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

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Fingertip-to-floor test and Straight leg raising: Validity, responsiveness and predictive value in patients with acute/sub-acute low back pain.

ABSTRACT

Objective

To investigated the validity over time of Fingertip-to-floor test (FTF) and Straight leg raising test (SLR) using 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

Out-patient physical therapy clinic.

Participants

Sixty-five subjects with acute/sub-acute low back pain (≤13 weeks' symptom duration). Thirty-eight (58%) had radicular pain as determined by the Slump test.

Interventions

Not applicable

Main Outcome Measures

Self-reported disability was used as reference variable and was measured using RMDQ at baseline and after 1 & 12 months. FTF and SLR were measured at baseline and after 1 month. Responsiveness and imprecision were assessed by using effect size (ES) and minimum

detectable change (MDC). The sample was stratified by presence/absence of radicular pain (categorized by the Slump test).

Results

The change in FTF was significantly correlated to the one-month-change in RMDQ, both in the entire sample (r=0.63) and in the group with radicular pain (r=0.66). Similar analysis for 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). MDC, for FTF and SLR were 4.5 cm and 5.7°, respectively. Change in FTF over one month was independently more strongly associated with the 12-month (R^2=0.27-0.31) change in RMDQ than any of the other variables and multivariate combinations.

Conclusions

Our results suggest that the FTF test has good validity in patients with acute/sub-acute 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 one year. In contrast, the validity of SLR can be questioned in the present group of patients.

Key Words

Low back pain; Range of motion; Disability; Prognostic factors

List of Abbreviations

AUC	Area under the curve
BL	baseline
ES	effect size

FTF	fingertip-to-floor test
LBP	low back pain
MDC	minimal detectable change
MRI	magnetic resonance imaging
RMDQ	Roland-Morris disability questionnaire
ROC	Receiver operating characteristics
SEM	standard error of measurement
SLR	straight leg raising
VAS	visual analogue scale

Physical impairment tests, such as 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 non-specific 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 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 tranforaminal epidural steroid injection [7, 8]. Although these two tests have been widely used, the tests are not thoroughly investigated regarding: firstly, the criterion validity over time; secondly, the measurement properties and thirdly, the predictive

value for different subgroups such as subjects with and without radicular pain or with acute/sub-acute (≤13 weeks of symptoms) and chronic LBP.

The criterion validity of a test describes whether test scores are meaningfully related to other valuable measures, e.g. self-reported disability. Roland Morris disability questionnaire (RMDQ) is such a validated, reliable and responsive measure [9, 10]. Along with criterion validity, responsiveness and minimal detectable change 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], e.g. acute/sub-acute radicular pain, for which outcome measures are valid. The frequently used dichotomous slump test [15], previously proven to distinguish such a subgroup [5] and to predict lumbar disc surgical outcome [16], has successfully been used to determine radicular pain[15, 17] .

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

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

METHODS

Subjects

We consecutively recruited patients with acute (< 6 weeks' symptom duration) or sub-acute (6-13 weeks' symptom duration) LBP in a primary care out-patient 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 percent (n=41) of these subjects were also included in a previous cross-sectional report where identical inclusion and exclusion criteria were used [5]. Enrolment of the present study is shown in Figure 1.

All included patients were seen in the clinical setting at baseline and after one 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 [range 2-16] visits) by the same physiotherapist (HE) using the McKenzie method[18], manual therapy and stabilizing exercises. Ethical aspects (according to the Declaration of Helsinki) were documented and followed prior to the initiation of the trial.

Outcome measure

At baseline (BL) and after one month, assessment was performed by the same physiotherapist (HE) using an identical structure. Firstly, the fingertip-to-floor test was performed, secondly the slump test and thirdly the SLR were obtained. Finally, a neurologic assessment was

performed. After clinical assessment, pain measures and demographic history were taken and last the self-reported disability questionnaire (RMDQ) was filled out [5]. The clinical examination, including time to fill out self-reports, took approximately 25 minutes.

Fingertip-to-floor test (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 centimetres[2].

Straight leg raising test (SLR) was performed according to the published instructions and the angle between the tibial crest and the horizontal plane was measured using a goniometer in (non-rounded) degrees [4].

The Slump test, a validated dichotomous test to assess the presence/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.

Neurologic sign was determined if patellar reflex, Achilles reflex, strength of large toe in dorsiflexion or sensibility in a specific dermatome area were asymmetrically deranged.

Roland and Morris disability questionnaire (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 have an impact on patients with LBP. A total score is compiled by summing the "yes" answers (1 point each), ranging from 0 (no disability) to 24 (extremely severe disability).

Three different measures of pain were obtained using a horizontal VAS, with 0 mm indicating no pain, and 100 mm the worst imaginable pain [22]. The measures, low back pain (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 three days (Pain VAS high), were self-rated.

Statistical analysis

Entire group / radicular pain group

Statistical analysis were made using SPSS (15.0). A subgroup of subjects with radicular pain was determined from the entire sample by the use of the slump test at baseline. A cross-sectional comparison between the entire sample and those with radicular pain was done at baseline (Table 1), one-month and 12-month follow-up. Statistical comparisons were made between those with radicular pain and the entire sample using the T-test (normally distributed variables) or the Chi-square test (dichotomous variables).

Longitudinal validity over four weeks

For validity testing, we used the change in each outcome from baseline to one month to calculate the effect size (ES), the standard error of measurement (SEM), and the minimal detectable change (MDC). To provide a frame of reference for effect size values: A small effect size is approximately 0.20, a medium is 0.50 and a large effect size is $\geq$0.80 [23]. We calculated the SEM as the standard deviation of the mean change (SD) x $\sqrt{1-\alpha}$), where α is the coefficient of test-retest reliability. Since we did not perform test-retest measurements in the present study, we used values from previous reports; $\alpha = 0.88$ for RMDQ [21], $\alpha = 0.98$ for FTF [24] and $\alpha = 0.95$ for SLR [4]. In a second step, we calculated the MDC using the formula 1.96 x SEM [11]. The criterion validity was assessed by relating the one-month individual

changes in RMDQ to the individual changes in FTF and SLR using the Pearson's coefficient of correlation (Spearman's 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 ($p<0.05$). R^2 was used to describe the approximate proportion of the variation in the response that is explained by the model. Baseline characteristics (Table 1) and one-month changes in continuous variables (i.e. SLR, FTF and Pain VAS scores) were related to the one-month longitudinal change in RMDQ and to the 12-month change of RMDQ. Due to obvious inter-relationship 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 (i.e. FTF, a cut-off point of 4.5 cm 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 significantly increased number of neurologic signs ($p<0.001$), increased pain VAS leg ($p=0.029$), decreased lumbar flexion ROM ($p=0.006$) and decreased SLR angle in left leg ($p=0.041$) in comparison to the entire sample at BL (table 1). At the one-month follow-up, however, the only difference between these groups was an increased number of neurologic signs among those with radicular pain ($p<0.001$). At 12 months, no

difference was found in RMDQ between the entire sample (Mean 3.6, SD 4.8) and those with radicular pain (3.1, 3.8, p=0.28). Furthermore, no significant differences were seen between the two groups regarding number of treatment visits or type of treatment received (data not shown).

Longitudinal validity over four weeks

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

In the entire sample, the change in RMDQ correlated well to the change in FTF (r=0.63, p<0.001) but poorly to the change in SLR (SLR left r=0.13, SLR right r=0.15).

In patients with radicular pain, the change in RMDQ correlated well to change in FTF (r=0.66, p<0.001) but poorly to SLR of the affected side (r=0.28, p=0.10).

Predictive value

Age (years), gender (male/female), BMI (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 one month (p>0.16 for entire sample and p>0.18 for radicular pain group) or over 12 months (p>0.07 and p>0.06 respectively). In the entire sample, symptom duration (days), pain VAS high at BL, and change in pain VAS high over one month were independently and significantly associated with the one-month and 12-month change in RMDQ ($0.08 \leq R^2 \leq 0.31$). In the radicular group however, these variables only showed significant relationships to the one-month ($0.18 \leq R^2 \leq 0.25$), but not the 12-month change in RMDQ (Table 3). FTF at BL and the one-month change in FTF were significantly

associated with both one-month and 12-month change in RMDQ for the entire sample as well as for the radicular group with crude R^2 values ranging from 0.12-0.43 (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 one month ($p< 0.023$, $R^2=0.25$) and 12 months ($p<0.048$, $R^2=0.15$). In those with radicular pain however, the same combination of variables showed a better relationship to the one-month change ($p< 0.010$, $R^2=0.35$) but a non-significant relationship to the 12-month change ($P>0.05$) in RMDQ. Still, change in FTF over one month was independently more strongly associated with the one-month and 12-month change in RMDQ than any of the multivariate combinations and explaining 27-43% of the variance in RMDQ variables (Table 4). ROC analysis in subjects with radicular pain showed a higher discriminative value of FTF (cut-off point 4.5 cm) in predicting change in RMDQ over one month and over 12 months (AUC = 0.92 and AUC=0.85 respectively [95% CI 0.70-1.00]) versus the entire sample (AUC = 0.80 and AUC=0.77 [95% CI 0.65-0.91]). A cut-off point larger or smaller than 4.5 cm decreased AUC.

DISCUSSION

This is to our knowledge the first study to assess the criterion validity over time of FTF and SLR in patient with acute/sub-acute LBP before and after stratification using 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 of time. 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 non-specific low back pain, and an even better predictor in those with radicular pain.

Recommendations about clinical selection of LBP patients 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% was presented with 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 positive slump test and in agreement with earlier reports [16, 27] we recommend clinicians to 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 one 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 in consequence of relatively high reliability coefficient, suggesting a precision of < 4.5 cm. In accordance with several other reports [28-31], the criterion validity was analysed not by the use of baseline values but by the use of changes in the measures and thus ruling out the contribution of the individual baseline variation of the impairment measures. The FTF test 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 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 in order 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 to the changes in FTF, the strongest predictor in this and a previous [29] study. 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 non-improvement, in the patient's own opinion of disability at one month and at 12 months. Furthermore, the change in disability over 12 months can be predicted by the change in FTF over one month in 77% of the cases in the entire sample and in 85% of the cases in the radicular pain group when using a cut-off point of 4.5 cm. An increase in FTF of >4.5 cm predicts improvement in disability and seems to be an applicable value for clinical use.

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

Study limitations

Our study had limitations. Firstly, 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/sub-acute LBP recruited from primary care, and therefore our results are best generalized to such patients. Secondly, the sample size was determined for analysis on the entire sample whereas sub-group analysis was limited by a

small sample size. Thirdly, 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.

CONCLUSION

In this study on patients with acute/sub-acute non-specific LBP, more than half of the sample had radicular pain as classified by the slump test. Our results suggest that the FTF test has good validity in patients with acute/sub-acute 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 one year. In contrast, the validity of SLR can be questioned in the present group of patients.

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Table 1. Baseline characteristics for the entire population and for those with and without radicular pain. Statistical comparison was made between the entire population and those with radicular pain. All values are mean (SD) except Gender, Smoker, Neurological sign [n (%)]

Variable	All (n=65)	Pos slump (n=38)	Neg slump (n=27)	Group comparison †
Age (years)	45 (11)	46 (11)	42(11)	0.172
Gender (men) [n (%)]‡	30 (46)	16 (42)	14(52)	0.520
BMI	25(3.6)	26(3.8)	25(3.6)	0.345
Smoker (yes) [n(%)]‡	12 (18)	7(18)	5(19)	0.752
Symptoms of LBP (days)	24 (23)	22 (20)	27(27)	0.386
Neurological sign [n(%)]‡	7 (11)	7 (18)	0(0)	**<0.001****
Disability (RMDQ)	11.2 (5.6)	12.0 (5.3)	10.0(5.9)	0.161
Pain VAS lumbar (mm)	23 (18)	20 (16)	27(20)	0.152
Pain VAS leg (mm)	7(15)	10 (16)	2(11)	**0.029***
Pain VAS high (mm)	56 (24)	54 (23)	59(25)	0.408
FTF (cm)	24 (16)	28 (16)	17(15)	**0.006****
SLR left (°)	64 (15)	61 (14)	68(15)	**0.041***
SLR right (°)	65 (13)	63 (13)	68(13)	0.087

†T-test ‡ Chi-square test *P<0.05 **p<0.01

Table 2. Change in RMDQ, Fingertip-to-floor test (FTF) and Straight leg raising test (SLR) over the first month. The effect size (ES) and minimum detectable change (MDC) are presented for the entire population (n=65) and for those with radicular pain (n=38). All values are mean (SD).

	Entire sample (n=65)					Radicular group (n=38)				
Variable	BL value	Change at 4 w	p-value†	Effect size	MDC	BL value	Change at 4 w	p-value †	Effect size	MDC
RMDQ	11.2 (5.6)	5.2(5.4)	< 0.001	1.0	3.8	12.0(5.3)	5.3(6.2)	< 0.001	1.1	3.6
FTF (cm)	24 (16)	12(13)	< 0.001	0.8	4.5	28 (16)	15(14)	< 0.001	0.9	4.5
SLR left (°)	64 (15)	2.8(9.5)	0.021	0.2	6.6	61 (13)	2.3(9.7)	0.009	0.4	6.1
SLR right (°)	65 (13)	1.9(5.6)	0.008	0.2	5.7	62 (13)	2.0(5.3)	0.002	0.2	5.7
SLR aff side (°) ‡						57 (12)	3.3(7.9)	0.001	0.5	5.7

† Using T-test to test significant change after one month. ‡Affected side according to slump testing.

Table 3. The crude relationship between the one-month and 12-month change in self-reported disability (RMDQ) and baseline characteristics, one-month change in Fingertip-to-floor test (FTF) and Pain VAS high in the entire population(n=65) and in patients with radicular pain (n=38).

	Entire sample (n=65)				Radicular group (n=38)			
	Change in RMDQ over 1 month		Change in RMDQ over 12 months		Change in RMDQ over 1month		Change in RMDQ over 12 months	
Variable†	β- coeff. (95%CI)	p- value (R^2)	β- coeff. (95%CI)	p- value (R^2)	β- coeff. (95%CI)	p- value (R^2)	β- coeff. (95%CI)	p- value (R^2)
Symptoms (days)	-0.75(-0.13-0.02)	0.010 (0.10)	-0.08(-0.15-0.02)	0.014 (0.09)	-0.12(-0.21-0.03)	0.008 (0.18)	-0.07(-0.16-0.02)	0.115(0.07)
Pain VAS high baseline	0.91(0.45-1.49)	<.001 (0.18)	0.80(0.11-1.40)	0.022 (0.08)	1.20(0.43-1.98)	0.003 (0.22)	0.74(0.00-0.15)	0.060(0.09)
Change in Pain VAS high	1.09(0.68-1.49)	<.001 (0.31)	0.82(0.29-1.35)	0.003 (0.13)	1.14(0.48-1.80)	0.001 (0.25)	0.53(-0.15-1.22)	0.125(0.06)
FTF baseline	0.14(0.06-0.21)	0.001 (0.18)	0.17(0.09-0.26)	<.001 (0.20)	0.13(0.01-0.25)	0.035 (0.12)	0.15(0.04-0.26)	0.007 (0.19)
Change in FTF	0.26(0.18-0.34)	<.001 (0.39)	0.25(0.15-0.36)	<.001 (0.27)	0.29(0.18-0.40)	<.001 (0.43)	0.23(0.11-0.34)	<.001 (0.31)

† Four pain variables, all SLR variables and remaining characteristics not shown due to minor relationship to dependent variable (p>0.06)

Table 4 Multivariate linear regression analysis; change in self-reported disability (RMDQ) at one - month follow-up and at 12-month follow-up as dependent variables, comparing patients characteristics, changes in Fingertip-to-floor test (FTF) and Pain VAS high at one-month follow-up in all patients (n=65) and in patients with radicular pain (n=38) i.e. positive slump test.

	Entire sample (n=65)				Radicular group (n=38)			
	Change in RMDQ 1 mo		Change in RMDQ 12 mo		Change in RMDQ 1 mo		Change in RMDQ 12 mo	
Variable	p	Multivariate R^2 ‡	p	Multivariate R^2 ‡	p	Multivariate R^2 ‡	P	Multivariate R^2 ‡
Symptoms (days)	0.023*		0.048*		0.010*		0.158	Excl
Pain VAS high baseline†	0.001**	0.25	0,020*	0.15	0.004**	0.35	0.082	Excl
Symptoms (days)	0.054	Excl	0.049*		0.052	Excl	0.243	Excl
Change in Pain VAS high†	<.001**	0.31	0.011**	0.18	0.001**	0.25	0.267	Excl
Symptoms (days)	0.043*		0.068	Excl	0.008**	0.18	0.259	Excl
FTF baseline†	0.002**	0.23	<0.001**	0.20	0.088	Excl	0.007**	0.19
Symptoms (days)	0.109	Excl	0.119	Excl	0.318	Excl	0.978	Excl
Change in FTF †	<.0001**	0.39	<.0001**	0.27	<.0001**	0.43	<.0001**	0.31

*p<0.05. **p<0.01. † Due to multicollinearity Pain and FTF variables were analyzed separately. ‡ Level for inclusion in model p<0.05. Excl Excluded due to not significant association (p>0.05)