ORIGINAL ARTICLE

Fingertip-to-Floor Test and Straight Leg Raising Test: Validity, Responsiveness, and Predictive Value in Patients With Acute/Subacute Low Back Pain

Harald Ekedahl, PT, MSc, Bo Jönsson, MD, PhD, Richard B. Frobell, PT, PhD

ABSTRACT. Ekedahl H, Jönsson B, Frobell RB. Fingertip-to-floor test and straight leg raising test: validity, responsiveness, and predictive value in patients with acute/subacute low back pain. Arch Phys Med Rehabil 2012;93:2210-5.

Objectives: To investigate the validity over time of the fingertip-to-floor test (FTF) and the straight leg raising test (SLR) using the Roland Morris Disability Questionnaire (RMDQ) and correlation coefficient (*r*), and to assess the predictive value of factors related to the change in RMDQ over 12 months using multivariate regression analysis.

Design: Longitudinal study.

Setting: Outpatient physical therapy clinic.

Participants: Subjects (N=65) with acute/subacute low back pain (≤13wk of symptoms). Thirty-eight (58%) had radicular pain as determined by the slump test.

Interventions: Not applicable.

Main Outcome Measures: Self-reported disability was used as a reference variable and was measured using the RMDQ at baseline and after 1 and 12 months. The FTF and SLR were measured at baseline and after 1 month. Responsiveness and imprecision were assessed by using effect size (ES) and minimal detectable change (MDC). The sample was stratified by the presence or absence of radicular pain (categorized by the slump test).

Results: The change in FTF results was significantly correlated to the 1-month change in RMDQ, both in the entire sample (r=.63) and in the group with radicular pain (r=.66). Similar analysis for the SLR showed a weak relationship to RMDQ. FTF showed adequate responsiveness (ES range, 0.8–0.9) in contrast to SLR (ES range, 0.2–0.5). The MDC for FTF and SLR were 4.5cm and 5.7°, respectively. The change in FTF results over 1 month was independently more strongly associated with the 12-month (R^2=.27–.31) change in RMDQ than any of the other variables and multivariate combinations.

Conclusions: Our results suggest that the FTF has good validity in patients with acute/subacute low back pain and even better validity in those with radicular pain. The change in FTF results over the first month was a valid predictor of the change in self-reported disability over 1 year. In contrast, the validity of SLR can be questioned in the present group of patients.

Key Words: Low back pain; Predictive value of tests; Range of motion; Rehabilitation.

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PHYSICAL IMPAIRMENT TESTS, such as the fingertip-to-floor test (FTF) and straight leg raising (SLR), are highly reliable measures.[1,2] Both tests measure specific physical incapacity. Since patients with chronic, nonspecific low back pain (LBP) lack such a specific dysfunction, the tests are consequently proven to have low validity in this population.[3,4] However, in patients with a specific dysfunction such as LBP with radicular pain, FTF and SLR show a good relationship to self-reported disability, and thus appropriate validity for this particular group.[5,6] Moreover, FTF and SLR have been used successfully as outcome measures in patients with radiculopathy after lumbar transforaminal epidural steroid injection.[7,8] Although these 2 tests have been widely used, the tests are not thoroughly investigated regarding (1) their criterion validity over time, (2) their measurement properties, and (3) their predictive value for different subgroups, such as subjects with and without radicular pain or with acute/subacute (≤13wk of symptoms) and chronic LBP.

The criterion validity of a test describes whether test scores are meaningfully related to other valuable measures—for example, self-reported disability. The Roland Morris Disability Questionnaire (RMDQ) is such a validated, reliable, and responsive measure.[9,10] Along with criterion validity, responsiveness and minimal detectable change (MDC) are essential psychometric properties to establish the usefulness of measurements.[11,12] Once validity is determined, the mode of usage needs validation, in this case, the ability of the tests to predict outcome.

Early prognostic signs in an episode of LBP can contribute to an improved management of a specific disorder.[13] As the population with LBP is heterogenic and the prognostic outcomes might not be equally useful for the entire population, it is essential to distinguish a patient subgroup with a specific disorder[13,14] (eg, acute/subacute radicular pain) for which outcome measures are valid. The frequently used dichotomous slump test,[15] previously proven to distinguish such a subgroup[5]

List of Abbreviations

AUC	area under the curve
BL	baseline
CI	confidence interval
ES	effect size
FTF	fingertip-to-floor test
LBP	low back pain
MDC	minimal detectable change
RMDQ	Roland Morris Disability Questionnaire
ROC	receiver operating characteristics
SLR	straight leg raising
VAS	visual analog scale

From the Department of Orthopaedics, Clinical Sciences Lund, Lund University, Lund, Sweden.

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Reprint requests to Harald Ekedahl, PT, MSc, Helsingborgs Fysio, Bergaliden 11, 252 23 Helsingborg, Sweden, e-mail: *harald.ekedahl@med.lu.se*.

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and to predict lumbar disk surgical outcome,[16] has successfully been used to determine radicular pain.[15,17]

The aims of this study were to (1) distinguish a subgroup of subjects with radicular pain from a sample of persons with nonspecific acute/subacute LBP by using the slump test; (2) investigate the differences in patient characteristics, disability, pain, FTF, and SLR between these 2 groups; (3) investigate psychometric properties and criterion validity over time (1mo) of the FTF and SLR by using the RMDQ as a reference; and (4) assess the predictive value of the factors above related to the change in the RMDQ over 1 month and over 12 months in patients with nonspecific LBP and in the subgroup with radicular pain.

We hypothesized that (1) there is a stronger association between the RMDQ and functional impairment in subjects with radicular pain; and (2) in the latter population, the FTF and SLR show a stronger relationship to the change in the RMDQ over time than in the entire sample.

METHODS

Participants

We consecutively recruited patients with acute (symptom duration, <6wk) or subacute (symptom duration, 6–13wk) LBP in a primary care outpatient physiotherapy clinic in the south of Sweden. Recruitment started in December 2006 and ended in March 2008 when 82 patients had consented to participate. Sixty-five subjects (35 women, 30 men) were included in the present study, and 63% (n=41) of these subjects were also included in a previous cross-sectional report where identical inclusion and exclusion criteria were used.[5] Enrollment of the present study is shown in figure 1.

All included patients were seen in the clinical setting at baseline (BL) and after 1 month. An additional follow-up was performed over the phone after 12 months where only self-reported disability was obtained. During the 12-month period, all patients received individual treatment (median, 6 visits; range, 2–16 visits) by the same physiotherapist (H.E.) using the McKenzie method,[18] manual therapy, and stabilizing exercises. Ethical aspects (according to the Declaration of Helsinki) were documented and followed before the initiation of the trial.

Outcome Measure

At BL and after 1 month, assessment was performed by the same physiotherapist (H.E.) using an identical structure. The FTF was performed first, followed by the slump test and the SLR test. A neurologic assessment was then performed. After clinical assessment, pain measures and demographic history were taken, and the self-reported disability questionnaire (RMDQ) was then filled out.[5] The clinical examination, including time to fill out self-reports, took approximately 25 minutes.

The FTF was performed according to the published instructions, and the vertical distance between the tip of the index finger and the floor was measured in centimeters.[2]

The SLR test was performed according to the published instructions, and the angle between the tibial crest and the horizontal plane was measured, using a goniometer, in (nonrounded) degrees.[4]

The slump test, a validated dichotomous test, was used to assess the presence or absence of radicular pain.[19] The occurrence of neural tissue mechanosensitivity was assessed through a combination of sitting thoracolumbar flexion, cervical flexion, ankle dorsiflexion, and knee extension, performed in this order according to published instructions[19] and in agreement with the theory of sequencing.[20] The results from this test also determined which leg (left/right) was affected, and this information was used in the analysis of SLR results.

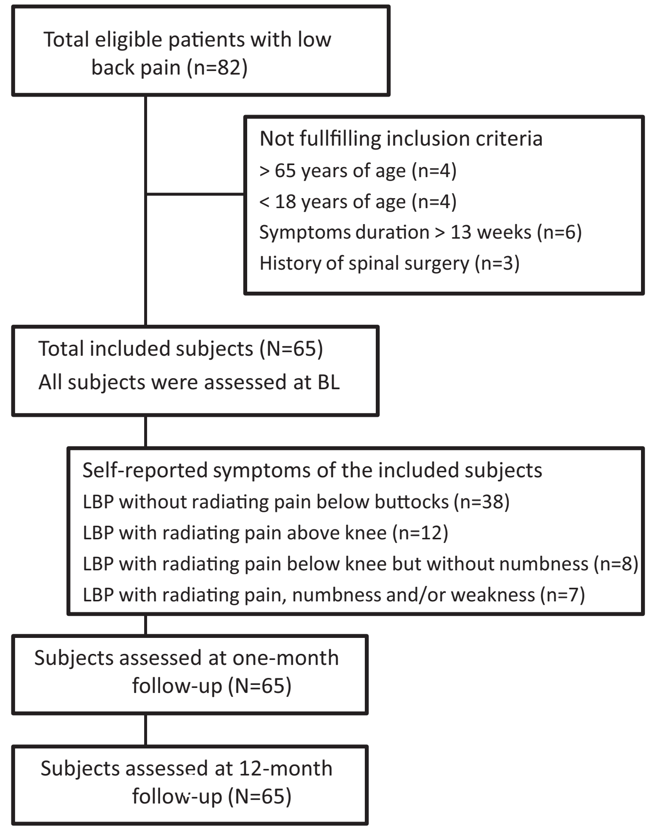

Fig 1. Flowchart showing patient recruitment.

Neurologic sign, an involvement of motor or sensory nerves, was determined if the patellar reflexes, Achilles' reflexes, strength of the large toe in dorsiflexion, or sensibility in a specific dermatome area were asymmetrically deranged.

The RMDQ, a reliable, responsive, and valid test of self-reported disability among patients with LBP,[3,9,10] is available in a validated Swedish version[21] and was self-reported by the patient. The RMDQ consists of 24 dichotomous (yes/no) statements about activities of daily living likely to affect patients with LBP. By summing the "yes" answers (1 point each), a total score is compiled ranging from 0 (no disability) to 24 (extremely severe disability).

Three different measures of pain were obtained using a horizontal visual analog scale (VAS), with 0mm indicating no pain and 100mm, the worst imaginable pain.[22] The measures—LBP (lumbar and gluteal region) at present (Pain VAS lumbar), leg pain (thigh or more distal) at present (Pain VAS leg), and the worst lumbar/leg pain during the last 3 days (Pain VAS high)—were self-rated.

Statistical Analysis

Entire group/radicular pain group. Statistical analyses were made using SPSS (version 15.0).[a] A subgroup of subjects with radicular pain was determined from the entire sample by the use of the slump test at BL. A cross-sectional comparison between the entire sample and those with radicular pain was done at BL (table 1), 1-month, and 12-month follow-up. Statistical comparisons were made between those with radicular

Table 1: Baseline Characteristics for the Entire Population and for Those With and Without Radicular Pain

Variable	All (N=65)	Slump Test: Positive (n=38)	Slump Test: Negative (n=27)	Group Comparison*
Age (y)	45±11	46±11	42±11	.172
Sex (men)†	30 (46)	16 (42)	14 (52)	.520
BMI (kg/m^2)	25±3.6	26±3.8	25±3.6	.345
Smoker (yes)†	12 (18)	7 (18)	5 (19)	.752
Symptoms of LBP (d)	24±23	22±20	27±27	.386
Neurologic sign†	7 (11)	7 (18)	0 (0)	<.001§
Disability (RMDQ)	11.2±5.6	12.0±5.3	10.0±5.9	.161
Pain VAS lumbar (mm)	23±18	20±16	27±20	.152
Pain VAS leg (mm)	7±15	10±16	2±11	.029‡
Pain VAS high (mm)	56±24	54±23	59±25	.408
FTF (cm)	24±16	28±16	17±15	.006§
SLR left (deg)	64±15	61±14	68±15	.041‡
SLR right (deg)	65±13	63±13	68±13	.087

NOTE. Values are mean ± SD, n (%), or as otherwise indicated. Statistical comparison was made between the entire population and those with radicular pain.
Abbreviation: BMI, body mass index.
**t* test.
†χ^2 test.
‡$P<.05$; §$P<.01$.

pain and the entire sample using the *t* test (normally distributed variables) or the chi-square test (dichotomous variables).

Longitudinal validity over 4 weeks. For validity testing, we used the change in each outcome from BL to 1 month to calculate the effect size (ES), the standard error of measurement, and the MDC. A frame of reference for ES values is as follows: a small ES is approximately .20; a medium ES, .50; and a large ES, ≥.80.[23] We calculated the standard error of measurement as SD × $\sqrt{(1-\alpha)}$, where α is the coefficient of test-retest reliability. Since we did not perform test-retest measurements in the present study, we used the following values from previous reports: α is .88 for RMDQ,[21] α is .98 for FTF,[24] and α is .95 for SLR.[4] In a second step, we calculated the MDC using the formula 1.96 × standard error of measurement.[11] The criterion validity was assessed by relating the 1-month individual changes in RMDQ to the individual changes in FTF and SLR using the Pearson coefficient of correlation (Spearman correlation gave similar results).

Predictive value. Univariate linear regression was performed for all explanatory variables. Multivariate linear regression was performed for the variables that significantly contributed to the model ($P<.05$). R^2 was used to describe the approximate proportion of the variation in the response that is explained by the model. BL characteristics (see table 1) and 1-month changes in continuous variables (ie, SLR, FTF, and Pain VAS scores) were related to the 1-month longitudinal change in RMDQ and to the 12-month change of RMDQ. Because of an obvious interrelationship among the Pain VAS and the FTF variables, each variable was analyzed separately in the multivariate analysis. Receiver operating characteristics (ROC) analysis was performed to assess the discriminative ability of the predictive variable (ie, FTF, a cutoff point of 4.5cm was chosen). The validity analysis, the regression analyses, and the ROC analysis were made for the entire sample as well as for the subgroup with radicular pain.

RESULTS

Entire Group/Radicular Pain Group

Thirty eight subjects (58%) had radicular pain as determined by a positive slump test. Those with radicular pain had a significantly increased number of neurologic signs ($P<.001$), an increased Pain VAS leg ($P=.029$), a decreased FTF distance ($P=.006$), and a decreased SLR angle in left leg ($P=.041$) in comparison with the entire sample at BL (see table 1). At the 1-month follow-up, however, the only difference between these groups was an increased number of neurologic signs among those with radicular pain ($P<.001$). At 12 months, no difference was found in RMDQ between the entire sample (mean ± SD: 3.6±4.8) and those with radicular pain (3.1±3.8, $P=.28$). Furthermore, no significant differences were seen between the 2 groups regarding number of treatment visits or type of treatment received (data not shown).

Longitudinal Validity Over 4 Weeks

In the entire sample as well as in those with radicular pain, RMDQ and FTF displayed a large ES (ES=1.0 and 1.1, 0.8 and 0.9, respectively), whereas SLR of the affected side displayed a medium ES (ES=0.5) (table 2).

In the entire sample, the change in RMDQ correlated well to the change in FTF ($r=.63$, $P<.001$), but poorly to the change in SLR (SLR left, $r=.13$; SLR right, $r=.15$).

In patients with radicular pain, the change in RMDQ correlated well to the change in FTF ($r=.66$, $P<.001$), but poorly to SLR of the affected side ($r=.28$, $P=.10$).

Predictive Value

Age (years), sex (men/women), body mass index (kg/m^2), smoker (yes/no), neurologic signs (yes/no), Pain VAS lumbar, Pain VAS leg, and all SLR variables showed no independent (crude) relationship to change in RMDQ over 1 month ($P>.16$ for entire sample; $P>.18$ for radicular pain group) or over 12 months ($P>.07$ and $P>.06$, respectively). In the entire sample, symptom duration (days), Pain VAS high at BL, and change in Pain VAS high over 1 month were independently and significantly associated with the 1-month and 12-month change in RMDQ ($.08\leq R^2\leq .31$). In the radicular group, however, these variables only showed significant relationships to the 1-month ($.18\leq R^2\leq .25$) but not the 12-month change in RMDQ (table 3). The FTF at BL and the 1-month change in FTF were significantly associated with both the 1-month and 12-month change in RMDQ for the entire sample, as well as for the

Table 2: Change in RMDQ, FTF, and SLR Over the First Month

Variable	BL Value	Entire Sample (N=65)				BL Value	Radicular Group (n=38)			
		Change at 4wk	P*	ES	MDC		Change at 4wk	P*	ES	MDC
RMDQ	11.2±5.6	5.2±5.4	<.001	1.0	3.8	12.0±5.3	5.3±6.2	<.001	1.1	3.6
FTF (cm)	24±16	12±13	<.001	0.8	4.5	28±16	15±14	<.001	0.9	4.5
SLR left (deg)	64±15	2.8±9.5	.021	0.2	6.6	61±13	2.3±9.7	.009	0.4	6.1
SLR right (deg)	65±13	1.9±5.6	.008	0.2	5.7	62±13	2.0±5.3	.002	0.2	5.7
SLR affected side (deg)†						57±12	3.3±7.9	.001	0.5	5.7

NOTE. Values are mean ± SD or as otherwise indicated. The ES and MDC are presented for the entire population (N=65) and for those with radicular pain (n=38).
*Using *t* test to test significant change after 1 month.
†Affected side according to slump testing.

radicular group, with crude R^2 values ranging from .12 to .43 (see table 3).

In the multivariate analysis of the entire sample, the combination of symptoms duration plus Pain VAS high at BL was associated with the change in RMDQ over 1 month ($P<.023$, $R^2=.25$) and 12 months ($P<.048$, $R^2=.15$). In those with radicular pain, however, the same combination of variables showed a better relationship to the 1-month change ($P<.010$, $R^2=.35$) but a nonsignificant relationship to the 12-month change ($P>.05$) in RMDQ. Still, change in FTF over 1 month was independently more strongly associated with the 1-month and 12-month change in RMDQ than any of the multivariate combinations, explaining 27% to 43% of the variance in RMDQ variables (table 4). ROC analysis in subjects with radicular pain showed a higher discriminative value of FTF (cutoff point, 4.5cm) in predicting change in RMDQ over 1 month and over 12 months (area under the curve [AUC]=.92 and AUC=.85, respectively; 95% confidence interval [CI], .70–1.00]) versus the entire sample (AUC=.80 and AUC=.77, respectively; 95% CI, .65–.91). A cutoff point larger or smaller than 4.5cm decreased AUC.

DISCUSSION

This is to our knowledge the first study to assess the criterion validity over time of FTF and SLR in patients with acute/subacute LBP before and after stratification with the slump test. We have shown that the change in FTF, but not in SLR, is strongly related to the change in self-reported disability (RMDQ) over the same period. Our results also suggest that early change in FTF is a good and valid predictor of long-term changes in disease-specific disability among patients with nonspecific LBP, and an even better predictor in those with radicular pain.

Recommendations about clinical selection of patients with LBP in primary care are unclear, but ignoring the heterogeneity of these patients was suggested as a suboptimal strategy.[13] Consequently, we stratified the population according to radicular pain (classified by the slump test) and found that 58% had radicular pain. This frequency is well in line with earlier studies using this classification.[19,25] In agreement with earlier results,[26] we showed that LBP in subjects with radicular pain is more greatly influenced by impairment. We therefore suggest a different underlying cause of LBP in the subjects with a positive slump test, and in agreement with earlier reports,[16,27] we recommend that clinicians use the slump test to distinguish the painful structure and accordingly make treatment decisions.

The responsiveness of FTF was stated to be low in subjects with lower initial disability in 1 report,[3] but in agreement with other reports,[2,28] our results suggest a good responsiveness for FTF as well as adequate precision (MDC). The low MDC for FTF in this study was a consequence of a relatively high reliability coefficient, suggesting a precision of <4.5cm. In accordance with several other reports,[28-31] the criterion validity was analyzed not by the use of BL values but by the use of changes in the measures, and thus ruling out the contribution of the individual BL variation of the impairment measures. The FTF was previously shown to have a weak to moderate correlation ($r<.50$) to disability in subjects without nerve root involvement,[28,31] but was suggested to correlate better to self-reported disability in samples with higher frequencies of radiating pain,[29] and even more so in patients with verified radiculopathy.[7,30] This agrees well with our findings where FTF was

Table 3: Crude Relationship Between the 1- and 12-Month Change in Self-Reported Disability (RMDQ) and BL Characteristics, 1-Month Change in FTF and Pain VAS High in Entire Population and in Patients With Radicular Pain

Variable*	Entire Sample (N=65)				Radicular Group (n=38)			
	Change in RMDQ Over 1mo		Change in RMDQ Over 12mo		Change in RMDQ Over 1mo		Change in RMDQ Over 12mo	
	β (95% CI)	P (R^2)	β (95% CI)	P (R^2)	β (95% CI)	P (R^2)	β (95% CI)	P (R^2)
Symptoms (d)	−0.75 (−.13 to .02)	.010 (.10)	−.08 (−.15 to .02)	.014 (.09)	−0.12 (−.21 to .03)	.008 (.18)	−.07 (−.16 to .02)	.115 (.07)
Pain VAS high BL	0.91 (.45 to 1.49)	<.001 (.18)	.80 (.11 to 1.40)	.022 (.08)	1.20 (.43 to 1.98)	.003 (.22)	.74 (.00 to .15)	.060 (.09)
Change in Pain VAS high	1.09 (.68 to 1.49)	<.001 (.31)	.82 (.29 to 1.35)	.003 (.13)	1.14 (.48 to 1.80)	.001 (.25)	.53 (−.15 to 1.22)	.125 (.06)
FTF BL	0.14 (.06 to .21)	.001 (.18)	.17 (.09 to .26)	<.001 (.20)	0.13 (.01 to .25)	.035 (.12)	.15 (.04 to .26)	.007 (.19)
Change in FTF	0.26 (.18 to .34)	<.001 (.39)	.25 (.15 to .36)	<.001 (.27)	0.29 (.18 to .40)	<.001 (.43)	.23 (.11 to .34)	<.001 (.31)

Abbreviation: β, beta coefficient.
*Four pain variables, all SLR variables, and remaining characteristics not shown because of minor relationship to dependent variable (*P*>.06).

Table 4: Multivariate Linear Regression Analysis; Change in Self-Reported Disability (RMDQ) at 1- and 12-Month Follow-Up as Dependent Variables, Comparing Patients' Characteristics, Changes in FTF and Pain VAS High at 1-Month Follow-Up in All Patients and in Patients With Radicular Pain

	Entire Sample (N=65)				Radicular Group (n=38)			
	Change in RMDQ 1mo		Change in RMDQ 12mo		Change in RMDQ 1mo		Change in RMDQ 12mo	
Variable	*P*	Multivariate R^2*	*P*	Multivariate R^2*	*P*	Multivariate R^2*	*P*	Multivariate R^2*
Symptoms (d)	.023‡	.25	.048‡	.15	.010‡	.35	.158	Excl
Pain VAS high BL†	.001§		.020‡		.004§		.082	Excl
Symptoms (d)	.054	Excl	.049‡	.18	.052	Excl	.243	Excl
Change in Pain VAS high†	<.001§	.31	.011§		.001§	.25	.267	Excl
Symptoms (d)	.043‡	.23	.068	Excl	.008§	.18	.259	Excl
FTF BL†	.002§		<.001§	.20	.088	Excl	.007§	.19
Symptoms (d)	.109	Excl	.119	Excl	.318	Excl	.978	Excl
Change in FTF†	<.0001§	.39	<.0001§	.27	<.0001§	.43	<.0001§	.31

NOTE. Change in self-reported disability (RMDQ) at 1- and 12-month follow-up as dependent variables, comparing patients' characteristics, changes in FTF and pain VAS high at 1-month follow-up in all patients (N=65) and in patients with radicular pain (n=38).
Abbreviation: Excl, excluded because of not significant association ($P>.05$).
*Level for inclusion in model $P<.05$.
†Because of multicollinearity, Pain and FTF variables were analyzed separately.
‡$P<.05$; §$P<.01$.

shown to have good criterion validity, particularly in subjects with radicular pain. For SLR, in contrast to FTF, we failed in establishing criterion validity, not only in the entire sample but also in the radicular pain group.

A great number, although not the majority, of patients are at risk of persistent back problems, and to reduce this risk, guidelines suggest early identification of risk factors and then multifaceted therapy.[13] In agreement with previous results,[32] we showed that symptom duration and Pain VAS were factors contributing significantly in explaining the longitudinal change in self-reported disability. However, we looked at several additional variables and found that their contribution were only minor in comparison with the changes in FTF, the strongest predictor in this and a previous study.[29] Our results suggest that a large improvement or a lack of improvement in FTF over the first month is a valid and good predictor of improvement, or nonimprovement, in the patient's own opinion of disability at 1 month and at 12 months. Furthermore, the change in disability over 12 months can be predicted by the change in FTF over 1 month in 77% of the cases in the entire sample and in 85% of the cases in the radicular pain group when using a cutoff point of 4.5cm. An increase in FTF of >4.5cm predicts improvement in disability and seems to be an applicable value for clinical use.

Thus, we recommend that clinicians use the validated FTF rather than the SLR (or both in combination) when assessing patients with acute/subacute LBP and radicular pain.

Study Limitations

Our study has limitations. First, although the study group in the present study mirrors the population in similar studies[14,25,32] regarding self-reported disability, pain symptoms, and radicular pain, our sample included patients with acute/subacute LBP recruited from primary care, and therefore our results are best generalized to such patients. Second, the sample size was determined for analysis on the entire sample, whereas subgroup analysis was limited by a small sample size. Third, the MDC in our study was based on previous results of the reliability coefficients; thus the precision might be slightly inaccurate for the present study group. Finally, psychological factors, previously shown to be associated with LBP,[33] and fear-avoidance beliefs, previously linked to a reduced ability to flex forward,[31] were not assessed. Therefore, to better understand the transition from acute to long-term LBP, we suggest future research to explore the relationship between different prognostic factors and the impairment tests in a larger sample with radicular pain.

CONCLUSIONS

In this study of patients with acute/subacute nonspecific LBP, more than half of the sample had radicular pain as classified by the slump test. Our results suggest that the FTF has good validity in patients with acute/subacute LBP, and even better validity in those with radicular pain. The change in FTF over the first month was a valid predictor of the change in self-reported disability over 1 year. In contrast, the validity of SLR can be questioned in the present group of patients.

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