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Correlation between spinal nerves, anterolateral abdominal wall muscle tone and inguinal hernia

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Abstract

Background: The complete diagnosis of pathomorphological disorders in case of diseases of the spine determines the choice of effective treatment, pathogenetically argued in various diseases which, according to modern classifications, do not have a direct link with it. Continuous improvement of diagnostic and treatment methods in some pathologies, both surgical and therapeutical requires a more detailed study of clinical anatomy and spinal biomechanics. Thus, perhaps even revising concepts are well-rooted in the consciousness of scientists and modern practitioners. As we will try to analyze the anatomical-clinical component of the appearance and recovery of antero-lateral abdominal wall hernias, we will limit ourselves to some analysis and discussion of one of the predisposing factors, namely the lack of resistance or insufficient resistance of the abdominal muscles. This is closely related to the condition of the constituent elements of the abdominal wall, and in particular depends on the innervation and vascularization of the musculo-aponeurotic layers, which determine the strength and muscle tone.

Conclusions: One of the causes of inguinal hernias is the decrease in the tone of the abdominal muscles. It depends on several factors: the elasticity of the muscular tissue, state of neuro-muscular transmission, the state of peripheral nerve fibers and motor neurons in the spinal cord, superior motion control centers. Thus, the causes of muscle tone decrease can be both muscular in origin and generated by pathology of the nervous system at different levels. Because the causes are multiple, the treatment is different at certain stages of hernia development. In this way, our treatment – qualitative nutrition, vitamins, special exercises, spinal region work, paravertebral muscles massage fit perfectly into hernia etiology and pathogenesis. This treatment is physiologically accessible and can be performed and supervised by physicians with non-surgical specialties in stationary or outpatient settings, after prior consultation with the surgeon.

Key words: spinal nerves, anterolateral abdominal muscle tone, inguinal hernia.

Introduction

The complete diagnosis of pathomorphological disorders in case of diseases of the spine determines the choice of effective treatment, pathogenetically argued in various diseases which, according to modern classifications, do not have a direct link with it.

Continuous improvement of diagnostic and treatment methods in some pathologies, both surgical and therapeutical requires a more detailed study of clinical anatomy and spinal biomechanics. Thus, perhaps even revising concepts are well-rooted in the consciousness of scientists and modern practitioners.

We all know the notion of hernia of the anterolateral wall of the abdomen: which represents the partial or total exteriorization of one or more internal organs, from the peritoneal cavity to the weak areas of the abdominal wall, pre-existing anatomically, with the parietal sheet of the peritoneum. The causes of any acquired hernia are the result of the interaction of two categories of forces: 1. resistance of the abdominal wall determined both by the mechanism of its constitution and by the state of its structural elements; 2. and the intraabdominal pressure exerted from the inside on it represented by the pressure gradient of the abdominal internal organs, overlapping complementary forces that destabilize the existing balance at some point and become the determinant element in the production of hernias [1, 2].

Because we will try to analyze the anatomical-clinical component of the appearance and recovery of antero-lateral abdominal wall hernias, we will limit ourselves to some analysis and discussion of one of the predisposing factors, namely the lack of resistance or insufficient resistance of the abdominal muscles. This is closely related to the condition of the constituent elements of the abdominal wall, and in particular depends on the innervation and vascularization of the musculo-aponeurotic layer, which determines the strength and muscle tone.

Generally, the vascularization and innervation of a muscle is determined by a major artery that is accompanied by 2 veins and a nerve. The vessels are located along the muscle fibers and gradually divide into smaller arteries. Innervation is performed by a single nerve branch, which penetrates the muscles together with the vessels, forming within it a rich plexus intramuscularly. The nerve of the muscle is mixed, having motor, sensory and vegetative fibers. Vegetative fibers enter the muscles and form perivascular plexuses, being sympathetic fibers with action on their vessels. Special anatomo-experimental investigations and clinical observations have shown that *nn. vasorum* go to vessels in the composition of spinal nerves in which they are also sympathetic fibers. Sympathetic fibers, to the periphery at different levels, come out of their composition and penetrate into the perivascular tissue, then into the vessel wall. The arteries have more *nn. vasorum*, than the veins.

The muscle has several properties that characterize it: contractility, elasticity and tonicity. Thus, muscle tone is a state of mild and permanent contraction of the muscle at rest, and is manifested by a low degree of tension. This is the fundamental property of the muscle, which has preserved innervation. The mechanism of muscle tone production is of a nervous nature [3, 4].

Thus, in order to maintain the normal muscle size, it is necessary to receive permanent contractile impulses. When a muscle loses its innervation, it is subject to atrophy that begins almost immediately [5].

The vessels and nerves play an essential role in maintaining muscle strength and tone in the anterior-lateral abdominal region. It can be said that any disruption in their activity, both internal and external, will have effects on the muscles. However, in order to answer questions about the causes of the installation of muscle hypotonia in the abdomen's antero-lateral region, it is necessary to examine the vascularization and innervation.

Superficial arteries and veins in the anterolateral abdominal wall are found in the subcutaneous layer. The arteries in the lower compartment: superficial epigastric arteries, superficial circumflexes iliac artery (femoral artery), and in the region of superficial inguinal ring – external pudenda artery. In the upper compartment are branches of intercostal and lumbar arteries. The veins are better developed than the arteries and form plexuses. In the umbilical region, the toracoepigastric vein begins to flow into the lateral thoracic vein and anastomoses the superficial epigastric vein that flows into the femoral vein (link between the axillary vein and the femoral vein). Superficial veins anatomies in the umbilical region with deep veins (upper and lower epigastric veins) and paraombilical vein that flow into the portal vein. This makes the connection between the lower inferior venous system and the portal. The deep arteries and veins: the upper epigastric artery – the terminal branch of the internal thoracic artery and the umbilical anastomosis with the inferior epigastric artery branch of the external iliac artery. In the lower regions is the deep iliac circumflex artery, branch of the external iliac artery. Likewise, the anterolateral abdominal wall is vascularized by the last 5 intercostal arteries and the lumbar arteries. The veins accompany the arteries.

Both superficial and deep muscular innervation is performed by the lateral and anterior branches of the intercostal nerves from VII to XII, and in the lower portions – the ileohipogastric and ilioinghinal nerves from the lumbar plexus. Thus, in the epigastral region there are the intercostal nerves VII-IX, the intercostal nerves X-XI branch in the mezogastrium, and in the hypogastrium the subcostal nerve XII, the ileohipogastric and ilioinghinal nerves [1, 6-11].

Because the previously named nerves play a primary role in maintaining the muscular tonus of the anterior abdominal wall, we will describe their topography and some causes of disorder of the transmission of nerve impulses to the muscles and blood vessels. As mentioned above, the spinal nerves VII-XII, the ileohypogasic and ilioinghinal (lumbar plexus) nerves, which are emerging from the lower and lumbar thoracic column, are responsible for the anterolateral abdominal wall's innervation.

Generally, the spine is the axis of support of the whole skeleton of the body. It has the form of a resistant and flexible bone column, it consists of bone pieces, called vertebrae, among which there are fibrocartilage formations called intervertebral discs. The vertebrae give the spine the resistance to support the weight of the body, and the intervertebral discs give it the flexibility that ensures its movements. The vertebral body and arch are defining the vertebral opening. The vertebral arch is linked to the vertebral body by two thin blades – the vertebral pedicles. The upper and lower margins of the vertebral pedicle present the vertebral incisions. The vertebral incisions of two neighboring vertebrae form an orifice (the intervertebral orifice) through which the spinal nerves pass. Vertebral bodies are linked together by joint discs and ligaments. An intervertebral disc has at its periphery a fibrous ring made of fibrocartilage and fibrous tissue, and towards the center – a soft, gelatinous elastic substance (pulp nucleus). All spine biomechanics depend on the state of the intervertebral discs. In adults, the discs make up 20-25% of the entire length of the spine. Disc degeneration leads to loss of substance in the pulp nucleus, decrease in intervertebral orifice size, and compression of spinal nerves.

Spinal nerve originates in the spinal cord and is the way to drive the nervous influx to and from the spinal cord. They are formed by joining the nerve fibers of the posterior and anterior roots. They are mixed nerves, consisting of sensitive fibers and motor fibers (somatic and vegetative). They are short and divide into four branches: posterior, anterior, visceral and meningian. 1. The posterior branch innervates the skin, sweat and sebaceous glands, blood vessels, back muscles and muscles in the occipital and parietal regions of the head. 2. The anterior branch is more bulky and embraces the same organs as the posterior branch, but from the regions: cervical, temporal, auricular, upper, lateral and anterior parts of the thorax and abdomen, as well as upper and lower limbs. 3. The visceral branch or the white communicating branch contains only vegetative fibers, through which the vegetative nervous system connects to the central nervous system. 4. The meningeal branch is a thin branch that returns through the conjugation hole into the spinal canal and innervates the spinal meninges.

There are 31 pairs of spinal nerves, placed symmetrically on both sides of the spinal cord and metamerically distributed as follows: 8 pairs in the cervical region, 12 in the thoracic, 5 in the lumbar, 5 in the sacral, 1 in the region coccygeal. Each pair starts from a medullary nerve center (31 nerve centers) and corresponds to a specific skin area called dermatom, parts of the muscle (myotom), osteoarticular elements (sclerotoma), vascular elements (angiotom) and visceral elements (viscerotom), in which there is a permanent anatomical connection.

Nerve plexuses are the anastomoses of the anterior branches of the spinal nerves, with the exception of the thoracic region. Because the subject of our discussion is innervation and vascularization of the abdominal anterolateral wall, we will focus more on the lower thoracic and lumbar column.

The thoracic segment: The anterior branches of the thoracic spinal nerves pass through the intercostal space and form the intercostal neurovascular bundle. The first six intercostal nerves are branched and reach the sternum. Intercostal nerves from VII to XII, pass to the anterior abdominal wall and provide sensory and motor innervation.

The lumbar nerve plexus consists of anastomoses of the anterior branches of T_{12} and the first four lumbar nerves. This plexus innerves lower abdominal muscles, obturator muscles, thigh muscles (medial groups), skin of lower abdomen, scrotum or greater pudendal lips, skin of the thigh, skin of the calf and foot on the medial face. From the lumbar plexus, two types of branches are formed – collateral and terminal.

Collateral branches of the lumbar nerve plexus:

1. The ileo-hypogastric nerve through the muscular branch innerves the wide abdominal muscles and rectus abdominis muscle. Another branch is the cutaneous branch and innervates the skin of the hip, pubic and scrotum region for male, and for female – the large lips.

2. The ilioinghinal nerve innerves the skin of the scrotum to the males, or the large lips in the woman.

3. The lateral cutaneous femoral nerve innerves the skin of the fessier region and the skin of the thigh's lateral region. 4. The genitofemoral nerve innerves the skin of the medial face of the thigh and scrotum or large lips skin.

Terminal branches of the lumbar nerve plexus:

1. The obturator nerve has an anterior and posterior branch. The anterior branch innerves external obturating muscles, pectinum, long and short adductor, and skin in the knee region and mid-thigh. The posterior branch innerves the large adductor muscle and the coxofemoral joint.

2. The femoral nerve is the most voluminous nerve of the lumbar plexus. In the pelvic cavity it gives branches for the iliopsoas and pectinum muscles, for the femoral artery, and under the inguinal arcade forms numerous branches for the anterior muscles of the thigh [1, 6, 12-20].

We may consider that some causes of the installation of the abdominal hernias are vertebrogenic, i.e. pathologies of the peripheral nervous system, which predominantly affect the spinal nerves in the inferior thoracic and lumbar region in our case. According to the literature, these pathologies are the number one among neurological pathologies. Their etiology may be different: trauma, ischemia, infection, endogenous and exogenous intoxications [21, 22, 23].

However, regardless of the nature of this syndrome, the decrease in the tone of the muscles in the anterolateral abdomen region is associated with spinal nerve compression. Among the pathologies of the peripheral nervous system, an important part is its secondary affection, which develops in patients with traumatic discopathy and osteochondrosis of the spine. In case of osteochondrosis, compression of the spinal nerves develops gradually with the installation of edema and muscle spasm. The inflammatory process occurs as a consequence of degenerative processes in connective tissue. The herniated disc can compress the spinal nerves.

Spinal pathologies with compression of a spinal nerve in most cases are associated with acute pain access. But there may be disturbances in the functioning of the muscles and internal organs. It depends on the part that was involved: motor, sensory or vegetative.

Thus, compression of the sensory nerves is manifested immediately by the occurrence of pain, but the motor and vegetative are for a long time asymptomatic, and the patients address to the physician only after the changes and complications of the internal organs or muscles occur [24, 25].

An important role in the normal functioning of the spinal nerves belongs to the intervertebral disc. Degenerative processes in the intervertebral disc gradually arise and affect the disintegration of the function of the blood vessels and nerve fibers that participate in its nutrition. In addition, intervertebral disc cells are sensitive to decreased oxygen concentration, decreased glucose concentration, and local pH [21, 22, 26].

Considering the above mentioned, it can be stated that at the initial stages of degenerative processes in the spine, effective treatment can be conservative treatment: diet, physical culture, massage and healthy lifestyle.

The diet should contain active products and substances directed to the rehabilitation of vessels and nerves in the intervertebral disc region and to the normalization of oxygen and glucose concentration and local pH. These requirements more closely coincide with a predominantly vegetarian diet rich in vitamins and mineral salts, including proper hydration.

Physical culture and massage enhance tonus of paravertebral muscles and trophic adjacent tissues. These procedures are important because the blood vessels and the nerves only reach the periphery of the intervertebral disc, and its nutrition is made from the surrounding tissues.

Healthy lifestyle involves proper sleep, avoiding smoking, toxins of different genesis and stress.

As a demonstration of the above, we want to describe a clinical case of a 9 year old examined patient G. M., a pupil at a secondary school in Chisinau.

The reason for addressing a physician is the presence of unaccountable pain in the right inguinal region, which accentuates a bit in cough, physical effort and prolonged orthostatism, accompanied by the presence of a pseudotumoral formation corresponding to the right inguinal canal (fig. 1). The child's father states that this formation appeared about 4-5 months ago, noticed it by accident when the boy was bathing. The child at the time of the examination did not show any other illnesses or complaints. He is an active boy who plays football in his free time. From the parents' words, the child was born in term, naturally,

without any complications, 3.6 kg weight. 5-6 months after birth, in the region of the right inguinal canal, during the weeping there was a swelling, the size of a cherry, which in the palpation gave a feeling of crepitation. After referring to the pediatric surgeon it was established the diagnosis of incipient congenital inguinal hernia. Hernia has developed from the peritoneovaginal process, which obliterated after birth. In the case of this child, it persisted and was recommended a surgical intervention in order to terminate the process. Parents refused to have the child operated on motivating that the swelling was diminishing in dimensions, compared to its initial ones. They struggled to compress this formation with a diaper, which was fixed just above the hernia. Half a year later hernia disappeared. The pediatric surgeon who repeatedly consulted the child stated that the peritonoevaginal process had stopped and the child had no hernia. Until the age of 9, the child and parents did not notice any formation in this region.

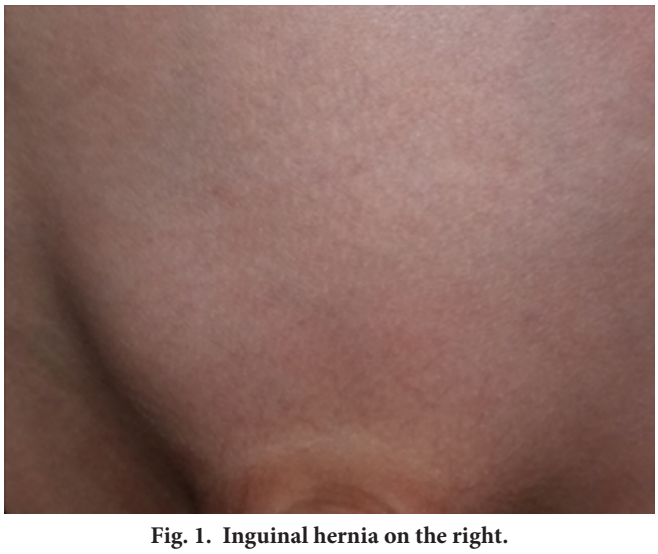

Fig. 1. Inguinal hernia on the right.

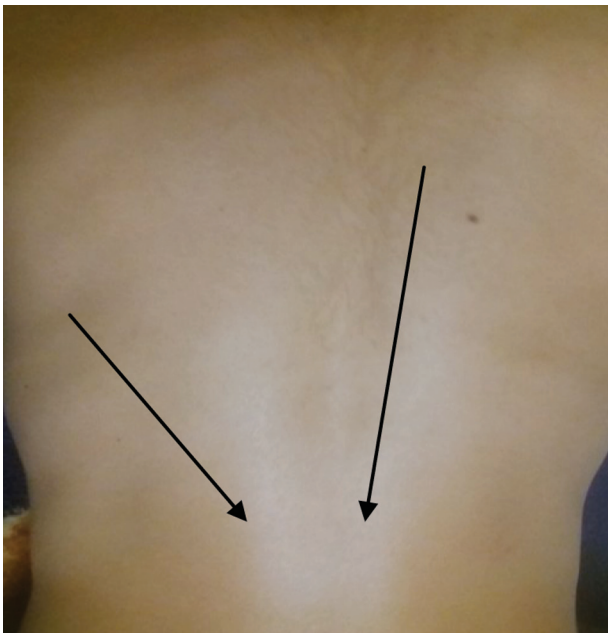

Fig. 2. Appearance of paravertebral muscles before treatment.

Local examination on the day of physician referral, performed at the patient in orthostatism, revealed an elongated, reducible pseudotumoral formation of elastic consistency. At percussion – tympanism and intestinal gargling at auscultation, which corresponds to the inguinal straight canal and extends along its entire tract.

The diagnosis established today is inguinal hernia acquired on the right, which is also shown in the picture below.

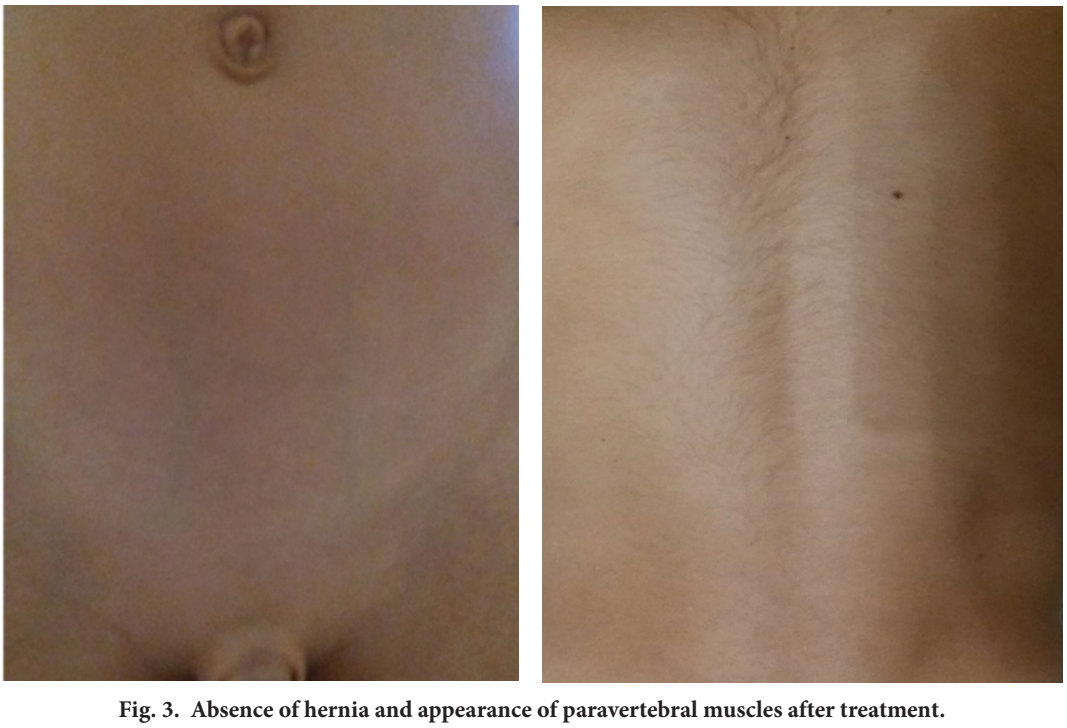

Fig. 3. Absence of hernia and appearance of paravertebral muscles after treatment.

As a result of the back examination, an underdevelopment of the paravertebral muscles was observed in the lower thoracic and upper lumbar segment (fig. 2). In other words, the paravertebral muscles at this level look as if they were interrupted, thus showing the picture of a crater or a muscle defect. That is the muscles above and below this segment are strong, full, elevated, while in this area they seem to be lacking. Moreover, this area is covered with much more developed hair than the rest of the back.

As a result of a treatment of 4-5 months, which consisted of general measures, mentioned above – a predominantly natural and vegetarian diet, excluding products rich in preservatives, dyes and other food additives, gymnastics and local measures – spine work, we obtained the following results.

As shown in the figure 3, the hernia has disappeared and the paravertebral muscles are full and strong.

Conclusions

As a result of studying the literature and our experience we can state that one of the causes of inguinal hernias is the decrease in the tone of the abdominal muscles. It depends on several factors: the elasticity of the muscular tissue; state of neuro-muscular transmission; the state of peripheral nerve fibers and motor neurons in the spinal cord; superior motion control centers. Thus, the causes of muscle tone decrease can be both muscular in origin and generated by pathology of the nervous system at different levels. Because the causes are multiple, the treatment is different at certain stages of hernia development. In this way, our treatment – qualitative nutrition, vitamins, special exercises, spinal region work, paravertebral muscles massage fit perfectly into hernia etiology and pathogenesis. This treatment is physiological, accessible and can be performed and supervised by physicians with non-surgical specialties in stationary or outpatient settings, after prior consultation with the surgeon.

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