Tests of Functional Limitations in Fibromyalgia Syndrome: A Reliability Study

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Objective. *To evaluate the reliability and discriminative ability of a test battery consisting of 7 tests designed for the assessment of functional limitations in patients with fibromyalgia syndrome (FMS).*

Methods. *The intrarater reliability of the test battery was evaluated for 15 women with FMS. Interrater reliability was calculated on 4 tests separately. Fifteen healthy women constituted a reference group.*

Results. *The intrarater coefficient of variation was <8% for the shoulder range of motion tests, chair test, and 6-minute walk test, and <21% for the shoulder endurance test, with correlation coefficients above 0.80 for all tests. Kappa was 0.70–0.80 for the hand-to-scapula tests. The interrater coefficient of variation was <5% for shoulder range of motion. The performances of the FMS patients were significantly decreased in comparison with healthy subjects in all the tests except for the hand-to-scapula movement.*

Conclusions. *All but 1 of the selected 7 tests were considered to possess acceptable intrarater reliability for use in FMS in clinical physical therapy practice.*

Key words. *Fibromyalgia; Functional performance; Reliability.*

INTRODUCTION

Fibromyalgia syndrome (FMS) is characterized by diffuse widespread musculoskeletal pain, aching, and stiffness (1,2). Associated conditions include disturbed sleep, subjective soft tissue swelling, fatigue, headache, and irritable bowel syndrome (1,2). Consequences of FMS have been described on different levels. Most FMS patients report disability in such everyday activities as climbing stairs, running, carrying objects, and working with their arms in an elevated position (3,4). Physical, environmental, and emotional stress factors have been reported to aggravate the symptoms (2,5), and many patients develop disability that may be severe enough to prevent continued employment (5,6). Earlier studies have shown that patients with FMS have less muscle strength in both the upper and lower extremities than healthy subjects (3,7–9). Decreased voluntary muscle strength in dynamometer tests has been attributed to impaired central drive, and tests relating to functional activities have been suggested to be more reliable measures in FMS than laboratory strength measurements (7). Functional performances of patients with FMS have been reported to be significantly decreased in comparison with healthy subjects when assessed by standardized functional tests (3,9–14).

Functional tests that assess complex activities are common measures in clinical physical therapy

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Table 1. Characteristics of the fibromyalgia syndrome (FMS) group and the reference group

	FMS group (n = 15)			Reference group (n = 15)			
	Mean	SD	Range	Mean	SD	Range	*P* value
Age, years	52	10.0	28–66	52	11.5	29–69	0.98
Duration of symptoms, years	13	10.8	2–35	–	–	–	–
Weight, kg	68	11.9	52–93	65	7.7	52–78	0.05
Height, cm	164	04.1	155–169	167	4.5	157–174	0.52
Medication							
NSAIDs (subjects)*	5			0			0.04
Simple analgesics (subjects)	5			0			0.04
Employment status: full- or part-time/ nonemployed (subjects)†	6/9			11/4			0.14

* NSAIDs = nonsteroidal anti-inflammatory drugs.
† Nonemployed = homemakers, unemployed, retired, sickness-benefit.

practice. The functional limitations assessed by these tests refer to individual capabilities without reference to situational requirements and serve as a bridge between impairment and disability (15). Tasks such as walking, climbing stairs, lifting objects, etc., are easy to perform in clinical settings and give important information in addition to the patient's self-report of disability and symptoms. However, evaluations of reliability of the tests used for the assessment of patients with FMS are scarce. Because functional tests are used to describe and monitor health status and treatment effects, it is important to evaluate them. The aim of this study was to evaluate the reliability of a test battery designed for the assessment of functional limitations in the upper and lower extremities in patients with FMS. In addition, functional limitations of the patient group were compared with those of an age-matched group of healthy women.

PATIENTS AND METHODS

Patients. Fifteen women with FMS participated in the study. Criteria for inclusion were female sex, age 25 to 70 years, fulfillment of the American College of Rheumatology criteria for FMS (1), and not being treated at a specialist clinic. Criteria for exclusion were concomitant rheumatologic diseases or other severe somatic or psychiatric diseases that might influence the results. Background characteristics of the patients are presented in Table 1. The study was approved by the Ethics Committee of the Faculty of Medicine at Göteborg University.

Reference group. For comparison of the functional limitations between the patients and healthy subjects, 15 age-matched healthy women were invited to participate in the study. No significant differences were seen between the background characteristics of the FMS and reference groups except for intake of drugs for pain (Table 1).

Study design. For the intrarater evaluation, the performances of the patients were assessed for all the tests by the same physical therapist on 2 occasions with an interval of 2–3 days between the tests. Because patients with FMS often describe exacerbations of pain after physical activity (16), they were asked not to exercise, undergo any treatments, or change their medication during the week of the study. The test values of the FMS group were compared with those of the reference group. The reference group was not subjected to any restrictions concerning physical activity.

Interrater reliability was evaluated for shoulder range of motion and functional shoulder movements (see below). The patients performed the tests twice, with 5 minutes of rest between the tests. The measurements were carried out by two independent physical therapists, and the test order was randomly varied. Due to the risk of exacerbations of pain, interrater reliability was not evaluated for the tests assessing muscle endurance of the upper and lower extremities.

Selection of the tests. Tests that were easy to perform in clinical settings and had earlier been applied to patients with FMS were selected for the evaluation. Tests that assess endurance of shoulder abductor muscles by means of a weight cuff or without any load (11,12,14) and endurance of lower extremities by counting the number of stand-ups from

Table 2. Functional movements of the arm

Hand-to-neck
0 The fingers reach the posterior median line of the neck with the shoulder in full abduction and external rotation. The wrist is not dorsally extended.
1 The fingers reach the median line of the neck but do *not* have full abduction and/or external rotation.
2 The fingers reach the median line of the neck, but with compensation by adduction (over 20 degrees in the horizontal plane) or by shoulder elevation.
3 The fingers touch the neck.
4 The fingers do not reach the neck.
Hand-to-scapula
0 The hand reaches behind the trunk to the opposite scapula or 5 cm beneath it in full internal rotation. The wrist is not laterally deviated.
1 The hand reaches the opposite scapula 6–15 cm beneath it.
2 The hand reaches the opposite iliac crest.
3 The hand reaches the buttock.
4 Cannot move the hand behind the trunk.

a chair (14,17) or by measuring a walking distance (14,18) are common measures in FMS and other musculoskeletal disorders. Since most patients with FMS report pain in their shoulders, the battery was supplemented with tests assessing shoulder range of motion and functional movements of the arm initially designed for patients with rheumatoid arthritis (RA) (19). The tests are listed in the order used in the examination.

Tests for the upper extremities. *Shoulder range of motion.* Active forward elevation (flexion) and lateral elevation (abduction) were measured with a full-circle goniometer while the subject was sitting on an ordinary chair with a back rest (20). The intrarater reliability of the test has been reported to be acceptable for healthy subjects (21).

Hand-to-neck and hand-to-scapula. Two functional movements of the arm, hand-to-neck and hand-to-scapula, were scored on a 5-point scale, where 0 represented normal function and 4 the most decreased function (Table 2).

Endurance of the shoulder abductor muscles. The isometric endurance of the shoulder abductor muscles was measured as the maximum time that a subject sitting on an ordinary chair with a back rest could keep her arm in 90 degrees of abduction with a 1 kg weight cuff attached immediately proximal to the caput ulna. The subject was asked to estimate the rate of perceived exertion (RPE) continuously on Borg's 15-point scale (22).

Pain. The intensity of pain perceived in each shoulder was rated by the subjects before the testing and directly after each test using a 100-mm visual analog scale (VAS), where 0 was defined as "no pain" and 100 as "the worst conceivable pain" (23).

Tests for the lower extremities. *Chair test.* Muscular endurance of the lower extremities was tested using a 45-cm high ordinary chair with a back rest but without arm rests. The subject was instructed to keep her arms on her chest and her feet on the floor during the performance, and to stand up in a straight position and sit down on the chair as fast as possible and as many times as possible in one minute. The number of times the subject stood up in one minute was counted.

6-minute walk test. The test was performed in a level hallway 25 meters in length. The subject was instructed to walk as rapidly as possible, but not to run, up and down the hallway for 6 minutes. The distances covered in 3 and 6 minutes were noted. The heart rate was measured by manual palpation for 15 seconds before and after the test. The subject assessed her rate of perceived exertion on Borg's 15-point scale (22).

Pain. The intensity of pain in the legs and/or low back perceived during the tests was rated on the VAS (23) after each of the tests.

Statistical analyses. The intrarater reliability is expressed both as the SD of the differences between readings and as the intrarater coefficient of variation, i.e., intrarater SD $\times$ 100/mean. The numerator of the latter quantity, the intrarater SD, is approximately equal to $1/\sqrt{2}$ times the SD of the differences. The interrater reliability is expressed both as SD of the differences between readings and as interrater coefficient of variation, i.e., interrater SD $\times$ 100/mean. In the coefficients of variation above, the variances are calculated as means of variances within each individual. Spearman's rank correlation coefficient was used to analyze correlations. Wilcoxon's signed rank test was chosen to analyze systematic differences of the continuous variables between the two test occasions.

Mann-Whitney U test was used to analyze the differences of test values between the patient and reference groups. The mean values of two test performances were calculated for each individual, and these means were then chosen for group comparisons. Characteristics of the two groups were analyzed by Fisher's nonparametric permutations test and Fisher's exact test. The agreement of the assessments on the ordinal scale was calculated with percentage agreement and by kappa statistics (24). In 4 assessments, kappa could not be calculated. The significance level was set at 0.05.

Table 3. The intrarater reliability (n = 15): means, standard deviations and correlation coefficients (r), and intrarater coefficients of variation

	Difference			Intrarater coefficient of variation
	Mean	SD	r	
Active flexion, degrees*				
R	−2.5	6.3	0.91	3.0
L	0.3	5.7	0.94	2.5
Active abduction				
R	2.1	14.5	0.86	6.6
L	4.2	10.8	0.92	5.1
Endurance, seconds				
R	0.3	16.0	0.87	20.5
L	1.9	8.9	0.95	11.8
Chair test, number of stand-ups	1.1	2.0	0.96	7.6
3-minute walk test, meters	−6.8	23.3	0.91	6.3
6-minute walk test, meters	−5.3	21.3	0.93	2.9

* R = right arm; L = left arm.

RESULTS

Intrarater reliability. The means and standard deviations of the differences between the two test occasions and the intrarater coefficient of variation were calculated and are depicted in Table 3. Wilcoxon's signed rank test did not reveal any systematic changes for any of the analyzed tests performed on the two occasions. The percentage agreement and kappa of the scores obtained in the hand-to-neck and hand-to-scapula tests are presented in Table 4.

Interrater reliability. The mean differences, SD of the mean, interrater coefficient of variation, and Spearman's correlation coefficients for the values obtained by the two observers in the evaluations of active flexion and active abduction are presented in Table 5. No systematic differences were found either in the analyses of the values obtained by the two observers or in the analyses of the stability of the test order. The percentage agreement and kappa of the interrater evaluations of the hand-to-scapula tests are given in Table 4. A measurement bias influenced the evaluation of the hand-to-neck test since one of the independent observers was not able to discriminate the limit between the scores 0 and 1 for a few subjects. Thus, analyses of the interrater reliability could not be done for these observations.

Table 4. The intra- and interrater reliability of the hand-to-neck and hand-to-scapula scores (n = 15) on a 0−4 scale*

	Intrarater agreement		Interrater agreement	
	%	Kappa	%	Kappa
Hand-to-neck				
R	53	–	–	–
L	66	0.36	–	–
Hand-to-scapula				
R	80	0.80	87	0.80
L	70	0.70	80	–

* Percentage agreement and kappa are depicted. R = right arm; L = left arm.

Table 5. Interrater reliability of the goniometry of active flexion and active abduction (n = 15)*

	Difference			Interrater coefficient of variation
	Mean	SD	r	
Active flexion, degrees				
R	0.1	10.9	0.78	4.9
L	0.9	10.8	0.74	4.9
Active abduction				
R	0.1	11.8	0.86	5.3
L	−0.5	8.3	0.92	3.8

* The means, standard deviations, correlation coefficients (r), and coefficients of variation are depicted. R = right arm; L = left arm.

Assessment of functional limitations. The test performances of the patients with FMS were significantly decreased in comparison with the healthy subjects in all the tests with the exception of the hand-to-scapula test (Table 6). The FMS group reported significantly higher exertion ($P = 0.04$) on Borg's RPE scale after the 6-minute walk test (mean 13, SD 2) than the reference group (mean 11, SD 2). The mean heart rate was 107 (SD 22) in the FMS group and 78 (SD 16) in the reference group before the walk test. No significant changes were obtained during the walk test in any of the groups.

Pain. The FMS group reported significantly higher pain ($P < 0.01$) than the healthy group during all the tests (Table 7). The level of pain rated in the right shoulder at rest increased significantly in the FMS group during 3 tests: active abduction ($P = 0.01$), the hand-to-neck test ($P = 0.04$), and the hand-to-scapula test ($P = 0.02$). The level of pain in the left arm increased significantly in 2 tests: active flexion ($P = 0.03$) and active abduction ($P = 0.01$). The level of shoulder pain perceived at rest increased signifi-

Table 6. The medians and ranges of all tests*

	Fibromyalgia syndrome group (n = 15)		Reference group (n = 15)		
	Median	Range	Median	Range	*P*
Active flexion†					
R	161	120–175	167	126–180	0.0233
L	158	130–170	168	130–180	0.0168
Active abduction					
R	155	60–180	180	126–180	0.0107
L	158	110–180	180	120–180	0.0153
Hand-to-neck					
R	1.0	0–3	0.0	0–2	0.0006
L	1.0	0–2	0.0	0–2	0.0001
Hand-to-scapula					
R	0.5	0–3	0.0	0–3	0.1018
L	0.0	0–1	0.0	0–3	0.1279
Shoulder endurance					
R	49	0–130	140	85–275	0.0001
L	49	0–130	118	75–252	0.0001
Chair test	22	6–32	31	22–46	0.0016
3-minute walk test	268	177–332	306	275–360	0.0120
6-minute walk test	536	350–651	617	536–684	0.0042

* The significance levels for the differences between the groups are depicted (*P*). R = right arm; L = left arm.
† Active flexion and abduction are measured as degrees, hand-to-neck and hand-to-scapula on a 0–4 scale, shoulder endurance as seconds, the chair test as number of stand-ups, and the walk test as meters.

cantly in both arms during the shoulder muscle endurance test in the FMS group ($P = 0.01$) and in the reference group ($P = 0.03$).

DISCUSSION

Functional tests have been regarded as valuable measures in physical therapy of patients with chronic disorders such as rheumatic diseases (25–27). Knowledge of reliability of repeated measurements over time in the specific patient population is a critical consideration in analysis of change in rehabilitation (28). The present study evaluated the reliability of a test battery commonly employed in physical therapy practice. Correlation coefficients were found to be above 0.80 for the shoulder range of motion tests, shoulder endurance test, chair test, and 6-minute walk test, indicating acceptable intrarater reliability for the tests (29). The intrarater coefficients of variation were below 8% for the active shoulder range of motion, chair test, and 6-minute walk test, but they were somewhat higher for the shoulder endurance test (12–21%). Exercise-induced pain and reduced muscular endurance could to some extent explain the more fluctuating values in the shoulder endurance test, which has to be considered in analyses of longitudinal studies. The results are in line with an earlier evaluation that reported intrarater coefficients varying 18–27% in hand force test in patients with FMS and RA (9).

Calculations of kappa indicated good intrarater agreement for the hand-to-scapula test. Kappa for intrarater agreement of the hand-to-neck test in the left arm was below 0.40, which is classified as a fair agreement according to Altman (24) and as a low agreement according to other authors (30). Pain in the shoulders was considered to have an impact on the test performance, and further standardization of the hand-to-neck test is needed for use in FMS patients. It seems likely that the stability of the test would improve if the scores 0 and 1 were combined. Kappa could not be calculated for the hand-to-neck test in the right arm, since kappa analysis requires equal distribution of the scores, which was not obtained in that test.

The analyses indicated acceptable interrater reliability for the active shoulder range of motion tests. The percentage interrater agreement of the hand-to-scapula scores was acceptable (80–87%), though kappa (0.80) could only be calculated for one test. The hand-to-neck test could not be analyzed for in-

Table 7. Pain perceived during the tests, assessed on a 0–100 mm visual analog scale by the fibromyalgia syndrome (FMS) group (n = 15) and the reference group (n = 15): means, standard deviations, ranges, and significance levels between groups*

	FMS group			Reference group			
Perceived pain	Mean	SD	Range	Mean	SD	Range	*P*
Shoulder pain at rest							
R	27	26	0–85	0	0	0	0.0001
L	23	22	0–73	0	0	0	0.0001
Active flexion							
R	32	23	0–84	0	0	0	0.0001
L	29	20	0–62	0	0	0	0.0001
Active abduction							
R	35	24	0–84	0	0	0	0.0001
L	32	24	0–81	0	0	0	0.0001
Hand-to-neck							
R	37	24	1–84	0	0	0	0.0001
L	28	19	0–60	0	0	0	0.0001
Hand-to-scapula							
R	38	24	2–84	2	9	0–35†	0.0001
L	28	22	0–69	2	8	0–30	0.0001
Shoulder endurance							
R	49	24	2–85	10	15	0–44	0.0001
L	46	26	0–89	7	12	0–44	0.0002
Chair test	32	17	0–55	0	0	0	0.0001
6-minute walk test	32	17	0–49	0	0	0	0.0001

* R = right; L = left.
† Some healthy women reported pain during the tests: 2 in the right arm during the hand-to-scapula test, 1 in the left arm during the hand-to-scapula test, 5 in the right arm during the endurance test, and 6 in the left arm during the endurance test.

terrater reliability, as one of the observers failed to discriminate between the scores 0 and 1.

The FMS group included patients from primary care and represented a wide range of ages and symptom durations. Except for medication for pain, the background variables did not differ significantly between the FMS and reference groups. As expected, the FMS group perceived a higher intensity of pain during the tests than the healthy subjects (16). Because pain might influence test performance, the patient group was asked not to change their medication during the week of the study. The fact that the FMS group was also subjected to some restrictions concerning their physical activity during the week of the study, while the healthy group was not, might of course have caused a bias in the analysis comparing the two groups. However, the results of the present study are in line with previous studies reporting lower muscular endurance in FMS in comparison with healthy subjects (3,9–14). The significant differences of the test values between the groups in all of the tests, with the exception of the hand-to-neck test, provide some evidence of discriminative validity for the tests.

There is a need to develop standardized, reliable, and valid tests for use in rehabilitation. The tests evaluated in the present study, except for the hand-to-neck test, are considered to possess acceptable reliability for use in patients with FMS as complements to patients' self-reports.

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