Levator Veli Palatini Muscle Morphology in Adults with Repaired Cleft Palate

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Levator veli palatini
Background Information

*Levator veli palatini*
Cleft Anatomy
- Levator: abnormal insertion points, hypoplastic
- Velum: shorter, may have reduced range of motion
- Methods of visualization with known limitations

Static MRI
- Enables visualization of muscles of the VP mechanism
- Advantages to three-dimensional MRI
- Previous investigators studied sustained phonation

Dynamic MRI
- Advancements allow real-time acquisition with synchronized audio
- Used successfully on adults with normal anatomy
Significance/Purpose

Improved dynamic MRI protocol

- Real-time visualization of speech production
- Primary advantage of MRI use in cleft palate research

The purpose of this study was to examine differences in velopharyngeal structures and function between adults with repaired cleft palate and adults with normal anatomy at rest and during speech production.
Methods

- **Participants**
  - 12 adults 19-36 years (25.3 +/- 5.6)
    - 6 normal anatomy
    - 6 repaired cleft lip & palate

- **Static 3D MRI**

- **Dynamic MRI (15.8 fps)**
  - “ampa”

Figure demonstrates oblique coronal plane relative to midsagittal. Arrows indicate origin points and midline of levator muscle.
Speech Task

“ampa”

<table>
<thead>
<tr>
<th>Phoneme</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ɑ/</td>
<td>low, back vowel</td>
</tr>
<tr>
<td>/m/</td>
<td>bilabial nasal</td>
</tr>
<tr>
<td>/p/</td>
<td>bilabial stop</td>
</tr>
<tr>
<td>/ɑ/</td>
<td>low, back vowel</td>
</tr>
</tbody>
</table>

Cranial Measures Showing Significant Differences

• Posterior cranial base angle
  – Normal: 140.63° +/- 6.3, Cleft: 128.58° +/- 5.03 (p = 0.004)

• Palate length
  – Normal: 56.33 mm +/- 1.8, Cleft: 51.73 mm +/- 3.87 (p = 0.025)

• Palate height
  – Normal: 12.05 mm +/- 2.39, Cleft: 8.73 mm +/- 1.41 (p = 0.015)
Velopharyngeal Measures Showing Significant Differences

• Pharyngeal depth
  – Normal: 20.89 mm +/- 2.52, Cleft: 28.15 mm +/- 3.49 ($p = 0.02$)

• VP Ratio
  – Normal: 1.28 +/- 0.26, Cleft: 0.85 +/- 0.18 ($p = 0.008$)

Levator Measures—No Significant Differences

• Minimal variability between groups
Static Results

Normal Anatomy

Repaired Cleft Palate
Dynamic Results

α angle

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>m</th>
<th>p</th>
<th>α a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Anatomy</td>
<td>+ 0.77%</td>
<td>+ 5.49%</td>
<td>+ 0.54%</td>
<td>+ 0.46%</td>
</tr>
<tr>
<td>Repaired Cleft</td>
<td>- 4.3%</td>
<td>+ 3.42%</td>
<td>- 6.08%</td>
<td>- 5.84%</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.007*</td>
<td>p = 0.673</td>
<td>0.006*</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>
## Dynamic Results

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>m</th>
<th>p</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Anatomy</td>
<td>-7.02%</td>
<td>+13.23%</td>
<td>-17.84%</td>
<td>-20.33%</td>
</tr>
<tr>
<td>Repaired Cleft</td>
<td>-11.4%</td>
<td>+6.12%</td>
<td>-15.14%</td>
<td>-14.07%</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.034*</td>
<td>0.022*</td>
<td><em>p = 0.167</em></td>
<td>0.045*</td>
</tr>
</tbody>
</table>

**β angle**

![Image of anatomical structure with β angle labeled]
Dynamic Results

Velar stretch
- No significant differences

Dynamic levator measures
- No significant differences

Change in levator length

<table>
<thead>
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<th>p</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Anatomy</td>
<td>- 1.67 %</td>
<td>- 1.46 %</td>
<td>- 20.77 %</td>
<td>- 16.2 %</td>
</tr>
<tr>
<td>Repaired Cleft</td>
<td>- 7.32 %</td>
<td>+ 0.82 %</td>
<td>- 11.61 %</td>
<td>- 10.82%</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.485</td>
<td>0.586</td>
<td>0.084</td>
<td>0.420</td>
</tr>
</tbody>
</table>
Static Condition

- Compared to normal group, cleft group demonstrated—
  - More acute posterior cranial base angle
  - Shorter and more variable palate length
  - Shorter palate height
  - Greater pharyngeal depth
  - Smaller VP ratio

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal Anatomy</th>
<th>Repaired Cleft</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior cranial base angle</td>
<td>140.63° (6.3)</td>
<td>128.58° (5.03)</td>
<td>0.004</td>
</tr>
<tr>
<td>Palate length</td>
<td>56.33 mm (1.8)</td>
<td>51.73 mm (3.87)</td>
<td>0.025</td>
</tr>
<tr>
<td>Palate height</td>
<td>12.05 mm (2.39)</td>
<td>8.73 mm (1.41)</td>
<td>0.015</td>
</tr>
<tr>
<td>Pharyngeal depth</td>
<td>20.89 mm (2.52)</td>
<td>28.15 mm (3.49)</td>
<td>0.02</td>
</tr>
<tr>
<td>VP ratio</td>
<td>1.28 (0.26)</td>
<td>0.85 (0.18)</td>
<td>0.008</td>
</tr>
</tbody>
</table>
Discussion

Static Condition

- No significant differences in levator measures between repaired cleft and normal anatomy

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<th>Repaired Cleft</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin to origin distance</td>
<td>56.91 mm (4.27)</td>
<td>55.47 mm (3.86)</td>
<td>0.554</td>
</tr>
<tr>
<td>Mean muscle length</td>
<td>45.29 mm (3.54)</td>
<td>44.36 mm (5.04)</td>
<td>0.722</td>
</tr>
<tr>
<td>Mean angle of origin</td>
<td>56.09° (3.27)</td>
<td>55.88° (5.34)</td>
<td>0.937</td>
</tr>
<tr>
<td>Mean extravelar length</td>
<td>31.1 mm (4.57)</td>
<td>31.3 mm (3.12)</td>
<td>0.930</td>
</tr>
<tr>
<td>Intravelar segment</td>
<td>23.86 mm (2.56)</td>
<td>20.98 mm (2.66)</td>
<td>0.085</td>
</tr>
<tr>
<td>Velar insertion distance</td>
<td>26.04 mm (3.96)</td>
<td>26.01 mm (4.47)</td>
<td>0.990</td>
</tr>
</tbody>
</table>
Discussion

Speech Condition

- $\alpha$ angle “ampa”
- $\beta$ angle “ampa”

Normal Anatomy

Repaired Cleft
Discussion

Speech Condition

• No significant differences in levator length changes during speech
Future Research & Clinical Implications

We need to understand more about the dynamic movements involved in VP closure to better understand differences in velar positioning during speech between normal and repaired cleft anatomy.

- Frame-by-frame analyses of VP function during speech
- Effects of different cleft repair surgeries on functioning of structures and muscles involved in VP closure during speech
- Effects of scar tissue on VP functioning after cleft repair surgery
- Perceptual differences in speech without resonance disorder may be related to timing, coordination, and overall structural movements
- Some surgery types may provide more favorable outcomes related to functioning of muscles/integrity of structures
- Currently no longitudinal investigations on humans to determine effects of scar tissue on VP function
Thank You

• Any questions?

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References


