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Comparison of Neurological Manifestations of Lumbar Intervertebral Disc Hernia With Anatomical and Morphological Data

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The mechanism of formation of GPMD is associated with osteochondrosis of the spine, which is a genetically determined polyetiological dystrophic lesion, starting from the pulpous nucleus of the intervertebral disc, spreading to the fibrous ring, and then to other elements of the vertebral motor segment (A. A. Lutsik , 1997). For the diagnosis of GPMD, the most common method is currently MRI and CT. In most studies, the diagnostic accuracy of these methods is estimated from 80 to 90%, including in the case of a combination of disc herniation with concomitant lumbar stenosis (Kent DL, Haynor DR, Larson E.B. et al. al ., 1992). Against the background of modern tomographic research methods, most authors (Kholodov S.A., 2002; F. Postacchini , G. Gualdi , 1999, Musalatov Kh.A., Aganesov A.G., 1998) began to note the low diagnostic value of radiography of the lumbosacral spine in patients with discogenic diseases. The main task of spondylography remains the identification of possible spinal anomalies, the exclusion of infectious-inflammatory and tumor lesions.

The first discectomy was performed in 1908 by Krause in Berlin. In 1967 Yasargil applied an operating microscope in practice for surgical treatment of herniated lumbar intervertebral discs. This technique was most widely used after its improvement by W. Caspar in 1976 and RW Williams in 1978. Since the first publications, the microdiscectomy method has rapidly gained popularity and is currently one of the most common methods of surgical treatment of lumbar intervertebral discs. From 1970 to 1980, the number of operations per 100,000 population per year was 69 in the USA, 41 in Finland, 20 in Sweden, and 10 in the UK (F. Postacchini , 1999).

Despite the accumulated vast experience in the use of this operation, there remains a stable percentage of intra- and postoperative complications, dissatisfaction in a number of cases with postoperative results, and discussions continue about the use of certain technical methods in microdiscectomy depending on the localization of the disc herniation and determining the scope of surgical intervention in case of multilevel lesions.

A complex problem of surgical treatment is the syndrome of failed operations on the lumbar spine (Failed Back Surgery Syndrome — FBSS). The incidence of this syndrome ranges from 5-10% (Davis , 1994) to 15-50% (M. S. Gelfenbein , 2000) of all surgeries. One of the main reasons

for the development of FBSS is the recurrence of a disc herniation at the same or adjacent level (A. J. L. Krivoshapkin, 2004). Among the intraoperative factors influencing the results of treatment, the most common is damage to the nerve root. Analytical reviews of numerous reports give various conclusions about the frequency of these complications from 1 to 10% (Abramovitz YN, 1993). S. A. Kholodov (2003) describes the following complications based on literature data: microdamage to the dural sac - 4.1%, damage to the dural membrane requiring a suture - 1%, cerebrospinal fluid leakage - less than 1%, damage to the nerve root - 0.1% - 0.5%. According to H. Musalatov and A. Oganesov (1998), 8% of patients after microdiscectomy experience an increase in neurological disorders in the form of hypoesthesia and paresthesia, and this is associated with intraoperative trauma to the root during its mobilization. Repeated operations for recurrent hernias carry an even greater risk of developing similar complications, which occur in 30-40% of cases, and in 15% they are persistent (M. V. Gerasimov, 2002).

The reasons leading to unsatisfactory results are often related to the choice of adequate surgical access. One of the important stages of microdiscectomy is passing through the interanterior foramen into the epidural space. This stage is accompanied by opening and removing the yellow ligament and, as a rule, resection of bone structures in one or another volume. Different authors define the expected volume of bone resection according to different criteria, and its boundaries are proposed in the widest range from complete refusal of resection to hemilaminectomy and complete facetectomy . Authors proposing the use of medial facetectomy (R. Tyler Frizzel and MarkN . Hadley , 1998), perform it without determining the indications, regardless of the level and localization of the intervertebral disc herniation and without determining the volume of bone resection. The problems of choosing the tactics of microsurgical intervention are associated with insufficiently studied features of the relationship of anatomical structures in the zone of disc- radicular conflict at the lumbar level.

The obtained results will allow using the data of the anatomical and morphological study to compare the neurological manifestations of lumbar intervertebral disc herniations with the data of MRI, CT studies, as well as to justify the performance of medial facetectomy in their microsurgical treatment. The use of medial facetectomy in lumbar microdiscectomy will increase the effectiveness of the operation and will reduce the disability and invalidity of this category of patients. The anatomical and topographic study revealed the structural features of the nerve root canal at different levels of the lumbar region, which allow better orientation during surgery in the anatomical structures, reduce trauma to healthy tissue and facilitate the removal of the pathological substrate. The studied anatomical and morphological structural features of the nerve root canal at the lumbar level allow justifying the neurological symptoms occurring in the zone of disc- radicular conflict in GPMD, identified by MRI and CT studies. The coincidence of these data with the data of the patient's examination helps to correctly determine the indications and scope of surgical intervention, especially in multilevel and bilateral GMD. The revealed features of the anatomical and topographic structure of the nerve root canal made it possible to justify the need and scope of MFE at different levels. When accessing the disc zone, the greatest volume of bone resection during MFE is required at the level of the L3-L4 segment and the least at the level of the L5-S1 segment. To visualize the pedicle zone of the nerve root canal at all levels, MFE must be supplemented with resection of the base of the superior articular process and the upper edge of the arch of the inferior vertebra. The volume of this bone resection does not differ fundamentally for each of the levels considered. MFE should be performed to the maximum extent to visualize

the foraminal zone of the nerve root with the maximum volume of bone resection at the level of the L3-L4 segment and the minimum at the level of L5-S1. The use of MFE provides good opportunities for a full revision of the intradiscal space, which allows for a low percentage of relapses. Good early and late postoperative results, the absence of complications associated with damage to neurovascular formations during surgery indicate the high efficiency of using MFE in microsurgical treatment of GPMD.

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When studying the distribution of patients by the level of location of the GPMD in different age groups, a difference in the prevalence of one or another localization in younger and older patients was found. The average age of patients with GPMD at the L5-S1 level was 39.4 years, at the L4-L5 level - 44.4 years and at the L3-L4 level - 45.5 years. By location relative to the midline, all GPMDs were distributed into median, paramedian , posterolateral and foraminal . In most patients, hernias had a paramedian location - in 394 (74.3%) cases, posterolateral hernias were much less common - in 92 (17.4%) cases, median - in 33 (6.2%) and foraminal - in 11 (2.1 %) cases. All patients underwent radiography of the lumbosacral spine in two projections before surgery, magnetic resonance imaging (MRI) was performed in 95% of patients, computed tomography (CT) in 4%, and myelography in 1%. All operations presented in the work were performed under general anesthesia using a microscope and microsurgical instruments.

To study the structure of the formations of the spinal canal and intervertebral openings of the lumbar spine, we used blocks of the spinal column, including vertebrae, intervertebral discs, dural sac, spinal roots and ganglia, venous and arterial vessels. The study was conducted on 10 cadavers with the study of three lower levels of the lumbar spine. Lumbar blocks were removed

from the lumbar region, separating from soft tissues and crossing the spinal column at the level of L3 and S1 vertebrae. The study of the topographic and anatomical relationships of neurovascular formations, intervertebral discs and bone-ligament structures that form the spinal canal and intervertebral openings was carried out by comparing frontal and transverse sections of the lumbar spine. For a better understanding of the anatomical and topographic relationship of the nerve root with the surrounding structures and for planning adequate microsurgical approaches to the zone of discoradicular conflict, we used the concept of the nerve root canal. This canal is more of an anatomical concept than a true canal, but has clear, stable anatomical landmarks. We distinguish three zones in the nerve root canal: disc; pedicle ; foraminal . The disc zone of the canal is limited in front by the intervertebral disc, behind and laterally by the anterior surface of the intervertebral joint covered by the yellow ligament. The pedicle zone is limited in front by the posterior surface of the vertebral body, laterally by the pedicle, behind by the base of the superior articular process and the lamina of the vertebral arch. From the medial side, throughout the first two zones, the border of the nerve root canal is the lateral surface of the dural sac. The lateral border of the disk and pedicle zone coincides with the lateral border of the spinal canal, which is an imaginary line drawn along the medial edge of the pedicles. The foraminal zone is located in the intervertebral foramen. Behind, this zone is limited by the anterior surface of the inferior articular process, in front - by the posterolateral surface of the vertebral body, and on the cranial side - by the pedicle.

Thus, by the term "nerve root canal" we mean an anatomical formation that includes the lateral part of the spinal canal and the area of the intervertebral foramen, where the nerve root exiting the dural sac is located and where discoradicular conflicts most often occur . In order to identify the features of the anatomical and topographic relationship of the nerve root canal at different levels of the lumbar spine, we conducted studies on cadaveric material. Most discoradicular conflicts that manifest clinically and require surgical intervention occur in the disc zone of the nerve root canal. In all other variants of the localization of GPMD, there is also a need for surgical manipulations in the disc zone to revise the area of rupture of the fibrous ring and the intradiscal space. Thus, each time during microdiscectomy, we are faced with the need to access the disc zone of the nerve root canal. As we have already noted, the posterolateral wall of this zone is formed by the intervertebral joint, covered by the yellow ligament on the side of the spinal canal. During resection of the medial sections of the facets of the articular processes that form the intervertebral joint, the disc zone of the nerve root canals is exposed at the lower lumbar level. We call this type of resection of the facets of the articular processes, necessary for visualization of the nerve root canal, medial facetectomy (MFE). The lateral border of MFE, necessary for a complete review of the disc zone of the root canal, is the lateral border of the spinal canal, passing along the medial edge of the pedicles.

The volume of bone resection during MFE to visualize the entire cross-section of the nerve root to its lateral border in the disc zone, which is necessary during surgical intervention, is determined by two factors:

The revealed features of the anatomical and topographic structure of the nerve root canal made it possible to justify the need and volume of MFE at different levels. When accessing the disc zone, the largest volume of bone resection during MFE is required at the level of the L3-L4 segment and the smallest at the level of the L5-S1 segment. To visualize the pedicle zone of the

nerve root canal at all levels, MFE must be supplemented with resection of the base of the superior articular process and the upper edge of the arch of the inferior vertebra. The volume of this bone resection does not differ fundamentally for each of the levels considered.

Without dynamics, cases with the absence or insignificant decrease of radicular pain and neurological symptoms, preservation of orthopedic disorders were assessed. These patients required additional surgical intervention to remove migrated disk fragments that were not found during the first operation. A significant majority of patients immediately after the operation noted a decrease in pain syndrome and signs of regression of preoperative neurological disorders, more often in cases of symptoms appearing in the last two to three months. Many of these patients already in the first days noted a decrease in the hypoesthesia zone and an increase in the range of motion.

Conclusion. The conducted anatomical and topographic studies of the structural features of the nerve root canal at different levels allow in each specific case to plan the need and volume of MFE, better navigate during the operation in the anatomical structures, reduce trauma to healthy tissue and facilitate the removal of the pathological substrate. Good early and late postoperative results, the absence of complications associated with damage to neurovascular formations during surgery indicate the high efficiency of using MFE in the microsurgical treatment of GPMD.

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