

# LUMBAR SPINAL STENOSIS: SEDIMENTATION SIGN

CANAL LOMBAR ESTREITO. SINAL DA SEDIMENTAÇÃO

CANAL LUMBAR ESTRECHO. SEÑAL DE LA SEDIMENTACIÓN

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## ABSTRACT

**Objective:** To verify the presence of the sedimentation sign in patients with lumbar spinal stenosis (LSS) in comparison to those without LSS. **Methods:** Retrospective, cross-sectional and descriptive study. Review of the imaging processes of patients with LSS operated between January 1, 2008 and December 31, 2009, comparing with patients without LSS observed in outpatient consultations. Patients were divided into two groups: group I had 34 patients with a diagnosis of LSS. Diagnostic criteria: existence of low back pain and/or neurogenic claudication and/or radiculopathy, associated with an anteroposterior canal diameter of less than 10 mm. Group II had 40 patients observed in outpatient consultations for low back pain without clinical LSS. The canal diameter was measured and the presence of the sedimentation sign between D12 and S1 was verified. **Results:** A positive sedimentation sign was identified in 31 of the 34 patients in group I (91.2%); only below the stenosis in two of these 31 patients. The sign was not observed in the patients in group II. A statistically significant correlation was observed between the variables "canal diameter" and "presence of sedimentation sign" ( $p < 0.01$ ) in the group of patients with lumbar spinal stenosis. **Conclusion:** The diagnosis of LSS is not always easy due to the frequent dissonance between the clinical and imaging findings. The sedimentation sign is positive in patients with LSS between L1 and L5 and can be a valid sign to complement the diagnosis of LSS.

**Keywords:** Lumbar; Roots; Diagnosis; Magnetic resonance spectroscopy; Sedimentation.

## RESUMO

**Objetivo:** Verificar a presença do sinal de sedimentação nos pacientes com canal lombar estreito (CLE) comparando-os com os pacientes sem CLE. **Métodos:** Realizado um estudo retrospectivo, transversal e descritivo. Realizada a revisão dos processos imagiológicos dos pacientes com CLE operados entre 1 de janeiro de 2008 e 31 de dezembro de 2009, comparando-os com os dos pacientes sem CLE observados em consulta externa. Os pacientes foram divididos em dois grupos: grupo I com 34 pacientes com diagnóstico de CLE. Critérios diagnósticos: existência de lombalgia e/ou claudicação neurogênica e/ou radiculopatia, associados a um diâmetro anteroposterior do canal menor que 10mm e grupo II com 40 pacientes observados em consulta externa por lombalgia sem clínica de CLE. Foi feita a medição do diâmetro do canal e verificada a presença do sinal de sedimentação entre D12 a S1. **Resultados:** O sinal de sedimentação foi positivo em 31 dos 34 pacientes do grupo I (91,2%), em dois destes 31 pacientes apenas abaixo da estenose. Este sinal não foi encontrado em nenhum paciente do segundo grupo. Verifica-se uma correlação estatisticamente significativa entre as variáveis "diâmetro do canal" e a "presença do sinal de sedimentação" ( $p < 0.01$ ) no grupo de pacientes com canal lombar estreito. **Conclusões:** O diagnóstico de CLE nem sempre é fácil atendendo à frequente dissonância entre os achados clínicos e imagiológicos. O sinal de sedimentação é positivo em pacientes com CLE entre os níveis L1 e L5, podendo ser um sinal válido para complementar o diagnóstico de CLE.

**Descritores:** Lombar; Raízes; Diagnóstico; Espectroscopia de ressonância magnética; Sedimentação.

## RESUMEN

**Objetivo:** Verificar la presencia de la señal de sedimentación en los pacientes con Canal Lumbar Estrecho (CLE), comparándolos con los pacientes sin CLE. **Métodos:** Realizado un estudio retrospectivo, transversal y descriptivo. Realizada la revisión de los procesos de imagen de los pacientes con CLE operados entre el 1ro de enero de 2008 y el 31 de diciembre de 2009, en comparación con los pacientes sin CLE observados en las consultas externas. Creamos dos grupos de pacientes: grupo I, 34 pacientes con diagnóstico de CLE. Criterios de diagnósticos: existencia de lumbago y/o claudicación neurogénica y/o radiculopatía, asociados a un diámetro anteroposterior del canal menor de 10 mm. Grupo II, 40 pacientes observados en consultas externas por lumbago sin clínica de CLE. Se realizó la medición del diámetro del canal y fue verificada la presencia de la señal de sedimentación entre D12 y S1. **Resultados:** La señal de la sedimentación fue positiva en 31 de los 34 pacientes del grupo I (91,2 %), en dos de estos 31 pacientes solamente por debajo de la estenosis. Esta señal no se encontró en ningún paciente del segundo grupo. Se verificó una correlación, estadísticamente significativa, entre las variables "diámetro del canal" y la "presencia de la señal de la sedimentación" ( $p < 0,01$ ) en el grupo de pacientes con canal lumbar estrecho. **Conclusiones:** El diagnóstico de CLE no siempre es fácil atendiendo a la frecuente discrepancia entre los hallazgos clínicos y de imagen. La señal de sedimentación es positiva en pacientes con CLE entre los niveles L1 y L5, pudiendo ser una señal válida para complementar el diagnóstico de CLE.

**Descriptores:** Lumbar; Raíces; Diagnóstico; Espectroscopia de resonancia magnética; Sedimentación.

## INTRODUCTION

The incidence of lumbar stenosis varies between 1.7% and 8% in the general population, and is greater beginning in the fifth decade of life.<sup>1</sup> Lumbar spinal stenosis means reducing the space available for nerve elements – cauda equina.<sup>2</sup> Lumbar spinal stenosis (LSS) may be congenital and/or acquired, and the latter may be degenerative,

iatrogenic, neoplastic, or traumatic. It may also be associated with acromegaly, Paget's disease, and ankylosing spondylitis.<sup>3,4</sup>

The lumbar spinal stenosis is the end result of a series of progressive changes that terminates at the narrowing of the canal. It is a disease that typically manifests in physical activity.

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The most common symptoms are intermittent neurogenic claudication, low back pain in the standing position (94%), paresthesia of the lower limbs (63%) and subjective muscle weakness (43%). Differential diagnosis includes hip disease, vascular disease and peripheral neuropathy. Patients with central stenosis frequently present with pseudoclaudication and are generally older. Those with foraminal stenosis or stenosis of the lateral recesses predominantly exhibit a root component and may have pain while at rest.<sup>3-6</sup>

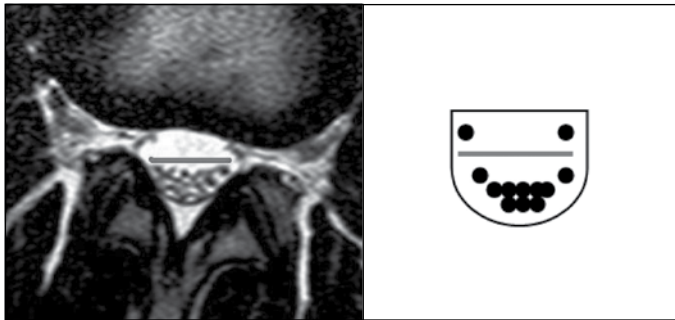
LSS is one of the most common causes of spinal surgery and the clinical findings are not always in line with the imaging findings.

MRI is the method of choice for diagnosing LSS.<sup>7-12</sup> Typical findings are hypertrophy of the yellow ligament and the joint facets, the hourglass shape of the canal (in sagittal sections), and root "overcrowded". The narrowing of the canal on MRI is accepted as a good differentiating factor for canal stenosis.<sup>7-12</sup>

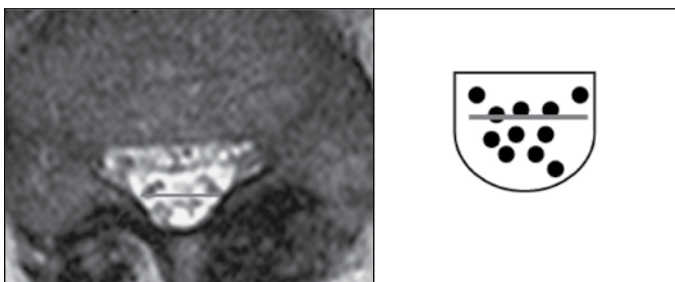
Although there is a wide range of clinical, electrophysiological, and radiological findings that lead us to the diagnosis, the indication for surgical treatment has still not been clearly defined, so that additional diagnostic signs are important in guiding the choice of surgery.

Barz et al.<sup>13</sup> demonstrated for the first time in 2010 that in patients without LSS a sedimentation of the nerve roots to the dorsal region of the dural sac in magnetic resonance images by gravitational force (Figure 1) and defined its absence as a positive sedimentation sign. (Figure 2)

The aim of this study is to verify the presence of the sedimentation sign in patients with LSS and evaluate its diagnostic value.



**Figure 1.** Negative sedimentation sign: sedimentation of the nerve roots to the dorsal region of the dural sac in magnetic resonance images by gravitational force.



**Figure 2.** Positive sedimentation sign.

## METHODS

We conducted a retrospective, transversal, and descriptive study with an imaging review of the processes of patients operated for LSS between January 2008 and December 2009, comparing them with patients without LSS observed in outpatient consultations.

Exclusion criteria were the presence of peripheral arterial disease, polyneuropathy, or other musculoskeletal disorders with impaired walking ability. We also excluded patients with contraindications to magnetic resonance imaging, absence of imaging study including D12 to S1, and presence of artifacts that significantly diminished image quality. Patients with lumbar spinal stenosis at the level of L5/S1 were excluded because the roots of S1 and S2 left the dural sac in a ventral

position, inhibiting sedimentation to the dorsal region of the sac. Two groups were defined:

Inclusion criteria for group I: patients with a diagnosis of LSS (existence of low back pain and/or neurogenic claudication and/or radiculopathy), and anteroposterior diameter of the dural canal less than 10 mm in MRI.

Inclusion criteria for group II: patients observed in outpatient consultations for lower back pain without clinical LSS.

The MRI study was done in a high-field magnet. All patients were examined in the same imaging center. T1-, T2-, and STIR-weighted sagittal imaging was performed, as well as T2- and T3-coronal imaging, T1- and T2-axial imaging. During the examination the patient was supine with the hips and knees slightly bent (with support under the knees).

The Imatrix® imaging system was used to assess the diameter of the canal, which was measured in millimeters (mm). The sedimentation sign was evaluated from D12 to S1, immediately above and below the stenosis.

A descriptive statistical study of the samples was performed and the Spearman ordinal correlation for the variables "canal diameter" and "presence of sedimentation sign" was calculated (using Microsoft Office 2010-Excel).

A positive sedimentation sign was defined as the absence of sedimentation of the nerve roots at the level above and below the stenosis in at least one cross-section magnetic resonance image, irrespective of the level of the section and its proximity to the maximum stenosis. As a rule, the nerve roots usually settle into the dorsal region of the dural sac by gravity, which was defined as a negative sedimentation sign. The only exception are the two roots exiting the dural sac one level below the stenosis. If there are nerve roots in the ventral dural sac (apart from the exception mentioned above), the sign is positive.

## RESULTS

Eighty patients underwent surgery with a diagnosis of lumbar spinal stenosis. After applying the inclusion and exclusion criteria, 34 patients were included in group I. The average age in group I was 68 years (minimum 47, maximum 95); 70% (n = 23) of the patients were female, and 30% (n = 11) were male. Forty patients were included in group II. The average age in group II was 49 years (minimum 32, maximum 81); 60% (n = 24) of the patients were female and 40% (n = 16) male. (Table 1) All patients included in group I had degenerative and acquired lumbar spinal stenosis. A positive sedimentation sign was identified in 31 of 34 patients (91.2%), two patients had positive sign only below the stenosis and one had it only above. (Table 2) There is a statistically significant correlation between the variables "canal diameter" and "presence of sedimentation sign" ( $p < 0.01$ ) in the group of patients with lumbar spinal stenosis.

The changes most frequently encountered in the imaging study were thickening of the yellow ligament, hypertrophy of joint mass, osteoarthritis of interapophyseal and/or posterior joints, degenerative apophysemegaly, spondylolisthesis, and synovial cyst.

There was no difference in sign detection between the various levels of stenosis. This sign was not positive in any patient in the second group. (Table 3)

**Table 1.** Table of frequencies.

	Patients with Lumbar Spinal Stenosis	Patients without Lumbar Spinal Stenosis
Female	70%	60%
Male	30%	40%
Average Age	68 years	49 years
Average Canal Diameter	6.47 mm	14.24 mm
Standard Deviation	1.66	1.43

**Table 2.** Results obtained in group I.

Patient	Sex	Age (years)	Level	Canal AP diameter (mm)	Sedimentation sign above stenosis*	SS below*
1	F	77	L3-L4	6.5	-	-
2	F	57	L3-L5	9.7	+ L2	+ L5
3	F	66	L3-L4	5.8	+ L3	+ L4
4	F	72	L2-L3	4.8	+ L2	+ L3
5	M	67	L3-L4	5.3	+ L3	+ L4
6	F	76	L2-L5	3.1	+L1	+ L5
7	F	63	L4-L5	9.3	+ L4	+ L5
8	F	60	L3-L5	5.3	+ L3	+ L5
9	M	61	L4-L5	4.5	-	-
10	M	83	L3-L5	5.8	+ L2	+ L5
11	M	61	L2-L4	7.0	+ L1	+ L5
12	F	75	L4-L5	6.0	+ L4	+ L5
13	F	70	L3-L5	6.4	+ L3	+ L5
14	F	81	L2-L4	4.4	-	+ L4
15	F	64	L3-L4	5.9	+ L3	+ L4
16	F	63	L3-L5	6	+ L3	+ L5
17	F	64	L3-L5	6.8	+ L3	+ L5
18	F	72	L2-L3	6.4	+ L1	+ L4
19	M	59	L4-L5	7.4	+ L4	+ L5
20	F	79	L3-L4	6.1	+ L3	+ L5
21	F	62	L4-L5	3.2	+ L4	+ L5
22	M	71	L4-L5	5.2	+ L4	+ L5
23	F	79	L4-L5	5.7	+ L4	+ L5
24	F	58	L4-L5	8.4	-	+ L5
25	M	95	L4-L5	7.6	+ L4	+ L5
26	F	77	L3-L4	9	+ L3	+ L4
27	F	73	L3-L5	8.1	-	-
28	F	56	L3-L5	5.3	+ L3	+ L5
29	M	66	L4-S1	9.5	+ L4	-
30	M	55	L4-L5	7.1	+ L4	+ L5
31	M	47	L4-L5	4	+ L4	+ L5
32	F	52	L4-L5	9	+ L4	+ L5
33	F	70	L4-L5	8.6	+ L4	+ L5
34	M	78	L2-L5	6.9	+ L4	+ L5

F: female, M: male, SS: sedimentation sign, +: positive, -: negative, \*: refers to the level when there is a positive sign.

**DISCUSSION**

LSS is one of the most common causes of spinal surgery and the correlation between the clinical and imaging findings is not always consonant. The decrease in the canal diameter in the MRI has been accepted as a good discriminator for LSS.<sup>8,9</sup> However, in patients with foraminal stenosis, dynamic stenosis during physical activity, and rapidly progressive stenosis, patients may experience LSS symptoms without a correlation with the size of the canal. Moreover, older patients with markedly stenotic canal may not present with clinical LSS. Hence the need to identify additional signs to guide the need for surgical intervention.

In 2010, when Barz<sup>13</sup> described the absence of sedimentation of the nerve roots to the dorsal region of the dural sac in magnetic resonance images by force of gravity as a positive “sedimentation sign”, an important sign was added for deciding on surgery. This demonstrated that in patients with LSS above L5, the sedimentation sign is positive in 94% of patients, while in patients with low back pain but no signs of stenosis, the sign was always negative.

The present study shows that patients with lumbar spinal stenosis between L1 and L5 have a positive sedimentation sign in 91.2%

**Table 3.** Results obtained in group II.

Patient	Sex	Age (years)	Canal diameter (mm)	Sedimentation sign
1	F	48	13.8	-
2	F	55	16.1	-
3	F	45	14.8	-
4	M	66	12.9	-
5	M	43	16.4	-
6	F	57	14.8	-
7	M	41	13.2	-
8	M	81	14.4	-
9	M	45	13.8	-
10	M	46	13.2	-
11	F	55	14.6	-
12	F	52	16.4	-
13	F	54	16.6	-
14	M	37	12.7	-
15	F	38	13.5	-
16	F	56	12.9	-
17	M	54	16.1	-
18	F	36	13.8	-
19	F	45	10.8	-
20	M	32	12.4	-
21	F	48	13.8	-
22	F	54	16	-
23	F	45	14.9	-
24	F	66	14	-
25	M	43	16.4	-
26	F	57	14.7	-
27	M	42	13.5	-
28	F	76	14.5	-
29	M	45	13.8	-
30	M	46	13.8	-
31	F	55	14.6	-
32	F	52	16.3	-
33	F	54	16.6	-
34	F	35	13.5	-
35	F	39	13.5	-
36	F	52	12.9	-
37	M	53	16	-
38	F	35	12.9	-
39	M	45	12.1	-
40	M	32	12.6	-

F: female, M: male, SS: sedimentation sign, +: positive, -: negative.

of cases, whereas in patients with low back pain but without clinical lumbar stenosis, it is always negative. The results presented in the series are in line with the literature.<sup>13</sup>

The sedimentation sign was identified at the level above and/or below the stenosis in 93.5% of cases in which it was positive. No difference was observed in the identification of the sign between L1 and L5, contrary to what happened between D12-L1 and L5-S1, levels at which the distribution of nerve roots is not similar to the other lumbar levels. None of the changes described were found in patients without LSS.

In our series, the selection of patients under study (case studies, retrospective study), the absence of a double-blind study on the sedimentation sign evaluation and the exclusion of patients with

stenosis at L5-S1, as well as patients with foraminal stenosis may constitute a bias of this study.

Although the results of this study suggest more than 90% sensitivity and 100% specificity, these results are certainly overestimated, taking into account that it is a retrospective, case-dependent study in which patients were already defined *ad inicium*. These results do not fail, however, to be promising and should encourage further studies to verify the diagnostic value of the sedimentation sign and its correlation with clinical signs and symptoms, such as claudication, pain, or others. In 2011, Staub et al.<sup>14</sup> published a clinical trial that attempted to demonstrate such clinical validation, that will run for 24 months and will provide data to estimate the potential benefit or harm of using the sedimentation sign as a guide for surgical decisions.

## CONCLUSION

LSS is one of the most common causes of spinal surgery, and there is frequently dissonance between the clinical and imaging findings. In patients without lumbar spinal stenosis, there is sedimentation of the roots towards dorsal dural sac due to the force of gravity.

A positive sedimentation sign in patients with LSS between L1 and L5 presents itself as a complementary sign of this identity, and its validity and predictive value is important to define in prospective studies.

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All authors declare no potential conflict of interest concerning this article.

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## REFERENCES

- Lieberman JR, editor. AAOS comprehensive orthopaedic review. Lumbar degenerative disease and low back pain. Rosemont: AAOS; 2009. p. 769-71.
- Amundsen T, Weber H, Lilleås F, Nordal HJ, Abdelnoor M, Magnaes B. Lumbar spinal stenosis. Clinical and radiologic features. *Spine (Phila Pa 1976)*. 1995;20(10):1178-86.
- Mroz T, Suen P, Payman R, Wang J. Spinal stenosis: pathophysiology, clinical diagnosis, differential diagnosis. In: Herkowitz H, Garfin S, Eismont F, Bell G, Balderston R, editors. *Rothman-Simeone the spine*. 5th ed. Philadelphia: Elsevier; 2006. p. 995-1009.
- Katz JN, Dalgas M, Stucki G, Lipson SJ. Diagnosis of lumbar spinal stenosis. *Rheum Dis Clin North Am*. 1994;20(2):471-83.
- Haak M. History and physical examination. In: Spivak J, Connolly P, editors. *Orthopaedic knowledge update spine*. 3rd. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2006. p. 43-55.
- Katz JN, Dalgas M, Stucki G, Katz NP, Bayley J, Fossel AH, et al. Degenerative lumbar spinal stenosis. Diagnostic value of the history and physical examination. *Arthritis Rheum*. 1995;38(9):1236-41.
- Chiodo A, Haig AJ, Yamakawa KS, Quint D, Tong H, Choksi VR. Magnetic resonance imaging vs. electrodiagnostic root compromise in lumbar spinal stenosis: a masked controlled study. *Am J Phys Med Rehabil*. 2008;87(10):789-97.
- Lurie JD, Tosteson AN, Tosteson TD, Carragee E, Carrino JA, Kaiser J, et al. Reliability of readings of magnetic resonance imaging features of lumbar spinal stenosis. *Spine (Phila Pa 1976)*. 2008;33(14):1605-10.
- Hamanishi C, Matukura N, Fujita M, Tomihara M, Tanaka S. Cross-sectional area of the stenotic lumbar dural tube measured from the transverse views of magnetic resonance imaging. *J Spinal Disord*. 1994;7(5):388-93.
- Carlson DH. Serpentine lumbar nerve roots. *J Can Assoc Radiol*. 1982;33(2):89-90.
- Cressman MR, Pawl RP. Serpentine myelographic defect caused by a redundant nerve root. Case report. *J Neurosurg*. 1968;28(4):391-3.
- Yu W, Lai Williams S. Spinal imaging: Radiographs, computed tomography, and magnetic imaging. In: Spivak J, Connolly P, editors. *Orthopaedic knowledge update spine*. 3rd. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2006. p. 57-68.
- Barz T, Melloh M, Staub LP, Lord SJ, Lange J, Röder CP, et al. Nerve root sedimentation sign: evaluation of a new radiological sign in lumbar spinal stenosis. *Spine (Phila Pa 1976)*. 2010;35(8):892-7.
- Staub LP, Barz T, Melloh M, Lord SJ, Chatfield M, Bossuyt PM. Clinical validation study to measure the performance of the Nerve Root Sedimentation Sign for the diagnosis of lumbar spinal stenosis. *Contemp Clin Trials*. 2011;32(3):470-4.