Relationship between Upper Limb injury, muscle bulk, beliefs and function.

Analysis of FCE results of 220 long-term patients with upper limb injuries and persisting disability

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AMA Guides 5th Edition

• **Impairment** is a significant deviation, loss, or loss of use of any body structure or body function in an individual with a health condition, disorder or disease

• **Disability** is activity limitations and/or participation restrictions in an individual with a health condition, disorder or disease

• **With AMA Guides 5th**, physicians can measure the extent of impairment as related to normal functional capacity
**Table 17-6: Impairment Due to Unilateral Leg Muscle Atrophy**

<table>
<thead>
<tr>
<th>Difference in Circumference (cm)</th>
<th>Impairment Degree</th>
<th>Whole Person (Lower Extremity) Impairment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-0.9</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>1-1.9</td>
<td>Mild</td>
<td>1-2 (3-8)</td>
</tr>
<tr>
<td>2-2.9</td>
<td>Moderate</td>
<td>3-4 (8-13)</td>
</tr>
<tr>
<td>3+</td>
<td>Severe</td>
<td>5 (13)</td>
</tr>
</tbody>
</table>

**a. Thigh:** The circumference is measured 10 cm above the patella with the knee fully extended and the muscles relaxed.

**b. Calf:** The maximum circumference on the normal side is compared with the circumference at the same level on the affected side.

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**Leg Muscle Atrophy**

*Impairment due to Unilateral Leg Muscle Atrophy*

**Arm Muscle Atrophy**

*Nil*
Marked Impairment but No Disability

- Left ruptured Achilles Tendon 18 months ago
- Conservative treatment, imperfect union.
- Slight limp and reduced running ability.
- 3.5 cm loss of upper calf circumference (gastrocnemius)
- 3 cm loss lower calf (soleus)

‘Guides’

- Severe disability - 13% lower limb impairment rating.

FCE

- Nil disability with heavy lifting ability regardless of using back or legs. Heavy repetitive carrying ability with slight limp.
- Only problem is being penalised in body building competitions
No Impairment but Moderate Disability

- Right cervical nerve root injury 12 months ago.
- Reduced fine manipulative ability markedly affected precision work tasks (diesel mechanic).
- Minimal loss (0.6 cm) of forearm bulk
- Full mobility, normal manner of movement
- Marked intrinsic wasting
- NCT and MRI normal, 4 specialist assessments inconclusive.

‘Guides’ and IME

- No disability.

FCE

- Clinically; marked wasting intrinsic muscles.
- Consistent FCE effort, believable results
- Fine manipulative tests moderately slower
- Pinch Grip 5 kg right, 9 kg left
- Grip 33 kg right, 49 kg left
- OK for medium work, not heavy work. Reduced precision work ability.
What should arm muscle atrophy be?

Arm muscle bulk is arguably 50% that of leg bulk

**Thigh Atrophy (5th ed. Guides)**

<table>
<thead>
<tr>
<th>Range (cm)</th>
<th>Degree</th>
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<tbody>
<tr>
<td>0 – 0.9</td>
<td>None</td>
</tr>
<tr>
<td>1 – 1.9</td>
<td>Mild</td>
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<td>2 – 2.9</td>
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</tr>
</tbody>
</table>

**Upper Arm Atrophy**

<table>
<thead>
<tr>
<th>Range (cm)</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 0.5</td>
<td>None</td>
</tr>
<tr>
<td>0.6 – 1.0</td>
<td>Mild</td>
</tr>
<tr>
<td>1.1 – 1.5</td>
<td>Moderate</td>
</tr>
<tr>
<td>1.5+</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Comparing injured arm to uninjured arm
Why this research is important

**Persistent Low Back Disability**

There is extensive data on FCE assessment of LBP

- Treatment of Low Back Pain has improved following therapeutic approaches centred on the ‘bio-psychosocial’ model.
- Normal activities, in spite of pain, hastens recovery from LBP

**Persistent Upper Limb Disability**

- Maladaptive beliefs in upper limb pain have not been extensively described.
- There is lack of data about function in upper limb injuries that provides evidence of clinical and functional normality.
Why this research is important

**Injury, atrophy, weakness, function**
Process from Injury to Recovery may be affected by...

- Maladaptive beliefs:
  - Magnify disability
  - Clinical findings do not match disability
  - Functional results are affected by psychosocial and psychological issues

- Leg injuries
  - Atrophy easy to see and measure
  - Variable relationship between atrophy & functional ability. *Job dependent*
  - Guides rate impairment on atrophy

- Arm Injuries
  - AMA Guides do not have circumferential arm measurements
Intrinsic Muscle wasting

Observation – flattening of left thenar eminence and lumbricals
Upper Limb Functional Assessment

Current Deficiencies
1. No definition of muscle wasting or if it means anything
2. Vague relationship between impairment and disability
3. ‘Guides’ has no criteria for assessing impact of psychosocial or psychological effect on upper limb function.

This research
1. Muscle bulk wasting in upper limbs after injury
2. Effect on function
3. Effect of non-physical factors
Data Base

220 patients
• All referred for FCE as part of Return to Work assessment process
• Injury to Assessment median time 2.4 years (0.2 – 31 years)
• 30 Patients had bilateral injuries
• 65% male, average age 47, 93% right handed.
• 39% Hand/wrist injury, 34% Shoulder, 15% Elbow, 12% Other
• 51% Strains/Sprains, 32% Fractures, 13% Post-surgical Complications
• Most labelled with “Chronic Pain Syndrome” on a wide variety of criteria

Measurements:
• Muscle Circumference, Grip strength, Beliefs
• Up to 45 items of functional information (Blankenship FCE system)
• Single Assessor (RGMS)
Data Base

Patient Self-report (Dallas Questionnaire)

• Function: 47% severely disabled
• Work: 64% barely able or unable to work
• Psychological and Psychosocial: 45% severely disabled
Pain and Function

220 Patients, median time since injury 2.4 years

- How much does pain affect function in patients with long-term injuries?
- FCE Pain: Moderate to Very Strong (26% had “maximal” pain during last month)
- According to the patient, how bad is their pain (average)?
  - Least pain 30 days prior to FCE: 3/10+ “Moderate” Pain
  - Worst pain 30 days prior to FCE: 7/10+ “Very Strong” Pain
  - Pre-FCE pain: 4/10+ “Somewhat Strong” Pain
  - Post-FCE pain: 5/10+ “Strong” Pain
Expected result of muscle atrophy measurement

Muscle atrophy should be present to a significant degree in at least half of FCE patients, reflecting the severe self-reported ongoing disability, loss of function and overwhelming pain

Grip strength should be within a normal range if there is no muscle wasting

The results...
Muscle mass NORMAL upper arms compared to INJURED upper arms 115 males

Body Weight

Circumference

- Normal
- Injured
- Normal Arm Trend
- Injured Arm Trend
Muscle mass NORMAL upper arms compared to INJURED upper arms 115 males
Muscle mass comparison - Upper Arm

INJURED RIGHT arm to Normal Left arm (71 males)
Muscle mass comparison – Upper Arm
INJURED LEFT arm to Normal Right arm 45 males

Circumference

Weight  70  71  72  76  79  83  85  85  91  95  97  115  117

Injured Left  
Normal Right

- Injured Left
- Normal Right

Arrow indicators at key weight points.
Right Shoulder Joint Injury 47 Males and Females
Upper Arm Circumference Impairment

<table>
<thead>
<tr>
<th>Impairment Description</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe Impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate Impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild Impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injured Side Better</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Impairment Description - Number
- Severe Impairment
- Moderate Impairment
- Mild Impairment
- No Impairment
- Injured Side Better

Percentage
- 0%
- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
- 40%
- 50%
- 60%
- 70%
Muscle Mass Comparison - Proximal Forearm

INJURED RIGHT distal arm to normal left arm (70 males)
No difference in muscle circumference
All Patients with Persistent Upper Limb Disability and Pain Impairment by measured muscle atrophy

Severe  Moderate  Mild  None  Reverse

- Upper Arm
- Proximal forearm
- Distal forearm
Features of Impairment Measurement

‘Severe Impairment’ of upper arm was defined as 1.5 cm or more

• Only 1 of 220 patients had ‘severe impairment’ in all three areas

• Equal muscle bulk suggests normal bilateral arm use, even though most patients stated they had to use their uninjured arm to compensate for the injured arm

• With AMA Guides 5th, physicians can measure the extent of impairment as related to normal functional capacity
The Questions...

Long-term upper limb injuries
• Does muscle atrophy persist after injury? **NO**
• Do FCE findings correlate with the degree of claimed disability? **NO**
• Does atrophy correlate with muscular and functional weakness? **NO**
• Does pain appear to affect functional ability? **NO**
Grip Strength

Equal forearm muscle bulk should result in equal grip strength
Grip Strength Percentiles
Injured side vs Non-injured arm

Injured Percent vs Normal Percent

- 1-9
- 10-19
- 20-29
- 30-39
- 40-49
- 50-59
- 60-69
- 70-79
- 80-89
- 90-99
Grip Percentile
Injured Right Arm - Male and Female

- Below Average
- Average
- Above Average

- Normal Left
- Injured Right
Grip Percentile and FCE Score Relationship

Grip Percentile

FCE Score

Grip Percentile Trend

FCE Score Trend

Grip Percentile

FCE Score

Grip Percentile Trend

FCE Score Trend
Dallas Score and Grip Percentiles
Dallas Questionnaire

Four Sections

1. Activities of Daily Living
2. Work, Travel and Social Ability
3. Psychological – Anxiety, Emotions and Depression
4. Psychosocial – Relationships and Social Support

>50% indicates significant effect
Grip Percentile and Dallas Functional / Work

Dallas Score (Functional and work)
Distal arm injury and Dallas Score

Injured left vs non-injured right arms

Injured left percentile
Non-injured right percentile

Poly. (Injured left percentile)
Poly. (Non-injured right percentile)
FCE Report
John Smith – FCE

Patient Presentation...
- Chronic pain from finger injury
- Unable to work >1 hour/day
- Barely able to use right arm
- No improvement from four years of treatment
- Medical reports said unable to use right arm, unable to work
  But working 1 hr day in own company
- Refused questionnaires

FCE Results
- 39% Validity (indicates presence of non-injury factors)
- No muscle wasting
- Marked improvement of grip on REG testing
- Normal use on distraction (phone use and dressing)
- No pain increase handling boxes and electronic test equipment
  “Very strong” pain but normal interaction
John Smith – FCE Report

Findings
• Insignificant clinical impairment
• Apprehension and fear-avoidance affected results
• Better when he does not think about injury (distraction)
• Safe to work fulltime
• Work is now less physical (new testing equipment, more admin, supervision and marketing)

Recommendations
1. Return to normal work
2. Given ‘new’ exercises to improve speed and confidence
3. Suggested ‘buddy taping’ to encourage normal use
4. Strong reassurance that normal work would stimulate normal function and pain reduction
Normal muscle mass, male right arm

☆ is muscle mass of injured arm of John Smith

Grading by Body Weight (51 males, 54 - 126 kg)
FCE Validity
Blankenship FCE System

Good effort = equals good score.
The higher the score, the more believable the results are in translating FCE effort to Work Ability

- >80%: Good effort
- 70-80%: Fair effort, assessor interpretation required
- <70%: Poor effort, significant psychological and psychosocial factors
- <50%: Very poor effort, conscious manipulation of testing present (opinion of RGMS)
FCE Validity compared to time since injury

Validity

Years since injury
51 Males by weight, uninjured right upper arm circumference; 12 cm proximal to elbow
51 Males by weight,
Uninjured right upper arm circumference; 12 cm proximal to elbow

Circumference cms vs Weight kgs graph

- Circumference
- Trend with increasing weight
- First Standard Deviation
- Right arm Mr ***
Findings and Conclusions
Major findings

• Muscle atrophy is not a factor in ongoing upper limb disability
  • 79% of long term patients with severe upper limb pain and disability have normal muscle bulk regardless of the site of injury.
  • Just 7% of patients had severe atrophy of 1 area
  • Less than 1% had severe atrophy of 2 areas

• Demonstrated disability is not related to measured impairment
  • Beliefs are a much greater factor in ongoing disability

• Heightened beliefs about disability do have a significant effect on functional ability
  • The more heightened the beliefs about pain and disability the worse the overall FCE performance
Discussion

• Normal muscle bulk indicates normal use. This has significant ramifications for insurance carriers.

• The relationship of normal muscle bulk with markedly reduced grip strength provides objective evidence of maladaptive beliefs affecting normal work.

• The normality of muscle bulk across 220 adult males and females provides the basis of a database that will provide objective evidence of normal function.

• Reproduction of this research will add to the validity of these findings and provide further confirmation of what is normal upper limb muscle bulk.

• Investigation of muscle atrophy in the immediate post-injury period will add to the understanding of the development of recovery of muscle bulk and the related effect of maladaptive beliefs.

• The effect of medication and medicalisation/confirmation of beliefs are likely to be significant factors and need further research.