Rheumatology function tests: Quantitative physical measures to monitor morbidity and predict mortality in patients with rheumatic diseases

T. Pincus

Division of Rheumatology and Immunology, Department of Medicine, Vanderbilt University Medical Center, Nashville, Tennessee, USA.

Supported in part by grants from the Arthritis Foundation and the Jack C. Massey Foundation.

Please address correspondence to: Theodore Pincus, MD, Professor of Medicine, Division of Rheumatology and Immunology, Vanderbilt University School of Medicine, 203 Oxford House, Box 5, Nashville, TN 37232-4500, USA. E-mail: t.pincus@vanderbilt.edu

Clin Exp Rheumatol 2005; 23 (Suppl. 39): S85-S89.

Key words: Rheumatoid arthritis, physical measures, grip strength, walking time, button test.

ABSTRACT

Physical measures of functional status, including grip strength, walking time and button test, had been used in rheumatology clinical trials for many years, but have been supplanted in recent years by patient questionnaires. While patient questionnaire measures involve minimum professional time and have greater predictive value than physical measures for severe long-term outcomes of rheumatoid arthritis (RA), physical measures bypass socio-cultural differences which may be seen in use of patient questionnaires. Inter-observer and intra-observer reliabilities of these physical measures were excellent when administered according to a standard protocol for instructions. Physical measures of function also were significant predictors of mortality in two cohorts of patients with RA, one monitored between 1973 and 1988, and a second between 1985 and 1990.

Introduction

Functional status is recognized as important in assessment, monitoring and prognosis of patients with rheumatoid arthritis (RA) and other rheumatic diseases. Physical measures of functional status, including grip strength (1) and walking time (2) and others had been used in rheumatology clinical trials for many years, but have been supplanted in recent years by patient questionnaires. Patient questionnaire measures have several advantages over physical measures, as they involve minimum professional time and have greater predictive value than physical measures for severe long-term outcomes of RA, such as work disability (3) and mortality (4-7). Nonetheless, physical measures of functional status are significant predictors of long-term outcomes, generally at higher levels of significance than radiographic scores or laboratory tests (6, 7).

Physical measures have one major advantage over questionnaire measures of functional status – they bypass socio-cultural differences which may be seen in use of patient questionnaires. Patient questionnaires obviously must be translated into different languages in order to be used in different cultures. Perhaps even more importantly, patients in different cultures may differ in reporting of scores for functional status, pain, fatigue and global status. Some cultures are characterized by stoicism and others for tendencies towards exaggeration of symptomatology. Of course, individuals vary within cultures, but information concerning performance of physical activities may be useful, particularly to compare patient status in different settings, countries, and regions. For example, little information is available concerning physical measures (or patient questionnaire measures) of functional status in the prediction of mortality outside of the United States.

In this essay, we describe briefly methods for performing physical measures of functional status and evidence of reliability of these measures when performed carefully according to a protocol. We also review the value of these measures in documentation of changes in status over 5-10 years in 2 cohorts of patients with RA, and performance in prediction of premature mortality in these cohorts.

Methods to assess physical measures

A number of methods have been described to assess grip strength (1), walking time (2) and button tests (8). We describe below methods used at our clinical site (9, 10), recognizing that variants of these methods have also been used effectively.

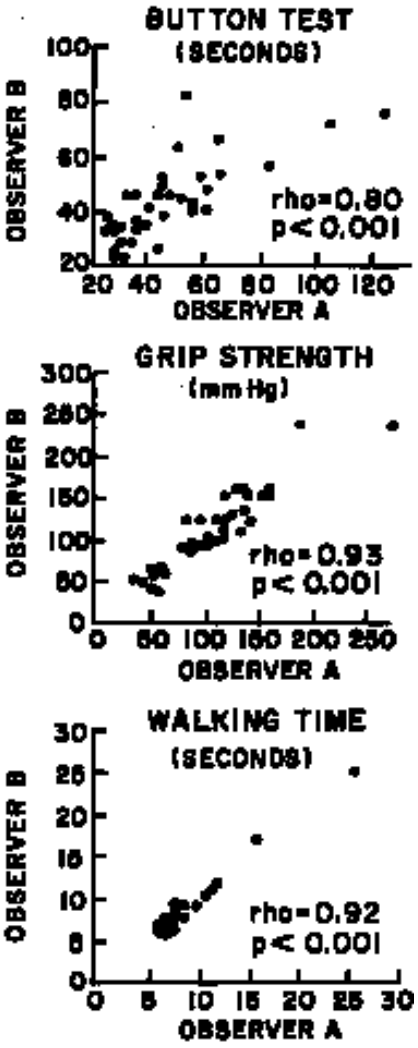

Fig. 1. Interobserver reliability of button test, grip strength and walking time measures in 40 patients with RA assessed by two observers using standard instructions. Evidence of excellent interobserver reliability is seen. Source: Pincus et al., *J Rheumatol* 18: 999, 1991.

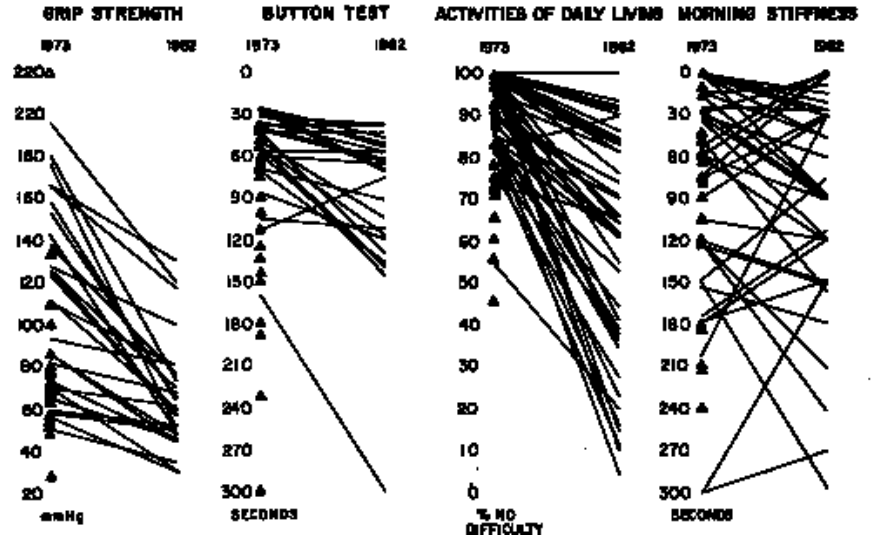

Fig. 2. Measurement of grip strength, button test, responses to questions regarding ADL, and morning stiffness in patients with RA9 years apart (1973-1982). The triangles depict patients who died over the 9-year period, for whom a second point is not available.
Source: Pincus & Callahan, *J Rheumatol* 19:1053, 1992.

1. Grip strength – A blood pressure cuff is inflated to 20 mm of mercury, and the patient is asked to squeeze as hard as he or she can (1). Values are obtained 3 times each for the right and left hands, and the median level recorded as the grip strength value. Values for the right and left hands are highly correlated ($r = 0.833$, $p < 0.001$), and often only data concerning the right hand are reported.
2. Walking time – A 25 or 50 feet or meter walking time is assessed by asking the patient to begin walking at a normal pace to a point 25 or 50 feet or meters away, and timing the walk with a stopwatch to a 10th of a second (2).
3. Button test – A standard board (J.A. Preston, Clifton, NY 07012) is used, in which the patient is asked to unbutton 5 buttons and then button them as quickly as possible, with the score recorded in seconds (8).

Inter-observer reliability of physical measures of function

Inter-observer reliability, in which two observers assessed grip strength, walking time and button test, was analyzed in 40 patients according to a standard protocol, with significant correlations ($rho > 0.80$, $p < 0.001$) (Fig. 1) (9). Correlations for intra-observer reliabilities were even higher (data not shown), and no evidence was seen of higher or lower values on the part of either observer. These data indicate that physical measures of functional status provide reliable quantitative data for assessment of clinical status in RA, when administered according to standard instructions.

Physical measures of function in the documentation of morbidity in two cohorts of patients with rheumatoid arthritis

The capacity of physical measures of functional status to document morbidity and predict mortality have been analyzed in two cohorts of patients with RA, one monitored between 1973 and 1988 (4), and a second monitored between 1985 and 1990 (7).

In the first patient cohort, analyses of changes in status between 1973 and 1982 (Fig.2) indicated declines for grip strength in all 27 patients in whom it was measured twice (mean of 115.5 mm Hg to 65.6 mm Hg), button test increases (indicating poorer status) in 21 of 25 patients (mean of 61.0 to 89.6 seconds), and walking time increases in 23 of 26 patients, with an adjustment of 52% from higher levels of the method used in 1973 (which involved arising from a chair before the walk and sitting down on a chair after the walk) compared to 1982 (data not shown) (10). Functional status declines were also seen for responses to questions about activities of daily living (ADL) in 47 of 50 patients for whom data were available at both assessments (Fig.2). Morning stiffness was improved in 22 of 50 patients studied (Fig.2), a pattern quite different from that seen for measures of functional status, suggesting that patients might improve in measures of inflammatory activity while progression occurred in measures of functional status (10).

Significant correlations were observed for all 4 measures at baseline and 9-year review, including $r = 0.477$ for

Table I. Change scores of measures of physical function over 5 years in 100 patients with rheumatoid arthritis.

Variable	Type of measure*	Mean values at Baseline	Mean values at 5-year review	Change over 3 years	Effect size at 5 years
Grip strength (mm Hg)	A& D	109.8	82.0	27.8	-0.50**
Walk time (seconds)	A& D	10.0	12.8	-2.9	-0.36
Button time (seconds)	A& D	59.5	54.3	5.2	0.11

* A: activity; D: damage; A& D: both.
** Sign changed in depicting effect size only, so that positive effect sizes reflect improvement, and negative effect sizes indicate progression.
Source: Callahan et al., *Arthritis Care & Research* 10: 384, 1997.

grip strength, r = 0.779 for the button test, r = 0.682 for the modified walking time, and r= 0.505 for responses to ADL questions (all $p < 0.001$) (10). These levels of correlation appear particularly striking as the measures were obtained by different observers 9 years apart, and different methods were used to measure walking time. The data suggest that baseline values for each measure of functional status not only document severe declines over 9 years, but also predict values 9 years later (10).

A second cohort of 210 patients with RA with a baseline 12 years later in 1985 was reviewed after 5 years in 1990 (4). Mean grip strength was decreased from 109.8 mm Hg at baseline to 82.0 after 5 years, and mean walk time was increased from 10.0 to 12.8 seconds, while no meaningful change was seen in button time, MHAQ scores, morning stiffness, ESR, and hemoglobin. Swollen joint and tender joint counts were improved over 5 years, while radiographic scores indicate progression over the 5-year period (Table I). Analyses of the effect sizes of these changes (Fig. 3) indicated that measures of inflammatory activity, such as number of swollen joints, tender joints and ESR may be improved or unchanged over a 5 year period, while measures of damage, such as grip strength and walk time (as well as joint deformity, and radiographic scores) indicated disease progression (4).

Identification of work disability in patients with rheumatoid arthritis

A cohort of 210 patients with RA reviewed in 1985 was analyzed according to whether the patients were working full time or receiving work disability payments (3). Among the patients who were less than 65 years old and therefore in the working age population, 36 patients were working full time and 55 were receiving work disability payments. These findings were consistent with most studies at that time of the prevalence of work disability in patients with RA (11). All three measures of physical function, grip strength, walk time and button test, distinguished patients who were working full time from patients who were receiving disability payments (Table II) (3). However, in recursive partitioning analysis, a patient questionnaire, a modified health assessment questionnaire (MHAQ) was the most significant variable to discriminate between the two groups.

Prediction of mortality over15 years

Physical measures of functional status were analyzed as possible predictors of mortality in the two cohorts. Analyses of the first cohort with baseline of 1973 after 9 years in 1982 (5) and after 15 years in 1988 (6) indicated significant differences in survival according to physical measures of function. Modified walking time baseline values of less than 10 seconds predicted survival greater than 90% at 5 years and 70% at 15 years compared to survival of less than 50% at 5 years and less than 30% at 15 years if baseline values were greater than 30 seconds. In analyses according to button tests, all patients with baseline values of less than 40 seconds survived for 5 years, and 90% survived for 15 years ($p< 0.001$), com-

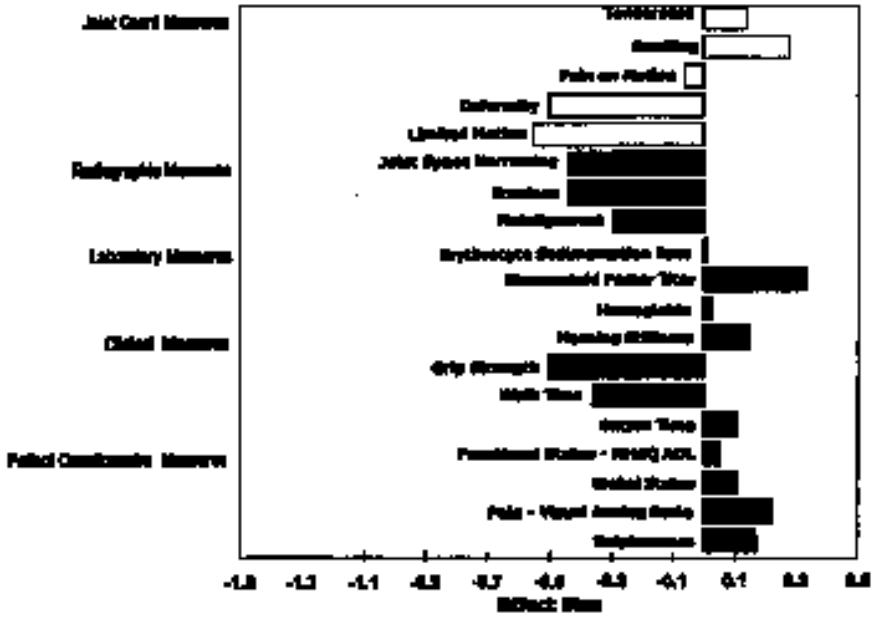

Fig. 3. Changes in measures in 100 patients with rheumatoid arthritis over 5 years determined by effect size. MHAQ = modified Health Assessment Questionnaire; ADL= activity of daily living.
Source: Callahan et al., *Arthritis Care & Res* 10: 385, 1997

Table II. Observer-derived functional status variable in rheumatoid arthritis patients less than 65 years of age, compared and classified according to whether working full-time or receiving disability payments.

	Comparison of means of work status groups Patient work status							Significance of individual variables assessed by logistic regression		
	Median	Mean	Working full-time (n = 36)		Receiving disability payments (n = 55)		p* value	Odds**	95% CL for odds	p value
Grip strength (mm Hg)	96.5	110.3	137.0	(10.5)***	92.9	(5.5)	< 0.001†	0.2	(0.1, 0.4)	< 0.001†
Walk time (seconds)	8.0	10.6	7.6	(0.4)	12.6	(1.5)	< 0.01	7.2	(2.7, 18.9)	< 0.001†
Button time (seconds)	49.0	61.9	46.4	(4.4)	72.0	(5.4)	< 0.005‡	4.6	(1.8, 11.3)	< 0.001†

* Differences which were statistically significant remained significant controlling for age and duration of disease using analysis of covariance.
** Odds represent the increase (> 1.0) or decrease (< 1.0) in the odds for receiving work disability payments estimated from a (univariate) logistic regression model.
*** Standard error in parentheses; † p < 0.01 adjusted for multiple comparisons; ‡ p < 0.05 adjusted for multiple comparisons.
Source: Callahan et al., *Journal of Clinical Epidemiology* 45:133, 1992.

pared to survival of 50% at 5 years and 30% at 15 years in patients whose baseline button test values were greater than 120 seconds (6). Differences in survival rates according to grip strength were also seen, statistically significant in women ($p = 0.04$) but not in men ($p > 0.2$); however, the numbers in each of the two groups were small.

In the second cohort with baseline of 1985, the standardized 5 year mortality ratio of 1:61 was consistent with other series of patients with RA (5,12-16). Significant differences in 5-year survival according to functional measures were seen (Fig.4), with "dose-response" relations according to the 3 physical measures of functional status: grip strength ($p < 0.05$), walking time ($p < 0.001$), and button time ($p < 0.001$). Significant differences in survival were also seen according to MHAQ scores, helplessness scale scores, and patient report of global status (Fig. 4). The data indicate that physical measures of functional status provide significant prediction of mortality in patients with RA.

Conclusion

Physical measures of grip strength, walk time and button time are reliable (reproducible) measures to assess functional status in patients with rheumatic diseases and bypass possible cultural issues in patient questionnaire assessment of functional status. These measures document morbidity, identify work or disability status, and predict premature mortality in patients with RA. These measures, however, remain relatively underutilized in rheumatology clinical research. The 5 minutes

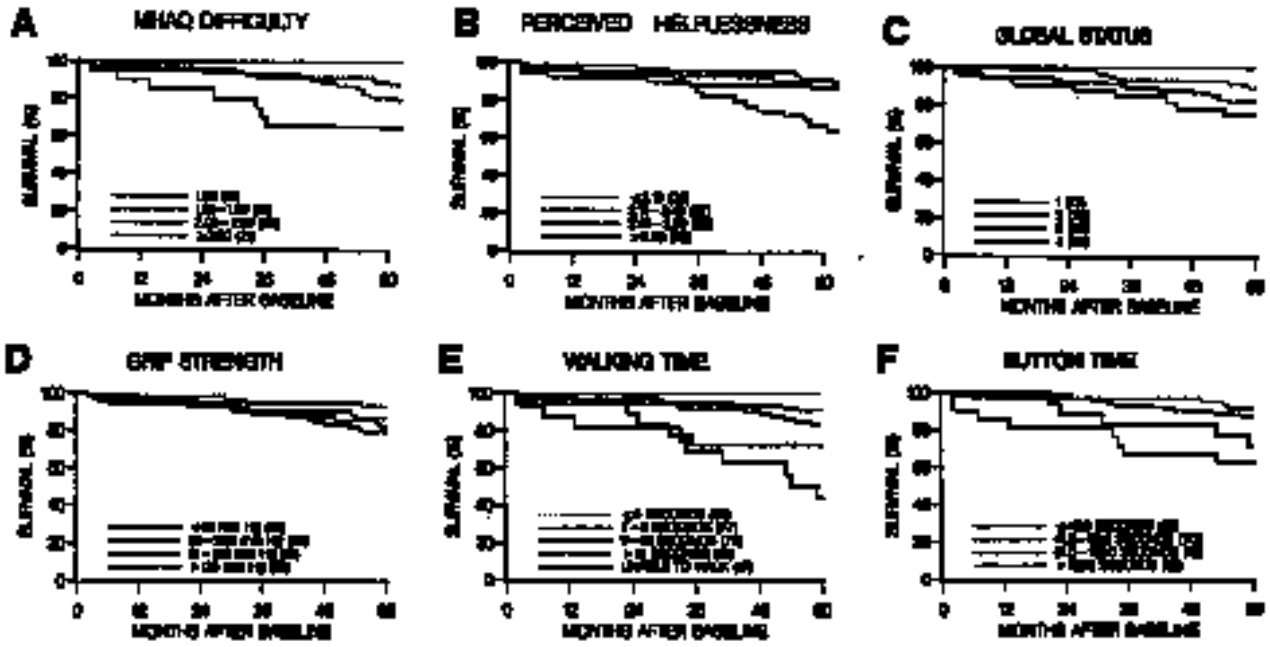

Fig. 4. Actuarial survival of 206 patients with rheumatoid arthritis over 5 years according to various measures of functional status, including questionnaire responses, global status, and helplessness, as well as grip strength, walk time, and button time. MHAQ: modified Health Assessment Questionnaire.
Source: Callahan et al, *Arthritis Care & Res* 10: 388, 1997

required to perform these assessments at baseline might be of considerable value in clinical research involving cohorts which are designed to be monitored over 5 years or longer.

References

1. LEE P, BAXTER A, DICK WC, WEBB J: An assessment of grip strength measurement in rheumatoid arthritis. *Scand J Rheumatol* 1974; 3:17-23.
2. DECEULAER K, DICK WC: The clinical evaluation of antirheumatic drugs. *In* KELLY WN, HARRIS ED JR, RUDDY S and SLEDGE CB (Eds.): *Textbook of Rheumatology*, Philadelphia, W.B. Saunders 1981: 729-39.
3. CALLAHAN LF, BLOCH DA, PINCUS T: Identification of work disability in rheumatoid arthritis: Physical, radiographic and laboratory variables do not add explanatory power to demographic and functional variables. *J Clin Epidemiol* 1992; 45: 127-38.
4. PINCUS T, CALLAHAN LF, SALE WG, BROOKS AL, PAYNE LE, VAUGHN WK: Severe functional declines, work disability, and increased mortality in seventy-five rheumatoid arthritis patients studied over nine years. *Arthritis Rheum* 1984; 27: 864-72.
5. PINCUS T, CALLAHAN LF, VAUGHN WK: Questionnaire, walking time and button test measures of functional capacity as predictive markers for mortality in rheumatoid arthritis. *J Rheumatol* 1987; 14: 240-51.
6. PINCUS T, BROOKS RH, CALLAHAN LF: Prediction of long-term mortality in patients with rheumatoid arthritis according to simple questionnaire and joint count measures. *Ann Intern Med* 1994; 120: 26-34.
7. CALLAHAN LF, PINCUS T, HUSTON JW III, BROOKS RH, NANCE EP JR, KAYE JJ: Measures of activity and damage in rheumatoid arthritis: Depiction of changes and prediction of mortality over five years. *Arthritis Care Res* 1997; 10: 381-94.
8. CLAWSON DK, SOUTER WA, CARTHUM CJ, HYMEN ML: Functional assessment of the rheumatoid hand. *ClinOrthop* 1971;77:203-10.
9. PINCUS T, BROOKS RH, CALLAHAN LF: Reliability of grip strength, walking time and button test performed according to a standard protocol. *J Rheumatol* 1991; 18: 997-1000.
10. PINCUS T, CALLAHAN LF: Rheumatology Function Tests: Grip strength, walking time, button test and questionnaires document and predict longterm morbidity and mortality in rheumatoid arthritis. *J Rheumatol* 1992; 19: 1051-7.
11. YELIN E, MEENAN R, NEVITT M, EPSTEIN W: Work disability in rheumatoid arthritis: effects of disease, social, and work factors. *Ann Intern Med* 1980; 93: 551-6.
12. PINCUS T, CALLAHAN LF: Taking mortality in rheumatoid arthritis seriously – predictive markers, socioeconomic status and comorbidity. *J Rheumatol* 1986; 13:841-5.
13. CALLAHAN LF, CORDRAY DS, WELLS G, PINCUS T: Formal education and five-year mortality in rheumatoid arthritis: Mediation by helplessness scale scores. *Arthritis Care Res* 1996; 9: 463-72.
14. ABRUZZO JL: Rheumatoid arthritis and mortality. *Arthritis Rheum* 1982; 25: 1020-3.
15. MITCHELL DM, SPITZ PW, YOUNG DY, BLOCH DA, MCSHANE DJ, FRIES JF: Survival, prognosis, and causes of death in rheumatoid arthritis. *Arthritis Rheum* 1986;29:706-14.
16. WOLFE F, MITCHELL DM, SIBLEY JT *et al.*: The mortality of rheumatoid arthritis. *Arthritis Rheum* 1994; 37: 481-94.