Functional Range of Motion Norms for Individuals with Chronic Tetraplegia

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Background

- Range of Motion (ROM) requirements for individuals with tetraplegia have been traditionally accepted but there is limited evidence supporting specific range of motion needs.
The 'perfect quad' is made, not born.

Functional mobility is dependent on appropriate ROM/flexibility.

Neck:
As normal as possible.

Scapulo-thoracic-glenohumeral:
≈ 120°

Int Rot: 90°
Ext Rot: 90°

Full elbow ext
Full supination & pronation

90° Wrist ext

Sufficient finger flexor tightness for tenodesis in absence of active finger flexors

Minimal trunk extensibility

Sufficient trunk rotation for bed mobility:
Hip - 90° Ext Rot, 45° Int Rot

Hamstring length to 110°

Hip flexion to 120° for transfers

Gastroc to 0°
Literature Review

• Diong et al 2012- Measured ROM within 35 days of injury and 1 year later. The incidence of contracture in major joints 1 year after spinal cord injury ranges from 11–43%. The ankle, wrist and shoulder are most commonly affected. Data collection with a visual ROM screen using 4 point scale.

• Eriks Hoogland et al 2009- Up to 70% of individuals with tetraplegia and 29% of those with paraplegia experienced a limited shoulder ROM during inpatient rehabilitation to one year after. Shoulder flexion was affected most. Increased age, tetraplegia, spasticity of elbow extensors and longer duration between injury and start of active rehabilitation increased the risk. Presence of shoulder pain associated with decreased shoulder ROM.

• Bryden et al 2004- Sample of 43 individuals with tetraplegia. 46% of C5 and 63% of C6 lack full elbow extension.

• Salisbury et al 2003- 41 patients with tetraplegia lost ROM in flexion, abduction, and external rotation at 90° abduction during rehabilitation when shoulder pain was present. Loss of ROM associated with previous shoulder injury.

• Dalyan et al 1998- Of a sample of 482 patients, 9% of patients developed contracture during inpatient rehab. Patients with pressure ulcers, spasticity and concurrent TBI more likely to have a contracture.
Literature Review Summary

• Research conducted using norms from ‘able bodied’ population
• No consensus on how ROM limitations should be defined
• ROM limitations are prevalent in SCI population
  • 9-70% of individuals with SCI
  • Most common at shoulder, elbow, and ankle
• Multiple factors are associate with ROM limitations
  • Extended acute care stay
  • Concurrent TBI
  • Spasticity
  • HO
  • Shoulder Pain
  • Age
Procedures

- Convenience Sample of 30 individuals recruited via support group, adapted sports program, and outpatient clinics
- Demographic Questionnaire
- ROM measurements completed in supine by 2 clinicians
  - >10 years experience
  - Inter-clinician reliability was within 5 degrees of one subject
- Functional ability self-report (SCIM and SCI-FI)
Inclusion Criteria

• LOI C5-8
• At least 1 Year post injury
• Full Time Wheelchair User
Demographic Data - General

- 30 participants enrolled. One withdrew due to inability to complete ROM evaluation due to bladder issues.
- Age: 21-64 (Mean 42.3)
- Gender: 27 Male, 2 Female
- Race: 14 Black, 13 White, 1 Hispanic, 1 Native American
- Time Since Injury: Range 1.17-40 years, Mean 11.64 Years
- 27 Traumatic, 2 Non-traumatic
## Demographic Data - ISNCSCI

<table>
<thead>
<tr>
<th>Level</th>
<th>AIS A</th>
<th>AIS B</th>
<th>AIS C</th>
<th>AIS D</th>
<th>Total</th>
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<tbody>
<tr>
<td>C5</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>C6</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>C7</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>C8</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>10</strong></td>
<td><strong>4</strong></td>
<td><strong>14</strong></td>
<td><strong>1</strong></td>
<td><strong>29</strong></td>
</tr>
</tbody>
</table>
Demographic Data- Activity Level

- Mobility: Power Wheelchair 12, Manual 17
- All but 1 participant report spasticity, and all but 3 took spasticity meds
- 21 participants completed ROM regularly and of those 17 only perform self ROM. Home ROM frequency mean 3.41 times per week.
- Home Strength Exercise: 21 exercises on a regular basis. Those who exercised, exercised an average of 3.33 times per week
## SCIM Scores

<table>
<thead>
<tr>
<th></th>
<th>C5</th>
<th>C6</th>
<th>C7-8</th>
<th>All Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>33.14 (18.89)</td>
<td>57.15 (19.19)</td>
<td>74.11 (11.94)</td>
<td>56.62 (22.61)</td>
</tr>
<tr>
<td>Self Care</td>
<td>4.0 (4.20)</td>
<td>11.86 (4.49)</td>
<td>16.44 (1.67)</td>
<td>11.40 (5.89)</td>
</tr>
<tr>
<td>Mobility</td>
<td>6.86 (6.12)</td>
<td>12.50 (5.48)</td>
<td>17.33 (5.24)</td>
<td>12.63 (6.61)</td>
</tr>
</tbody>
</table>
Findings

• For the majority of joints, norms from the normal population are applicable to SCI
• Specific joints differed significantly from the normal population
  • Possible relationship with LOI
## UE Findings

<table>
<thead>
<tr>
<th>Motion</th>
<th>Norms (General Population)</th>
<th>Mean SCI</th>
<th>Range</th>
<th>C5</th>
<th>C6</th>
<th>C7-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder Extension</td>
<td>60</td>
<td>72.4</td>
<td>44-95</td>
<td>72.21</td>
<td>73.04</td>
<td>71.61</td>
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<tr>
<td>Elbow Extension</td>
<td>0</td>
<td>-6.21</td>
<td>-64-30</td>
<td>-11.14</td>
<td>-0.54</td>
<td>-10.56</td>
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<tr>
<td>Forearm Pronation</td>
<td>80</td>
<td>65.86</td>
<td>-31-92</td>
<td>51.71</td>
<td>69.15</td>
<td>72.11</td>
</tr>
<tr>
<td>Wrist Extension</td>
<td>70</td>
<td>79.14</td>
<td>40-110</td>
<td>75.79</td>
<td>79.12</td>
<td>81.78</td>
</tr>
</tbody>
</table>
## LE Findings

<table>
<thead>
<tr>
<th>Motion</th>
<th>Norm (General Pop.)</th>
<th>Mean (SCI)</th>
<th>Range</th>
<th>C5</th>
<th>C6</th>
<th>C7-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight Leg Raise</td>
<td>100</td>
<td>76.52</td>
<td>35-112</td>
<td>64.71</td>
<td>77.69</td>
<td>84</td>
</tr>
<tr>
<td>Hip Extension</td>
<td>20</td>
<td>-8.34</td>
<td>-36-20</td>
<td>-8.43</td>
<td>-0.50</td>
<td>-6.28</td>
</tr>
<tr>
<td>Hip Flexion</td>
<td>120</td>
<td>110.09</td>
<td>61-142</td>
<td>97.29</td>
<td>114.38</td>
<td>113.83</td>
</tr>
<tr>
<td>Hip Abduction</td>
<td>45</td>
<td>32.07</td>
<td>3-90</td>
<td>34.00</td>
<td>28.42</td>
<td>35.83</td>
</tr>
<tr>
<td>Hip External Rotation</td>
<td>40</td>
<td>50.07</td>
<td>17-78</td>
<td>46.57</td>
<td>51.81</td>
<td>52.61</td>
</tr>
<tr>
<td>Hip Internal Rotation</td>
<td>45</td>
<td>30.64</td>
<td>6-64</td>
<td>30.14</td>
<td>28.81</td>
<td>33.67</td>
</tr>
</tbody>
</table>
Limitations

• Convenience sample
• Community dwelling
• Sample size
• Self-report functional ability
• Data was not collected regarding pain, splint use or hours of attendant care per day
Next Steps

• Comparing ROM high and low functioning individuals by level
• Exploring relationships between individual factors, ROM and function
• Examining clinician perceptions of ROM requirements
Summary

• For the majority of joints, norms from the normal population are applicable to SCI

• Specific joints differed significantly from the normal population
  • UE- Shoulder extension, elbow extension, pronation and wrist extension
  • LE- SLR; Hip flexion, extension, ABduction, ER and IR; ankle dorsiflexion

• Clinical Takeaways
  • Clinicians should promote participation in a home ROM program as maintenance of ROM promotes function
  • Individuals with tetraplegia may be at risk for elbow hyperextension
References

• Reese NB, Bandy WD. Joint range of motion and muscle length testing. Saunders. 2009.