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Research Article

The Fingertip-to-floor Distance: What Statement makes the Test Regarding to Spinal Mobility in Individuals with Lumbar Spine Disorders?

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Abstract

Study Design: Monocentric study. **Purpose:** Evaluation of the Fingertip-To-Floor-test (FTF-test) as a measure for the lumbar spine mobility by correlation with the gold standard for spinal movement, the radiologically determined Range of Motion (ROM). **Background:** The FTF-test is a routinely used examination in everyday clinical practice to evaluate the lumbar spine mobility. Furthermore, it is part of official assessments, for example regarding the degree of disability. However, various studies disagree on the value of the FTF-test. To avoid misinterpretation regarding the FTF-test there is a need to evaluate this examination. **Methods:** The FTF-test and the radiologically determined Range Of Motion (ROM) have been raised on 61 patients (37 male and 24 female). The correlation between the two tests was determined by the Pearson's correlation coefficient. For further validation a linear regression analysis was used. **Results:** The results of the data analysis of the FTF-test and the radiologically determined ROM of the lower spine showed a negative correlation as well as they were not significant on a level of significance of α=0.05. By the linear regression analysis r^2 turned out to be 0.00001. **Conclusion:** In conclusion, this study shows that the regularly used FTF-distance does not provide information about the mobility of the lumbar spine and is therefore incorrectly used as a measure to verify lumbar spine mobility.

Keywords: Fingertip-to-floor-test, Low back pain, Range-of-motion, Lumbar spine disorder

Introduction

The prevalence of back pain is described in the Health Report of the German Ministry of Health with a lifetime prevalence of 74-85% [1]. With such a high prevalence in the population and the associated costs estimated at 50 billion euros per year [2], meaningful tests for assessing the conditions are an important component in diagnostics.

In this context, the Fingertip-To-Floor (FTF)-distance is a parameter that is often used for measuring trunk [3] and spine mobility [4]. Apart from some other tests, the FTF- Test is used for assessing various conditions of the spine as well as for follow-up examinations [5,6] and it is part of the spine measurement sheet of the German Statutory Accident Insurance [7]. The aim of the study is therefore to evaluate the FTF-distance as a measure of lumbar spine mobility in correlation with functional imaging of the lumbar spine. An analysis of the results should enable the validation of this test.

Material and Methods

The patients examined are patients suffering from degenerative lumbar spine conditions who came for spinal surgery consultation.

Inclusion Criteria

Patients with the following lumbar spine pathologies diagnosed based on the patients' medical history or the medical findings obtained are included in the study:

- Disk prolapse
- Spinal stenosis
- Facet joint arthrosis
- Spondylolisthesis

Exclusion Criteria

Patients with the following health impairments are excluded from the study:

- Restricted mobility of the lower extremity. A hip flexion of less than 110° and a maximum hip or knee extension of less than 0° is considered to be impaired.
- Patients who had previous thoracic/ lumber spine surgery resulting in restricted mobility (e. g. spondylodesis, surgery for fractured vertebral bodies).

Examinations

Fingertip-to-Floor Distance (FTF-Distance)

The FTF-test was used as a regular non-invasive tool for assessing lumbar spine mobility.

For this test, the patient stands on a flat ground barefooted, with completely stretched legs and feet hip-distance apart. Now the patient is asked to bend forward, with stretched arms and attempt to reach for the floor with his/her fingertips. The distance between the patient's middle finger and the floor is measured using a measuring tape. This corresponds to the value for the FTF-distance in centimeters. The FTF-distance is measured twice, namely at the beginning and at the end of the examinations.

Lumbar Spine Range of Motion (ROM) determined by Radiological Examination

The orthopedic examination of the spine routinely includes two-level X-ray imaging of the lumbar spine in an upright position as well as functional imaging with the trunk inclined/reclined. Radiological functional imaging results were analyzed using Cobb's method. For this, a line is drawn through the upper plate of the first lumbar vertebra and a line through the first sacral vertebra. The angle used is formed by two perpendicular lines dropped onto them. The radiological flexion of the lumbar spine is determined by the change in the angle between the image in the neutral position and the image in maximal inclination.

Schober Test

The Schober-test is another non-invasive examination tool. For this test, the patient stands upright in a neutral position. Using a pen, the examiner marks the spinous process of the first sacral vertebra and another point on the spine at a distance of 10 cm from the first point in cranial direction, which results in a line with a length of 10 cm. Now the patient is asked to bend forward as far as possible and once the patient has reached the final position, the length of the line between the markings is measured once more. The difference of the distances between the two markings in the patient's initial position and, respectively, in maximum flexion, corresponds to the ROM of the lumbar spine.

Examination of the Elasticity and Length of the Femoral Muscles

The passive straight-leg raise-test is performed to determine the length and elasticity of the ischiocrural muscles. On the same occasion, the test for Lasègue's sign is performed, which indicates extension pain of the sciatic nerve.

The Thomas test is performed to ascertain a shortening of the iliopsoas muscle.

Assessment of the Mobility of the Hip/ Knee Joints

The range of motion of the hip/knee joint is assessed using the Neutral-0-Method. For this, the patient lies flat on their back on an examination table, and passive movement is performed by the examiner. The assessment of mobility is conducted to exclude any potential result distortion.

Statistical Analysis

Statistical analyses were performed using the IBM® SPSS® statistics software package (version 24/version 28).

A Pearson's correlation analysis with $\alpha = 0{,}05$ and $\alpha = 0{,}01$ was performed for analyzing the collected parameters. The main objective is the correlation coefficient between the FTF and the radiologically determined range of motion. Additionally, a correlation between the FTF and the Schober measurement was sought. Since a correlation only represents the relationship and not causal links between the tests, linear regression analysis of the two parameters was used to evaluate the associations.

Results

A total of 61 patients (M=37, F=24, D=0) were included in the study. 50 patients underwent complete radiological diagnostic procedures including functional imaging. There were no evaluable photographs of the Straight Leg Raise test for three of the 61

patients. The average age of the participants was 56 years, with a standard deviation of 18.6 years (see Figure 1). Their age range was between 21 and 88 years.

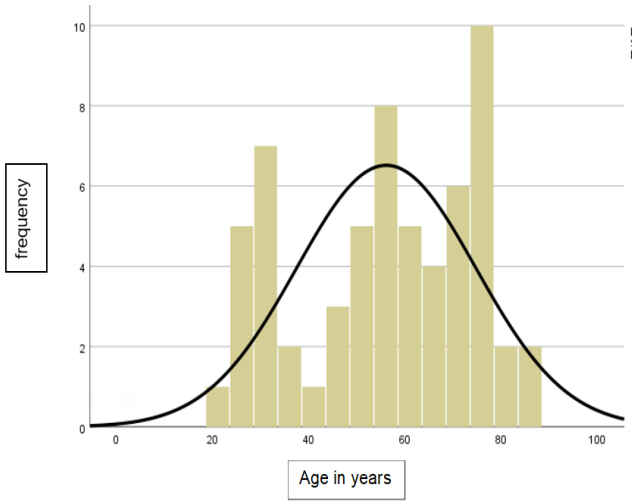


Figure 1: Histogram with normal distribution curve showing the age of the study participants in years; patients with pathologies of the lumbar spine from the spine clinic, 2015-2017. SD: standard deviation =18,666, N: total number of the study population = 61. Average value = 56.07.

The average values of the FTF-distances measured at the first (Z1) and the second (Z2) point in time were T1: 18.5 cm and T2: 16.7 cm. Table 1 shows that the FTF-distances and the ranges of motion determined by radiological examination, with a confidence interval of 95%, do not correlate and are not significant.

		FBA Z1	ROM LWS
FTF Z1	**Pearson-Correlation**	1	-0,003
	Sig. (2-sided)		0,982
	N	61	50
ROM Lumbar	**Pearson-Correlation**	-0,003	1
	Sig. (2-sided)	0,982	
	N	61	50

Table 1: Presentation of the correlation between FTF at time point 1 and the radiologically determined ROM of the lumbar spine in patients with pathologies of the lumbar spine from the spine clinic, 2015-2017. FTF: finger-to-floor-distance, T1: measurement time point 1, ROM: range of motion, Lumbar: lumbar spine, Sig.: significance, N: total number of the study population.

The linear regression analysis conducted between the FTF-tests and the ranges of motion determined by radiological examination showed a coefficient of determination (r^2) of 0.00001 (see Figure 2).

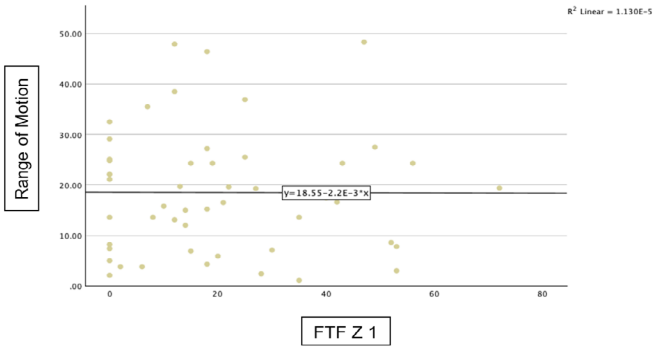


Figure 2: Regression line (r^2=0.00001130) of the FFD at T1 in cm and the radiologically determined ROM of the lumbar spine, patients with pathologies of the lumbar spine from the spine clinic, 2015-2017. The box shows the calculation of the regression line. FFD: finger-to-floor distance, T1: measurement time point 1.

On the other hand, the correlation between the FTF-distances at Z1 and the Schober- test showed a significant negative correlation of -0.558 at a level of significance of α=0.01. The r^2 of the FTF-test at Z1 and the Schober's-tests was 0.312 at a level of significance of α < 0.001. According to these results, 31% of the FTF-values can be explained by the Schober-test.

Table 2 shows the correlation between the FTF-test at Z1 and the Straight Leg Raise- test. Here a negative correlation was found, which was highly significant with a significance level of α=0.01.

		FBA Z1	Straight-leg-raising Test
FTF Z1	**Pearson-correlation**	1	-0,510**
	Sig. (2-sided)		<0,001
	N	58	58
Straight-leg-raising Test	**Pearson-correlation**	-0,510**	1
	Sig. (2-sided)	<0,001	
	N	58	58
** die Korrelation ist auf dem Niveau von 0,01(2-seitig) signifikant			

Table 2: Presentation of the correlation between FTF at time point 1 and the straight-leg-raising test on the right in patients with pathologies of the lumbar spine from the spine clinic, 2015-2017. FTF: finger-to-floor distance, T1: measurement time point 1, Sig.: significance, N: total number of the study population.

The linear regression analysis conducted between the FTF-tests and the Straight Leg Raise-tests showed an r^2 = 0.260 at a level of significance of α <0.001. This suggests that 26% of the values measured in the FTF-tests can be explained by the Straight Leg Raise-tests.

Discussion

The result of the study indicates that the FTF-test, regularly used for examination and assessment purposes, does not provide information regarding the mobility of the lumbar spine and is therefore incorrectly used as a measure to verify lumbar spine mobility.

In the regression analysis performed, the relationship between both parameters is examined using the coefficient of determination (r^2). The r^2 defines the degree of suitability of the independent variable for explaining the variance of the dependent variable. However, with an r^2 of 0.00001, the values of the measured fingertip-to-floor- distances cannot be explained by the radiologically determined flexion.

Due to the excellent inter- and intratest reliability of the FTF-test reported in the literature [3,4,6], and in order to minimize systematic errors as much as possible, the examinations were conducted by a single examiner experienced in spinal surgery. \

The examiner ensured that the tests were performed in the same manner across different patients. In order to eliminate systematic errors a consistent starting position was chosen for the various assessments. For the FTF-test, for example, it was specified that the patients should place their feet next to each other and keep their knees straight during the execution of the FTF-test.

Radiological functional imaging was the limiting factor of the examinations performed. So, only 50 out of 61 patients could be included with complete imaging. For 10 out of 11 patients, neither all functional images were performed, or the images could not be evaluated due to the poor quality. As to the evaluation of the functional imaging, a critical view may be taken with regard to the fact that only the angle between the upright position and maximum inclination is considered to show the range of motion of the lumbar spine. However, when considering the execution of the FTF-test, it becomes clear that only the act of maximal forward bending is measured. Furthermore, the Cobb method is also used in literature as the gold standard for determining the radiological ROM of the lumbar spine [4].

As stated in the results section, a significant linear regression (r^2 = 0.260) between the FTF- test and the Straight Leg Raise test was observed. This suggests that the FTF- distance is significantly influenced by muscular flexibility. Gajdosik et al. [8] came to the same conclusion in their study. Regarding to their study, 30 participants were divided into three groups based on the Straight-Leg-Raise (SLR) test: patients with shortened thigh muscles (SLR < 65°), patients with moderate flexibility of the thigh muscles (65° ≤ SLR ≤ 85°), and patients with high flexibility of the thigh muscles (SLR > 85°). It turned out that the length of the thigh muscles significantly influenced the mechanisms during bending forward.

Furthermore, the results support the thesis formulated by Magnusson et al. [9], which states that the FTF-test is a better measure of hip flexibility than lumbar spine mobility. This view is further reinforced by the results of measuring the FT- distance at two time points. The mean values show a difference of almost 2 cm between Z1 (=18.5 cm) and Z2 (=16.7 cm). These results suggest that a certain exercise and stretching effect is observed in the study participants. This can be attributed to the warm-up and stretching of the muscles resulting from the examinations conducted in the interim.

This phenomenon is also described by Ensink et al. [10] in their study. In their study, various non-invasive mobility measurements, including the FTF-test, were performed on 29 patients at three different times of the day. The measurements showed differences depending on the respective time of day, and Ensink et al. concluded that the measurements should invariably be performed at the same time to obtain reliable results. Similarly, Kippers et al. [11] demonstrate in a study with 33 young adults that the FTF- test is not a measure of the ROM of the lumbar spine. The statistical analysis showed a correlation between the FTF and trunk/hip flexion.

In contrast to this study, the study by Viitanen et al. [12] involving 151 adult patients with ankylosing spondylitis showed a significant correlation between the FTF-distance and radiologic changes of the lumbar spine. However, only images showing the progression of ankylosing spondylitis were taken, but no radiological functional images. The images were analysed using the method of Dale and Vinje [13], which is based on conventional X-ray images but does not include any functional images. Therefore, no comparison of the radiological range of motion with the FTF-test was made; instead, a change in the FTF-test was observed only with radiological progression. In this context, it should be noted that patients experiencing an active flare of ankylosing spondylitis may also exhibit additional disease symptoms that may lead to limitations in mobility.

The study by Perret et al. [3] also indicates that the FTF-test is excellent in terms of validity, reliability and responsiveness. To determine validity, 10 patients with chronic lumbar spine symptoms were included in this part of their study. The radiological assessment of the ROM of the lumbar spine was performed using functional imaging, and statistical analysis was conducted by using Spearman's correlation coefficient. The average age of the participants included in the study by Perret et al. was 42 years. This shows a clear discrepancy compared to the patient population in this study where the average age was 56 years. In the study of Perret et al. the factor of age and associated comorbidities were therefore reduced. Additionally, the chosen patient group with n=10 is significantly smaller than the patient group included in this study n=61.

As Robinson et al. [4] also demonstrate in their study, the FTF-test results and the Schober measurements correlate. With an r = -0.56 (compared to r = -0.47 in Robinson et al.), this study shows a higher correlation between these two tests. However, the results obtained from the Schober test did not show any significant correlation with the ROM determined by radiological examination, likewise the results of the FT-test.

On the other hand, other studies attribute an excellent correlation between the Schober measurement and the mobility of the lumbar spine [14]. This cannot be confirmed in this study. The study of Horre [15], in which various studies are compared, also shows that the Schober measurement generally cannot capture the entire lumbar spine. Miller et al. [16] showed that the upper marking of the Schober measurement was located at the level of the L2/L3 segment. Additionally, they demonstrated that there were difficulties in identifying the anatomical landmarks. Based on

these results, both tests should be questioned as measures of lumbar spine mobility. Further investigations into the Schober measurement would also be useful due to the contradictory study findings, to assess its clinical relevance.

In several other studies [19-20], instead of the Schober Test, the "modified Schober" or the "modified Schober-Test" was used. Unlike the conventional Schober measurement, in the modified Schober measurement, an additional point is marked 5 cm caudal to the first sacral vertebra, and after reaching maximal flexion, the distance between these two points is determined using a ruler. The measured distance minus 15 cm then gives the Schober measurement. For this study, the standard Schober test was chosen, as this method is the most common one and is most widely used in everyday clinical practice.

Conclusions

In conclusion, this study shows that the regularly used FTF-distance does not provide information about the mobility of the lumbar spine and is therefore incorrectly used as a measure to verify lumbar spine mobility.

Furthermore, it remains to be discussed which non-invasive examination could be used instead of the two regularly assessed parameters for lumbar spine mobility. Further scientific investigations are needed to address this.

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