OBJECTIVE MEASUREMENT OF THE EFFECT OF ‘MINOR BURN’ ON MUSCLE STRENGTH IN THE ACUTE ENVIRONMENT

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INTRODUCTION
Since 1983 in WA, mortality due to burn injury has reduced ~2% per year, with the overall rate of 0.4%. Of those admitted to the Burn Service of WA, 86.3% suffer burns <15% TBSA and 82% of those injuries involve the hand and upper limb. However, are minor burns innocuous? Shakespeare (1998) showed that minor burns cause functional deficits up to four months post-injury. Our group demonstrated in an animal model, that a 4% TBSA burn has a systemic, negative effect on muscle strength. It is unknown how much muscle strength contributes to poor post-burn function and return to participation. Objective, clinical assessment of muscle strength is rendered by the lack of feasible, reliable and valid measurement options. Isometric hand held dynamometry (HHD) presents as a possible solution to an age-old problem for burn therapists and other clinicians.

AIMS
The aims were to: a) develop an HHD protocol in burns patients; b) determine the reliability of HHD protocol; and c) examine the sensitivity and validity of the HHD method.

METHODS
Burn Patient Sample
This was a prospective cohort study performed at Royal Perth Hospital (RPH) between November 2011 – May 2012. A convenience sample was recruited based on the following criteria:

Inclusion
- Adults ≥ 18 years
- ≥2% – 10% TBSA
- In and out patients

Exclusion
- Medically unstable
- Musculo-skeletal injury last 3/12 months
- Non-English speaking

Procedure
Isometric strength tests: Grip, Biceps, Triceps, Deltoids, Quadriceps, Hamstrings.
Each individual test was conducted as an isometric ‘make’ test, holding a maximum contraction for 5 seconds.

Grip strength was measured using the Jamar dynamometer (~AUD$600). All other muscle group tests were conducted with the Lafayette or Nicholas muscle meter (pictured, ~AUD$1600). Tests were conducted in triplicate each session, right and left side after the patient explanation and practice. The last sequence occurred second daily to day 10, then days 15 and 20 in 18 wounded.

Maximum isometric strength was measured as the peak value reached during the contraction.
Muscle strength was assessed first, in series, starting with the right biceps ending with left hamstrings (Fig’s 1-5). A single test was only omitted where the burn or donor site location precluded it.

Pain scores (10) were recorded at the end of each session of testing.
A testing session involving all muscle groups was completed in ~20 minutes, with the patient in a seated position.

Data Analysis
Reliability was examined by assessing concordance (intraclass correlation coefficient [ICC]); variance (95% Confidence Interval [95% CI]); and, systematic differences (p value < 0.05 considered significant) between trials using data from the first assessment only. Concordance was considered excellent if ICC ≥ 0.75; moderate to inadequate for clinical use below those levels (Cohen, 1977). Clinical utility and sensitivity of the technique was assessed by calculating the Minimum Detectable Difference (MDD). Reliability analyses were conducted with the data collected from measurements on the first day of testing. Validity of the method was examined by multivariate longitudinal regression analyses testing for associations between isometric strength measures and gender, age, dominance, TBSA, and pain (using all available data). Significant associations were denoted at p < 0.05.

RESULTS
Sample Characteristics
- 30 pts: 25 males (83%)
- Median age: 28.5 yrs
- Range: 17-79yrs
- Mean TBSA: 5.4% (SD 2.6)
- Inpatient: 60% (n=24)
- 90% R hand dominant (n=27)

Validity
- Gender: All muscle groups tested and grip strength measures confirmed that males showed consistently higher strength levels than females.
- Dominance: Grip strength and biceps measures were significantly different between sides based on dominance. The dominant upper limb was stronger. Lower limbs and deltoids did not exhibit a significant difference between sides.
- Age: Grip strength (Hanten et al., 1989) and lower limb strength and balance (Boehm, 1994) reduces with age. Isometric grip measures significantly reduced with advancing age in the cohort as did lower limb strength.
- TBSA: Burn size was not associated with grip or other muscle group strength measures over time.
- Pain: Only lower limb muscle strength measures were associated with pain scores. Upper limb grip and muscle strength measures were not significantly associated.

DISCUSSION & CONCLUSION
The results of our study confirm the reliability and validity of use of isometric muscle strength measures when these assessments are conducted with the standardised protocol described. The MDD’s calculated are clinically useful while accepting caution must be applied when assessing the quads.

The systematic fatigue effects demonstrated in the non-dominant hamstrings and dominant biceps were in both instances less than the MDD and would not affect clinical decision making based on the measures.

The validity results based on gender, dominance and age were not unexpected or as hypothesized. TBSA may have been considered an unexpected result except when considering the cohort, the sample size and the longitudinal assessment of the measures which varied markedly between individuals. The contrasting associations of pain with upper and lower limb measures may be related to the location of test equipment, contact and location of burn wounds and donor sites.

Table 1 - Reliability and Sensitivity

<table>
<thead>
<tr>
<th>Test</th>
<th>Upper Limb Dominance</th>
<th>ICC</th>
<th>95% CI</th>
<th>MDD (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip</td>
<td>D</td>
<td>0.95</td>
<td>(0.91-0.97)</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>0.95</td>
<td>(0.94-0.99)</td>
<td>0.6</td>
</tr>
<tr>
<td>Biceps</td>
<td>D</td>
<td>0.91</td>
<td>(0.86-0.96)</td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>0.91</td>
<td>(0.83-0.95)</td>
<td>5.3</td>
</tr>
<tr>
<td>Triceps</td>
<td>D</td>
<td>0.90</td>
<td>(0.82-0.95)</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>0.89</td>
<td>(0.81-0.95)</td>
<td>5.3</td>
</tr>
<tr>
<td>Deltoids</td>
<td>D</td>
<td>0.92</td>
<td>(0.86-0.96)</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>0.93</td>
<td>(0.87-0.98)</td>
<td>3.6</td>
</tr>
<tr>
<td>H'strings</td>
<td>D</td>
<td>0.90</td>
<td>(0.82-0.95)</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>0.90</td>
<td>(0.82-0.95)</td>
<td>6.1</td>
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<tr>
<td>Quads</td>
<td>D</td>
<td>0.79</td>
<td>(0.65-0.89)</td>
<td>9.9</td>
</tr>
<tr>
<td></td>
<td>ND</td>
<td>0.77</td>
<td>(0.62-0.87)</td>
<td>12.2</td>
</tr>
</tbody>
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