The Strength-Dexterity Test is a Novel and Clinically Informative Measure of Treatment Outcome in Thumb Osteoarthritis

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Abstract

OBJECTIVES: We currently lack quantitative and objective measures of treatment outcome for dynamic pinch function. We have previously shown that the Strength-Dexterity test (S-D test) can distinguish better between unimpaired subjects and patients with carpometacarpal osteoarthritis (CMC OA) that pinch strength[1]. We now investigate whether the S-D test is a sensitive predictor of treatment (Hylan G-F 20 injection) outcome in patients with symptomatic CMC OA, a common hand impairment in older adults.

METHODS: 32 patients with CMC OA received intra-articular injection of Hylan G-F 20 for 3 consecutive weeks. Functional evaluation at baseline (prior to 1st injection), and 26 weeks later included visual analog scale (VAS) for pain; Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH, a validated measure of upper arm function); key and opposition pinch strength; and the mean sustained maximal load during the S-D test. The S-D test consists of compressing a slender spring prone to buckling using the thumbpad to maximize vertical compressive load, and holding it for 5 seconds[2]. (See Fig 1)

RESULTS: Average age was 64 years, (range 46-79), 69% female, and 97% Caucasian. Only 19 patients have completed the study so far, out of which 1 patient did not compress the S-D Spring long enough to provide interpretable data. Only DASH and VAS scores showed significant improvement after 26 weeks (Table 1). The S-D test measured at baseline was a stastistically significant predictor (slope=3.12 N^{-1},p=0.0255) of improvement in DASH score (14.2, p=0.0033) after 26 weeks as revealed by a stepwise regression of change in DASH against change in VAS, S-D score at baseline and pinch strength at baseline. Opposition pinch strength at baseline was not able to predict this improvement in DASH score and key pinch strength at baseline correlates strongly with VAS for pain (Spearman r=-0.49, p=0.038), rendering its regression meaningless. The S-D test before/after treatment correlated poorly with both opposition grip and key grip after treatment (Spearman r=0.04/-0.16 p=0.87/0.52 ; Spearman r=0.04/-0.17 p=0.85/0.50, respectively).

CONCLUSIONS: The DASH and VAS for pain, both clinically important outcomes measures for CMC OA, significantly improved after treatment with Hylan G-F 20. The S-D score at baseline was predictive of improvement in DASH, while pinch strength was not. Thus, the S-D test, by virtue of testing sensorimotor capabilities at low forces below the threshold for pain induced impairment, is a more sensitive predictor of treatment outcome than tests of maximal pinch strength. We will now include the S-D test in larger randomized controlled trials to compare outcomes for different treatments in a wide range of CMC OA patients.

Methods

- 32 CMC OA patients received weekly intra-articular injections of Hylan G-F 20 for 3 consecutive weeks.
- Functional evaluation at baseline (before injection) and 26 weeks later – visual analog scale for pain (VAS), Disabilities of the Arm, Shoulder and Hand questionnaire (DASH), key and opposition pinch strength, and the S-D test.

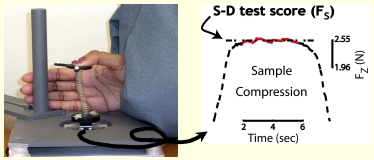

Figure 1: The experimental setup for the S-D test and an example calculation of the S-D score from collected data. The S-D test assesses dynamic sensorimotor capabilities of the thumb at very low forces (<3 N), that elicit little or no effect of pain on performance in CMC OA patients.

Results

- S-D score at baseline and change in VAS for pain significantly explained improvement in hand function as measured by the DASH:
  $\Delta(DASH) = 3.11*(Baseline\ S\text{-}D) + 4.45*(\Delta VAS); R^2=0.81$
  ($p=0.025$ for Baseline S-D; $p=0.0009$ for ΔVAS)
- None of the other baseline measures contributed significantly to Δ(DASH) (stepwise regression with a threshold p-value of 0.20).

	Baseline (N=32)	Week 26 (N=19)	p-value: Baseline to week 26
DASH score	29.1±16.5	14.9±13.5	0.011
VAS for pain	6.2±1.8	4.2±2.3	0.022
Key pinch strength	13.6±5.6	14.1±5.3	0.379
Opposition pinch strength	10.6±5.3	11.6±5.5	0.204
S-D score	2.66±0.26	2.65±0.27	0.754

Table 1: DASH score and VAS for pain are the only measures that showed a significant improvement after 26 weeks.

Pairwise Spearman correlation calculations	Spearman r (p-value)
S-D vs key/opp pinch at baseline	**0.04/0.04** (0.87/0.85)
S-D score vs key/opp pinch at week 26	**-0.16/-0.17** (0.52/0.50)
Improvement in VAS vs key/opp pinch at baseline	**-0.49/-0.2** (0.038/0.43)

Table 2: Only baseline key pinch strength correlates well with Δ(VAS) thus becoming redundant in the multiple regression.

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Conclusions

1 Patients with better S-D score at baseline (dynamic pinch function), benefit more from treatment.

- A higher S-D score at baseline indicates that patients with inherently better dynamic pinch function do show greater improvement (as measured by the DASH score).
- The multiple regression confirms that pain relief does not explain all the improvement in pinch function.
- The force required to perform the S-D test is very low (<3 N), thus probably making it independent of any effects due to pain.

2 Static pinch strength is not informative of functional improvement, unlike the S-D test.

- Both baseline pinch strength (key or opposition) and change in pinch strength after treatment are rejected by stepwise regression because they do not add significant explanatory power to the multiple regression.
- There is no correlation between the S-D scores and pinch strength, in agreement with our previous studies that show that pinch strength cannot distinguish between CMC OA patients and unimpaired controls[1].
- Pain is unavoidable when trying to produce higher forces. So, patients who had lower initial strength measurement were probably in greatest pain, thus showing the greatest pain relief magnitude with treatment (negative Spearman r).

3 The S-D test will be included in larger randomized controlled trials to assess its potential to predict treatment outcome.

- Our results suggest that the S-D test, designed to specifically target dynamic sensorimotor pinch function, is clinically informative and able to predict treatment efficacy independent of: strength differences, effects due to pain or lack of thumb specificity and inherent subjectivity in questionnaires such as the DASH.

References

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