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Anatomical-biomechanical peculiarities, pathogenesis, clinical fedatures and diagnosis of iliolumbar ligament syndrome (literature review)

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Low back pain is the most widespread manifestation of pathology in the locomotor system. This pain has a multifactorial nature and in a number of cases can be caused by ligament defects in the lumbosacral region, particularly in the iliolumbar ligaments. Objective. To find out the modern trends in the development, clinical manifestation and diagnosis of iliolumbar ligament (ILL) syndrome based on the analysis of scientific-medical information. Results. ILL syndrome is characterized by variability of its form, attachment sites and even number. It has been revealed that ILL's play an important biomechanical role in providing of stability in the frontal plane on the level of L_V vertebra, and in the horizontal plane they restrict rotation of L_{IV} with respect to the pelvis. Asymmetry of the spatial orientation of ILL causes an increased risk of formation of disc herniation in L_{IV}–S_I. Under the effect of overloads ILL's develop structural changes or damages, whose risk increases with age. Diagnostic algorithms usually provide use of physical and radial techniques for revealing of ILL damages. Difficulties in physical diagnosis and blocking of ILL syndrome are caused by their insufficient specificity. Also rather weak is an association between pain manifestations in the low back and results of radiological examinations. CT and MRI make it possible to visualize ILL's, but so far these opportunities do not give too much for practice because of absence of any signs, whose relationship with the appearance and dynamics of low back pain would be doubtless. Ultrasound examination is a more informative method for instrumental diagnosis of ILL syndrome. Conclusions. Development of provocative tests and therapeutic-diagnostic blocks, which hold on the principles of evidence-based medicine, is a promising trend in improving diagnosis of ILL syndrome. Biochemical criteria for revealing and monitoring ILL pathology and their correlation with sonographic characteristics of different stages in the development of ligamentopathy require specification. Key words. Iliolumbar ligament, anatomical-biomechanical peculiarities, pathogenesis of iliolumbar ligament syndrome, methods of diagnosis.

Біль у нижній частині спини є найпоширенішим проявом патології опорно-рухової системи. Він має мультифакторіальну природу і в низці випадків може бути обумовленим порушеннями зв'язок попереково-крижової ділянки, зокрема, клубово-поперекових. Мета. На підставі аналізу науково-медичної інформації визначити сучасні тенденції щодо розвитку, клінічних проявів і діагностики синдрому клубово-поперекової зв'язки (КПЗ). Результати. КПЗ характеризуються варіабельністю форми, місць прикріплення та навіть їхньої кількості. З'ясовано, що КПЗ відіграють важливу біомеханічну роль у забезпеченні стабільності у фронтальній площині на рівні L_V хребця, у горизонтальній — обмежують обертання L_{IV} по відношенню до таза. Асиметрія просторової орієнтації КПЗ обумовлює підвищення ризику формування грижі міжхребцевих дисків L_{IV}–S_I. Під дією перенавантажень у КПЗ виникають структурні зміни або ушкодження, ризик яких збільшується з віком. Діагностичні алгоритми, зазвичай, передбачають використання фізикальних і променевих методик виявлення ушкоджень КПЗ. Труднощі фізикальної діагностики та блокад синдрому КПЗ обумовлені недостатньою їхньою специфічністю. Також досить слабка асоціація між проявами болю в нижній частині спини та результатами променевих досліджень. КТ і МРТ дають змогу візуалізувати КПЗ, проте для практики ці можливості наразі малоінформативні через відсутність будь-яких ознак, взаємозв'язок яких з виникненням і динамікою болю в нижній частині спини є безсумнівним. Інформаційнішим методом інструментальної діагностики синдрому КПЗ є ультразвукове обстеження. Висновки. Перспективними напрямами поліпшення діагностики синдрому КПЗ є розроблення фізикальних провокативних тестів і лікувально-діагностичних блокад, які базуються на принципах доказової медицини. Потребують уточнення біохімічні критерії виявлення та моніторингу патології КПЗ, їхня кореляція з сонографічними характеристиками різних стадій розвитку лігаментопатії.

Key words. Iliolumbar ligament, anatomical-biomechanical peculiarities, pathogenesis of iliolumbar ligament syndrome, methods of diagnosis

Pain in the lower back is the most common manifestation of musculoskeletal disorders [1–4]. It has a multifactorial nature and in some cases may be due to disorders of the lumbosacral region, in particular, the iliolumbar [5-8].

The purpose of the review: based on the analysis of scientific and medical information to identify current trends regarding the development, clinical manifestations and diagnosis of iliolumbar ligament syndrome.

Anatomical and biomechanical features of the iliolumbar ligaments

Anatomical studies of the iliolumbar ligaments (ILLs) indicate variability in their shape, attachment sites, and even their number [9]. Fundamental editions consider it both as a single structure [10] and as one consisting of two parts [11]. A. Fujiwara et al. [12] identified two options: type A is characterized by the division of the ILLs into anterior and posterior, and type B does not stipulate such a distribution. The angle of the anterior part in the type A ligament is more oriented backwards, compared to the type B. The posterior part is shorter and more oriented backwards in men than in women.

A. Pool-Goudzwaard et al. [13] found that after dividing the iliolumbar ligaments into two bundles in the experiment, the range of motion in the sacroiliac joint (SIJ) increased significantly. According to this study, the greatest influence on this mobility is exerted by the anterior part of the ligament. The authors suggested a high probability that postoperative complications up to the instability of the SIJ may be due to surgical division of this ligament during operations on the lumbosacral spine. The posterior part of the ILL is directed specifically along the plane of the SIJ. It also provides a restriction of the discrepancy between the auricular surfaces of the sacrum and iliac bone during nutation.

T. Aihara [14] fixed sacral and iliac bones of the five corpses with L_V vertebral spondylolysis. The author created different bending/straightening forces and left / right rotation for bending/straightening of L_{IV} and L_V before and after the separation of the ILLs. It is established that bending and axial rotation are largely regulated by the ILLs, especially their posterior part. The author concluded that the integrity of the ILL, especially their posterior part, determines the stability of the lumbosacral spine and the degree of L_V sliding relative to the sacrum. According to the author, this fact should always be kept in mind during the treatment of L_V spondylolysis, and to reduce the degree of lysthesia, it is necessary not to expose the ILLs to excessive stress. It has also been found that the ILLs play an important biomechanical role in ensuring frontal stability at the levels of L_V vertebrae and, to a lesser extent, L_{IV}. Although ILLs are not always attached to the transverse process of the L_{IV}, their stabilizing ability extends to the L_{IV} through the cross-links. This function provides approximately 8° tilt to the left and 8° tilt to the right, a larger tilt causes the connection to be overstressed. The ILLs stabilize the lumbar spine in the sagittal plane. They regulate the mobility of L_{IV} and, most importantly, L_V. During bending, the ILLs are tensed, and during straightening undergo reduction.

In the horizontal plane, the ILLs also play a stabilizing role and limit the rotation of the L_{IV} relative to the pelvis. In this way, the arcuate joints are protected from intense and repeated compression. In cases of separation of the ILLs as a result of surgery, apparently due to these circumstances, there are degenerative changes in the arcuate joints.

A study of MRI scans showed the most important role of asymmetry of the spatial orientation of the right and left ILLs in increasing the risk of herniation of intervertebral discs L_{IV}–S_I, rather than their length [15].

Modern views on the pathogenesis of ILL syndrome

Under the action of overloads, ILLs can either be damaged [16] or, like other ligaments, change according to the principle «form follows function» [17]. The changes that occur in the ILLs are similar to those in tendons and ligaments of other localization, respectively, the mechanisms of formation of adaptive and pathological changes in these structures are common [18, 19]. The latter allows to view changes in the ILLs from the same positions as changes in the relationship of another location.

According to A. M. Yurkovsky [20], structural changes in the ILLs are the result of the interaction of many factors. At the same time, there is reason to believe that regardless of their nature, the changes that occur take place in certain stages: reactive ↔ potentially reversible → irreversible. And each of these stages corresponds to a certain histological picture.

The stage of reactive changes is a short-term adaptive and relatively homogeneous thickening of a part of a tendon or ligament, which provides redistribution (reduction) of load per unit cross-sectional area [21]. This adaptation differs from normal to load, in which there is only a slight change in thickness [22]. It is logical to assume that such changes are also inherent in the ILLs, because thickening of this ligament was observed in ballet dancers and athletes, both in those who presented with pain, and in those who did not have it at the time of the survey [6]. Confirmation that

such reactive transformations may occur in response to overload was obtained during the study of tendons and ILLs [23, 24].

It should be noted that ligament damage can occur under conditions of relatively low levels of load, for example, according to experimental data by P. P. Provenzano et al. [25], structural violations were detected under conditions of stress increase of 5.14 %. The risk of ligament and tendon damage increases with age due to a decrease in the content of water, glycosaminoglycans and increased expression of matrix metalloproteinase-9 (secondary to insignificant changes in collagen) [26].

Noting a certain similarity of changes that occur in response to congestion in the ILLs, as well as in the ligaments and tendons of other localization, we should not forget that each of these structures has its own, unique properties, which determines the ability to respond to congestion [27].

Presentation and diagnosis of ILL syndrome

According to N. Bogduk, anatomical structures can be a source of pain in the lower back in the following cases: if they have innervation; are able to reproduce pain in healthy volunteers similar to that determined clinically; if there is a possibility of their damage as a result of inflammation or injury; if it is possible to verify the changes by reliable diagnostic methods [28, 29]. Therefore, functional and dystrophic disorders of the lumbosacral spine and sacroiliac joint can cause lower back pain [5].

The proportion of ligament disorders in the structure of possible causes of lower back pain, according to some estimates, reaches 8.9 % [6]. Moreover, the ILLs are most often considered as a structure potentially able to initiate this pain [30–33].

Iliolumbar syndrome most often occurs in athletes who experience significant static loads on the lumbar spine during training. The disease usually occurs in people not older than 35 years. All patients experience constant pain in the lower back and groin, which is exacerbated during running, lifting heavy objects, rotational movements [5, 6, 34].

Diagnostic algorithms usually involve the use of physical and radiological techniques to detect damage to the ILLs. However, there is no consensus on the possibilities of physical methods: some experts doubt their reliability [28], others believe that they are quite sensitive [32, 33].

Physical examination mostly focuses on the following signs: the presence of characteristic areas of reflected pain in the groin and outer thigh to the level of the knee joint (with radiation of groin pain in case of damage to the ILLs in place of attachment to the transverse processes of the vertebrae and along the outer thigh under conditions of violations in the area of distal attachment); the presence of a positive provocative test (sharp increase in pain during the reduction of the hip bent at right angles and the pressure on its axis); the presence of a positive rotational test (pain in the affected area of the ILLs during pelvic rotation); tenderness on palpation in the «ILLs area» [5, 6, 32, 33].

The possibilities of the latter technique (i. e. palpation of the ILLSs) are the least clear. On the one hand, there are doubts about the reliability of the information obtained in this way [28], on the other hand, there are data that seem to confirm the feasibility of palpation [5, 6, 16, 34].

For example, a symptom such as tenderness on palpation in the area of the transverse processes of the lower lumbar vertebrae, iliac wings, and the upper third of the sacroiliac joint has been observed in patients with ILLs injury [5]. Some studies note tenderness on deep palpation in the area between the inner wing of the iliac bone and the spine in some patients with pain in the lower back, which also, according to the authors, suggests an impairment of the ILLs [16]. Palpation of the ILLs in conditions of lower back pain is clearly indicated by P. Brukner and K. Khan [33]. But, unfortunately, those authors whose reliability is not in doubt, do not provide any data to obtain an idea of the sensitivity, specificity and accuracy of the study, based, if understood, only on the assumption that the ILLs are palpable [33].

The factor that determines the possibility (or impossibility) of palpation is nothing more than the thickness of soft tissues (i. e. subcutaneous fat, lumbar fascia, *m. erector spinae, m. multifidus, m. quadratus lumborum*) in the projection area of the lumbosacral joint [28, 29]. The variability of the parameter can be illustrated in such a way: 5.8–6.7 cm at the level of L_{IV} and 5.3–8.8 cm at the level of L_V [16]. It is believed that the diversity of the structures of the soft tissue layer and the wide range of values of their thickness do not give grounds to confirm with certainty that the local pain in this area is associated only with the ILLs [35].

The difficulty of physical diagnosis of ILL syndrome is that today there are no highly sensitive and specific methods of manual testing, and the diagnosis is often established on the basis of analysis of a set of provocative clinical tests [25]. Some authors consider it necessary to use 5 or more tests in one patient to increase the informativeness and diagnostic value of provocative tests.

The proposed, due to the ambiguity of these physical data, diagnostic blockade also, according to some researchers, does not solve all the problems associated

with the lack of specificity of these techniques. However, among the authors of scientific works there are supporters of the opinion that this manipulation allows to clarify the diagnosis and, moreover, to reduce the pain syndrome [6]. However, others deny both the therapeutic effect of the procedure and its specificity [28, 29].

Discussions about the diagnostic value of blockades performed without radiological or sonographic control over the accuracy (or selectivity) of anesthetic administration into the ILLs force doctors to use it only in combination with physical and radiation methods. After all, even the reduction of pain after the introduction of anesthetics in the area of the ILLs does not mean that the disorder of this structure is the only source of pain in the lower back. However, for other reasons, diagnostic injections, according to S. S. Boyajian [37], help to make a definite diagnosis in no more than 70–80 % of cases (and under conditions of radiological control).

Of course, physical methods, even in combination with diagnostic blockade, cannot provide comprehensive information about the sources of pain in the lower back. But the hopes placed on new imaging technologies also did not fully materialize, both in general for such pain and in case of damage to the ILLs. Many researchers have noted a rather weak association between the manifestations of lower back pain and the results of radiological studies [38–40]. As for the visualization of the ILLs by this method, such a possibility appears only in the case of its ossification (usually secondary).

Computed tomography (CT) solves the same problems. However, in contrast to traditional X-ray spondylography, this method allows (according to some data in 83 %) to visualize the ILLs due to the presence of fat. But this feature is used not only to diagnose disorders of the ILLs, but also to visualize the L_V vertebra (as ILLs frequently take their origin from it) for further use as a guide for the identification of transitional vertebrae [42].

In contrast to CT, magnetic resonance imaging (MRI) allows almost in all patients to visualize the ILLs in the form of single or double hypointensive strands on T1- and T2-weighted images [43]. However, the method in the case of using only axial and (or) sagittal sections does not give a complete picture of the anatomical and morphological features of the ILLs, the image is fragmentary. Therefore, it is necessary to use 3D mode and computer reformation to obtain information about the spatial position of the ILLs [44]. However, for practice, these possibilities of MRI are uninformative due to the absence of any signs, the relationship of which with the development and time course of pain in the lower back is unquestionable. Of course, in this context, it is not a question of damage to the ILLs due to pelvic fractures, when MRI can actually give clinical information about the presence or absence of damage to this structure [45].

Application of thermography in disorders of ILLs

Some believe that the method allows to visualize certain changes in case of damage to the ILLs: in the acute period in the form of zones of increased heat radiation in the projection zone of the connection with the spread to neighboring areas (presumably, due to lower quadrant sensory irritation syndrome); at a later date (with the development of dystrophic changes) in the form of zones of reduction of heat radiation. Moreover, in both cases, the greatest severity of changes was noted in the area of distal attachment of the ILLs [5, 46]. Unfortunately, there are no recent publications in relevant scientific sources that would confirm the above results. In general, according to most authors, this method has low prognostic [40] and diagnostic value [46].

A more informative method of instrumental diagnosis of ILL syndrome is ultrasound, which allows the differentiation of reactive, potentially reversible and irreversible lesions. In the stage of reactive changes, ultrasound examination identifies intact collagen bundles with hypoechoic areas and ligament thickening scattered between them. These features are due to an increase in the amount of bound water (due to increased production of proteoglycans) [47].

In the reverse stage, ultrasound results reflect disorganization of the extracellular matrix, which enhances the increase in the thickness of the ligament or tendon and the disorganization of collagen fibers. Sonography reveals heterogeneity of the fibrillar texture and small hypoechoic foci [48].

In the stage of irreversible changes sonographic studies show hypoechoic zones with poorly differentiated small bundles of collagen, an increase in the number of vessels. In patients of the fifth or sixth decade of life, the echo-pattern of ILL syndrome may become more uncertain due to foci of myxoid (from the fifth decade) and fatty dystrophy (from the sixth) [49].

Conclusions

Promising areas for improving the diagnosis of ILL syndrome are the development of provocative physical tests and treatment and diagnostic blockades, which are based on the principles of evidence-based medicine. The biochemical criteria for detecting and monitoring disorders of the ILLs, their correlation with the sonographic characteristics of different stages of ligamentopathy need to be clarified.

Conflict of interest. The authors declare the absence of conflict of interest.

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ANATOMICAL-BIOMECHANICAL PECULIARITIES, PATHOGENESIS, CLINICAL FEDATURES AND DIAGNOSIS OF ILIOLUMBAR LIGAMENT SYNDROME (LITERATURE REVIEW)

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