Using an Impact Wrench in Different Postures—An Analysis of Awkward Hand–Arm Posture and Vibration

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Background

Occupational disease by hand-Arm vibration
BK 2103
2113

© WavebreakmediaMicro

Bone and joint disease

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Circulatory and nerve dysfunction

Influence of posture???

Pressure damage to the median nerve in the carpal tunnel
ISO TR 10687 WBV and posture

Mechanical vibration — Description and determination of seated postures with reference to whole-body vibration

ISO PWI 3153
Mechanical vibration — Posture in whole-body vibration environments

<table>
<thead>
<tr>
<th>Category</th>
<th>Head inclination sagittal</th>
<th>Head inclination lateral</th>
<th>Neck torsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td>0° to 25°</td>
<td>-10° to 10°</td>
<td>-45° to 45°</td>
</tr>
<tr>
<td>Moderate</td>
<td>25° - 85°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awkward</td>
<td>&lt; 0° no head support or &gt; 85°</td>
<td>&lt; -10° or &gt; 10°</td>
<td>&lt; -45° or &gt;45°</td>
</tr>
</tbody>
</table>

Figure B.1 Assessment categories for the head and neck

Figure 13 — Lateral flexion of the neck
Setup

working in three directions
- identical conditions for the subjects
- height adjustable setup
- defined posture of arm (90° angle)
- 12 Screwing operations in oak wood (pre-drilled)
- scheduled breaks between directions
- Impact wrench 1.2 kg, 18 V and torque 200 Nm
Population

11 subjects (4 female, 7 male)

<table>
<thead>
<tr>
<th>Age [years]</th>
<th>Size [cm]</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 ± 11</td>
<td>178 ± 8</td>
<td>76 ±15</td>
</tr>
</tbody>
</table>

upwards

forwards

downwards
Measurement posture

inertial sensors:
- Head
- Shoulders
- Upper arm
- Lower arm
- Hands
- Pelvis
- Sternum
Assessment of body angles

Head Inclination (sagittal)  Upper Inclination (sagittal)  Wrist Flexion  Wrist Adduktion/Abduktion

- Extension
- Flexion
+ Extension
+ Flexion
- Extension
+ Flexion
+ Radialduktion
+ Ulnarduktion

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Measurement vibration

- Hand-arm vibration (ISO 28927-5:2009)

- $a_{hv}$ Vibration total value

$$a_{hv} = \sqrt{a_{hwx}^2 + a_{hwy}^2 + a_{hwz}^2}$$
Measurement muscle activity

- Elektromyography
- Muscle activity
  - Trapezius
  - Biceps brachii
  - Extensor digitorum
  - Flexor capri ulnaris
- Maximal Valontary Contraction (MVC)
Subjective perception

- Subjective perception
- Borg scale
Results . Exposures

Head inclination (sagittal) in °

Upper-arm inclination (sagittal) in °

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Results: Muscle activity

Muscle activity as percentage of maximum voluntary contraction in %

**Trapezius descendens**

- Upwards: 70, 61, 52, 44, 37
- Forwards: 12, 8, 6, 10, 6
- Downwards: 17, 10, 4, 3

**Biceps brachii**

- Upwards: 61, 56, 49, 41, 34
- Forwards: 38, 33, 28, 23, 20
- Downwards: 13, 8, 5, 4, 3
Results: Hand-arm vibration

Vibration exposure in m/s²

- Upwards: X = 2.6, Y = 3.0, Z = 4.8
- Forwards: X = 2.4, Y = 2.3, Z = 2.7
- Downwards: X = 2.5, Y = 2.5, Z = 4.7

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Results: Subjective perception

Subjective perception for total exposures
(0-10 Borg scale)

<table>
<thead>
<tr>
<th>Working direction</th>
<th>Upwards</th>
<th>Forwards</th>
<th>Downwards</th>
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</thead>
<tbody>
<tr>
<td>Score</td>
<td>7.4</td>
<td>4.1</td>
<td>3.6</td>
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</tbody>
</table>

Bewertung

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Absolut Nichts</td>
</tr>
<tr>
<td>0,3</td>
<td>Extrem Schwach</td>
</tr>
<tr>
<td>0,5</td>
<td>Sehr Schwach</td>
</tr>
<tr>
<td>0,7</td>
<td>Schwach</td>
</tr>
<tr>
<td>1,5</td>
<td>Mittelmäßig</td>
</tr>
<tr>
<td>2</td>
<td>Stark</td>
</tr>
<tr>
<td>2,5</td>
<td>Sehr Stark</td>
</tr>
<tr>
<td>3</td>
<td>Extrem Stark</td>
</tr>
</tbody>
</table>

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Summary

Different postures:
- Vibration – **no differences following ISO-Standards**
- Posture – overhead and also downwards working notably **higher exposures**
- EMG - overhead and also downwards working notably **higher muscle activity**
- Subjective perception – **highly unpleasant** during overhead working

**Vibration x Posture x Forces**

**Misinterpretation of vibration exposure!**
• Thank you for your attention!