

Relationship between sedimentation sign and morphological grade in symptomatic lumbar spinal stenosis

P. A. Laudato¹ · G. Kulik¹ · C. Schizas²

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Abstract

Purpose We aimed to study the relationship between two morphological parameters recently described on MRI images in relation to lumbar spinal stenosis (LSS): the first is the sedimentation sign (SedS) and the second is the morphological grading of lumbar stenosis.

Materials and methods MRIs from a total of 137 patients were studied. From those, 110 were issued from a prospective database of symptomatic LSS patients, of whom 73 were treated surgically and 37 conservatively based on symptom severity. A third group consisting of 27 subjects complaining of low back pain (LBP) served as control. Severity of stenosis was judged at disc level using the four A to D grade morphological classification. The presence of a SedS was judged at pedicle level, above or below the site of maximal stenosis.

Results A positive SedS was observed in 58, 69 and 76 % of patients demonstrating B, C and D morphology, respectively, but in none with grade A morphology. The SedS was positive in 67 and 35 % of the surgically and conservatively treated patients, respectively, and in 8 % of the LBP group. C and D morphological grades were present in 97 and 35 % of patients in the surgically and conservatively treated group, respectively, and in 18 % of the LBP group. Presence of a positive SedS carried an increased risk of being submitted to surgery in the

symptomatic LSS group (OR 3.5). This risk was even higher in the LSS patients demonstrating grade C or D morphology (OR 65).

Discussion and conclusion One-third of surgically treated LSS patients do not present a SedS. This sign appears to be a lesser predictor of treatment modality in our setting of symptomatic LSS patients compared to the severity of stenosis judged by the morphological grade.

Keywords Lumbar spinal stenosis · Morphological stenosis grade · Sedimentation sign · Imaging studies · Classification

Introduction

Symptomatic lumbar spinal stenosis (LSS) is common in the elderly population. Treatment is dependent not only on clinical symptoms but also on radiological findings. There is no consensus on the radiological classification of LSS. Dural sac cross-sectional area (DSCA) has been the main radiological measurement used in clinical practice but it does not always correspond to the degree of entrapment of the neural structures. Radiological LSS is considered moderate when DSCA is less than 100 mm² and severe if DSCA is less than 75 mm² [1]. Nevertheless, there is a significant overlap in DSCA values between symptomatic and asymptomatic individuals [2]. To overcome those shortcomings, recently clinicians have been looking into morphological parameters to grade radiological LSS.

The morphological grading (Fig. 1) of LSS severity based on the rootlet/cerebrospinal fluid relationship as seen on axial MRI images is an attempt to classify stenosis based on qualitative rather than quantitative criteria [3].

✉ C. Schizas
cschizas@hotmail.com

¹ Department of Orthopedics, Centre Hospitalier Universitaire Vaudois, University of Lausanne, Avenue Pierre-Decker 4, Lausanne, Switzerland

² Neuro-Orthopaedic Spine Unit, Hirslanden Group of Private Hospitals, Clinique Cecil, Lausanne, Switzerland

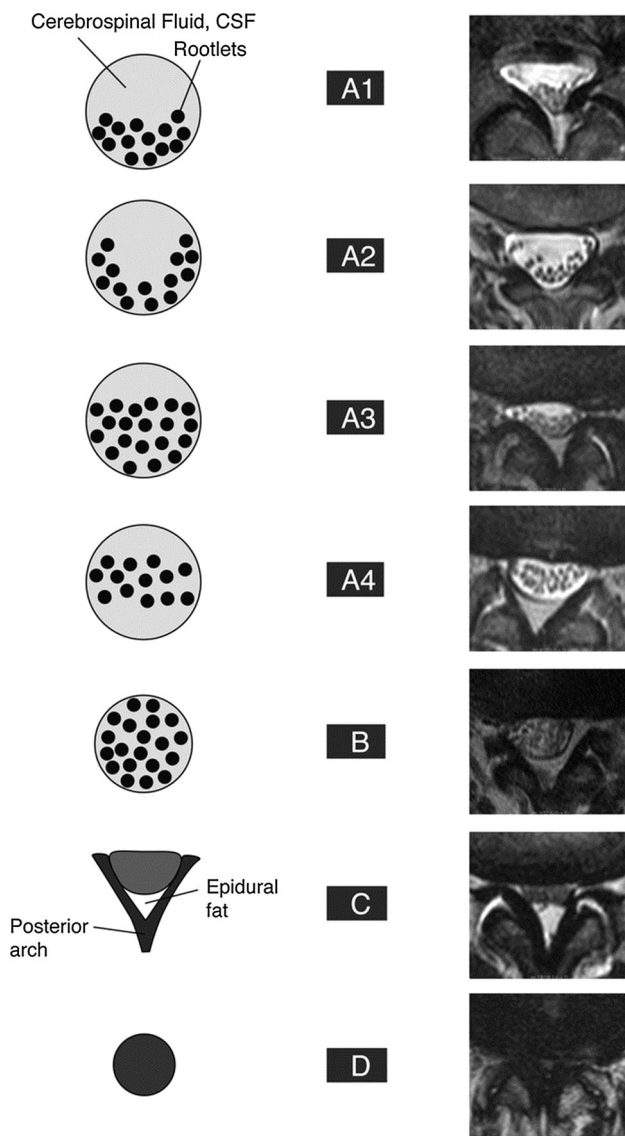


Fig. 1 Description of the morphologic classification of spinal stenosis combining graphic and MRI examples [3]

The grading comprised 4 grades (A to D) and has been shown to carry a prognostic value with C and D grades being strong predictors of failure of conservative measures [odds ratio (OR) 29.8].

Barz et al. proposed another morphological sign namely the nerve root sedimentation sign (Fig. 2) which allows to discriminate between symptomatic and asymptomatic patients [4].

Indeed, nerve rootlet abnormalities on spinal imaging such as so-called nerve root clumping have been described previously in arachnoiditis and degenerative conditions such as spinal stenosis [5, 6].

Barz et al. described those abnormalities as a sedimentation abnormality and aimed at testing the hypothesis that

this sign could help in distinguishing LSS from low back pain (LBP) patients.

They suggested that a positive sign is to be regarded as an additional pathomorphologic sign used in combination with other tests.

The sign is considered positive if there is absence of sedimentation of rootlets in supine position in axial MRI images, more than half of the dural sac being therefore, occupied by nerve tissue. This configuration corresponds in fact to the A3 grade of the morphological classification by Schizas et al.

This sign is sought according to the authors in at least one transverse MRI scan, at a level above or below, disregarding the location of the scan within the level and its proximity to the maximal stenosis. Practically speaking this corresponds to the level of the pedicles. In their study, 100 patients with a DSCA $<80 \text{ mm}^2$ and a walking distance less than 200 m were compared to 100 patients with DSCA $>120 \text{ mm}^2$ and a walking distance greater than 1000 m. In the former group, the sedimentation sign was positive in 94 % of cases while in the latter it was negative in all cases.

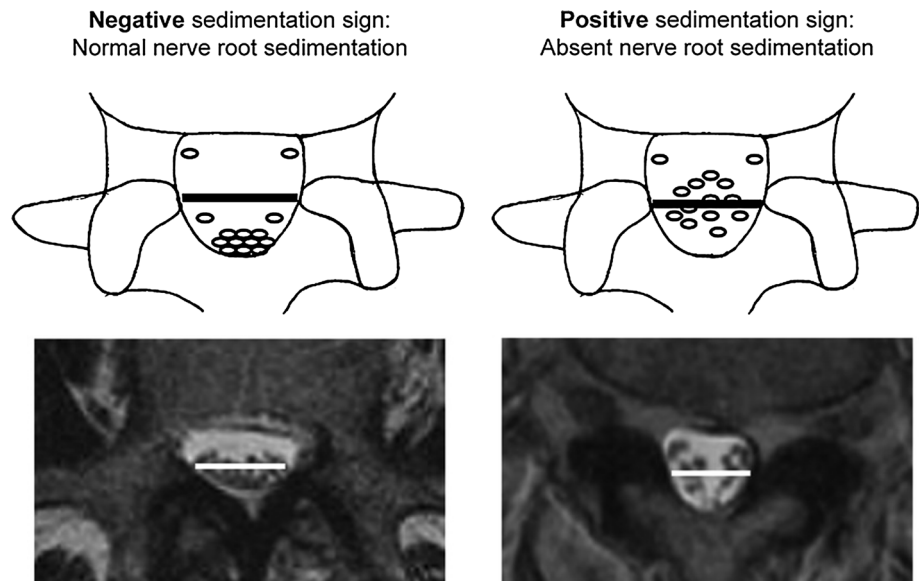
The aim of the present study was to investigate the relationship between those two radiological descriptions and respective clinical implication.

Materials and methods

A total of 137 subjects were included in this study with an average age of 70 years and a female/male ratio of 1.36. Patients were divided into three groups: the first two groups comprised 110 patients from our prospective LSS database for whom MRI images were available in the PACS system of our institution. All 110 had symptomatic LSS with neurogenic claudication. From this LSS group 73 were treated surgically and 37 conservatively based on pattern and severity of symptoms. All surgical patients had symptoms non-responding to conservative measures for a period of at least 6 months. Patients were offered surgery providing that MRI imaging confirmed spinal stenosis. No measurement or structured grading was performed on MRIs prior to the patients being offered surgery. All surgical patients had lower limb symptoms classical of spinal stenosis (pain and or sensory symptoms on walking improved by either bending forward or sitting down).

None of the conservatively treated patients underwent surgery during the follow-up period that was of 38 months (range 24–68). A control group of 27 subjects with low back pain and no claudication (LBP group) constituted the third group. We are not reporting on clinical results of the surgical group, comparison of surgical and non-surgical

Fig. 2 Nerve root sedimentation sign: comparison of MRI scans with a negative sedimentation sign (*left*) and a positive sedimentation sign (*right*) [4]



treatment in LSS being outside the scope of the present study.

Two spine surgeons examined T2 MRI images using the Osirix software and studied the morphological grade of stenosis at all lumbar disc levels and looked for evidence of positive sedimentation sign (i.e. A3 in the morphological grade), the latter being measured above and/or below the level of maximal stenosis, at pedicle level. This was done in accordance with the recommendations of the original Barz et al. paper as well as personal communication to us by the authors who state that “at the level of the stenosis, nerve roots lie tightly packed in the dural sac and, therefore, cannot be identified and judged adequately” [4].

Ethical committee approval was obtained for this study. Statistical analysis included χ^2 , χ^2 trend and OR. Additionally we calculated sensitivity and specificity of the sedimentation sign and the morphological grade.

Results

We found the presence of C or D morphological grades in 97 % (71/73) of the surgical group, in 35 % (13/37) of the conservative group and in 18 % (5/27) of the LBP group.

The sedimentation sign was positive in 67 % (49/73) of the surgically treated patients, in 35 % (13/37) of the conservatively treated patients and only in 8 % (2/25) of the LBP patients.

The more severe the morphological grade, the greater the proportion of patients presented a positive sedimentation sign (χ^2 trend = 49, $P < 0.001$): no patient with grade A morphology had a positive sedimentation sign, while it was present in 58 % of those with grade B

(moderate) stenosis. In patients with grade C (severe) and D (extreme) stenosis, the sedimentation sign was positive in 69 and 76 % of cases, respectively.

Sensitivity and sensitivity of sedimentation sign

LSS vs LBP groups

Comparing patients with symptomatic LSS (both surgically and conservatively treated) and LBP subjects, we found that the presence of a positive sedimentation sign in the LSS group had a sensitivity of 56 %, a specificity of 93 %, a positive predictive value 97 % and a negative predictive value of 34 %. The presence of a positive sedimentation sign carried an OR of 16 between those two groups.

Surgically vs conservatively treated groups

While comparing the two groups of patients with LSS who were either treated surgically or conservatively, we found that the presence of a positive sedimentation sign in the surgical group carried a sensitivity of 67 %, a specificity of 65 %, a positive predictive value 79 % and a negative predictive value of 50 %. The positive sedimentation sign carried an OR of 3.5 between those two LSS groups.

Sensitivity and sensitivity of morphological grade

LSS vs LBP groups

Comparing patients with symptomatic LSS and LBP subjects, we found that the presence of a C or D grade in the LSS group had a sensitivity of 76 %, a specificity of 92 %, a positive predictive value 97 % and a negative predictive value of 34 %.

a positive predictive value 94 % and a negative predictive value of 45 %. The presence of a C or D morphological grade carried an OR of 14 between those two groups.

Surgically vs conservatively treated groups

While comparing the two groups of patients with LSS who were either treated surgically or conservatively, we found that the presence of a C or D grade in the surgical group carried a sensitivity of 97 %, a specificity of 64 %, a positive predictive value 85 % and a negative predictive value of 92 %. The presence of a C or D morphological grade was a strong predictor of surgical treatment in the LSS group with an OR of 65 ($P < 0.001$).

Discussion and conclusion

We found a clear link between the presence of a sedimentation sign and the severity of stenosis according to the morphological grade as witnessed by the significance of the Chi^2 trend test result.

The main difference though is that the OR considering C and D grades together is higher than the presence of a positive sedimentation sign (65 vs 3.5) in predicting need for surgery in our cohort.

In addition, there is an important difference between the two morphological descriptions studied. The sedimentation sign might be used to differentiate between two patient cohorts but in itself cannot be used in deciding which particular level needs decompression. It is certainly an interesting research tool but it might not be as useful as the morphological grade in everyday clinical practice. It has been our practice to offer decompression mainly to C and D patients even though this practice predated the description of the grading system itself. This practice has not been limited to our unit, a recent survey demonstrated that most surgeons would decompress C and D grades irrespective of the DSCA given that symptoms are severe enough to warrant surgical treatment [7].

In the original study describing the sedimentation sign, the authors have excluded patients with DSCA between 80 and 120 mm^2 . This population though might include patients with stenosis symptomatic enough to warrant surgery and a decision tool would be useful in deciding on their treatment. The sedimentation sign can perhaps give some information but as we found, up to a third of patients with C and D grades (i.e. with myelographic blocs) would have a negative sedimentation sign. If we were to base decision only on the sedimentation sign, surgery would be denied in a significant proportion of those patients with DSCA ranging from 80 to 120 mm^2 . Indeed there are patients with C and D grades that have DSCA within this range [7].

There have been several other publications on the sedimentation sign since its original description. There appears to be nevertheless a misconception of the sedimentation sign which should be measured above or below the level of maximal stenosis, practically at pedicle level.

Since stenosis is progressive on the cranio-caudal direction within one motion segment, minimal or non-existent at pedicle level [8], maximal at disc level, evaluation of the sedimentation sign could differ between closely related slices. This was not mirrored by the inter- and intra-observer reliability of the sedimentation sign, which is reassuring. Nevertheless, testing the sedimentation sign in different setting than in the originating team would be interesting. It was similarly found that kappa values for reliability were lower if the morphological grading was tested outside the unit that initially described it [3].

Fazal et al. [9] did a very interesting study on the usefulness of the sedimentation sign. They reported that 90 % of decompressed levels in a cohort of 71 patients demonstrated a positive sedimentation sign. The main problem though was that they evaluated the sedimentation sign at disc level as seen in their figure and not above or below the area of maximal stenosis. In addition, they evaluated the sedimentation sign at every disc level. Sedimentation sign has been described as a single sign to be evaluated at a given level of the lumbar spine for each individual patient and not at every level. In essence they looked at the presence of any grade more severe than A3. Indeed the A3 grade of the morphological classification is defined as the one where the rootlets fill more than half of the dural sac in the supine position. If we analyse their results with this in mind we find a good relation with current clinical practice. Indeed Fazal et al. suggest that levels with morphology equivalent to A3 or less should not be included in the decompressive procedure, similar to what a survey on the subject has already shown [7]. It is also not surprising that nearly 90 % of their decompressed levels had grades at least as severe as A3. Whereas most surgeons in the above survey would agree that grades C and D need to be decompressed, B grades and to a greater extent A3 grades lie in a grey area. It has also been our practice to only decompress those levels if they are adjacent to levels to be fused since we have frequently observed progression of stenosis in such levels requiring decompression. Further studies on this subject would be of great interest since to our knowledge there are no clear guidelines.

Another study on the sedimentation sign was published recently by Macedo et al. [10]. They evaluated the sedimentation sign at pedicle level as shown in the images included, which is in accordance with the methodology of the original study. They found that the sedimentation sign was positive in 2, 23 and 54 % of patients with disc herniation, lateral stenosis and central stenosis, respectively.

Finally the originators of the sedimentation sign studied the validity of their sign in a cohort of LSS patients. They found that the sedimentation sign was positive in 56 and 36 % of surgical and conservatively treated patients, respectively. They also found that patients with positive sedimentation sign treated conservatively had a worse outcome. Sedimentation sign in contrast did not predict outcome of surgically treated patients.

Both above-mentioned studies confirm that there is a link between sedimentation sign and LSS. They fail nevertheless to prove the usefulness of the sedimentation sign as a decision-making tool for a specific patient or for surgical decompression indication at specific spinal segment.

There is on-going debate on the relationship between imaging and symptoms in LSS as shown on the Wakayama Spine Study [11]. The authors of that study found that 30 % of patients aged 66 years on average have severe stenosis but only 17 % are symptomatic. It would be interesting to know the prevalence of sedimentation sign and C or D grades in the above population. More importantly further studies are needed to establish more accurately the progression of symptoms in populations of patients with asymptomatic severe LSS.

Neither of those signs on their own can diagnose LSS but have to be regarded as elements helping in the diagnosis and therapeutic decisions. The sedimentation sign has not been used to our knowledge in deciding what treatment should be applied in LSS. By contrast a recent study reported that grades C and D among other parameters were significantly associated with a higher possibility of a surgical decision [12].

Both sedimentation sign and morphological grade might be useful tools in LSS but further evaluation by independent investigating teams in different patient cohorts is required before their widespread acceptance.

Conflict of interest None.

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