THE USE OF THE HAND ANATOMIC INDEX TO ASSESS DEFORMITY AND IMPAIRED FUNCTION IN SYSTEMIC SCLEROSIS

A.J. Roberts-Thomson[1], N. Massy-Westropp[2], M.D. Smith[3], M.J. Ahern[3], J. Highton[4], P.J. Roberts-Thomson[3].

1. Occupational Therapy student, University of South Australia.

2. Occupational Therapist, Department of Orthopaedics, Repatriation General Hospital, Daw Park, South Australia.

3. Rheumatology Unit, Repatriation General Hospital, Daw Park, South Australia.

4. Department of Medicine, University of Otago Medical School, Dunedin, New Zealand.

Correspondence to: P.J. Roberts- Thomson, Rheumatology Unit
Repatriation General Hospital
Daws Road, Daw Park, South Australia 5041.
Phone: (618) 8204 4585, Fax: (618) 8204 4158
Email: peter.roberts-thomson@flinders.edu.au

Running Title: Hand Anatomic Index in Scleroderma

ABSTRACT

Objective:

To determine the "hand anatomic index" (HAI - a quantitative measure of hand deformity) in systemic sclerosis (scleroderma) and to compare it with other measures of hand deformity and functional impairment.

Methods:

The HAI (measure of open hand span minus closed hand span/lateral height of hand) was determined in 30 patients with scleroderma and compared with hand deformity (as assessed by two independent rheumatologists) and with the Health Assessment Questionnaire (mHAQ), hand strength and prehensile gripability data.

Results:

The HAI was confirmed as a reliable measure which clearly distinguished patients with increasing hand deformity and separated patients with diffuse scleroderma (n=12) from limited scleroderma (n=18), p=0.005. The HAI correlated significantly with measures of global functional impairment (as measured by the MHAQ) r=-0.46, p=0.01, hand strength r=0.51, p=0.0001 and prehensile gripability, r=-0.37, p=0.05 but not with disease duration r=-0.16, p=NS nor age at disease onset r=0.20, p=NS. It was estimated that the HAI accounts for ~25% of the total global disability (as measured by HAQ).

Conclusion:

Measurement of the HAI in scleroderma provides a reliable and objective measure reflecting variable degrees of hand deformity and functional impairment and might provide a valid clinical outcome measure in patients with this disabling disorder.

Key words: Scleroderma, Hand Anatomic Index, Deformity, Functional Impairment.

A simple quantitative measurement of hand deformity in scleroderma would be a valuable clinical parameter particularly in the initial assessment of such patients and their subsequent follow up. Furthermore such an assessment of hand deformity might also closely relate to functional impairment, a clinical measure of much importance. Recently Highton and colleagues[1] have derived a hand anatomic index (HAI) from the measurements of certain hand dimensions and have shown it can clearly distinguish patients with rheumatoid arthritis (RA) from healthy controls. Additionally these investigators showed in their rheumatoid patients a significant correlation between this HAI and measure of disease duration, disease activity and functional impairment (as assessed by the modified Health Assessment Questionnaire (HAQ). They provided strong evidence, therefore, in support of their hypothesis that quantitative measurements of visible, structural abnormalities of the hands will detect the presence of RA and reflect its severity.

We have therefore derived this same HAI in 30 patients with scleroderma and compared it with a number of validated functional measurements. Our results support the notion that the determination of the HAI might provide a simple and clinically relevant measure of impairment of hand function in this enigmatic and frequently disabling disorder.

METHODS

Patients

Thirty patients with scleroderma were selected arbitrarily (i.e. without prior knowledge of their disease subtype or severity) from the South Australian Scleroderma Register[2] according to their geographic accessibility (i.e. closeness to research unit) and their willingness to participate in the study. Twelve of these patients had diffuse scleroderma and 18 limited scleroderma (with the disease being subtyped according to the criteria as discussed by LeRoy and colleagues[3]). The demographics, disease subtype, disease characteristic and serology of this patient cohort are listed in Table 1.

Hand Anatomic Index

The HAI was determined by the method of Highton[1] with the modification that callipers and ruler were used to determine the three hand dimensions rather than the determination using a computerised video imaging analytical program as initially described. The HAI is defined as the measurement of maximum hand spread (a) minus measurement of closed hand span (b) divided by measurement of maximum lateral hand height (c) (i.e. $(a-b)\div c$ where a = distance of maximum hand spread measured from middle tip of thumb to middle tip of fifth digit, b = distance of closed hand with thumb lying extended against index finger from middle tip of thumb to middle tip of fifth digit and c = distance of maximum hand height (from lateral view of open hand – generally from the apex of the most prominent MCP joint to the base)). The HAI was determined for both dominant and non dominant hands with the HAI (m) being the mean of the two values.

Functional Assessments

Health Assessment Questionnaire (HAQ).

Patients were requested to complete a modified HAQ[4]

Hand Grip Strength

Hand grip strength was measured using a calibrated Jamar dynamometer according to the standardised method of Fess[5].

Prehensile Hand Gripability

Prehensile hand gripability as measured according to the method of Dellehag[6]. In brief the gripability test was scored according to the combined time to complete 3 separate tasks, viz 1) placing flexi grip stocking over the non-dominant hand, 2) positioning of a paper clip on an envelope and 3) pouring water from a plastic jug into a cup.

Digital Photography

Digital photography of the hands in 3 views (antero-posterior view of hand in extended and closed position and lateral view of open hand) were obtained for each patient. Hand deformity was assessed by having 2 rheumatologists in a blinded but concasual fashion grade these images as normal, mild, moderate or grossly deformed

Ethics

The project had the approval of the Flinders Clinical Research Ethics Committee with all patients giving written consent to participate in the study.

Statistical Analysis

In general non-parametric statistical tests (Stata version 8 software) were used with a p value <0.05 being considered significant. Test-retest reliability was determined by intraclass correlation coefficient. Comparison between groups was performed using the Mann-Whitney test while correlation between two variables was assessed using Spearman rank-order correlation coefficients (r).

RESULTS

To confirm reliability of the HAI we measured the 3 specific hand dimensions on two occasions in 5 patients. Calculated test-retest reliability correlation coefficient was 0.994.

The HAI (m) was then correlated with hand deformity as assessed in a blinded fashion by 2 independent senior rheumatologists viewing 3 hand digital photographs from each patient. A progressive decline in the mean HAI was observed between hands graded as normal to those with gross deformity (r=-0.77, p=0:0000, Figure 1). Patients were then divided into those with limited and diffuse cutaneous scleroderma and the HAI (m) plotted (Figure 2). Patients with diffuse scleroderma had significantly lower values that those with limited scleroderma (p = 0.005, Mann-Whitney). The HAQ (m) was then correlated with HAQ score, hand strength, hand gripability, age at onset, and disease duration and the results are tabulated (Table II) and selected scatter plots are shown Figures 3, 4 and 5. Of particular interest was the significant correlation observed between the HAI (m) with other measures of hand functions and global disability (as measured by the HAQ). It was established by regression analysis that the HAI (m) accounts for ~ 25% of the total HAQ variance.

DISCUSSION

We describe a simple and reliable measure of quantifying hand anatomical deformity in scleroderma, have noted that it can discriminate significantly between patients with diffuse and limited cutaneous scleroderma and have then correlated this HAI with other measures of hand functional impairment and global impairment. We conclude that the HAI appears to have good construct validity in scleroderma but that further studies will be required to test its sensitivity to change over time.

The HAI was recently described by one of us[1] (JH) and was shown to produce a reliable measure to reflect the progression of anatomical abnormality of the hand caused by rheumatoid arthritis. As such it was suggested that it might provide a useful outcome measure in rheumatoid arthritis[1].

Hand deformity with disability is a prominent feature in scleroderma and we have therefore determined the HAI in 30 patients with this disease. In order to further simplify the measurement of the HAI we have modified the original description by removing the need for computerised video image analysis – we have merely measured the necessary hand dimensions using a calliper and ruler. We have verified that this is a reliable measure by replicating our measures in the same patient thus confirming its reproducibility. Further we have shown that the HAI will clearly distinguish between patients with diffuse and limited scleroderma the former having greater anatomical deformity as would be expected by the greater degree of flexural contractures and joint immobility seen in this more severe variant. In addition the HAI also correlated significantly with other measures of hand dysfunction and with the HAQ measure of global functional impairment. This is not unexpected as the hand is especially important in performing the activities of daily living as assessed in the HAQ. Indeed

we established that the HAI accounts for approximately 25% of the total variance of the HAQ score. The positive correlations of the HAI with hand function and global disability together with the lack of correlation of the HAI with age at disease onset and with disease duration would be consistent with the HAI having good construct validity in scleroderma.

It is of interest that the severity of the hand deformity in our diffuse scleroderma patients (as assessed by the HAI) is of a similar order of magnitude as is found in longstanding rheumatoid arthritis. Highton et al[1] quotes a HAI for healthy control subjects (of similar gender ratio and age range to our own patients) of 3.76 $\pm$ 0.6 (SD) versus 1.51 $\pm$ 0.9 in his rheumatoid arthritis patients. This latter figure is very similar to that observed for our diffuse scleroderma patients. Furthermore we have recently determined in a study involving 35 patients with diffuse scleroderma that the global functional impairment of these patients is likewise very similar to patients with rheumatoid arthritis (mean mHAQ $\pm$ 95% Cl for diffuse scleroderma = 0.82 (0.55-1.08) as compared with 1.03 (0.88-1.21) for 170 rheumatoid arthritis patients, unpublished observations).

There are a number of publications assessing hand function in RA, OA and Scleroderma [7-11] both of a quantitative nature (i.e.range of motion, grip strength, dexterity) and of a qualitative nature (i.e. pain, self-efficacy) and many have been validated. Recently the Cochin hand function scale CHFS (an 18 point questionnaire) has been shown to have favourable construct validity in scleroderma[6] with the CHFS total score explaining 75% of the HAQ global score variance (as assessed by ANOVA). We are now proceeding to compare the HAI with the CHFS. It would seem most efficient to have one qualitative assessment (eg CHFS) and one quantitative assessment (eg HAI) to comprehensively assess hand function in scleroderma, for the

purpose of sequential monitoring. However in both these measures further research will be necessary to assess the sensitivity to change over time.

In conclusion measurement of the HAI in patients with scleroderma reliably reflects hand deformity/functional impairment and might provide a valuable outcome measure in this disabling rheumatic disorder.

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TABLE 1

CHARTERISTICS OF PATIENTS WITH SCLERODERMA

	No	Gender Male:Female	Mean Age years (range)	Mean Disease Duration (range)	Serology (antibody)
Diffuse	**12**	**4:8**	**50.3 (39-68)**	**10.8 (2-18)**	**Scl-70 = 3**
Limited	**18**	**2:16**	**64.5 (36-84)**	**23.6 (4-64)**	**centromere = 7**

TABLE II

CORRELATION OF HAND ANATOMIC INDEX WITH OTHER HAND FUNCTIONAL INDICES AND DISEASE CHARACTERISTICS

	HAQ	HAND STRENGTH (av)	HAND GRIPABILITY	AGE AT ONSET	DISEASE DURATION
Hand anatomical Index (av)	**r=-0.46▲**	**r=0.51**	**r=-0.37**	**r=0.20**	**r=-0.16**
	p=0.01^{+}	**p=0.0001**	**p=0.05**	**p=NS**	**p=NS**

▲ correlation coefficient (Spearman)

p^{+} = p value. NS – not significant

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LEGEND TO FIGURES

Figure 1

Hand deformity as graded by 2 senior rheumatologists into 4 grades (x abscissa) and plotted against the HAI (y ordinate). Each point represent a patient and the horizontal bars represent the means for the 4 catagories. (n=29 patients only).

Figure 2

Box and wisker demonstration of HAI (m) between patients with diffuse cutaneous scleroderma (n=12) and limited cutaneous scleroderma (n=18) p=0.005. The box demonstrates the mean and 25^{th} and 75^{th} percentile while the wisker indicate the 5th and 95^{th} percentile.

Figure 3

Correlation between HAI (m) and HAQ. Spearman r=-0.46, p=0.01.

Figure 4

Correlation between HAI (m) and hand strength. Spearman r=0.51, n=0.0001.

Figure 5

Correlation between HAI (m) and hand prehensile gripability. Spearman r= -0.37, p=0.05.

Conflict of Interest Statement

No conflict of interest has been declared by the authors.

Key Messages:

- The hand anatomic index (HAI) (open hand span minus closed hand span/lateral height of hand) is a simple, reliable and quantitative measure of hand deformity.
- The HAI determined in 30 patients with scleroderma clearly distinguished patients with increasing hand deformity and correlated significantly with measures of hand strength ($p=0.0001$), prehensile gripability ($p=0.05$) and global functional impairment (as measured by the Health Assessment questionnaire $p=0.01$).
- Measurement of the HAI in scleroderma (and in rheumatoid arthritis) is a reliable and objective measure of hand deformity and functional impairment and might provide a useful clinical outcome measure. Its sensitivity to change over time needs to be determined.