis (TS)

**2 spinal levels:**
- T4-T5
- T8-T9

**Segmentation repeatability**

Intra- and inter-rater segmentation repeatability was found to be good/excellent

(A. Pai. S et al., 2020)

**Effect of spinal-level and posture on muscle parameters**

Two-way repeated measures analysis of variance (ANOVA) p<0.05
5. RESULT: EFFECT OF SPINAL LEVEL

- **Trapezius**
  - CSA at T9 ~40% larger and 18% medial than at T8, owing to the tapering geometry.
  - Large variation in CSA and insertion points along lower thoracic levels (T8-T12)

- **Erector Spinae**
  - CSA increases caudally at T4-T5 (~12%) and at T8-T9 (~10%)
  - magnitudes in consensus with anatomic descriptions

- **Transversospinalis**
  - CSA decreases from T4 to T5 (~16%) and increases from T8 to T9 (~11%)
  - magnitudes in consensus with data in literature
**6. RESULT: EFFECT OF POSTURE ON TRAPEZIUS**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Level</th>
<th>T4-T5</th>
<th>T8-T9</th>
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</thead>
<tbody>
<tr>
<td>CSA</td>
<td>10%↑</td>
<td>12%↑</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>23%↑</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radius</td>
<td>8%↑</td>
<td>7%↑</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>10%↑</td>
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- Increase in CSA- muscle activation in upright postures
- Increase in Radius- redistribution of muscle belly mass more posteriorly and laterally from the vertebral body

NS= Not significant
7. RESULT: EFFECT OF POSTURE ON ERECTOR SPINAES

Passive Stretching (Jorgensen et. al., 2001)

Erector spinae are extensor muscles of the back

Greater activation (higher CSA) in extended postures (standing) than in neutral (supine/seated) and flexed postures
8. RESULT: EFFECT OF POSTURE ON TRANSVERSOSPINALIS

Decrease in CSA in standing and flexion is attributed to passive stretching (Jorgensen et. al., 2001)

Increase in radius in sitting is attributed to extensor muscle activation
### 9. DISCUSSION

<table>
<thead>
<tr>
<th><strong>Clinical and Modeling Implications</strong></th>
<th><strong>Limitations and Future work</strong></th>
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<tbody>
<tr>
<td>- Muscle geometric parameters in different postures are not uniform along different thoracic spinal levels.</td>
<td>- The small sample size may influence the level and posture trends observed.</td>
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<td>- Muscle geometric data can be used to inform and develop functionally upright biomechanical spine models.</td>
<td>- The effect of side (left or right) and sex (male or female) has not been investigated.</td>
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<td>- Spinal level and posture-specific muscle geometric trends can aid in verification and validation of model outputs.</td>
<td>- Spinal muscle activations were not controlled for or measured in each posture.</td>
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<td>- Muscle data can be used as normative values to assess muscle health and functionality in spinal deformity patients.</td>
<td>- Reported muscle geometric data cannot be directly used in biomechanical spine models.</td>
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10. CONCLUSION AND SUMMARY

- This study adds to the spinal muscle literature in quantifying them beyond cervical and lumbar regions.
- First study to examine thoracic spinal muscle morphology in upright and weightbearing postures.
- Non-uniform muscle morphological variations found at different spinal levels and in different postures.
- Wide variations found in individual muscle size and position, relative sizes and positions, origin and insertion points illustrate the need for subject-specificity in assessment of spinal deformity, both biomechanically and clinically, for higher accuracy and better outcomes.