# The Effects of Early Rheumatoid Arthritis on Dominant and Non-dominant Hand Impairment and Function

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**Rheumatoid arthritis (RA) is defined as a symmetrical disease yet there is evidence that hand joint damage sustained in RA is related to use, and hand dominance could affect the degree of structural impairment evident in the wrist and hand. This exploratory research aimed to examine the relationship of dominant and non-dominant wrist and hand joint impairment and function in an early rheumatoid population. A multi-centre cohort study was conducted, recruiting consenting patients with early rheumatoid arthritis from eight outpatient occupational therapy departments. Wrist and hand joint impairment and function were assessed by measuring joint pain and swelling, range of motion and joint deviation, handgrip and hand dexterity. The results demonstrated that the non-dominant hand showed less pathological structural and functional involvement than the dominant hand in all but one outcome measure. These differences reached statistical significance between dominant and non-dominant hands on active range of motion in the wrist and some digits. Dominant hand structural impairment and dysfunction in this early RA sample was consistently greater than the non-dominant hand and bilateral handgrip ratio did not reflect healthy values for norms. Individuals with early RA showed a greater level of impairment in their dominant hands.**

## INTRODUCTION

Dominant handgrip has been routinely recorded in rheumatology trials as an indicator of disease activity and hand function (Uhlig et al 2000). Bechtol and Oakland (1954) developed the 10% rule, proposing that a healthy dominant hand is 5-10% stronger than the non-dominant hand. This ruling has been challenged but later studies have proved inconclusive. It is unusual for studies to publish structural impairment and functional activity levels of individuals related to hand dominance and this study aimed to explore the relationship between dominant and non-dominant hand function and impairment in early rheumatoid arthritis (RA).

## RHEUMATOID ARTHRITIS AND THE HAND

RA affects the wrist and hand early in the disease process. Deformities are common and hand functional ability can decline with disease duration (Sollermann 2000). In RA there is evidence that joint damage is related to use (Wollheim 1993), and it seems reasonable to suggest that the dominant hand is likely to be more severely affected than the non-dominant. However, evidence on symmetry of bony erosions, joint space narrowing and deformity in the wrist and hand has been contradictory (Flatt 1995, Clarke et al 1994, Mody et al 1989). Flatt (1995) argues strongly that degeneration and deformity do not develop symmetrically and Mody et al (1989) confirmed that

damage in the hand relates to dominance, the dominant hand developing more deformities than the non-dominant hand. However, Clarke et al (1994) state that any differences witnessed between dominant and non-dominant hands affect only a small minority of individuals and would be transient, and advocated only performing unilateral hand and wrist radiological examination. Madenci and Gursoy (2003) also report that in right-handed individuals with rheumatoid arthritis, the number of hand deformities and bilateral grip strength does not significantly differ between hands. This lack of agreement provided the basis for this exploratory study.

## METHODS

Following approval from one UK multi-regional ethics committee and six local research ethics committees, patients with early RA with identified wrist and hand difficulties and suitable for occupational therapy hand intervention programmes were recruited from eight specialist rheumatology departments. Local clinical occupational therapists recruited patients and obtained consent. Eligibility was based on patients fulfilling the American Rheumatology College diagnostic criteria for rheumatoid arthritis (Arnett et al 1988). Inclusion criteria were:

- aged 18 years and over
- with a diagnosis of definitive RA or
- with a diagnosis of inflammatory arthritis with the likelihood of an imminent diagnosis of definitive RA
- with disease duration of no more than five years.

## MEASUREMENT

All assessments and measurements were carried out in the patient's own home by one assessor. Background demographic data were collected from patient notes and through interview. Hand dominance was ascertained by asking patients to identify with which hand they wrote and used scissors.

### Structural impairment assessment

i) A 28-joint Quantitative Articular Index (Fuchs et al 1989) incorporating a Ritchie scoring system for pain (Ritchie et al 1968) and a binary 28 swollen joint count were carried out to assess localised pain and inflammation. The Ritchie score is a graded joint-tenderness score ranging from 0 to 3 for each joint. Tenderness of the joints' was elicited by firm pressure over the joints margin (sufficient pressure to blanch the assessor's fingernail bed). One of four grades for each joint area are recorded; 0 = the patient had no tenderness, 1 = the patient complained of pain/tenderness, 2 = the patient complained of pain and winced, 3 = the patient complained of pain, winced and withdrew. The Index is quick to perform (two and a half minutes) and has been shown to be sensitive to changes in pain levels over seven days (Ritchie et al 1968). The tenderness and swollen joint scores were recorded separately for dominant and non-dominant sides.

ii) Total Active Motion (TAM) of the wrist joint was measured using a 360-degree free arm goniometer. The total active flexion of the wrist is added to the total active extension to yield one summary active motion score.

iii) Ulnar deviation of the metacarpophangeal (MCP) joints of the index, middle, ring and little fingers was measured in accordance with the procedure recommended by the American Society for Surgery of the Hand (1992). For analysis ulnar deviation scores were summed for index, middle, ring and little fingers for dominant and non-dominant hands to provide a single total ulnar deviation score for each hand.

iii) Power handgrip strength was measured using recommended assessment protocols for patient positioning, rest period and verbal encouragement from the assessor (Mathiowetz 1991). A recently calibrated MIE digital grip analyser (MIE Medical Research Ltd, Leeds, UK) recorded grip force in Newtons. Three efforts for each grip were recorded and the mean effort was recorded for analysis. The dominant hand was measured first.

### Therapist assessed bilateral dexterity

i) The Nine Hole Peg Test (Mathiowetz et al 1985) was used as a therapist assessment of bilateral hand dexterity and administered as per protocol.

## DATA ANALYSIS

Data were entered into SPSS for Windows (SPSS Inc, Version 11.5, Chicago, USA). The difference between dominant and non-dominant hand impairment and ability was calculated to provide the range of differences within the group. Where scores displayed skewed distribution, the median and inter-quartile ranges are presented, all other data are presented as mean and standard deviation. Paired *t*-tests were used to compare differences between dominant and non-dominant hands and independent *t*-tests were used to examine the differences between those individuals who maintained and lost the 5-10% differential in bilateral handgrip strength. Analysis was done by dominance rather than by left and right hands. Intra-rater reliability of grip testing was examined and deemed to be acceptable using Intra Class Coefficient (ICC) (model 1,1) ICC=0.98.

## RESULTS

Of the 147 participants invited to take part in the study, seven did not fulfil the entry criteria and 21 declined to participate. One hundred and nineteen patients were recruited onto the study.

All individuals reported one dominant hand. The sample recruited was judged by the referring clinicians to be a representative sample (for age, gender and socio-economic class) of early RA patients referred to outpatient occupational therapy departments within specialist rheumatology departments for hand intervention programmes. Table 1 documents patient demographic details.

### Differences between dominant and non-dominant structural impairment and functional ability

Table 2 presents the comparison between dominant and non-dominant hand scores for all participants (n=119). The differences between dominant and non-dominant hand impairment and function were calculated and the distribution of these included. Paired *t*-tests were used to examine the significance of any differences between dominant and non-dominant structural impairment and functional ability.

Statistically significant differences ($p<0.05$) were found between dominant and non-dominant Total Active Motion of the wrist. TAM was significantly reduced in the dominant hand.

### Dominant to non-dominant grip strength ratio

Fifty seven percent (n=68) of the early RA patients had a dominant handgrip that was less than 5% stronger than their non-dominant hand. Seventy six percent (n=13) of left-hand-dominant patients and 54% (n=55) of right-hand-dominant patients had a dominant handgrip that was less than 5% stronger than the non-dominant hand. In spite of this trend towards the dominant handgrip strength being less than Bechtol and Oakland's ruling, there was no statistically significant difference ($p=0.86$) between dominant and non-dominant handgrip strength in this sample.

Table 3 shows the range of differences in characteristics of those patients who had a dominant grip strength at least 5% stronger than their non-dominant hand and those who had a dominant grip strength less than 5% stronger than their non-dominant hand. Independent *t*-tests were used to test the significance of these differences where appropriate.

| Gender | Age mean (SD), range | Time since diagnosis median, (IQR) range | Hand dominance |
|---|---|---|---|
| 87 (73%) female<br>32 (27%) male | 57 years (±13.76 years)<br>23 to 82 years | 6 months, (3-12)<br>0 to 58 months | 102 (86%) right-hand-dominant<br>17 (14%) left-hand-dominant |

*Table 1*
*Demographic data of participants with RA*

| Measures | Mean value | T value | Sig |
|---|---|---|---|
| Ritchie score (0-42)<br>Dominant<br>Non-dominant<br>Difference | <br>6.79 (SD: ± 8.05)<br>6.63 (SD: ± 8.81)<br>0.16 (SD: ± 4.46) | 0.39 | 0.70 |
| Swollen joint count (0-14)<br>Dominant<br>Non-dominant<br>Difference | <br>3.75 (SD: ± 3.19)<br>3.65 (SD: ± 3.37)<br>0.10 (SD: ± 1.76) | 0.63 | 0.53 |
| TAM Wrist joint (degrees)<br>Dominant<br>Non-dominant<br>Difference | <br>91.35 (SD: ± 23.38)<br>95.47 (SD: ± 22.45)<br>-4.12 (SD: ± 18.60) | -2.42 | 0.02* |
| Total MCPJ ulnar deviation (degrees)<br>Dominant<br>Non-dominant<br>MCPJ ulnar deviation difference | <br>27.09 (SD: ± 20.43)<br>25.53 (SD: ± 19.31)<br>1.56 (SD: ± 23.21) | 0.74 | 0.46 |
| Mean grip strength (Newtons)<br>Dominant<br>Non-dominant<br>Grip difference | <br>126.99 (SD: ± 83.02)<br>127.71 (SD: ± 81.10)<br>-0.72 (SD: ± 46.01) | -0.17 | 0.86 |
| Nine Hole Peg Test (seconds)<br>Dominant hand<br>Non-dominant hand<br>Difference | <br>36.05 (SD: ± 57.77)<br>36.06 (SD: ± 49.46)<br>-0.01 (SD: ± 17.35) | -0.01 | 1.00 |

*Table 2*
*The difference between dominant and non-dominant hand structural and functional ability in all participants*
** = p<0.05*

*Table 3*
*Characteristics and level of significance of those patients who maintain and those who lose a 5% differential between dominant and non-dominant hand grip ratio*

| | Patients with dominant hand grip 5% stronger and above than non-dominant (n=51) | Patients with dominant hand grip less than 5% stronger than non-dominant hand (n=68) | Significance (p value) |
|---|---|---|---|
| Hand dominance | 92% (n=47) right-handed<br>8% (n=4) left-handed | 81% (n=55) right-handed<br>19% (n=13) left-handed | n/a |
| Percentage difference between dominant and non-dominant grip (Newtons)<br>Mean (± SD:) Range | 147.85% (± 57.06)<br>105.48% to 400.00% | 79.28% (± 20.40)<br>16.67% to 104.76% | n/a |
| Age (years) | 57.63 (± 13.16) | 56.73 (± 14.28) | 0.73 |
| Duration of symptoms (months) | 29.49 (± 32.22) | 22.39 (± 24.12) | 0.17 |
| Time since diagnosis (months) | 11.13 (± 12.29) | 9.72 (± 10.68) | 0.50 |
| Ritchie score<br>Dominant<br>Non-dominant | 7.18 (± 8.94)<br>8.14 (± 10.06) | 6.50 (± 7.37)<br>5.50 (± 7.63) | 0.65<br>0.11 |
| Swollen joint score<br>Dominant<br>Non dominant | 3.84 (± 3.34)<br>4.00 (± 3.49) | 3.68 (± 3.10)<br>3.38 (± 3.28) | 0.78<br>0.33 |

## DISCUSSION

The results of this small-scale study need to be interpreted with caution. Power calculations were not carried out to inform the study sample size, and as such the study's results are susceptible to Type II errors in analysis. Care also needs to be taken in generalising the results beyond an early RA population with identified wrist and hand difficulties referred to specialist rheumatology departments. These data are not generalisable to the very young or very elderly RA population.

The majority of the individuals (57%) demonstrated a dominant handgrip strength that was not 5% stronger than the non-dominant hand and Bechtol and Oakland's 1954 ruling cannot be applied to this RA sample. This may be because of the increase in unilateral joint involvement affecting the dominant side in this sample and may provide evidence to support the findings of Wollheim (1993), Flatt (1995) and Mody et al (1989). Although the mean recordings of non-dominant joint motion and handgrip strength are greater than dominant recordings and the dominant side shows higher impairment scores in pain, swelling and degree of ulnar deviation at the MCP joints, these levels did not reach statistical significance and other explanations for their occurrence should be considered. Mean bilateral dexterity levels measured using the Nine Hole Peg Test differed to a clinically negligible amount (0.01 seconds) between dominant and non-dominant hand. This is potentially clinically relevant as healthy dominant hands are usually more accurate, dextrous and functionally quicker than non-dominant hands (Provins and Magliaro 1993) and this difference could be argued to be expected to be greater. Interestingly the dexterity test did not seem to reflect the differences in wrist TAM that were statistically significantly different between sides. Functional wrist flexion and extension were required to pick up the pegs from the box. However, compensatory movements may have occurred at the shoulder and elbow to complete the task that could in turn have reduced the necessity for full range of wrist motion. The Nine Hole Peg Test has been seen to be a reliable and valid measure of dexterity in chronic arthritic conditions (Backman et al 1991) and also one that is responsive to change in early RA (Adams et al 2005). However, it may be sensitive primarily to finger motion rather than wrist motion. It may also be the case that wrist motion is less important than wrist stability for finger dexterity in this population.

Forty three percent of individuals did maintain Bechtol and Oakland's 'healthy' handgrip ratio. This group had greater ulnar deviation at the MCP joints than the group that did not maintain this ratio. As power gripping can only occur from a position of wrist and MCP joint ulnar deviation, the slipping of the digital extensor tendons that exacerbate ulnar drift at the MCP joints may serve to increase flexor grip strength and such early deformity may increase the biomechanical advantage of flexor carpi ulnaris responsible for placing the wrist and hand in this position. The sum of ulnar deviation was not great in this sample so the argument may be tenuous without further biomechanical study.

There was no significant difference in the age of those people who maintained or lost a 5% grip differential. The influence of drug treatment and the length of time on a baseline DMARD also did not seem to influence the grip ratio.

Clinically, these results indicate that this sample of individuals with early RA has greater structural impairment affecting their dominant hands, although not to statistically significant levels. Nor is this impairment translated to the measurement of functional hand ability when recording grip strength and dexterity levels. This may be because functional hand assessments may not be sensitive in detecting these changes or because structural impairment may not necessarily correlate with functional measures in early RA. Furthermore, what is deemed to be statistically and clinically significant may differ. At the moment levels of clinical significance in structural impairment and functional hand ability measures have not been agreed by hand therapists and further ongoing work will be required to quantify whether differences in impairment such as these recorded here are clinically significant.

## LIMITATIONS OF THIS STUDY

The methodology used was limited in providing only a one-off strength assessment and clinically how this changes over time would be of further interest. The testing and measurement of structural impairment and functional ability are complex and susceptible to measurement error, assessor bias and performance bias. Genuine attempts to minimise measurement bias and improve reliability were made by ensuring that all assessments were carried out by one experienced occupational therapist using calibrated instruments and following standardised test protocols. Variables known to affect performance, such as time of day, were also made as constant as possible. The validity of the results could have been affected by the ability of some patients, with upper limb and trunk immobility, to comply exactly with wrist and arm positioning as recommended by Mathiowetz (1991) for grip strength testing. Finally the use of a standardised questionnaire to ascertain handedness, such as the Edinburgh Handedness Inventory (Oldfield 1971) could further have improved this study's reliability.

## FURTHER WORK

To place these results in a better context, normative data is required to establish the degree of bilateral structural ability in a similar sample without early RA. Ongoing work is also still required to attempt to quantify what are clinically significant changes in structural impairment and functional hand ability.

## CONCLUSION

This small study reported that the majority of individuals with early RA experience a weakening of dominant to non-dominant handgrip ratio. However, there remains a sizeable percentage that maintain the healthy 5-10% differential. Statistically there was no difference between dominant and non-dominant hand structural impairment and function measures in this sample. However, until the clinical significance of differences in impairment and function can be agreed, bilateral hand assessment is likely to be the most appropriate.

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