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Cramp finding: can it be used as a new diagnostic and prognostic factor in lumbar disc surgery?

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Abstract In this prospective study, the validity and the importance of a new finding (cramp finding) in the diagnosis and outcome after lumbar disc surgery were tested. The test is performed with the person in prone position. Against a forceful knee flexion, the examiner holds the leg with one hand and applies a force to overcome the knee flexion. The finding is positive if the examined person feels a disturbing cramp in the leg or thigh. The study was performed between October 1997 and December 1999. Besides the cramp finding, the classical disc herniation examination, including mechanical and neurological findings, magnetic resonance (MR) imaging tests, and

laboratory findings were checked pre- and postoperatively. The positive cramp finding in the operated group was 72% ($n=133$) preoperatively and straight leg raising (SLR) test was positive in all of them. Cramp finding was positive in 70%, 52%, 34%, and 8% of patients postoperatively in the first, 3rd, 12th and 24th months, respectively. The presented finding appears to be as valuable as the SLR, and especially contralateral SLR, tests in lumbar disc surgery. Cramp finding is also important in outcome evaluation.

Keywords Lumbar disc hernia · Straight leg raising · Diagnosis · Sensitivity · Specificity

Introduction

In spite of the variety of diagnostic approaches available for lumbar disc herniation, there is a wide range of interobserver variability. Physicians from different specialties follow unique diagnostic pathways when presented with the same clinical case. For example, it has been reported that electrodiagnostic techniques tend to be favored by neurologists and rehabilitation physicians, but imaging tests are favored by orthopedic and neurological surgeons [6].

Because no diagnostic test is perfect (each has false-positives and false-negatives), these findings raise concerns that both physicians and patients may be misled [6].

By combining the information obtained from the patient, primarily about the pain distribution, and physical findings, the probability of making a correct diagnosis is increased.

The straight leg raising (SLR) test today is regarded as probably the most important clinical test for evaluating lumbar nerve root tension caused by disc herniation [3]. The incidence of a positive SLR test varies between 72% and 99%, according to different reports [1, 4, 10].

The present study is focused on a new finding in patients with lumbar disc herniations, termed “cramp finding”, which was first noticed by the senior author (M.N.D.) in 1987. This finding seems to have a diagnostic value between that of the SLR test and the other findings. The aim of this study is to assess whether this new finding is as valuable as the SLR test and other findings.

Materials and methods

This prospective study was performed between October 1997 and December 1999. The study includes three different populations,

whose ages are under 45 years. Group A and group B comprise 100 people each, whereas group C comprises 184 patients. Group A comprises totally healthy people without any disease or discomfort. The patients in group B were the ones who had been admitted for their low back pain and sciatica only, but who otherwise were not proved to need lumbar disc surgery. Group C includes the patients who were operated for lumbar disc herniations at the levels of L4-5 and/or L5-S1. All three groups were tested to see whether they had this new sign and also were examined with SLR test. Group C patients were also evaluated for scoliosis, paravertebral spasm, limitation of lumbar movements, positive contralateral SLR test, and neurological deficits (motor, sensory and reflex). Blood Ca^{++} , Na^+ , K^+ , Cl^- , and Mg^{++} levels were also recorded. Magnetic resonance (MR) examinations were conducted for each patient. One month, 3, 12 and 24 months postoperatively, the group C patients were re-evaluated with SLR test and cramp finding.

Description of the new finding (cramp finding)

The test is performed with the person in prone position. Against a forceful knee flexion, the examiner holds the leg with one hand and applies a force to overcome the knee flexion. The finding is positive if the examined person feels a disturbing cramp in the leg or thigh (Fig. 1).

Lumbar spinal MRI studies were made for group C patients. Evaluation of MRI scans were made by radiologists, blindly, without knowing the results of the physical examination. The MRI findings were categorized as bulging, protrusion and sequestration; however, all of the operated disc herniations were either protrusions or sequestrations. Disc herniations were also categorized as central or lateral, according to their localization in the axial plane.

Fig.1 Photograph (A) and figure (B) showing the testing of the cramp finding

The SLR test was registered as one of the categories: positive at 0° – 30° , positive at 30° – 60° , positive at 60° – 90° and negative for greater angles. The lumbar anteflexion movement ranges were classified as free, or mildly or strictly restricted.

Lumbar disc herniation operations and the clinical evaluation tests were performed by the authors M.N.D., A.Ç., M.K., and the results were matched only at the end of study. Operations included partial hemilaminectomy, foraminotomy and discectomy for each herniated level.

Statistical evaluation was carried out using the McNemar test and Spearman's correlation constant test.

Results

Demographic data of the groups are shown in Table 1. In Group A, there was no positive SLR test or cramp finding. In group B, 16 patients had positive SLR test (5 had positive 0° – 30° , 3 had positive 30° – 60° , 8 had positive above 60°). Fourteen out of these SLR-positive patients had positive cramp findings in either legs or thighs (Table 2).

As outlined in Table 3, cramp finding in the group C patients was positive in 72% of patients, and various SLR degrees were positive in 93% of patients.

There were 132 patients with strictly restricted back movements and 52 patients with mildly restricted back movements. Their cramp finding results were 92 and 41

Table 1 Demographic variables of groups

	Age in years (range of mean)	Gender (Female/Male)
Group A	33 (20–42)	24/76
Group B	36 (20–45)	36/64
Group C	32 (20–45)	62/122

Table 2 In group B, 14 out of 16 patients who were positive on the straight leg raising (SLR) test had cramp findings

SLR grade	Cramp positive		Cramp negative
	In thigh	In leg	
0° – 30°	1	4	–
30° – 60°	1	2	–
60° – 90°	4	4	2

Table 3 Results of examination of patients in group C, classified by SLR grade

	SLR 0° – 30° (n=129)	SLR 30° – 60° (n=43)	SLR 60° – 90° (n=7)	Negative SLR (n=5)
Contralateral SLR	94	24	–	–
Cramp finding	95	36	2	–
Paravertebral spasm	99	15	14	2
Neurological deficit	97	28	–	–

Table 4 Magnetic resonance imaging (MRI) findings and their relation with cramp findings

MRI finding	Cramp finding
Bulging (<i>n</i> =0)	–
Protrusion	–
Central (<i>n</i> =12)	1
Lateral (<i>n</i> =116)	84
Sequestration	
Central (<i>n</i> =8)	5
Lateral (<i>n</i> =48)	43

patients respectively. The relationship between the MRI findings and cramp findings is shown in Table 4. Table 5 presents the relationship between cramp findings and SLR grade preoperatively and at follow-up examinations.

Specificity and sensitivity of the cramp finding

Of the 184 patients who were diagnosed with lumbar disc herniation requiring surgery, using mechanical and neurological, MRI and laboratory findings (taken as gold standard), 133 had positive findings on the cramp test (true-positives) and 51 had negative findings (false-negatives). A further five patients not diagnosed by the gold standard registered positive findings (false-positives) (Table 6).

The proportion of patients diagnosed by the gold standard who give positive findings on a given diagnostic test is a measure of the sensitivity of that test. It is calculated as $a/(a+c)$, where a represents true-positives, and c represents false-negatives. The sensitivity of the cramp test is therefore:

$$\text{Sensitivity} = 133/133+51 = 0.72282 \rightarrow 72.282\%$$

The ability of a given test to correctly identify the absence of disease is termed its specificity. It is calculated as $d/b+d$, where d represents true negatives and b represents false-positives. The specificity of the cramp test is therefore,

$$\text{Specificity} = 5/5+0 = 1 \rightarrow 100\%$$

In statistical analysis of results, there was a positive relation between SLR test and cramp finding results ($P=0.000$)

and good correlation between them according to the Spearman's correlation constant ($P=-0.284$).

Discussion

The mechanism of cramp is not clear. The afferent nerve fibers that transmit painful stimuli from muscle are small axons. Nociceptive axons probably have free endings in muscle and conduct impulses at relatively slow velocities. Nociceptors are commonly sensitive to strong local pressure and to stimulation by algesics. Repetitive stimulation of muscle nociceptors sensitizes them to mechanical stimuli [11].

For many imaging tests, surgical findings may be regarded as the gold standard. However, even these tests have important limitations. The imaging tests may give false-negative results [6]. In these circumstances, the best gold standard may be to have multiple expert clinicians review the clinical course of patients over time, considering the evolution of clinical findings and all other tests or treatments that may be applied [15].

The definition of a positive test must be specified. Definitions can vary for almost any diagnostic test. For example, there are different definitions of a positive result of dermatomal somatosensory-evoked potentials [6].

Several important terms are used to describe the comparison between a diagnostic test result and a gold standard diagnosis. Calculation of sensitivity and specificity typically requires a 2×2 table (Table 6). To be of any value, the diagnostic test must not only be positive when the disease is present, but also it must be negative when the disease is absent [6]. The ability of the diagnostic test to correctly identify the absence of disease is called specificity. The sensitivity identifies the positivity of the test in disease, and is defined as a percentage [12].

The pathophysiologic mechanism of radicular pain elicited by disc herniation is not fully understood. Apart from pure mechanical compression/angulation of the nerve root, biochemical affection and autoimmune reactions have been proposed as possible pain inducers [8]. Consequently, the mechanism behind the pain aggravation obtained by the SLR test remains to be fully explained. Nerve root motion and strain of the nerve root have been demonstrated as contributory factors, as have inflamma-

Table 5 Preoperative and postoperative follow-up SLR and cramp finding (CF) results (number of patients with a positive result) in relation to the SLR grade

SLR grade	Preoperative (SLR/CF)	1 month (SLR/CF)	3 month (SLR/CF)	12 month (SLR/CF)	24 month (SLR/CF)
0°–30°	129/95	11/66	5/45	0/29	0/4
30°–60°	43/36	12/27	8/24	6/16	3/7
60°–90°	7/2	6/0	6/0	4/0	4/0
Negative	5/0	5/0	5/0	5/0	5/0
Total	184/133	34/93	24/69	15/45	12/11
Percentage	100/100	18/93	13/52	8/34	6.5/8

Table 6 Sensitivity and specificity "2×2" table, (*a* true-positives, *b* false-positives, *c* false-negatives, *d* true-negatives)

		Gold standard	
		Pt. with disease (<i>n</i> =184)	Pt. without disease (<i>n</i> =5)
Diagnostic test result	Positive	133 (<i>a</i>)	0 (<i>b</i>)
	Negative	51 (<i>c</i>)	5 (<i>d</i>)

tory factors [7, 13, 14]. Deciding whether a patient with lumbar disc herniation needs to be operated is, indeed, a very complicated process. Strong indications for surgery are cauda equina syndrome and severe and/or progressive motor deficits. The relative indications include disabling pain unresponsive to aggressive non-operative therapy [2]. The limits of relative indications for surgery are widened with the development of new imaging techniques. The majority of patients complaining about low back pain and sciatica belong to this relatively indicated surgery group. Physical examination findings need to be more accurate and must not be overlooked.

One of the main problems is to make a precise diagnosis about nerve root impingement and the severity of the compression by the herniated disc. Although several tests are known to be important for such conditions, the SLR test is widely used as the most sensitive test. The limited accuracy of the tests, including the SLR test, indicates the need for other confirmatory tests [5]. The sensitivity of the other known tests and findings are so low that diagnosis of lumbar disc herniation is unlikely without using imaging tests.

The test under examination should be interpreted without knowledge of the gold standard result. Similarly, the gold standard comparison test should be interpreted without knowledge of the experimental test. Reproducibility of test interpretation is also important. If reproducibility were examined earlier in the dissemination of such diagnostic tests, problems could be identified and reasons for disagreements determined. Reproducibility can be examined in this way for both interobserver variability and intraobserver variability [6].

The cramp finding was found incidentally. It was first recognized by the senior author, M.N.D., in 1987. Since then, the finding has been tested on numerous patient se-

ries randomly, and it was felt that the incidence of positive cases was very high. The finding has been helpful in decision making for surgery. This prospective study was performed to maintain the objectivity of such observations.

The SLR test has diagnostic value, and postoperatively it has a prognostic value because of its correlation with other parameters that indicate level of pain and its correlation with postoperative clinical outcome. A positive SLR test 4 months after disc surgery is a strong sign of an unfavorable surgical result regarding sciatica [8].

By considering the study of Nachemson and La Rocca, cramp finding was independently compared with the gold standard "SLR test" [9]. The finding was assessed blindly relative to the SLR test. All of the results were documented and evaluated at the end of the period. Interpretation of cramp finding results with SLR was only possible at that time. The final diagnosis was established without the results of the finding. The cramp finding is reproducible and it was described in a reproducible manner. Interobserver variability is less or almost non-existent in such objective tests.

Ideally, diagnostic tests should be highly sensitive and specific. They are characteristics of a test [1]. The sensitivity and specificity of the finding were calculated for comparison with the final gold standard diagnosis. Sensitivity and specificity of a test are reported to be useful, because theoretically they do not change when different proportions of diseased and healthy population are examined [6]. The sensitivity and specificity results of cramp finding show that the accuracy for distinguishing between persons with and without the disease of interest is within acceptable limits.

Conclusion

Besides its technical efficacy, we consider the cramp finding to be effective in diagnosis and in outcome. The cramp finding is absolutely acceptable and safe for the patients. The finding is objective, because the cramp is felt both by the patients and by the examiner with palpation. We also conclude from the results that cramp finding is also effective for outcome evaluation. The results of the present study encourage us to perform new studies to evaluate the importance of this finding in different lumbar pathologies such as spondylosis, stenosis, etc.

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