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Modern View on the Mechanism of Development of Carpal Tunnel Syndrome in the Prenatal Period in Women

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Abstract

Carpal tunnel syndrome in the third trimester of pregnancy is quite common. The mechanism of development of this condition is based on the following factors: hormonal changes during pregnancy and fluid retention in the body lead to the formation of edema, and as a result of individual anatomical features, compression of the median nerve in the carpal canal may occur. Characteristic manifestations of carpal tunnel syndrome are tingling and numbness, severe pain in the arm, as well as decreased sensitivity and motor function of the hand. All these symptoms cause severe discomfort in the daily life of a pregnant woman and can affect the course of pregnancy and the prenatal period. The purpose of this work is to study the mechanisms of the development of carpal tunnel syndrome in women in the third trimester of pregnancy and in the prenatal period, taking into account modern scientific and diagnostic data.

Disciplinary: Medicine.

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1 Introduction

Currently, among the diseases of the peripheral nervous system, compression-ischemic neuropathies of the upper extremities are the most common pathology. Of these, 70% is tunnel neuropathy of the upper extremities - carpal tunnel syndrome. Tunnel syndrome is a symptom complex of sensitive, motor and trophic manifestations that occurs as a result of compression, infringement and ischemia of peripheral nerves in narrow anatomical areas. Every fifth patient complaining of pain, paresthesia and numbness in the upper limb suffers from carpal tunnel syndrome [1].

Carpal tunnel syndrome (carpal tunnel syndrome, carpal syndrome) is a pathological condition that occurs as a result of compression of the median nerve in the carpal (carpal) canal and has characteristic clinical manifestations [2]. Carpal syndrome is more common in women than in men due to the narrower carpal canal. The peak incidence occurs at the age of 40-60 years (although this disease can occur at any age, only 10% of those suffering from this disease are younger than 31 years). The syndrome is more common in representatives of the Caucasian race, in some African countries it practically does not occur. During pregnancy, the incidence of carpal tunnel syndrome is 45% [3].

According to its anatomical structure, the carpal canal is a limited space surrounded by the bones of the wrist and the transverse ligament of the wrist. In the carpal canal, the median nerve passes under the transverse ligament, which innervates the thumb, index, middle and ring fingers of the hand, some muscles of the hand, and also conducts vegetative fibers to local arteries and sweat glands. The median nerve passing through the carpal canal performs a vegetative-trophic function and participates in the coordination of movements of the muscles of the hand. Under the influence of various factors, there may be compression, swelling, and displacement of tissues in the wrist, causing compression and irritation of the median nerve, contributing to the formation of carpal tunnel syndrome [4].

Predisposing factors are important in the development of carpal syndrome. Risk factors include heredity, old age, obesity, smoking, alcoholism, stress, diseases of the endocrine system (diabetes mellitus, hypothyroidism), arthritis of various genesis, acromegaly, neoplasms, water-electrolyte balance disorders, renal and hepatic insufficiency, taking certain medications (hormonal contraceptives), tendon inflammation (tenosynovitis) [5-10]. There is the following pattern: the severity of symptoms increases with an increase in the load on the hand, traumatic injuries of the hand, prolonged vibration effects on the wrist, and overstrain of the hands. Carpal syndrome often has an idiopathic cause.

Carpal tunnel syndrome often occurs during pregnancy, mainly in the third trimester, but it does not require medical treatment and resolves independently after childbirth [11]. The mechanism of development of carpal syndrome during pregnancy is fibrosis of the synovial membrane of the tendon, which leads to compression of the median nerve, circulatory disorders, the occurrence of ischemia and hypoxia of tissues, followed by an increase in edema and the

appearance of pain syndrome [12]. Emerging pathological processes are associated with fluid retention in the body, or the occurrence of hormone-dependent acute tenosynovitis [13].

2 Literature Review

Clinical manifestations of carpal tunnel syndrome depend on the severity of damage to the median nerve. M. Mondelli and co-authors identified 5 stages: I – paresthesia only at night and/or in the morning; II – paresthesia during the day, especially with repetitive movements and prolonged postures; III – persistent sensory disorders; IV - hypotrophy and/ or weakness of the tenar muscles; V – atrophy and pronounced weakness of the muscles innervated by the median nerve. The main complaints in patients are a feeling of numbness and tingling of the hands, the appearance of weakness in the hands and impaired coordination of movements, burning pain on the palm surface of the hand and fingers with irradiation towards the forearm, local vegetative manifestations in the hand (an increase or decrease in the temperature of the hands, sweating disorders, discoloration of the skin). A characteristic feature of the carpal syndrome in pregnant women, according to some authors, is the daytime manifestation of symptoms, and their intensification occurs at night (because of which the patient may wake up), and decrease with shaking of the hand and wrist. It should be noted that the clinical picture of the disease has individual features of manifestation [14-16].

Diagnosis of carpal tunnel syndrome is based on the collection of anamnesis, clinical manifestations, specific diagnostic tests and laboratory and instrumental research methods. Questionnaires are widely used. The Boston Carpal Tunnel Questionnaire, BCTQ, consists of two evaluation criteria: the Symptom Severity Scale (SSS) and the Functional Status Scale (FSS). The results of the survey allow us to objectively assess the severity of clinical manifestations of carpal tunnel syndrome and track the dynamics of the patient's condition. The Disabilities of the Arm, Shoulder and Hand, DASH questionnaire is a questionnaire of outcomes and inability of the arm and hand (evaluates the results of impaired functions of the arm and hand). The main section of the DASH questionnaire (scale of disabilities/symptoms) consists of 30 items-questions related to the state of the brush function over the past week. At the same time, 21 of them reveal the degree of difficulty in performing various physical actions due to the limitation of shoulder or hand function; 6 points relate to the severity of some symptoms and 3 - social role functions [17].

There are also a number of basic specific diagnostic tests: Tinel's test - percussion in the projection of the median nerve (tapping with a neurological hammer in the area of the flexor retainer); Falen's test - flexion of the hand and holding it in this position for 1 minute causes paresthesia and pain due to tension of the nerve trunk; Goldberg's finger compression test – compression for one minute the opening of the carpal canal above the transverse ligament provokes pain and sensitive sensory disturbances; Gillett's test - compression of the shoulder with a pneumatic cuff provokes pain and numbness in the fingers [18].

An important instrumental diagnostic study is electroneuromyography (ENMG), which is a complex electrophysiological research method for assessing the functional state of the

neuromuscular system by recording, followed by qualitative and quantitative analysis of various types of the electrical activity of nerves and muscles. Determination of the degree of electrophysiological and morphological signs of nerve degradation is a reflection of the pathogenesis of carpal syndrome [19-21].

The main instrumental method for the study of the carpal syndrome is ultrasound examination (ultrasound) of the median nerve, which allows you to visualize the nerve and surrounding structures, identify the causes of compression and concomitant pathology (for example, tenosynovitis of the tendons of the hand muscles). Criteria for the diagnosis of pathology: thickening of the median nerve proximal to the carpal canal, flattening or decrease in the thickness of the nerve in the distal carpal canal, decrease in the echogenicity of the nerve before entering the canal, thickening and increase in the echogenicity of the flexor retention ligament [22].

Magnetic resonance imaging (MRI) is used for questionable symptoms of carpal syndrome, atypical course of the disease, to exclude volumetric formations of the hand and anomalies of the carpal canal. MRI is also informative for determining the causes of pathology and localization of nerve compression. However, this method has a high cost, labor intensity, and requires time for research, therefore it is rarely used [23-25].

Diagnostic imaging techniques such as ultrasound and MRI are effective for the indirect determination of compression of the median nerve on the wrist by determining the morphology of the nerve and anatomical features. In this study, ultrasound diagnostics became the tool of choice, due to the effectiveness, practicality in use, non-invasiveness and safety of the method.

Thus, the purpose of this prospective study is to study the mechanisms of the development of carpal tunnel syndrome in women in the third trimester of pregnancy and in the prenatal period, taking into account modern scientific and diagnostic data.

3 Method

A total of 63 patients participated in the prospective study. The criteria for inclusion in the study was the third trimester of pregnancy, regardless of the age of the patients. The exclusion criteria from the study were patients who did not fall into this category, patients with compression-ischemic lesions of nerve endings above the level of the hand (round pronator syndrome, cubital tunnel syndrome), as well as with cervical diseases.

The study was conducted in compliance with ethical principles and informed voluntary consent of patients.

All obstetric patients who met the inclusion criteria completed a 6-point Carpal Tunnel Symptom Scale (CTS-6): 1) pain at night; 2) pain during the day; 3) numbness and tingling at night; 4) numbness and tingling during the day; 5) waking up at night with pain in the arm; 6) waking up at night with numbness and tingling in the hand.

The Boston BCTQ questionnaire was used to assess the severity of carpal tunnel syndrome and determine functional disorders in patients with true carpal syndrome.

To assess the space inside the carpal tunnel, an ultrasound was performed on all patients. Patients with abnormal ultrasound results, such as bifurcated nerves, persistent anomalies of the median arteries and palmar muscles, and volumetric lesions were excluded. Ultrasound determined the following parameters: 1) the cross-sectional area of the median nerve at the level of the pea-shaped bone; 2) the thickness of the transverse ligament of the wrist; 3) the width and height of the trunk of the median nerve at the entrance to the carpal canal and at the exit; 4) the presence or absence of synovial thickening; 5) nerve mobility.

Research methods were used in the work: statistical, descriptive, comparative, analytical. The obtained data were analyzed using Excel and Biostat statistical processing programs [26,27].

4 Result and Discussion

The age of the study participants ranged from 20 to 42 years, of which the most common age was 28 years. Based on the collected anamnesis and examination data from 63 observed patients, carpal tunnel syndrome was diagnosed in 25 women. Of the 25 patients diagnosed with the carpal syndrome, only 2 women (8%) reported their symptoms to doctors and the vast majority of 23 women (92%) did not. Of the two patients, only 1 woman was treated.

According to the results of the Boston questionnaire, it was revealed that 76% of respondents noted mild carpal tunnel syndrome, 20% - moderate, and 4% of respondents had severe manifestations. Functional disorders were not noted by 56% of respondents, 28% had mild disorders and 16% had moderate disorders. The results obtained are shown in Table 1.

Table 1: Boston BCTQ Carpal Syndrome Assessment Questionnaire

Scale of severity of symptoms (n = 25 with carpal syndrome)	Light	Medium	Hard
n	19	5	1
% of all patients	30.2	7.9	1.6
% of patients with carpal syndrome	76	20	4
Scale of functional disorders (n = 25 with carpal syndrome)	Were absent	Lungs	Moderate
n	14	7	4
% of all patients	22.2	11.1	6.3
% of patients with carpal syndrome	56	28	16

Ultrasound data in patients with carpal tunnel syndrome showed that the cross-sectional area of the median nerve inside the carpal canal was on average 0.908 cm^2, i.e. more than in the group without the carpal syndrome, where the average value was 0.797 cm^2. In all patients, the minimum thickness of the transverse ligament of the wrist was 0.07 cm, and the maximum was 0.15 cm, while the average thickness was 0.1030 cm and the standard deviation was 0.01633. The thickness of the transverse ligament of the wrist measured at the level of the pea bone averaged 0.1058 cm in the group without carpal syndrome, while the group with carpal syndrome had an average value of 0.0988 cm. The data obtained are shown in Table 2.

Table 2: Thickness of the transverse ligament of the wrist

Thickness, mm	7	8	9	10	11	12	13	15	Total:
n	1	10	8	16	13	10	4	1	63
%	1.6	15.9	12.7	25.4	20.6	15.9	6.3	1.6	100

Mobility of the median nerve in the carpal canal: mobility less than the width of one tendon was found in 36% in the group with carpal syndrome and 63.2% in the group without the syndrome; mobility equal to the width of the tendon was found in 44% of respondents in the group with carpal syndrome and 28.9% in the group without the syndrome; mobility more than one tendon width was found in 20% of respondents in the group with carpal syndrome and 7.9% in the group without carpal syndrome.

The results obtained allow us to conclude that, based on clinical manifestations, the prevalence of carpal tunnel syndrome among pregnant women in the third trimester ranges from 31% to 62%. Of the 63 patients, only two reported their symptoms to the doctor, of which only one patient was treated.

There was no edema in both groups with reduced thickness of the transverse ligament of the wrist. Therefore, in the group with the diagnosed carpal syndrome, compression of the median nerve is not an external cause of carpal tunnel syndrome during pregnancy. Nevertheless, the proven increase in the median nerve during pregnancy suggests an internal factor in the occurrence of carpal syndrome, but additional research is needed to confirm this theory. With idiopathic carpal syndrome, fibrosis of the connective tissue of the carpal canal can be detected.

For the diagnosis of carpal syndrome, the cross-sectional area is important. In patients with carpal tunnel syndrome, the median nerve cross-sectional area was on average 0.908 cm2, i.e. larger than in patients without the syndrome, with an average value of 0.797 cm2.

The transverse ligament of the wrist was slightly thinner in the group with the carpal syndrome (on average 0.0988 cm) than in the other group (on average 0.1058 cm). The median nerve was more mobile in the group with the carpal syndrome. A more mobile median nerve (mobility of more than one tendon width) was observed in 20% of pregnant women with the carpal syndrome and only in 7.9% of them without carpal tunnel syndrome.

Thus, the revealed clinical and morphological features are important for determining the mechanism of development of carpal tunnel syndrome in the third trimester of pregnancy and the prenatal period.

5 Conclusion

Most pregnant women in the prenatal period experience mild to moderate manifestations of carpal tunnel syndrome. This may be due to some processes occurring in the body. During pregnancy, hormonal changes and glucose levels occur, fluid accumulation and swelling are formed, hypersensitivity of the median nerve is noted, which can lead to carpal tunnel syndrome. The accumulation of fluid in the body is within the limits of gestational weight gain, including an increase in the volume of circulating blood, an increase in the mass of the uterus, a developing fetus, in some cases, obesity. It was found that women with diagnosed carpal syndrome noted hand swelling twice as often as women without carpal tunnel syndrome.

In this study, the mechanisms of development of carpal tunnel syndrome in women in the third trimester of pregnancy and in the prenatal period were studied, taking into account modern

scientific and diagnostic data. The results of the study showed that fluid retention in the carpal tunnel is considered one of the causes of compression of the median nerve during pregnancy. Also, in the mechanism of development of carpal tunnel syndrome during pregnancy, individual characteristics, systemic connective tissue diseases (fibrosis, tenosynovitis) and the lifestyle of a pregnant woman (performing manual work associated with overstrain of the hands) are important.

The information obtained has an important prognostic value in the prevention, timely diagnosis and choice of therapeutic measures for carpal tunnel syndrome in the prenatal period in women.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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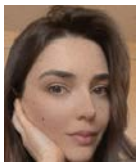

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