XI Congresso Nazionale Gruppo di Terapia Manuale
« The role of Manipulations in the treatment of Neuromusculoskeletal Disorders »
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Background

• RCTs show that MT techniques are effective in treating NP
  
  – Dunning et al. 2012, (8/10)
  – Lau et al. 2011, (8/10)
  – Leaver et al. 2010, (8/10)
  – Puentedura et al. 2011 (7/10)

• Clinical guidelines recommend MT for NP
  
  – Childs et al. 2008
Background

• What’s the underline mechanisms of MT techniques?

• Comprehensive model (Bialosky et al. 2009)
  – Peripheral mechanisms
  – Spinal mechanisms
  – Supraspinal mechanisms

• “The mechanisms behind the clinical effectiveness of MT are not established”
Research questions

• What’s the effect of MT techniques on cervical kinematic?

• How different MT techniques affect cervical kinematic?

• What’s the relationship between cervical kinematic changes due to MT techniques and the clinical outcomes?
The aim

• Develop a kinematic analysis suitable to describe the effect of manual techniques (MT) on cervical spine movements
  
  – Not only estimation of ROM
  – Parameters to describe “quality of active movements”
Development of the kinematic analysis

• Active movements: rotations and flexion-extension

• 3D kinematics approach
  – Coupling movement (*Cook et al. 2008*)

• Helical axis
  – *Woltring et al., 1985*
  – *Blankevoort et al., 1990*
Helical axis definition

- The motion of an object from one position to another can be broken down into a rotation about and a translation along the instantaneous axis of rotation.

- \((P_{xyz}, O_{xyz})\)
Helical axis and cervical spine

• During head movements the helical axis moves and describe the movement of the cervical spine (Grip et al 2008)

• NP may effect the position of the instantaneous axis of rotation (Winters et al., 1993; Woltring et al., 1994; Moore et al., 2005).

• Increased variation in axis movement in a group of NP patients as compared with a control group (Grip et al. 2007)
Helical axis and cervical spine

- Theoretical model using animations
  - “Ideal” head rotation
  - Head rotation with position variations
  - Head rotation with angular variations
  - Head rotation with position and orientation variations
“Ideal” head rotation
Head rotation with position variations
Head rotation with angular variations
Head rotation with position and angular variations
Parameters to describe HA behaviour

• Comprehensive 3D graphical description of joint motion

• Quantification?
  – Positions
  – Orientation

• Statistical analysis for a dataset?
Convex hull area

- Position and dispersion of finite helical axis

Convex Hull

Convex Hull Minimum Area

FHA_0

FHA_i

Section 1

Section 2

Section n
Mean angle deviation

- Orientation of the finite helical axis

Force all FHAs to pass through the origin

Angle between FHA\(_i\) and FHA\(_0\)
Feasibility investigation

• 2 Healthy volunteers, Montichiari, Italy

• 10 Active rotations and 10 active flexion-extension

• Experienced manual therapist
  – C1-2 rotatory HVLA thrust manipulation (left and right)
  – PA C2 mobilizations (3 sets x 30 ripetitions)
Methods

• Electromagnetic tracking system – VRSS, Khymeia
Methods
Data processing

- Helical axis estimation every 10° degrees at steps of 1°
- Pre/post Convex hull and mean angle deviation
**Rotation - Pre Mobilization**

Range: $-69.8^\circ \pm 2.21$ - $62.2^\circ \pm 3.11$

**Rotation - Post Mobilization**

Range: $-70.5^\circ \pm 3.63$ - $67.8^\circ \pm 2.12$
Rotation - Pre Mobilization - Angle: 4° ± 2.65°

Rotation - Post Mobilization - Angle: 3.46° ± 2.69°
Flexion - Pre Mobilization
Range: -50.3° ± 2.41 - 56.7° ± 2.11

Flexion - Post Mobilization
Range: -48° ± 5.27 - 59.3° ± 5.97
Flexion - Pre Mobilization - Angle: 3.03° ± 1.79°

Flexion - Post Mobilization - Angle: 5.29° ± 3.82°
Rotation - Pre Manipulation
Range: -67.9° ± 1.92   -   73.4° ± 4.93

Rotation - Post Manipulation
Range: -75° ± 1.32   -   87.6° ± 1.23

Rotation - Pre Manipulation
Range: -67.9° ± 1.92   -   73.4° ± 4.93

Rotation - Post Manipulation
Range: -75° ± 1.32   -   87.6° ± 1.23
Rotation - Pre Manipulation - Angle: 4.91° ± 3.6°

Rotation - Post Manipulation - Angle: 7.4° ± 4.15°
Flexion - Pre Manipulation
Range: -50.8° ± 2.21 - 64.6° ± 1.98

Flexion - Post Manipulation
Range: -62.2° ± 4.32 - 71.3° ± 3.08

Flexion - Pre Manipulation
Range: -50.8° ± 2.21 - 64.6° ± 1.98

Flexion - Post Manipulation
Range: -62.2° ± 4.32 - 71.3° ± 3.08
Flexion - Pre Manipulation - Angle: 2.86° ± 1.91°

Flexion - Post Manipulation - Angle: 2.11° ± 1.48°
## Results

### Mobilization, PA C2 - Rotation

<table>
<thead>
<tr>
<th></th>
<th>ROM Left (degree)</th>
<th>ROM Right (degree)</th>
<th>CH Left (cm$^2$)</th>
<th>CH Mild (cm$^2$)</th>
<th>CH Right (cm$^2$)</th>
<th>MA (degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre</strong></td>
<td>-68.8 ± 2.21</td>
<td>62.2 ± 3.11</td>
<td>2.24</td>
<td>1.75</td>
<td>2.42</td>
<td>4 ± 2.65</td>
</tr>
<tr>
<td><strong>Post</strong></td>
<td>-70.5 ± 3.63</td>
<td>67.8 ± 2.12</td>
<td>2.8</td>
<td>3.1</td>
<td>3.25</td>
<td>3.46 ± 2.69</td>
</tr>
</tbody>
</table>

### Manipulation, C1-C2 rotatory - Rotation

<table>
<thead>
<tr>
<th></th>
<th>ROM Left (degree)</th>
<th>ROM Right (degree)</th>
<th>CH Left (cm$^2$)</th>
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<th>CH Right (cm$^2$)</th>
<th>MA (degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre</strong></td>
<td>-67.9 ± 1.92</td>
<td>73.4 ± 4.93</td>
<td>4.07</td>
<td>2.97</td>
<td>5.29</td>
<td>4.91 ± 3.6</td>
</tr>
<tr>
<td><strong>Post</strong></td>
<td>-75 ± 1.32</td>
<td>87.6 ± 1.23</td>
<td>8.99</td>
<td>4.55</td>
<td>10.6</td>
<td>7.4 ± 4.15</td>
</tr>
</tbody>
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### Mobilization, PA C2 – Flexion extension

<table>
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<tr>
<th></th>
<th>ROM Left (degree)</th>
<th>ROM Right (degree)</th>
<th>CH Left (cm$^2$)</th>
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<th>CH Right (cm$^2$)</th>
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</thead>
<tbody>
<tr>
<td><strong>Pre</strong></td>
<td>-50.3 ± 2.41</td>
<td>56.7 ± 2.11</td>
<td>4.6</td>
<td>5.01</td>
<td>4.91</td>
<td>3.03 ± 1.79</td>
</tr>
<tr>
<td><strong>Post</strong></td>
<td>-48 ± 5.27</td>
<td>59.3 ± 5.97</td>
<td>7.93</td>
<td>9.23</td>
<td>7.71</td>
<td>5.29 ± 3.82</td>
</tr>
</tbody>
</table>

### Manipulation, C1-C2 rotatory – Flexion extension

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<th>ROM Left (degree)</th>
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<th>CH Left (cm$^2$)</th>
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<th>CH Right (cm$^2$)</th>
<th>MA (degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre</strong></td>
<td>-50.8 ± 2.21</td>
<td>64.6 ± 1.98</td>
<td>17.2</td>
<td>14</td>
<td>13.3</td>
<td>2.86 ± 1.91</td>
</tr>
<tr>
<td><strong>Post</strong></td>
<td>-62.2 ± 4.32</td>
<td>71.3 ± 3.08</td>
<td>22</td>
<td>17.4</td>
<td>24.1</td>
<td>2.11 ± 1.48</td>
</tr>
</tbody>
</table>
Conclusion

• The tested parameters provide an original description of the cervical spine kinematic

• Convex hull and mean angle deviation can be useful to investigate the effect of MT techniques on cervical spine kinematics

• RCTs on NP patients using MT techniques are needed