

ORIGINAL ARTICLE

Reliability of Box and Block Test for manual dexterity in patients with rheumatoid arthritis: a pilot study

Alok RANJAN,¹ Lydia Edward RAJ,² Dilesh KUMAR,³ Pulukool SANDHYA⁴ and Debashish DANDA⁴

¹School of Health Systems Studies, Tata Institute of Social Sciences, Mumbai, Departments of ²Physical Medicine and Rehabilitation, ³Community Health and Development, and ⁴Clinical Immunology & Rheumatology, Christian Medical College, Vellore, India

Abstract

Objective: This study is aimed to determine the reliability of the Box and Block (B&B) Test for manual dexterity of upper extremity function in patients with rheumatoid arthritis (RA) and to compare the results with age- and sex-matched healthy controls, and also with available normative data.

Methods: The reliability of B&B Test was assessed within and between testers using the intraclass correlation coefficient (ICC) in patients with RA attending rheumatology clinics of Christian Medical College Hospital, India. The dexterity scores of patients were then compared with age- and sex-matched controls and the Mathiowetz's population-based normative data by Student's independent *t*-test.

Results: The interrater and intrarater reliability of the B&B Test in patients with RA ($n = 60$) ranged from 0.92 to 0.97 and 0.91 to 0.95, respectively. The dexterity scores in patients with RA were lower as compared to the control group (dominant hand 54.87 *vs.* 68.18, $P < 0.001$; contralateral hand 52.65 *vs.* 65.6, $P < 0.001$) and population-based normative score (dominant hand 54.87 *vs.* 80.02, $P < 0.001$; contralateral hand 52.65 *vs.* 77.23; $P < 0.001$). The control group scores were also lower than the normative data. Higher age of patient, longer disease duration and higher disease activity reflected by Disease Activity Score of 28 joints (DAS-28) also correlated well with lower dexterity score.

Conclusions: The B&B Test is a reliable tool for assessing upper extremity function in patients with RA and the dexterity scores are lower for RA patients. The scores had correlation with age, disease duration and disease activity.

Key words: Box and Block Test, DAS 28, hand functions, manual dexterity, rheumatoid arthritis.

INTRODUCTION

Rheumatoid arthritis (RA) is one of the most disabling chronic inflammatory diseases.¹ Its prevalence varies from 0.5% to 1% in diverse populations and is 0.75% in India.² RA affects all aspects of a patient's life and hand function is one of the most affected. RA damages

joints, ligaments, tendons, bones and ultimately disrupts the arch of the hand leading to deformities that impair hand functions and prehension. Dexterity is one of the components of hand functions. It is a manual skill which is required for rapid co-ordination of fine and gross movements and is based on certain skills like prehension and co-ordination which is developed through learning, training and experience.³ It is of two types, fine motor dexterity and gross motor dexterity.^{4,5} Previous studies have shown a strong correlation between dexterity and functional independence.^{6–8}

Correspondence: Mr. Alok Ranjan, School of Health Systems Studies, Tata Institute of Social Sciences, Mumbai-400088, India.
Email: alokranjanmc@gmail.com

There are many tests to assess dexterity, such as the Minnesota Rate of Manipulation Test,⁹ the Box and Block (B&B) Test¹⁰ and Purdue Pegboard Test.¹¹

The B&B Test was developed by A. Jean Ayres and Patricia Buhler and its present form was copyrighted by Patricia Buhler and Elizabeth Fuchs in 1957.¹⁰ Intra-class correlation coefficient (ICC) for test–retest reliability at 6 month intervals was 0.937 (dominant) and 0.967 (contralateral) as established in 1976.¹⁰ Validity of the test was established by Cromwell *et al.* in 1976 in comparison with the Minnesota Rate of Manipulation Test. B&B Test is standardized, simple, portable and quick to administer. The patient is assessed in a comfortable position and the duration of the test is < 15 min. Normative score is available for a Western population for a wide spectrum of age groups.¹⁰ Considering all these aspects, B&B Test is a better tool for dexterity evaluation as compared to others.

This test has been already used in cerebral palsy,¹² multiple sclerosis,¹³ stroke,¹⁴ elderly people⁴ Charcot–Marie–Tooth disease¹⁵ and fibromyalgia.¹⁶ In a previous study, B&B Test was used as a tool to establish the validity of the ABILHAND Questionnaire for patients with RA¹⁷ and good correlation was noted between the two. To the best of our knowledge, no published study exists on the reliability of the B&B Test in patients with RA.

Our aim in this study was to evaluate the reliability and concurrent validity of the B&B Test which may help researchers and clinicians who work with RA patients. Considering its objectiveness and quick administration, it could lead to more effective treatment for patients with RA. It can also be used as a tool to assess the effectiveness of interventions.

MATERIALS AND METHODS

Study design

This was a cross-sectional inter- and intra-tester test–retest reliability study with the addition of comparison between a control group and experimental group consisting of RA patients.

Setting

The study was done at Christian Medical College (CMC), Vellore, India between February 2010 and March 2010. RA patients fulfilling the American College of Rheumatology (ACR) 1987 criteria¹⁸ were recruited from the outpatient and inpatient services of Department of Clinical Immunology and Rheumatology. Clinical data were retrieved from patients' hospital charts

and electronic records. Disease activity was assessed using the Disease Activity Score of 28 joints (DAS-28) for all patients.

Age and sex matched healthy adults above the age of 20 years without any systemic conditions which could cause general debility and those without any disease of the upper limb or limiting hand function, were taken as controls. Control population were recruited from hospital staff, students and patients' relatives.

Study patients and controls were recruited into the study group after obtaining informed consent and after applying inclusion and exclusion criteria. The study was approved and financially supported by the Institutional Review Board of Christian Medical College.

Box and Block Test

The tool used in this study for the B&B test is manufactured by Samson & Preston Company Bolingbrook, IL. It consists of a wooden box with two compartments separated by a wooden partition and 152 wooden cubes with dimensions of 2.54 cm.

The test was administered as per the methods developed by Mathivoetz on normative data for dexterity.⁹

Each participant was asked to sit comfortably on a high table and chair and complete the B&B Test using their dominant upper extremity. After instructions, a 15-sec trial was given to the patient by the primary investigator. After correction of errors in their performance, the actual test for 1 min was administered. The test involves grasping, moving and releasing 2.54 cm square wooden blocks from one side of an 20.32cm square box to another side by passing over a wooden partition of height 12.70 cm. The score was recorded as the number of blocks passed over the wooden partition in 1 min. Lower scores represent higher hand function impairment.

The primary investigator (PI1) and co investigator (CI) administered the test on the first day to find out ICC. This procedure was repeated by the primary investigator (PI2) alone on the second day. Each participant's score was determined as the mean of these three exercises. The mean score of the patient group was then compared with that of the control group. Scores in both the groups were also compared with normative data established by Mathiowetz *et al.*¹⁰

Reliability within the examiner and between the examiners was calculated for the patient group. As in a study of fibromyalgia described in the literature, we defined ICC of 0.4 to 0.6 as fair reliability, 0.6 to 0.75 as good reliability and 0.75 to 1.00 as excellent reliability.¹⁴

Statistical methods

All statistical analyses were performed using SPSS version 16.0 statistical software (SPSS Inc., Chicago, IL, USA). Sample size was calculated using one-way analysis of variance. To test interrater and intrarater reliability, ICC was calculated. Comparison of hand function score between the cases and the age- and sex-matched control group was done using Student's independent *t*-test. Correlation of hand function score with age, duration of disease and DAS-28 score was done using Pearson's product moment correlation coefficient (bivariate) test.

RESULTS

Initially 65 patients with RA and 60 age- and sex-matched healthy controls were recruited. Out of 65, two could not complete the test due to pain and three did not come for follow-up. Finally 60 patients and 60 controls completed the test successfully. The mean age of patients and controls were 45.73 ± 12.09 years and 45.80 ± 12.09 years, respectively. There were 53 women and seven men in each group. Right hand dominance was seen in 57 (95%) patients and 55 (91.6%)

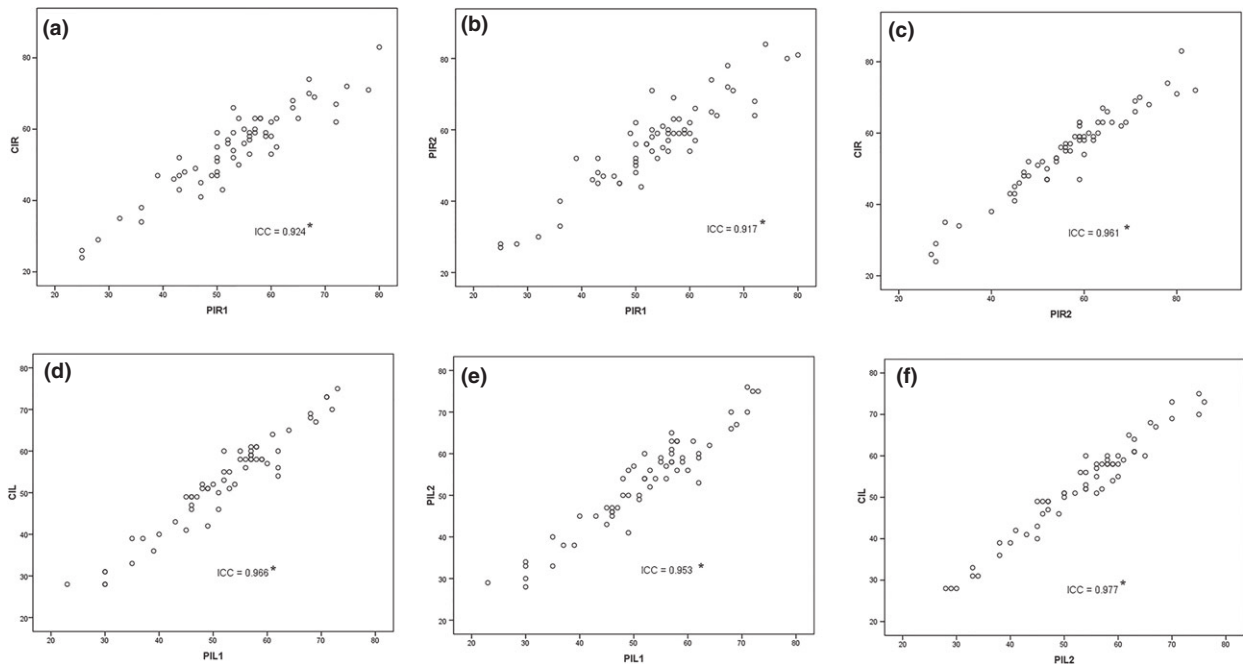


Figure 1 Intraclass correlation coefficient (ICC) between principal investigator and co-investigator. (a) ICC between co-investigator and first reading of principal investigator for right hand. (b) ICC between first and second reading of principal investigator for right hand. (c) ICC between co-investigator and second reading of principal investigator for right hand. (d) ICC between co-investigator and first reading of principal investigator for left hand. (e) ICC between first and second reading of principal investigator for left hand. (f) ICC between co-investigator and second reading of principal investigator for left hand. $P < 0.001$. PIL1: Principal investigator's first reading for left hand. PIL2: Principal investigator's second reading for left hand. PIR1: Principal investigator's first reading for right hand. PIR2: Principal investigator's second reading for right hand. CIL: Co-investigator's reading for left hand. CIR: Co-investigator's reading for right hand.

Table 1 Comparison of dexterity scores between cases and controls

| Dexterity score | Case (<i>n</i> = 60) | | Control (<i>n</i> = 60) | | Difference in mean (95% CI) | <i>P</i> -value |
|-----------------|-----------------------|------|--------------------------|------|-----------------------------|-----------------|
| | Mean | SE | Mean | SE | | |
| Right hand | 54.87 | 1.51 | 67.66 | 0.93 | 12.79 (9.264–16.315) | < 0.001 |
| Left hand | 52.65 | 1.46 | 65.68 | 0.91 | 13.02 (9.619–16.436) | < 0.001 |

SE, standard error.

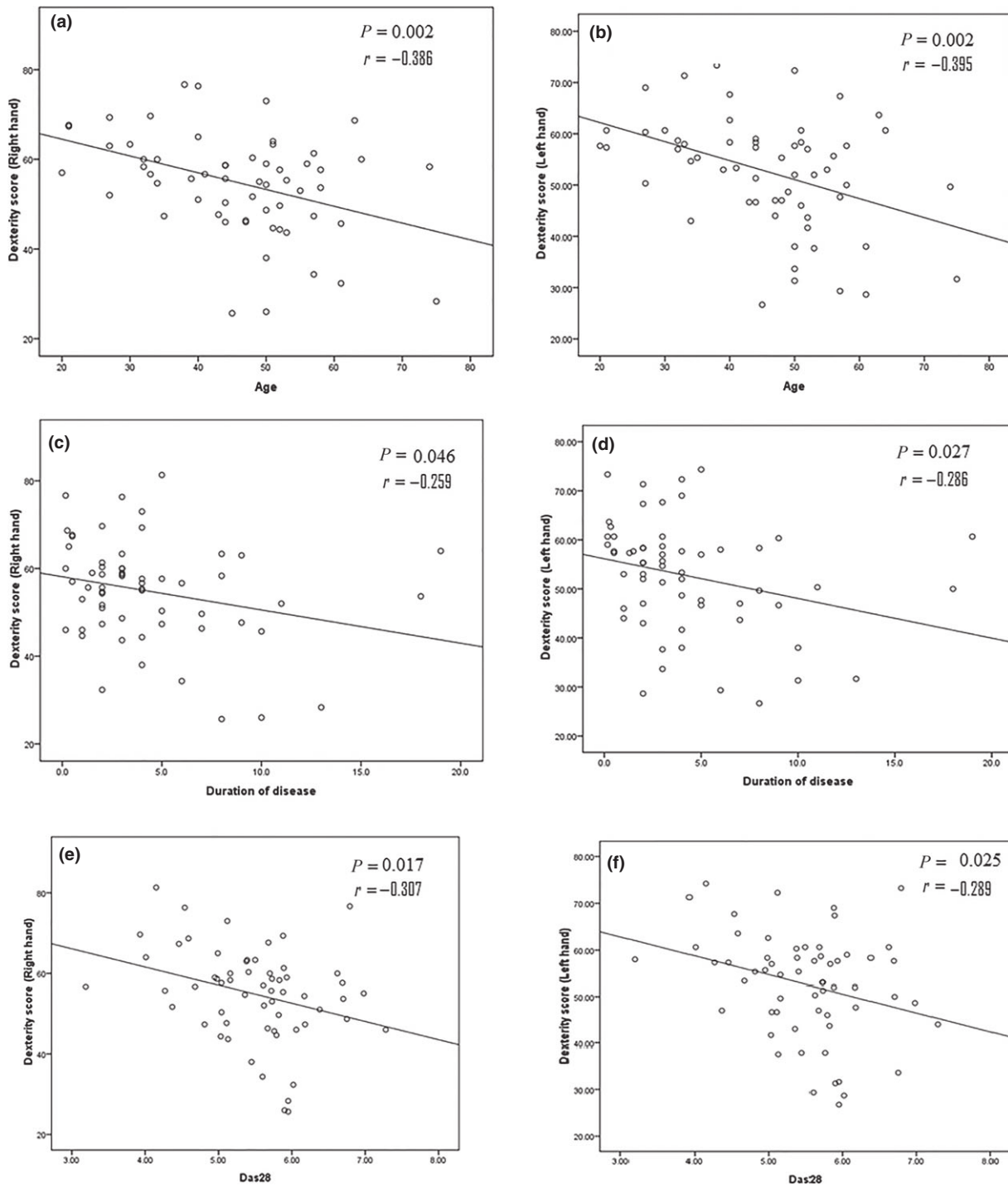


Figure 2 Correlation of hand dexterity score with age, duration of disease and DAS-28 score. (a) Pearson’s correlation between age and dexterity score for right hand in RA patients. (b) Pearson’s correlation between age and dexterity score for left hand in RA patients. (c) Pearson’s correlation between duration of disease and dexterity score for right hand in RA patients. (d) Pearson’s correlation between duration of disease and dexterity score for left hand in RA patients. (e) Pearson’s correlation between DAS-28 score and dexterity score for right hand in RA patients. (f) Pearson’s correlation between DAS-28 score and dexterity score for left hand in RA patients. DAS-28, Disease Activity Score of 28 joints; RA, rheumatoid arthritis.

controls, respectively. Deformity of the hand joints were present in 51.7% of the patients. Considering logistics and patient convenience, retests were done for four patients on more than 1 day, but they were all done within a week of the initial test.

The ICC between the primary investigator and co-investigator is depicted in Figure 1. In this study we found that ICC for the case group ranged from 0.92 to 0.97 between (interrater) investigators and 0.91 to 0.95 within the same investigator (intrarater). The dexterity scores of cases and controls are given in Table 1.

Performance of the case group (right hand 54.87, left hand 52.65) was considerably lower ($P < 0.001$) in comparison to the control group (right hand 68.18, left hand 65.68) and normative score (right hand 80.02, left hand 77.23). There was also considerable difference between the control group and the normative values. We also looked into the correlation between hand dexterity scores and various parameters, namely age, duration of disease and DAS-28 score: there were good correlations (Fig. 2). Higher age, longer disease duration and higher disease activity were associated with lower dexterity score.

DISCUSSION

This maiden study, to the best of our knowledge, on hand dexterity in patients with RA using the B&B Test showed an excellent correlation between both interraters and intraraters with an ICC of 0.92 to 0.97 and 0.91 to 0.95, respectively (Fig. 1). This implies that the B&B Test is reliable for measuring gross dexterity in patients with RA. This tool can also be used for measuring the level of impairment in hand function objectively; it can also be used for assessing the effect of treatment over a period of time, as there is correlation with disease duration and DAS-28 score.

The time interval between test and retest in our study was 1 day and was short, unlike most previous studies except one study on fibromyalgia. A longer time interval could not be given as most of the patients were from distant towns and restudy of the patients after a longer interval could not be ensured. However, studies using 1–3 day intervals do exist in the literature.¹⁹ Most of the patients included in this study were able to complete the test without any complaint of pain or fatigue. Only two patients discontinued the test in the first trial due to pain.

Dexterity score was found to show significant correlation with age, duration of disease and DAS-28 score (Fig. 2). While comparing patients' dexterity scores with

that of the control group and normative values, the mean score of the case group was found to be significantly ($P < 0.001$) lower than the control group and the normative score. These findings confirm and quantify considerable amount of hand function impairment in patients with RA. Higher right hand score as compared to left hand scores in our study was due to right hand dominance in the majority of our patients (57 out of 60 patients).

Although there are many tools which can be used for evaluating dexterity, there is no published study on reliability of the B&B Test for patients with RA. We tried to evaluate the B&B Test's reliability, as it is a standardized, quick to administer and simple technique with minimal equipment.

A previous study done for establishing reliability and validity of the B&B Test for an elderly population had emphasized the importance of measuring the reliability of this instrument for specific target populations.⁴ We have established in our study the reliability of the B&B Test in assessing hand function for patients with RA for the first time.

There was considerable difference between the control group and the standardized norms in this study. A similarly comparable discrepancy between controls and standardized norms was also found in the Mayo Clinic study on fibromyalgia.¹⁴ Hence, there may be considerable differences even within the same population and this implies a need for establishing normative values for each population.

As the B&B Test is a timed test, there is a component of stress involved in the performance of the test. Hence, this may not be extrapolated to all normal activities of daily living. Future research comparing the validity of this test with other tests of hand function is recommended for patients with RA.

We therefore conclude that there is excellent interrater and intrarater reliability of the B&B Test for Asian Indian patients with RA. Values for the B&B Test were significantly lower for patients with RA when compared with age- and sex-matched controls. This tool can also be used to evaluate change in hand function objectively in response to treatment in RA apart from assessing dexterity, as it predictably correlates well with chronicity and disease activity.

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