

Grading of MRI and STarT Back Screening Tool (SBST) in the diagnosis of severity of lumbar central canal stenosis: a sensitivity analysis

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ABSTRACT

Purpose: This study aimed to correlation between the grading stenosis and the STarT Back Screening Tool (SBST) in patients diagnosed with lumbar central canal stenosis (LCCS).

Methods: In a prospective clinical study, a total of 269 patients with LCCS were asked to respond to the questionnaire at their first visits. Grading of LCCS on MRI was determined and also the severities of the disease were observed based on SBST as the gold standard. Finally grading on MRI and calcification of the SBST were determined, and sensitivity analysis carried out to evaluate severity of LCCS on grading of MRI using the SBST.

Results: The mean age of patients was 58.6 (SD= 10.9) years; and 56.5% were female. According to patients' imaging they have been diagnosed as grade 1 (n = 86), grade 2 (n = 107) and grade 3 (n = 76). The sensitivity, specificity and accuracy of the estimated grading of LCCS on MRI for low, medium, and high risk groups were found to be desirable: 97.6%, 66.7%, 96.5% for low risk; 93.1%, 83.3%, 92.5% for medium risk, and 97.2%, 66.7%, 94.7% for high risk, respectively.

Conclusion: Our findings indicate that grading of LCCS on MRI correlate with SBST and suggest that it is a reliable measure for screening LCCS patients.

Keywords: Lumbar central canal stenosis; STarT Back Screening Tool; Grading of MRI

ICNSJ 2014; 1 (1):22-25

<http://journals.sbm.ac.ir/neuroscience>

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Received: April 23, 2014

Accepted: August 3, 2014

INTRODUCTION

Low back pain (LBP) is a common musculoskeletal disorder and is an extensive and expensive problem¹. Lumbar central canal stenosis (LCCS) is a common degenerative disease of LBP in the elderly, and usually causes neurogenic intermittent claudication, radicular pain, and sensory and motor disturbances in the lower extremities². Although, classification of severity of LCCS patients based on magnetic resonance imaging (MRI) was presented by Lee et al, however, the accuracy of its classification is controversial and any relationship between MRI findings and preoperative symptoms and disability would be of concern³. Recently, to recognize

subgroups of LBP patients to guide the initial decision making for screening, the STarT Back Screening Tool (SBST) has been established.

The SBST is a simple, concise, self-administered, reliable and valid questionnaire for screening of LBP patients as suggested previously⁴⁻¹².

The relationship between preoperative health-related quality of life and functional status, and the objectively measured dural sac area stenosis (severity of LCCS in cross-sectional area of MRI and CT) is still controversial.

The aim of this study was to evaluate severity of LCCS on grading of MRI using the SBST.

MATERIALS AND METHODS

Patients and data collection

Between March 2007 and January 2012 a sample of newly diagnosed LCCS patients attending the neurosurgery clinic of a large teaching hospital in Tehran, Iran, was investigated. The diagnosis of LCCS was performed using clinical symptoms, neurological examinations, and imaging studies including plain radiography, CT and MRI of the lumbar spine. All of the patients had the typical symptoms of LCCS, such as neurogenic intermittent claudication and leg pain and/or numbness. In all of the patients, the diagnosis was confirmed by more than one spine surgeon. The stenosis level(s) were analyzed on the MRI or CT images. There were no restrictions on patient selection with regard to severe, moderate or mild LCCS or age. The exclusion criteria were spinal anomalies and prior lumbar spine surgery.

Demographic data including age, gender and body weight were recorded. The duration of symptoms (in months) and walking distance (in meters) were evaluated. The SBST was determined for the purpose of evaluating screening LBP. It consists of 9 questions. The SBST produces two scores: overall score and distress subscale score. The overall score is used to separate the 'low risk' patients from the 'medium-risk' subgroup. Scores range from 0-9 and are made by adding all positive items. Patients who achieve a score of 0-3 are classified as low-risk subgroup and those who score 4-9 as medium-risk subgroup. The distress subscale score is used to identify the high-risk subscales^{4,9} (Appendix 1). In this study, the SBST was considered as the gold standard.

Additional measure

MRI is a non-invasive diagnostic tool that has been used for evaluating the spinal canal in patients with LCCS. Recently, Lee and colleagues described a 4-grade (0, 1, 2 and 3) classification of severity of LCCS using separation degree of the cauda equina on T2-weighted axial images. They defined grade 0=no lumbar stenosis without obliteration of anterior CSF space, grade 1=mild stenosis with separation of all cauda equina, grade 2=moderate stenosis with some cauda equina aggregated making it impossible to visually separate them, and grade 3 = severe stenosis with none of the cauda equina separated³.

Statistical analysis

Sensitivity analysis: First patients were classified using their severity of LCCS classification as proposed by Lee, et al³. Then, actual classification was derived from SBST

score as the gold standard for patients' classification as low, medium, and high risk. Finally the results obtained from the estimated and actual classifications were compared using the sensitivity analysis. In fact, with respect to the actual classifications score for each case, the estimated classifications were tested and designated as true positive, true negative, false positive, or false negative in order to calculate sensitivity, specificity, and accuracy for the estimated classifications¹³.

All statistical analyses were performed using the PASW Statistics 18 Version 18 (SPSS, Inc., 2009, Chicago, IL, USA).

Ethics

The Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran, approved the study.

RESULTS

The characteristics of the LCCS patients and their scores on the SBST and grading on MRI are shown in table 1. The mean age of patients was 58.6 (SD = 10.9) years. The overall mean SBST score (Q1-9) and psychosocial subscale (Q5-9) were 4.1 (SD = 2.4) and 2.1 (SD = 1.5), respectively.

Table 1. The characteristics of the study sample (n =269).

	Number	Percent
Age groups (Year)		
Mean(SD)	58.6 (10.9)	
Range	29-84	
Gender		
Male	117	43.5
Female	152	56.5
Body weight(kg)		
Mean(SD)	81.9±9.8	
Walking distance (m)		
Mean(SD)	329.3±244	
Grading system on MRI*		
Grade 3	76	28.3
Grade 2	107	39.8
Grade 1	86	31.9
Subgroups as classified by SBST**		
High risk group	72	26.8
Median risk group	114	42.4
Low risk group	83	30.8
Screening tool score by SBST		
Overall (Q1-9) Mean (SD)	4.1 (2.4)	
Psychosocial subscale (Q5-Q9) Mean (SD)	2.1 (1.5)	

*Grade 3: Severe, Grade 2: Moderate and Grade 1: *Mild of lumbar central canal stenosis based on separation degree of the cauda equina observed on T2-weighted axial MRI.

**Higher scores on the SBST indicate worst conditions.
SBST: STarT Back Screening Tool

Table 2. Two-by-two matrices of the relationship between the estimated low risk and the actual low risk (sensitivity analysis).

Estimated low risk (Grade 1)**	Actual low risk*		Total
	Positive	Negative	
Positive	81 (true positive)	1 (false positive)	82
Negative	2 (false negative)	2 (true negative)	4
Total	83	3	86

*Actual low risk: Classified based on the SBST score as the gold standard.

**Estimated low risk: by grading system observed on T2-weighted axial MRI.

- Sensitivity = $81 / (81+2) = 97.6\%$

- Specificity = $2 / (2+1) = 66.7\%$

- Accuracy = $(81+2) / (81+1+2+2) = 96.5\%$

- Positive predictive value (PPV) = (True positive) / (True positive + False positive) = $81/82=98.7\%$

- Negative predictive value (NPV) = (True negative) / (True negative + False negative) = $2/4 = 50\%$

Table 3. Two-by-two matrices of the relationship between the estimated median risk and the actual medium risk (sensitivity analysis).

Estimated median risk (Grade 2)**	Actual medium risk*		Total
	Positive	Negative	
Positive	94 (true positive)	1 (false positive)	95
Negative	7 (false negative)	5 (true negative)	12
Total	101	6	107

*Actual low risk: Classified based on the SBST score as the gold standard.

**Estimated low risk: by grading system observed on T2-weighted axial MRI.

- Sensitivity = $94 / (94+7) = 93.1\%$

- Specificity = $5 / (5+1) = 83.3\%$

- Accuracy = $(94+5) / (94+1+7+5) = 92.5\%$

- Positive predictive value (PPV) = (True positive) / (True positive + False positive) = $94 / 95 = 98.9\%$

- Negative predictive value (NPV) = (True negative) / (True negative + False negative) = $5/12 = 41.6\%$

The sensitivity and specificity, as well as the positive and negative predictive values regarding the diagnostic success of the grading of LCCS on MRI, were calculated. The sensitivity, specificity and accuracy of the estimated grading of LCCS on MRI for low risk (97.6%, 66.7%, 96.5%); medium risk (93.1%, 83.3%, 92.5%), and high risk (97.2%, 66.7%, 94.7%) were found to be desirable. The positive and negative predictive value of the SBST was 98.7%, 50% for low risk; 98.9%, 41.6% for medium risk; and 98.6%, 40.0% for high risk groups. The results for each group are shown in separate tables (Table 2, 3 and 4).

DISCUSSION

The results obtained from the present study indicated that the grading on MRI is reliable for assessment of severity of LCCS and may be useful to clinicians for practical assessment.

Dural sac cross-sectional area (DCSA) and morphology of the dural sac were measured to evaluate the severity of

Table 4. Two-by-two matrices of the relationship between the estimated high risk and the actual high risk (sensitivity analysis)*

Estimated high risk (Grade 3)**	Actual high risk*		Total
	Positive	Negative	
Positive	70 (true positive)	1 (false positive)	71
Negative	3 (false negative)	2 (true negative)	5
Total	73	3	76

*Actual low risk: Classified based on the SBST score as the gold standard.

**Estimated low risk: by grading system observed on T2-weighted axial MRI.

- Sensitivity = $70 / (70+2) = 97.2\%$

- Specificity = $2 / (2+1) = 66.7\%$

- Accuracy = $(70+2) / (70+1+3+2) = 94.7\%$

- Positive predictive value (PPV) = (True positive) / (True positive + False positive) = $70/71=98.6\%$

- Negative predictive value (NPV) = (True negative) / (True negative + False negative) = $2/5 = 40\%$

lumbar canal stenosis in some studies¹⁴⁻²⁰. Although, few studies¹⁴⁻¹⁹ have reported a positive relationship between stenosis and MRI findings, severity of LCCS in cross-sectional area of MRI is still controversial.

Relations between the grading of LCCS on MRI and the SBST have not been studied before. The current study performed sensitivity analysis and show that grading of MRI is a sensitive tool for discriminant purpose between groups in these patients. It is according to the SBST reliable and valid tool⁴⁻¹².

The grading on MRI is a sensitive measure for screening LCCS patients. The use of this simple measure is recommended in order to increase the diagnostic success of LCCS patients especially in teaching hospitals.

CONCLUSION

Our findings indicate that grading of LCCS on MRI correlate with SBST and suggest that it is a reliable measure for screening LCCS patients.

Competing interests

The authors declare that they have no competing interests.

Acknowledgment

The authors thank the staff of the Neurosurgery Unit at Imam-Hossain Hospital, Tehran, Iran.

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