

THE ASSOCIATIONS BETWEEN BIOMECHANICAL IMPAIRMENTS AND HAND FUNCTION IN PEOPLE WITH RHEUMATOID ARTHRITIS

Nancy A. Baker, and Joan C. Rogers
University of Pittsburgh, email: nab36@pitt.edu

INTRODUCTION

People with rheumatoid arthritis (RA) often experience significant limitations in hand function such as buttoning buttons and handling coins. RA is a form of polyarticular synovitis which can cause fixed structural deformities of the wrist, hand, and fingers, such as volar subluxation of the carpal bones on the radius, metacarpophalangeal joint ulnar deviation, metacarpophalangeal palmar subluxation, and swan neck deformities [1] (Figure 1). These deformities can lead to pain, stiffness, and restricted movement in the affected joints.

Healthcare professionals frequently measure biomechanical deficits, such as range of motion (ROM), grip strength, and dexterity as a method of quantifying hand function limitations. This study examined the association between biomechanical outcomes (ROM, grip, and dexterity) and functional hand use.

METHODS

45 people with RA were recruited from the University of Pittsburgh Medical Center (UPMC) Arthritis Network Disease Registry. Subjects had to have a primary diagnosis of RA, be between 18 and 65 years old, and report some limitations in hand use. Participants completed two hand performance tests: The Arthritis Hand Function Test (AHFT) [2] and the Keitel Hand Function Index (KHFI) [3].

Instruments: The AHFT measures both biomechanical outcomes and hand tasks. It consists of pure and applied tasks: 2 pure biomechanical outcomes (grip and 9-hole peg test), 4 bilateral applied dexterity tasks (lacing shoe, buttons, cutting “meat,” and manipulating coins) and 2 bilateral applied strength tasks (lifting cans and pouring water). The KHFI consists of 11 performance test items that measure active ROM of the thumb, fingers, wrists, forearms and elbows.

In addition to measuring performance, visible structural deformities were identified and listed by a



Figure 1: Examples of structural deformities of the hands in RA. A – metacarpophalangeal joint ulnar deviation; B – volar subluxation of the carpal bones on the radius, metacarpophalangeal palmar subluxation, swan neck deformities (R 3rd and 5th digits).

Certified Hand Therapist. From these a total number of hand problems score was developed.

Data processing: Total grip and total dexterity scores were developed by summing the right and left scores for each outcome. Each applied tasks AHFT raw score was transformed into a categorical impairment score (“severe,” “moderate,” “mild,” and “effective” [4]). These scores were summed to develop a Total Applied AHFT score which ranged from 6 to 24, with a higher score indicating greater hand function. Total Keitel scores range from 4 to 52, with higher scores indicating greater impairment in active ROM.

Statistical Analysis: Backward stepwise multiple regression models with each applied hand task as the outcome measure and the biomechanical variables (total grip, total dexterity, total Keitel), as well as the total problems, and age as the predictor variables were used to determine which biomechanical variables were most strongly associated with hand function.

RESULTS AND DISCUSSION

Subjects were 56.2 (± 8.5) years and primarily female (84%). They had had RA for a mean of 16.7 (± 10.3) years. The median of the total number of problems score was 2 problems and ranged from 0 to 15. The mean total grip strength score was 366.8 (± 160.3) mmHg. The mean total dexterity score was 51.2 (± 11.2) seconds. The mean Total Keitel score was 21.8 (± 10.8).

All models were significant except for Coins (Table 1). Grip was most often associated with hand function, playing a significant part in 4 of the 6 models. Dexterity, too, was an important predictor of hand function. Number of problems had only limited associations with hand function, and pure active range of motion, as represented by the Keitel, was not significant in any model.

For tasks which required strength rather than precision, such as cutting meat or lifting items, strength had the strongest association. For tasks requiring manipulation, such as doing buttons or tying laces, dexterity became more important. Overall hand function, as represented by the AHFT score, was more strongly associated with dexterity, suggesting that for many tasks, the ability to manipulate items is a better predictor of function than basic strength. Interestingly, manipulating coins, which involved picking up coins and

manipulating them in the hand, was not significantly associated with any biomechanical skill. The ability to perform in-hand manipulation tasks may require a set of skills not measured by current dexterity tasks.

CONCLUSIONS

Number of problems is a poor predictor of hand function, as is overall ROM for people with RA. Grip and/or dexterity, however, can provide a good index of overall hand performance for functional tasks regardless of age and structural deformity. Biomechanists should identify whether a hand task is more reliant on grip or dexterity to determine which of these variables to measure.

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Table 1 – Regression models predicting hand function from biomechanical variables

| | Mean (SD) | age | problem | partial <i>r</i> Keitel | grip | dexterity | R ² |
|---------|-------------|-----|---------|----------------------------|------|-----------|----------------|
| Shoe | 49.9 (15.5) | .38 | -- | -- | -.45 | .60 | .65 |
| Button | 30.3 (14.7) | -- | .45 | -- | -- | .41 | .37 |
| Cutting | 48.4 (29.8) | -- | -- | -- | -.59 | -- | .35 |
| Coins | 16.3 (14.2) | -- | -- | -- | -- | -- | -- |
| Lifting | 10.6 (2.7) | -- | -- | -- | .55 | -- | .30 |
| AHFT | 13.6 (3.6) | -- | -- | -- | -.41 | .64 | .79 |

Shoe – Lacing/tying a shoe lace (secs); Button – fastening/unfastening 4 buttons (secs); Cutting – cutting “meat” with a knife (secs); Coins – manipulating and inserting 4 coins (secs); Lifting – lifting tray with up to 12 cans (# of cans); AHFT – Total AHFT score; -- - variable did not significantly contribute to the model