Author's response to reviews

Title: Grip strength ratio correlates well with DASH score in different hand conditions

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Grip strength ratio correlates well with DASH score in different hand conditions

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Abstract

Background: Grip strength correlates with personal factors such as gender, age and nutritional status and has a good inter-rater reliability. It reflects fairly well how much people can use their hands. The Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure 3 is a 30-item, self-report, questionnaire that reflects the patients’ opinion on their disability due to upper-limb disorders. We assessed if grip strength and grip strength ratio correlate with DASH score.

Methods: In 3 groups (20 healthy volunteers, 17 patients after distal radius fractures, 12 patients with different hand conditions) grip strength and DASH scores (items 1-21, 22-30 and total) were assessed. To exclude personal factors grip strengths in the injured or non-dominant hand and grip strength ratios (grip strength in the injured or non-dominant hand divided by grip strength in the non-injured or dominant hand) were assessed too. Results were analyzed with a multivariate ANOVA.

Results: Significant correlations were found between the grip strength ratio and DASH as well as DASH subsections in all groups and between DASH scores and grip strength in some groups.

Conclusion: Grip strength ratio correlates well with the DASH score in different hand conditions. It is a valuable tool to assess patients that speak a different language and have problems with the non-dominant hand and probably easier to follow over time than the DASH score, which is time consuming to fill in and process.

Keywords: DASH, grip strength, Handgrip dynamometry, outcome measurement
Background

In patients with disorders of the hand and wrist it is important to examine how much the function of the hand and wrist is affected by the condition. Function of the wrist can be assessed objectively by physical examinations such as range of motion and grip strength and subjectively by questionnaires.

Grip strength in the dominant hand correlates well with certain anthropometric variables such as height, weight, BMI and total arm length and correlates indirectly with certain questionnaires (Koley 2009, Mitsionis 2009, Chan 2008, Incel 2009, Van der Giesen 2008). However, it is unknown if it correlates directly with the Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure in healthy and injured subjects with various hand conditions.

The DASH score consists of a 30-item, patient-reported questionnaire designed to measure physical function and symptoms in patients with musculoskeletal disorders of the upper limb (MacDermid et al. 1994, http://www.dash.iwh.on.ca). This score can aid to estimate the disability experienced by patients with wrist disorders and also to monitor changes in symptoms and function over time. It has been shown that this score performs well in both these roles and can be used for research purposes and in clinical practice (Hoang-Kim A et al. 2011, Schoneveld et al, 2009, Beaton et al. 2001, Hudak et al, 1996). However, it has been recognised that injuries in the non-dominant hand will not always be picked up fully with DASH, as opposed to the grip strength which is affected independent on which hand is injured.

To exclude personal factors grip strength in the injured or non-dominant hand can be processed into grip strength ratio (grip strength in the injured or non-dominant hand divided by grip strength in the non-injured or dominant hand). Grip strength ratio may be used to evaluate function and symptoms in patients with wrist disorders and this would be a very quick assessment.

The aim of this study is to assess the correlation between grip strength ratio and DASH score in healthy volunteers and patients with wrist disorders in order to simplify outcome measurement. We hypothesize that there is a correlation between grip strength ratio and DASH score.
Patients and Methods

This study involves analysis of grip strength of 29 patients with wrist conditions, who were seen in the outpatient clinic of the department of orthopaedics of the General Hospital of Helsingborg, Sweden, as well as the data collected in 20 healthy volunteers (staff at this hospital). Three groups have been created: Group A consists of 20 healthy volunteers (mean age 42 years, range 28-62). Group B consists of 17 patients with distal radius fractures undergoing rehabilitation after plaster removal (mean age 42 years, range 23-65). Group C consists of 12 patients with different hand conditions such as osteoarthritis, post-traumatic disorders and tendovaginitis (mean age 52 years, range 21-72).

Grip strength and DASH score (items 1-21, 22-30 and total) were assessed for correlation with DASH and subgroups. Grip strength was determined three times bilaterally with the Jamar dynamometer (in the second handle position).

In patients, the grip strength ratio was calculated by dividing the grip strength in the injured hand by the grip strength in the non-injured hand. In the healthy volunteers, this ratio was calculated by dividing the grip strength in the non-dominant hand by the grip strength in the dominant hand.

Results were analyzed with a multivariate ANOVA with significance set at p ≤ 0.01.

This study was conducted in accordance with the guidelines published by the Swedish Research Council and the International Committee of Medical Journal Editors and supported by the institutional review board of the General Hospital of Helsingborg with written informed consent obtained for publication of this report.
Results

The mean DASH score in group A (healthy volunteers) was 1, in group B (patients shortly after distal radius fractures) 37, and in group C (patients with various hand conditions) 20. Grip strength did correlate with DASH score in patients after a distal radius fracture (p < 0.05) but not with DASH score in the healthy volunteers and the patients with various hand conditions. Grip strength ratio correlated significantly with DASH score as well as DASH subsections in all groups.

Table 1: Correlation between DASH and grip strength and DASH and grip strength ratio in the 3 groups (mean (SD))

<table>
<thead>
<tr>
<th></th>
<th>Group A Healthy volunteers (n = 20)</th>
<th>Group B Distal radius fractures (n = 17)</th>
<th>Group C Various hand conditions (n = 12)</th>
<th>Entire group (n = 39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip strength (kg)</td>
<td>43 (10.6)</td>
<td>21.1* (10.6)</td>
<td>29.5 (14.7)</td>
<td>32.1 ** (15.5)</td>
</tr>
<tr>
<td>Grip strength ratio (%)</td>
<td>97* (27)</td>
<td>52** (3)</td>
<td>67** (23)</td>
<td>74 ** (28)</td>
</tr>
<tr>
<td>DASH score</td>
<td>1 (2)</td>
<td>37 (21)</td>
<td>26 (17)</td>
<td>20 (22)</td>
</tr>
</tbody>
</table>

* correlation between DASH and grip strength (ratio) with level at 0.05
** correlation between DASH and grip strength (ratio) with level at 0.01
**Discussion**

This study shows that the grip strength ratio correlates well with the DASH score and subgroup in different hand conditions. Grip strength (ratio) is a valuable tool in all patients but particularly useful to assess patients with intellectual or language difficulties. Furthermore grip strength (ratio) is much faster to process than DASH.

Grip strength ratio is a new ‘tool’. It is the relation of grip strength of the affected hand compared to the unaffected hand or the strength of the non-dominant divided by the dominant hand.

The purpose of the grip strength test is to measure the maximum isometric strength of the hand and forearm muscles. A series of squeezes on the dynamometer in the second handle position is sufficiently accurate to assess grip strength for all subjects. (Trampisch 2012). Grip strength correlates with personal factors such as hand dominance, gender, age and nutritional status (height, weight, BMI) as well as total length (Koley 2009). It has a good inter-rater reliability (MacDermid 1994) and reflects fairly well how much people can use their hands. Men have higher values of grip strength compared to women. Of specific importance is the knowledge that right hand and dominant hand grip scores are higher (statistically significant) compared to left hand and non-dominant hand grip scores. A positive association is also known to exist between height and dominant hand grip strength, while a negative association was observed between age and dominant hand grip strength. A positive association for weight and dominant hand grip strength was statistically significant in men only, whereas a positive, but not significant, association between BMI and dominant hand grip strength was seen in women (Mitsionis 2009). Statistically significant lower values in grip strength were seen in the age groups between 65 and 70 years old and 70 to 79 years old when compared with young adult mean values. (Incel 2009)

It is also known that grip strength is an independent predictor of bone mass in both sexes in children. This relationship between muscle strength and bone mass is systemic. Significant correlations were shown between grip strength and bone mass at hip, spine and whole body in boys (11/12 years old ) and girls (10/11 years old) (Chan 2008).

When grip strength in the injured or non-dominant hand is divided by grip strength in the non-injured or dominant hand a grip strength ratio is determined. This grip strength ratio is independent of the previously mentioned personal factors, and therefore more suitable to assess outcome in less homogenous groups.
Another way to assess outcome is the use of patient questionnaires. These allow the assessment of outcome without the need for the patient to come to the outpatient clinic. The Disabilities of the Arm, Shoulder and Hand Outcome Measure (DASH) is a 30-item, self-report, questionnaire that reflects the patients’ opinion on their disability due to upper-limb disorders (http://www.dash.iwh.on.ca).

With the objective to shorten the DASH score to make it more user friendly in clinical practice (1), the Quick-DASH was developed. This tool consists of 11 instead of 30 items and was also validated for evaluating function and symptoms in patients with wrist disorders (Beaton 2005). Because people use the dominant hand in many activities an important downside of DASH or Quick-DASH is the assessment of conditions affecting the non-dominant hand.

It would be easier and time-saving if patients could be evaluated using only grip strength. In certain groups of patients DASH was found to correlate with grip strength or other clinical and radiological findings (Zimmerman 2009, Wilcke, Abbaszadegan, Adolphson 2007). In a study correlating DASH to the Levine-Katz questionnaire using clinical findings and pinch and grip strength in patients with ulnar neuropathy, it was found that a high correlation between DASH scores, symptom severity and functional status of patients with ulnar neuropathy existed (Zimmerman 2009). Another indirect correlation between DASH and grip strength was found in patients after distal radius fractures. Certain radiological parameters of malunion of the distal radius (radial shortening of more than 2 mm, dorsal angulation of more than 15° and radial angulations of more than 10° each) are significantly associated with poorer DASH scores in patients with healed unilateral distal radius fractures. In these patients reduced grip strength, extension and ulnar deviation correlated with a poorer DASH score, whereas the better radiological and objective physical results (grip strength and range of motion) were associated with a better DASH score (Wilcke, Abbaszadegan, Adolphson 2007).

In multivariate analysis some patient questionnaires (SODA, AIMS, SOFI, GAT) were found to correlate with grip strength and certain clinical features (Van der Giesen 2008).

As mentioned before, in certain groups DASH was also found to correlate with grip strength or other clinical and radiological findings (Zimmerman 2009, Wilcke, Abbaszadegan, Adolphson 2007). To our knowledge, however, there are no reports that have directly
correlated the DASH score with grip strength as well as the grip strength ratio between the
two wrists, in healthy volunteers and groups of patients with different wrist conditions.
Patient questionnaires allow the assessment of outcome without the need for the patient to
visit the outpatient clinic. This saves a certain amount of time, but the forms still need to be
sent out, processed, monitored and evaluated. Although in general a patient questionnaire is a
very efficient and unbiased way of collecting information on outcome for routine use, grip
strength may be an easier tool in patients with different hand/wrist conditions. Since grip
strength is related to personal factors such as age, gender, hand dominance and weight, we
sought for a different modality of grip strength to correlate with the outcome of a patient
questionnaire, because these questionnaires cannot be used in patients with intellectual or
language difficulties, a growing group in our cosmopolitan world.
We chose a group with healthy volunteers, a homogenous group of patients with injuries
(patients shortly after treatment of a distal radius fracture with a plaster) and a non-
homogeneous group with various hand conditions to gain as much information as possible
about the correlation between grip strength, grip strength ratio and DASH score. As grip
strength ratio is shown to correlate well with the outcome of the DASH score in all 3 groups
(patients and healthy volunteers), including the group with various hand conditions, one might
expect this correlation to be present in more groups with more homogeneous afflictions, and
therefore be useful for clinical practice.
Since this is only a small study we advise that the correlation between grip strength ratio and
other hand/wrist conditions will be subject of further studies.

**Conclusion:** Grip strength ratio correlates well with the DASH score in different hand
conditions. It is a valuable tool to assess patients that speak a different language and probably
easier to follow over time than the DASH score, which is time consuming to fill in and
process.

**Competing interests**

The authors declare that they have no competing interests
Authors’ contribution

TL designed the study, acquired data and revised the manuscript. AB analyzed results and wrote and revised the manuscript. Both authors read and approved the final manuscript.
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www.dash.iwh.on.ca