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CURRENT STATE OF CT/MRI SPINAL CANAL STENOSIS DIAGNOSIS AT THE LUMBOSACRAL LEVEL (REVIEW)

Сучасний стан СТ/МРТ діагностики стенозу хребетного каналу на попереково-крижовому рівні (Огляд літератури)

Abstract

Issues of epidemiology, classification and radiological signs of the spinal stenosis in this review are present. Modern European criteria for spinal stenosis and radicular openings can improve the diagnosis of the condition of the spinal cord and roots; clarify the criteria for indications for surgical treatment.

Keywords: *spinal canal stenosis, CT/MPI, diagnosis.*

Резюме

У огляді представлені питання епідеміології, класифікації та рентгенологічних ознак стенозу хребетного каналу. Сучасні європейські критерії хребетного стенозу та радикулярних отворів можуть покращити діагностику стану спинного мозку та корінців, уточнити критерії показань до хірургічного лікування.

Ключові слова: *стеноз спинномозкового каналу, СТ/МРТ, діагностика.*

INTRODUCTION

Spinal stenosis is a condition in which part of the spinal canal (PC) narrows to a point where it can exert pressure on the nerves passing through the spine.

More and more patients complain of pain in the lumbar spine associated with narrowing of the PC. In patients over 65 years of age, narrowing of the spinal canal is the most common indication for surgical interventions.

The literature constantly discusses the issue of congenital or acquired causes of the development of compression syndromes in patients with PC stenosis. Degenerative-dystrophic changes in the spine often become a source of constant trauma to the roots and spinal cord (SC) and cause the development of compression neurological symptoms and syndromes. Clinical polymorphism of the manifestations of PC stenosis significantly increases the number of diseases with which differential diagnostics have to be carried out (SM tumors, multiple sclerosis, amyotrophic lateral sclerosis (ALS), syringomyelia, Strumpel's disease, etc.) [1].

EPIDEMIOLOGY

The most commonly affected area is the lumbar spine, followed by the cervical spine. Men suffer more than women (except in cases of degenerative spondylolisthesis). Prevalence increases with age – most newly diagnosed patients are older than 50 years.

ANATOMICAL CLASSIFICATION

Central – narrowing of the central parts of the spinal canal, the Jones-Thomson coefficient less than 0,22.

Lateral – most often due to the formation of osteophytes.

Foraminal – between the medial and lateral border of the leg of the vertebra extraforaminal –

the narrowing zone is located laterally with respect to the lateral edge of the leg.

RATING SYSTEM

Sagittal T1-weighted imaging was the main sequence evaluated in conjunction with T2-weighted images, also used as an additional tool to exclude false-positive results from misinterpretation of perineural cysts or nerve root edema. This evaluation system was proposed without changing the classic MRI protocol. Four degrees of stenosis were developed using a modification of the Kunogi and Hasue classification:

- Grade 0 refers to the absence of foraminal stenosis;
- Grade 1 refers to mild stenosis of the foraminal opening, showing obliteration of the perineural fat surrounding the nerve root in two opposite directions (vertical or transverse). It includes contact with the upper and lower parts of the nerve root or the front and rear parts of the nerve root. No evidence of a morphological change in the nerve root is detected.
- Grade 2 refers to moderate stenosis of the foraminal foramen, showing obliteration of the perineural adipose tissue surrounding the nerve root in four directions without morphological changes in both the vertical and transverse directions.
- Grade 3 refers to severe foraminal stenosis, showing collapse of the nerve root or morphological changes in the root [2].

The North American Spine Society defines degenerative lumbar spinal stenosis as "a condition in which there is limited space available for nerve and vascular elements in the lumbar spine and is secondary to degenerative changes in the spinal canal". Since this definition focuses on anomalies of the anatomical space, visualization can be considered anatomical as a method of choice for diagnosis.

However, the literature does not contain a detailed specification of radiological criteria for describing the presence of stenosis or parameters for classifying the degree of stenosis of the lumbar spine. The lack of clear unified radiological signs is one of the main problems of stenosis of the lumbar spine.

CENTRAL STENOSIS

One of the first coefficients proposed for measuring the degree of stenosis of the spinal canal of the lumbosacral spine was the Jones-Thomson coefficient (Fig. 1).

A group of researchers proposed 8 main radiological criteria for measuring the degree of central spinal stenosis (Fig. 2) [3]:

1. The cross-sectional area of the dural sac;
2. The cross-sectional area of the left and right side channels (including the total);
3. The total cross-sectional area of the dural sac and side channels;
4. The anteroposterior diameter of the dural sac;
5. The transverse diameter of the dural sac;
6. The distance of the ligamentous interface;
7. Depth of the side channel;
8. The lateral angle of the recess.

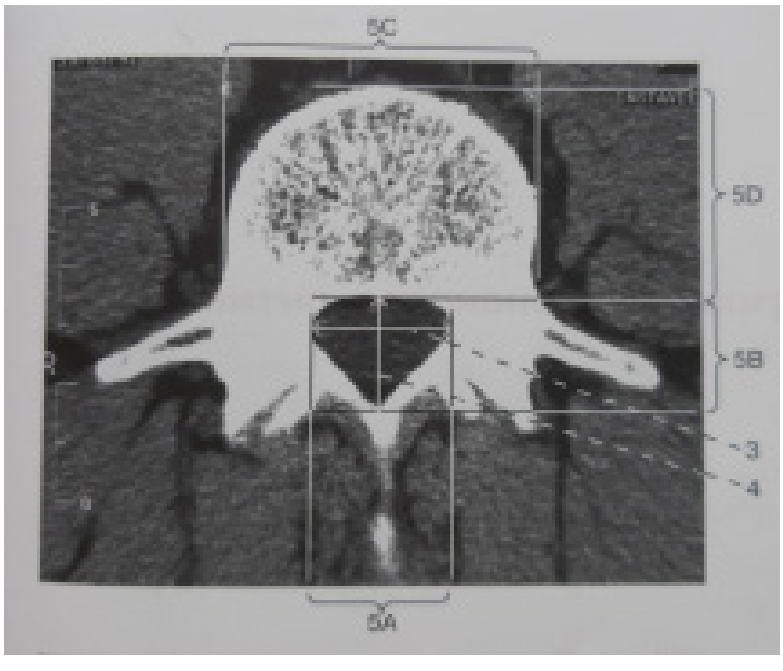

Figure 1. The measurement scheme of the Jones-Thomson coefficient.
Johnson-Thomson ratio = A × B/C × D. A is the width of the spinal canal; B – sagittal size of the spinal canal; C – vertebral body width; D – sagittal size of the vertebral body.
Between 0,5 and 0,22 = normal. Stenosis with a ratio of less than 0,22

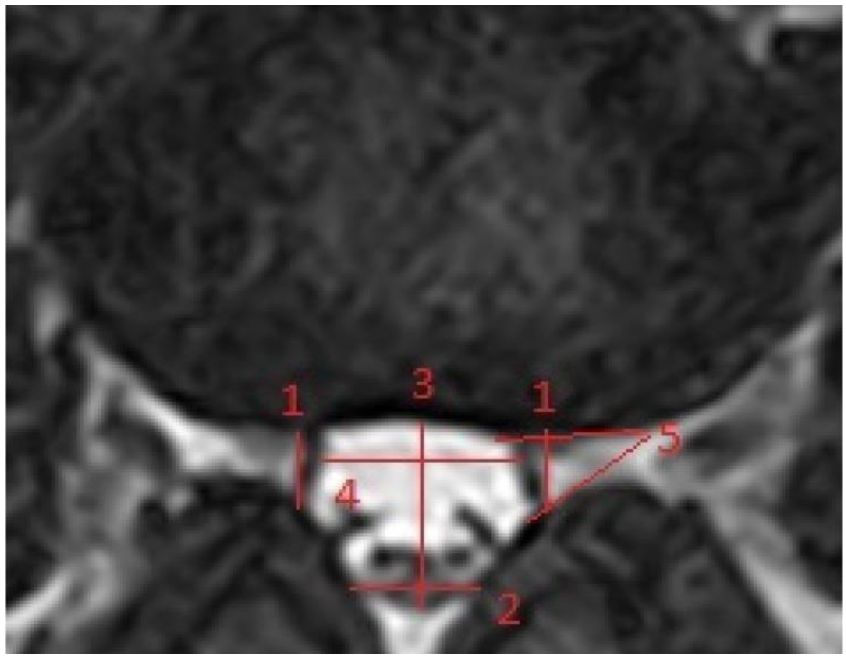

Figure 2. Scheme of the modern 8 basic radiological criteria calculation.
Measurements of linear dimensions of the spinal canal. 1. Depth of a side pocket; 2. The distance of the ligamentous interface; 3. The anteroposterior diameter of the dural sac; 4. The transverse diameter of the dural sac; 5. The angle of the side recess

The anteroposterior diameter of the dural sac is the distance between the middle of the vertebral body and the posterior wall of the dural sac. The critical value varies with different measurement zones (< 10 to < 15 mm).

Some research criteria used the «anteroposterior diameter of the spinal canal», but the authors concluded that its diagnostic value was limited. So, Bolender et al. (2015) suggested that this parameter had a lower value than the assessment of the contrast zone of the dural sac in myelograms (20% versus 83% of a clear diagnosis).

Deformation of the dural sac is considered to be a more objective indicator of spinal stenosis, since compression of the nerve elements in itself causes clinical signs of stenosis.

At the same time, narrowing of the spinal canal without deformity of the dural sac is not a sign of stenosis, because the anatomy of the spinal canal can vary in different patients.

The transverse diameter (size) of the dural sac is the distance between the lateral borders of the dural sac at the level of the lateral canals. Criteria are evaluated in 2 studies. The critical value for stenosis is < 15 – < 16 mm. The measurement zones are different.

Cross sectional area of the dural sac – the critical value is from < 75 to < 130 mm^2.

Interfacial distance – the distance between the inner surfaces of the yellow ligaments on the line connecting the joint space of the facet joints. Critical values are < 15 – < 16 mm. The measurement zones are different.

The depth of the side pocket is the distance between the upper articular facet and the upper part of the leg. Critical values are ≤ 3,6 to < 2 mm. The measurement zones are different.

Side recess angle – the angle between lines parallel to the bottom point and the roof of the side recess. Critical value < 30 °.

FORAMINAL STENOSIS

Lumbar-foraminal stenosis is defined as a narrowing of the bony exit of the nerve root caused by a decrease in the height of the intervertebral disc, osteoarthritic changes in the facet joints, subluxation of the head of the superior articular process of the lower vertebra and thickening of the ligamentum flavum or fibrous ring.

MRI is widely used to assess stenosis of the lumbar spine; however, there is no widely used diagnostic criterion or classification system for lumbar-foraminal stenosis in MRI. Several reports have been received on the classification of lumbar-foraminal stenosis in MRI [4, 5].

The rating system proposed by Wildermuth et al. focuses only on the degree of obliteration of epidural fat [4]. The classification of lumbar-foraminal stenosis proposed by Kunogi and Hasue included the anteroposterior, cephalocaudal, and peripheral types, without a degree of stenosis score [6]. Assessment System Wildermuth et al. and the classification proposed by Kunogi and Hasue does not take into account direct compression or deformation of the nerve root, which may be important.

S. Lee et al. created a new system for assessing the degree of foraminal stenosis, which is a

modification of previous systems and takes into account the type of stenosis, the amount of obliteration of fat and the presence of compression of the nerve root (Fig. 3–6) [2].

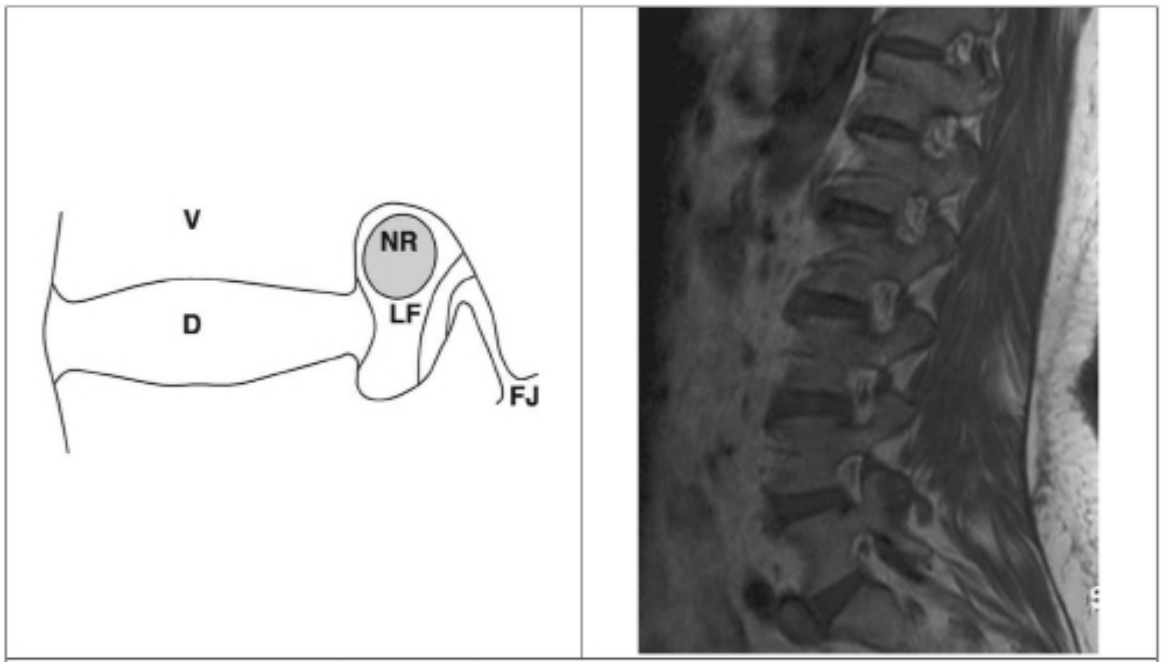

Figure 3. Grade 0 refers to the absence of foraminal stenosis.
A sagittal cross-sectional diagram of the hole shows the relationship between the hole and surrounding structures. NR = nerve root; V = vertebral body; D = intervertebral disc; LF = yellow ligament, FJ = facet joint

Grade 1 refers to moderate foraminal stenosis, showing obliteration of perineural fat in two opposite directions, vertical or transverse.

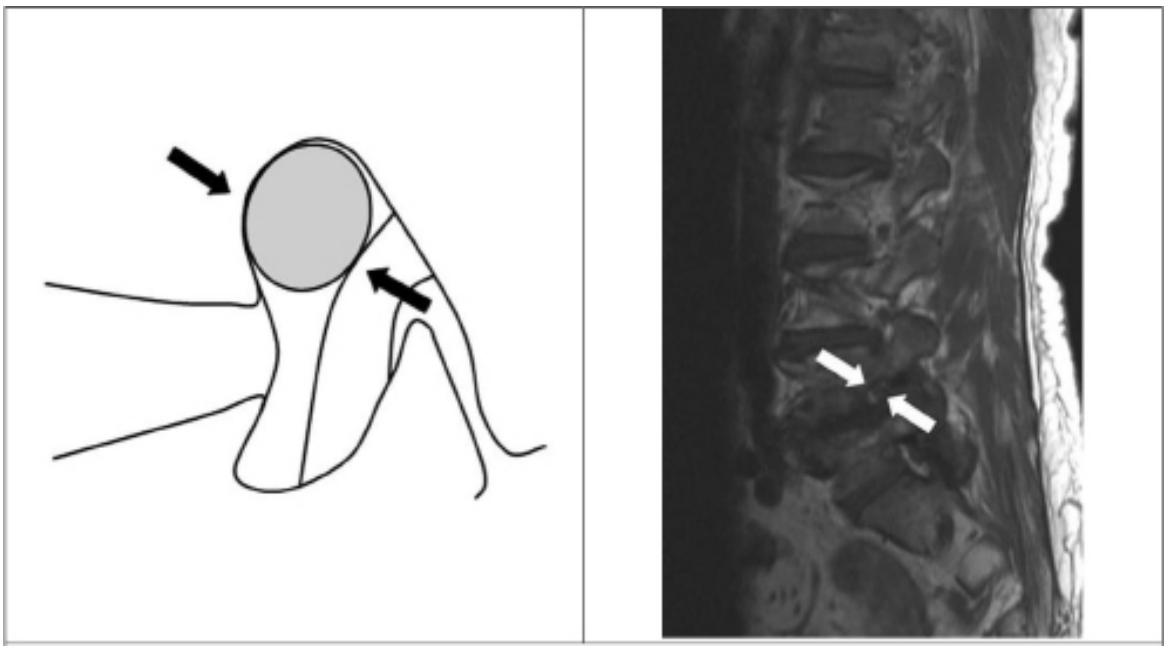

Figure 4. Degree 1 of foraminal stenosis. The diagram shows the obliteration of perineural fat around the nerve root in the transverse direction (arrows). There is a narrowing of the upper width of the hole due to the narrowing of the disk space and the thickened ligament of the flavum. No signs of a morphological change in the nerve root were found

Grade 2 refers to moderate foraminal stenosis, which shows obliteration of perineural fat in four directions without morphological changes in the root, both in the vertical and transverse directions.

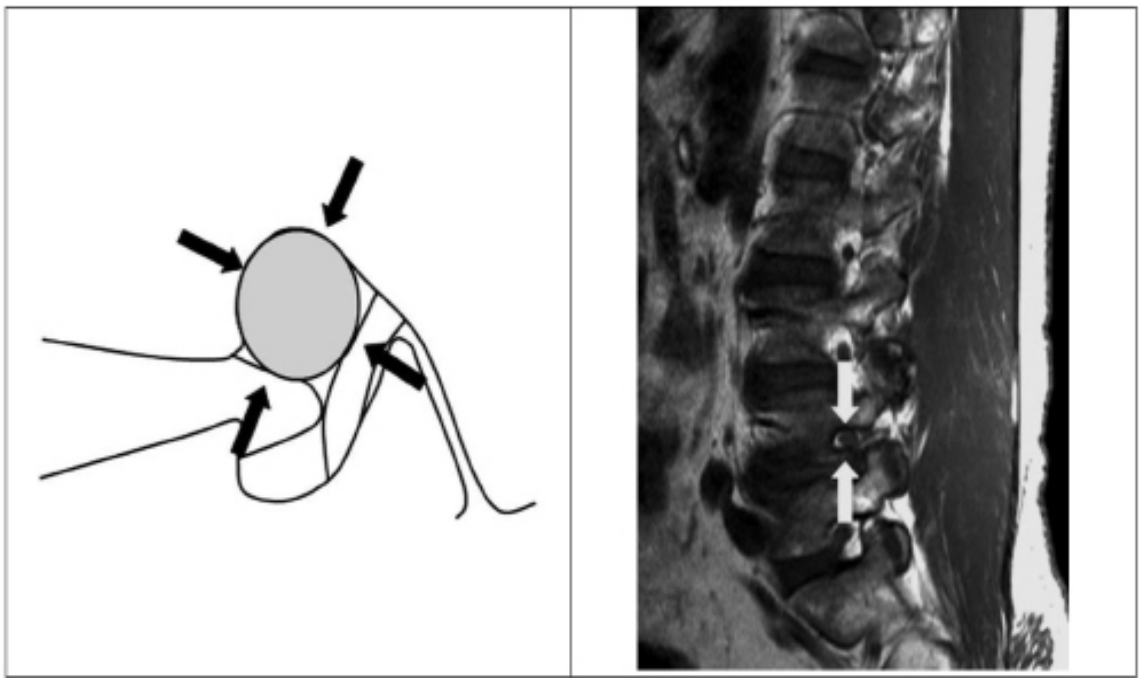

Figure 5. Degree 2 of foraminal stenosis. The diagram shows the obliteration of perineural fat around the nerve root in four directions (vertical and transverse) (arrows) without morphological changes. A narrowing of the width and height of the foraminal opening is observed, due to narrowing of the disk space, a thickened yellow ligament, arthropathy of facet joints and disco-osteophytic protrusion in the foraminal zone. No signs of a morphological change in the nerve root were found

Grade 3 refers to severe spinal canal stenosis, showing nerve root collapse or morphological change.

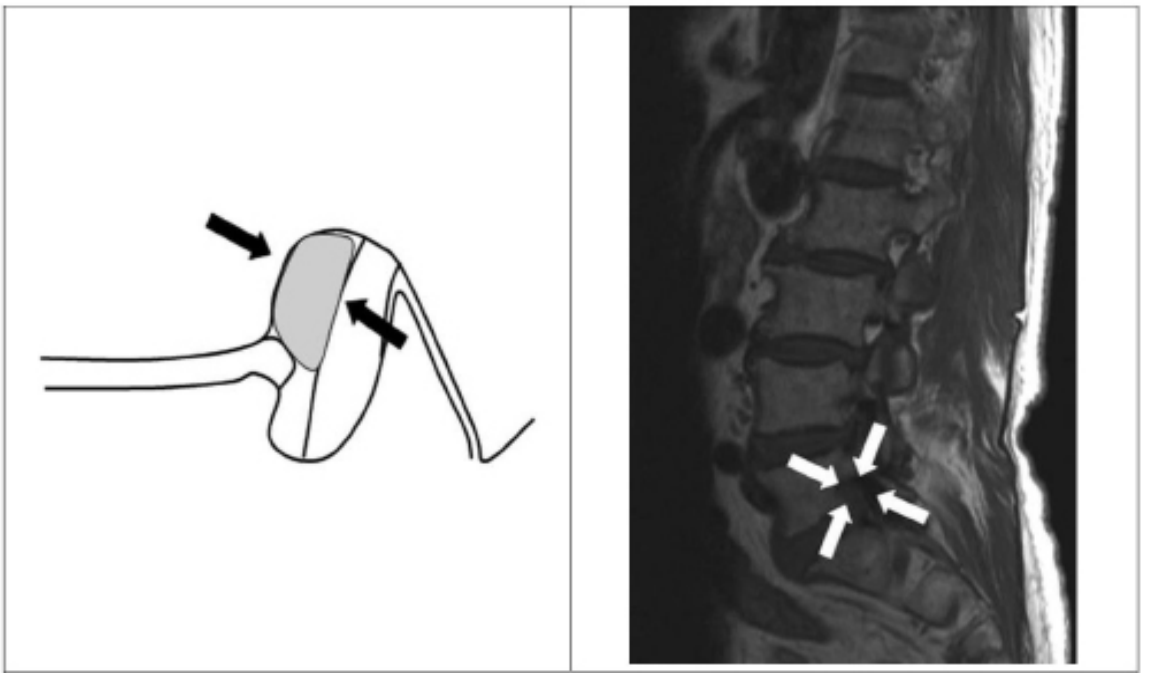

Figure 6. Degree 3 of foraminal stenosis. The schematic diagram shows the collapse of the nerve root or morphological change (arrows) due to a serious narrowing of the disk space, a markedly thickened yellow ligament, faceted arthropathy and disco-osteophytic protrusion in the foraminal zone

According to research, operational data in all cases showed that the nerve root of the symptomatic side was compressed for several reasons: 1) hypertrophic facet (mainly the upper facet), 2) osteophytes of the marginal end plate, 3) disk damage, such as convex and

calcified disc, 4) thickened yellow ligament and foraminal ligaments [7]. The compressed nerve root was swollen and with signs of venous stasis around it. These causes were eliminated using a decompression procedure, and the operation was finally completed after it was clearly established that the decompressed nerve root moved freely.

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