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CORRELATION OF MAGNETIC RESONANCE IMAGING DATA (MRI) AND CLINICAL SIGNS IN THE CASE OF THE LUMBAR MEDULLARY CANAL STENOSIS

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Introduction. The stenosis of the spine may also occur as a congenital developmental problem with a small caliber of the spinal canal, but it is usually acquired, due to dislocation of the disc, hernia, hypertrophy of facets and hypertrophy of the flavum ligament. Patients with lumbar canal stenosis may have pain in the area of the buttocks or lower extremities pain, radiculopathy or neurogenic claudication. Pain in the lower back region is very common in patients with lumbar stenosis, it is not due to stenosis, but results from degenerative changes in the lumbar spine, which just leads to stenosis. The MRI without contrast enhancement is considered the best imaging way for the diagnosis of spinal stenosis.
Aim is to assess clinical signs in correlation with Magnetic Resonance Imaging data in the case of lumbar spinal canal stenosis.
Material and methods. The study included 51 patients with low back pain radiating to the leg. All patients underwent a clinical neurological examination and imaging examination (especially, MRI of the lumbar spine).
Results. In 11 (91.7%) patients with imaging signs of spinal canal narrowing, a combination of degenerative changes was present, such as facet joint osteoarthritis, ligamentum flavum hypertrophy and intervertebral disc herniations (of which in one patient (9.1%) spinal canal narrowing was associated with L5-S1 intervertebral disc extrusion, and in 10 (90.9%) patients spinal canal narrowing was associated with various types of intervertebral disc prolapse with polysegmental localization). In only one patient (8.3%) was an association detected between spinal canal narrowing and cerebrospinal fluid flow disturbance, the spinal stenosis being congenital. Multivariate analysis with clinical symptoms suggested a correlation between lumbar spinal stenosis and loss of sensation in the lower limb, the significance threshold being only 10% ($p < 0.10\%$). Cerebrospinal fluid flow disturbance, however, demonstrated a significant correlation with numbness ($p < 0.10\%$).
Conclusion. A correlation was determined between lumbar spinal canal stenosis and loss of sensitivity in the lower limb, the significance threshold being 10% ($p < 0.10\%$). In the case of cerebrospinal fluid flow disturbance, a significant correlation with numbness was demonstrated ($p < 0.10\%$).
Key words: stenosis of the spine, MRI examination.

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КОРЕЛЯЦІЯ ДАНИХ МАГНІТНО-РЕЗОНАНСНОЇ ТОМОГРАФІЇ (МРТ) ТА КЛІНІЧНИХ ОЗНАК ПРИ СТЕНОЗІ ПОПЕРЕКОВОГО СПИННОМОЗКОВОГО КАНАЛУ
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Вступ. Стеноз хребетного каналу може виникати як вроджена патологія з вузьким просвітом хребетного каналу, але найчастіше він є набутим внаслідок зміщення диска, грижі, гіпертрофії фасеткових суглобів або зв'язки жовтої (ligamentum flavum). Пацієнти зі стенозом поперекового каналу можуть мати біль у ділянці сідниць або нижніх кінцівок, радикулопатію чи нейрогенну

кульгавість. Біль у поперековій ділянці є дуже поширеним у таких пацієнтів, проте він не завжди викликаний саме стенозом, а частіше є наслідком дегенеративних змін у поперековому відділі хребта, які і призводять до стенозу. МРТ без контрастного підсилення вважається найкращим методом візуалізації для діагностики стенозу хребетного каналу.
Мета – оцінити клінічні ознаки в кореляції з даними магнітно-резонансної томографії у разі стенозу поперекового хребетного каналу.
Матеріали та методи. У дослідження був включений 51 пацієнт із болем у попереку, що іррадіював у ноги. Усі пацієнти пройшли клініко-неврологічне обстеження та візуалізаційне дослідження (особливо МРТ поперекового відділу хребта).
Результати. У 11 пацієнтів (91,7%) із ознаками звуження хребетного каналу на зображеннях спостерігалася комбінація дегенеративних змін, таких як остеоартрит фасеткових суглобів, гіпертрофія зв'язки жовтої та грижі міжхребцевих дисків (у одного з пацієнтів (9,1%) стеноз хребетного каналу був асоційований із екструзією диска на рівні L5-S1, а в 10 (90,9%) – з різними типами пролапсу диска з багатосегментарною локалізацією). Лише в одного пацієнта (8,3%) було виявлено зв'язок між стенозом хребетного каналу та порушенням току спинномозкової рідини – стеноз був вродженим. Багатофакторний аналіз клінічних симптомів виявив кореляцію між поперековим стенозом хребетного каналу та втратою чутливості в нижній кінцівці, поріг значущості становив лише 10% ($p < 0,10$). Порушення току спинномозкової рідини також показало значущу кореляцію з онімінням ($p < 0,10$).
Висновок. Встановлено кореляцію між стенозом поперекового хребетного каналу та втратою чутливості в нижній кінцівці ($p < 0,10$). У разі порушення току спинномозкової рідини також доведено значущу кореляцію з онімінням ($p < 0,10$).
Ключові слова: стеноз хребетного каналу, МРТ-дослідження.

Introduction

Lumbar spine stenosis is an anatomical condition that frequently affects patients over 60 years old. The degenerative lumbar stenosis of the spine is caused by the decrease of the space for the neuronal and vascular elements in the lumbar channel, secondary to the degenerative lumbar changes [1]. The stenosis of the spine may also occur as a congenital developmental problem with a small caliber of the spinal canal, but it is usually acquired, due to dislocation of the disc, hernia, hypertrophy of facets and hypertrophy of the flavum ligament. Patients with lumbar canal stenosis may have pain in the area of the buttocks or lower extremities pain, radiculopathy or neurogenic claudication. Neurogenic claudication is defined as radiculopathy or pain and weakness at one extremity or both lower extremities, which worsen with walking and can be improved if the patient stops or bends forward [2; 3]. The MRI without contrast enhancement is considered the best imaging way for the diagnosis of spinal stenosis [3; 4; 5]. Pain in the lower back region is very common in patients with lumbar stenosis, it is not due to stenosis, but results from degenerative changes in the lumbar spine, which just leads to stenosis [6].

Lumbar spinal stenosis is usually caused by narrowing of the spinal canal or foramina due to a combination of degenerative changes, such as facet osteoarthritis, ligamentum flavum hypertrophy, and disc herniation. Anteroposterior spinal canal diameter of less than 12 mm is suggestive of stenosis [7]; however, the cross-sectional area of the dural sac is more appropriate in the diagnosis of spinal canal stenosis. Values of the cross-sectional area of the dural sac <76 mm² indicate a severe stenosis, while values between 76–100 mm² indicate a moderate stenosis [8; 9].

It is assumed that the symptoms of lumbar spinal stenosis result from venous congestion or ischemia of the nerve roots due to compression [10]. It has been experimentally demonstrated that moderate constriction-induced pressure on the nerve roots will disrupt their nutrition, and subsequent experimental studies have confirmed this hypothesis [11; 12]. The clinical impact of these changes is related to the speed at which the compression develops [13; 14].

Degenerative lumbar stenosis, anatomically, may involve the spinal canal, the lateral recesses, the foramina, or any combination thereof. Spinal canal stenosis may result from a decrease in anteroposterior diameter, transverse diameter, or combined with the consequences of decreased disc height with or without intervertebral disc prolapse and hypertrophy of the facet joints and ligamentum flavum. Fibrosis is the primary cause of ligamentum flavum hypertrophy, being driven by compression, particularly along the dorsal aspect of the ligamentum flavum. Transforming growth factor (TGF)-β released by endothelial cells may stimulate fibrosis, especially in the early phase of hypertrophy [15]. The same processes, decreased disc height, facet joint hypertrophy (with or without spondylolisthesis), and/or vertebral endplate osteophytosis, may also lead to lateral recess stenosis. Foraminal stenosis can be transversely resulting from a combination of disc space narrowing and overgrowth of structures anterior to the facet joint capsule and/or vertically resulting from posterolateral osteophytes from the vertebral endplates protruding into the foramen together with a laterally bulging annulus fibrosis or herniated disc compressing the nerve root against the superior pedicle [16]. Foraminal stenosis most commonly involves the L5 nerve root, as the L5-S1 foramen is the smallest one relative to the root foramen/area [16].

Aim

The aim is to assess clinical signs in correlation with Magnetic Resonance Imaging data in the case of lumbar spinal canal stenosis.

Materials and methods

The study included 51 patients with low back pain radiating to the leg. All patients underwent a clinical neurological examination and imaging examination (especially, MRI of the lumbar spine).

The clinical examination included: history of the disease, Visual Analogue Pain Scale, psychological changes assessment scale (HADS scale), assessment of social and professional adaptation disorders (ODI scale), patient satisfaction, quality of life (EQ-5D – Euro Quality of Life 5 Dimension), specific tests, neurological examination. Magnetic resonance imaging was performed using the Siemens Magnetom Skyra closed-type device, with a magnetic field strength of 3 Tesla. All examination planes were performed with a step of 4 mm, using T1 and T2 weighted sequences, T2 FS (with fat suppression), PD FS.

The obtained results were processed in Excel tables. The data were processed electronically. Fisher's exact test was used to estimate significant differences in imaging data and clinical signs in the study group. The significance threshold was considered to be p<0.10. The data are presented as absolute and relative values or as mean and standard deviation.

Results

Various degrees of lumbar spinal canal stenosis were recorded in 12 (23.5%) of the patients investigated by MRI, the correlation with clinical symptoms being shown in Tab. 1, and a representative MRI image – in Fig. 1.

Table 1

Multivariate analysis of clinical symptoms in patients with lumbar spinal canal stenosis

The dependent variable	F statistic	p
Loss of sensation in the lower limb	2.895	0.095
Numbness of the lower limb	0.291	0.592
Gait disorders	0.147	0.703
Weakness in the lower limb	0.052	0.820

Fig. 1. Spinal canal stenosis. MRI, T2-weighted sequence, sagittal view

Various degrees of cerebrospinal fluid flow disruption were recorded in 4 (7.8%) of the patients investigated by imaging, the correlation with clinical symptomatology being shown in Tab. 2, and a representative MRI image – in Fig. 2.

In 11 (91.7%) patients with imaging signs of spinal canal narrowing, a combination of degenerative changes was present, such as facet joint osteoarthritis, ligamentum flavum hypertrophy and intervertebral disc herniations (of which in one patient (9.1%) spinal canal narrowing was associated with L5-S1 intervertebral disc extrusion, and in 10 (90.9%) patients spinal canal narrowing was associated with various types of intervertebral disc prolapse with polysegmental localization). In only one patient (8.3%) was an association detected between spinal canal narrowing and cerebrospinal fluid flow disturbance, the spinal stenosis being congenital.

Table 2

Multivariate analysis of clinical symptoms in patients with cerebrospinal fluid flow disturbance

The dependent variable	F statistic	*p*
Numbness of the lower limb	1.789	0.187
Loss of sensation in the lower limb	0.269	0.606
Gait disorders	0.041	0.841
Weakness in the lower limb	0.014	0.905

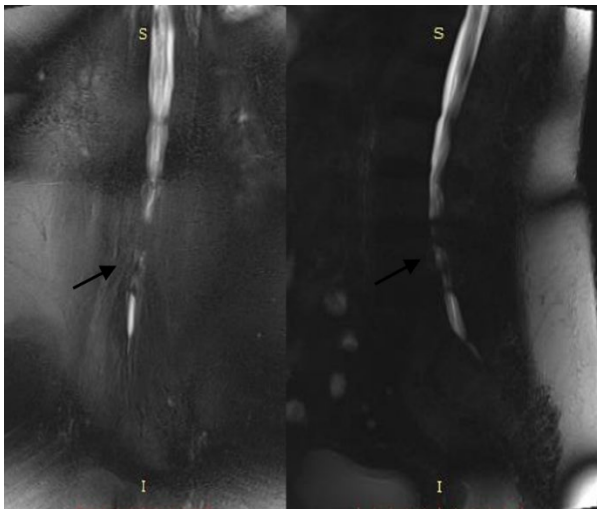

Fig. 2. Myelographic MRI sequences in coronal and sagittal views. Arrows indicate disruption of cerebrospinal fluid flow

Multivariate analysis with clinical symptoms suggested a correlation between lumbar spinal stenosis and loss of sensation in the lower limb, the significance threshold being only 10% (p < 0.10%, Table 1). Cerebrospinal fluid flow disturbance, however, demonstrated a significant correlation with numbness (p < 0.10%, Tab. 2).

Discussions

Despite a clinical definition that is often based on anatomical findings, clinical diagnosis and assess-

ment of the severity of lumbar stenosis depend primarily on the patient's description of their symptoms and physical examination. When considering interventions, correlation with imaging findings is also essential. Degenerative lumbar stenosis is less common in patients younger than 50 years, in contrast to those with primary lumbar stenosis due to a congenitally narrowed canal [17].

The most common symptom attributed to lumbar stenosis is neurogenic claudication, also known as pseudoclaudication. Neurogenic claudication refers to pain that involves the buttocks, groin, and anterior thigh, and radiates down the back of the leg to the foot. In addition to pain, it also includes fatigue, heaviness, weakness, and/or paresthesia. Patients with lumbar stenosis may also report nocturnal leg cramps [17] and neurogenic bladder symptoms. Symptoms may be unilateral or, more commonly, bilateral and symmetrical. The patient may have an accompanying back pain, but the leg pain and discomfort are usually more bothersome [18].

In addition to neurogenic claudication, lumbar stenosis may present with radicular symptoms. In contrast to neurogenic claudication, which is more commonly bilateral and associated with spinal canal stenosis, radicular symptoms due to spinal stenosis are more commonly unilateral and related to lateral recess or foraminal canal stenosis. Patients tend to be younger [19] and often have pain at rest and at night, which is exacerbated by the Valsalva maneuver [16]. Leg pain is often described as severe and radicular in distribution and may be exacerbated by lumbar extension [16]. Examination findings may include limited lumbar range of motion, especially in extension, focal motor weakness in a specific root distribution, variable signs of straight leg tension, and diminished reflexes in specific root distributions.

Some patients may report symptoms that are difficult to definitively attribute to lumbar stenosis. For example, they may report only back pain (without evidence of radiating to the leg), which is typical of neurogenic claudication (i.e., the characteristic positional nature of the symptoms).

The only study evaluating the value of patient-reported and clinical signs in diagnosing lumbar stenosis compared 43 patients in whom clinicians had at least 80% confidence that symptoms were due to lumbar stenosis with 32 patients in whom clinicians had less than 20% confidence that symptoms were attributable to lumbar stenosis [20]. Variables associated with the diagnosis of lumbar stenosis included older age, thigh pain lasting more than 30 seconds after lumbar extension, and the absence of pain in sitting and walking.

According to the North American Spine Society (NASS) Lumbar Stenosis Guidelines, there is insufficient evidence to correlate symptoms based on clinical signs with anatomical narrowing of the spinal canal visualized by imaging [21]. One reason could be variations in assessment methods due to the lack of clear criteria for evaluating imaging findings. Degenerative spinal stenosis is known to be primarily caused by age-related degeneration, such as bulging discs, osteophytes, hypertrophy of the facet joints, and thickening of the ligamentum flavum [22; 23]. In degenerative diseases of the lumbar spine, it has been found that elevated levels of inflammatory cytokines from the facet joint tissue are released into the spinal canal, which is suspected to be the cause of pain [24; 25; 26].

Potential force decreases in certain muscle groups, and corresponding changes in sensitivity and reflex responses, in a metameric distribution, are rarely present, depending on the location and degree of lumbar spinal stenosis.

In an international consensus, a group of 279 specialists from 29 countries concluded that 7 clinical signs and symptoms are required to be 80% certain of the presence of lumbar spinal stenosis based on history and physical examination, namely: pain in the buttock or lower limb during walking; improvement of symptoms during forward flexion; relief when patients use a supermarket trolley or ride a bicycle; sensory or motor disturbances when walking; normal or symmetrical peripheral pulses; weakness of the lower extremities and back pain [27].

In our study, a significant correlation was obtained between lumbar spinal canal stenosis and loss of sensitivity in the lower limb, the significance threshold being only 10% ($p < 0.10\%$), however, disruption of cerebrospinal fluid flow demonstrated a significant correlation with numbness ($p < 0.10\%$). According to the literature and our study, there is a significant correlation of clinical signs (pain in the lumbar region or in the lower limbs, sensory or motor disorders, weakness in the lower extremities) with lumbar stenosis. Only in one case, 8.3% of patients with lumbar stenosis presented congenital lumbar stenosis, and 91.7% of patients presented degenerative lumbar stenosis. Out of 12 patients with lumbar stenosis, 11 presented degenerative stenosis, and one patient presented congenital stenosis; in 4 patients, cerebrospinal fluid flow disruption was detected; in 1 patient, the association between lumbar stenosis and cerebrospinal fluid flow disruption was determined.

Conclusions

A correlation was determined between lumbar spinal canal stenosis and loss of sensitivity in the lower limb, the significance threshold being 10% ($p < 0.10\%$). In the case of cerebrospinal fluid flow disturbance, a significant correlation with numbness was demonstrated ($p < 0.10\%$). Spinal canal stenosis can be correlated with clinical signs that are revealed by statistical data and confirmed by data from the specialized literature.

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