КЛІНІЧНА ПРАКТИКА

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THE ROLE OF DOPPLEROMETRY IN THE ASSESSMENT OF LOCAL HEMODYNAMICS IN PATIENTS WITH UTERINE FIBROIDS

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The **purpose of the study** is to evaluate the features of velocymetric hemodynamics in perinodular tissues in uterine fibroids, depending on the size of the node and the presence of degenerative changes.

Material and methods. The research was carried out in 2020–2023 at the clinical units of Odesa National Medical University (Odesa, Ukraine). A clinical, instrumental, and laboratory study was conducted in 275 women of reproductive age with verified uterine fibroids.

Results. The average volume of the dominant leiomyoma node was (84.2 ± 0.1) cm^3 (corresponding to the range of (21.5–328.0) cm^3). The dominant fibroid node was vascular in 226 (82.2%) patients and nonvascular in 49 (17.8%) patients. 138 (50.2%) vascular dominant myoma nodules showed only peripheral (perifibroid) vascularity, whereas 62 (44.3%) showed both peripheral and central (intrafibroid) vascularity. The average linear velocity of blood flow in the uterine arteries was (39.6 ± 0.4) cm/s with the resistance index of 0.8±0.04 and the pulsatility index of 1.4 ± 0.05.

Conclusions:

1. The average velocity of blood flow in the largest myomatous node does not exceed (15.6 ± 0.8) cm/s with the resistance index of 0.7 ± 0.03 and the pulsatility index of 1.2 ± 0.09, which can be explained by a tendency to hypovascularization.

2. The main type of angioarchitectonics of myomatous nodes are nodes with peripheral vascularization, that is, with vessels that surround the myomatous node on its periphery. The angioarchitectonics of fibroids depends on the size of the nodes, their localization, the presence of changes in the adjacent endometrium.

3. Dominant nodes with both perifibroid and intrafibroid vascularity have a significantly larger ($p = 0.004$) average volume (225.5 ± 12.2) cm^3 than nodes with only perifibroid vascularity (average volume = 157.2 ± 9.5 cm^3) or avascular nodes (up to 50 cm^3).

4. The degree of vascularization significantly increased with the increase in the volume of the dominant myomatous node ($r = 0.75$; $p < 0.05$).

Keywords: uterine fibroids, angioarchitectonics, vascularization, dopplerography, diagnosis.

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РОЛЬ ДОПЛЕРОМЕТРІЇ В ОЦІНЦІ ЛОКАЛЬНОЇ ГЕМОДИНАМІКИ У ХВОРИХ НА МІОМУ МАТКИ

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Мета дослідження – оцінити особливості велосиметричної гемодинаміки в перинодулярних тканинах за міоми матки залежно від розміру вузла та наявності дегенеративних змін.

Показано, що середня швидкість кровотоку в найбільшому міоматозному вузлі не перевищує (15,6 ± 0,8) см/с за індексу резистентності 0,7 ± 0,03 та індексу пульсації 1,2 ± 0,09. Домінуючі вузли мають значно більший ($p = 0,004$) середній об'єм (225,5 ± 12,2) $см^3$, ніж вузли лише з перифіброїдною васкулярністю (середній об'єм = (157,2 ± 9,5) $см^3$) або безсудинними вузлами (до 50 $см^3$). Ступінь васкуляризації вірогідно зростав зі збільшенням об'єму домінантного міоматозного вузла ($r = 0,75$ $p < 0,05$).

Ключові слова: міома матки, ангіоархітектоніка, васкуляризація, доплерографія, діагностика.

Introduction. Ultrasound diagnostics is the first-line method of imaging in the diagnosis of uterine fibroids (UF), which usually appear as well-defined, solid, concentric, hypoechoic formations with varying numbers of acoustic shadows. With the development of myoma, the conditions for the appearance of myometrial vessels abnormalities, including venular ectasia and an increase in the venous plexus, arterial dilatation, localized expansion of myometrial vessels and abnormal organization of vessels in the perifibrous area are formed [1–3]. Most of these changes can be visualized and evaluated using dopplerometry [4, 5].

To date, the following dopplerometric characteristics of local hemodynamics in UF have been described: a peripheral rim of vascularization in the pseudocapsule (usually covering almost three quarters of their circumference)

[1, 2] and pronounced peripheral blood flow with reduced central blood flow, and in some cases with an avascular core [1, 3]. However, velosymetric indicators of arterial blood flow in the myomatous node have not been studied in detail yet [4].

The **purpose of the study** is to evaluate the features of velosymetric hemodynamics in perinodular tissues in uterine fibroids, depending on the size of the node and the presence of degenerative changes.

Material and methods. The research was carried out in 2020–2023 at the clinical units of Odesa National Medical University (Odesa, Ukraine). A clinical, instrumental and laboratory study was conducted in 275 women of reproductive age with verified uterine fibroids. The examination programme of the patients was in accordance with current clinical protocols and ACOG recommendations [6, 7].

The study was performed in compliance with modern bioethical requirements regulated by the declaration of the World Medical Organization (Helsinki, 1964); the recommendations of the Council of International Scientific Societies (1993, 2001), the recommendations on conscientious clinical practice of the GCP; WHO recommendations (1995), EU directives on the conduct and ethical principles of clinical trials (2001) [8]. All patients signed an informed consent to participate in the study. The study design was approved by local ethical commission (Protocol No. 16 of 18.05.2020).

All patients underwent transabdominal and transvaginal ultrasound examination of pelvic organs in convex and duplex modes. The research was conducted on days 5–8 of the menstrual cycle on a Toshiba Aplio XG device (SSA-790A). The thickness of the endometrium, presence, size and localization of myomatous nodes were evaluated. In addition to the convex sensor, color Doppler mapping was used [9, 10].

Statistical processing was performed using the methods of frequency and variance analysis using Statistica 14.0 software (TIBCO, USA) [11].

Results and discussion. The average age of the patients was (38.5 ± 0.4) years. Most of the patients (61.8%) had one myomatous node; 38.2% of patients had more than two myomatous nodes (on average 2.8 ± 0.2). The localization of nodes varied, intramural-subserosal – 48.4% and multiple hybrid localization – 20.4% were the most common. In most cases, the size of myoma was more than 7 x 5 cm (Fig. 1).

The average size of myomatous nodes in patients included in the study was (39.6 ± 0.5) mm x (42.4 ± 0.5) mm. Degenerative changes were observed in 101 (36.7%) cases: 62 (22.5%) patients had cystic degeneration, 33 (12.0%) had calcific degeneration, and 6 (2.2%) had cystic and calcific degeneration.

The average volume of the dominant leiomyoma node was (84.2 ± 0.1) cm^3 (corresponding to the range of (21.5–328.0) cm^3). The dominant fibroid node was vascular in 226 (82.2%) patients and nonvascular in 49 (17.8%). 138 (50.2%) vascular dominant myoma nodules showed only peripheral (perifibroid) vascularity, whereas 62 (44.3%) showed both peripheral and central (intrafibroid) vascularity.

The average linear velocity of blood flow (ALV) along the uterine arteries was (39.6 ± 0.4) cm/s with the resistance index of 0.8±0.04 and the pulsatility index of 1.4 ± 0.05. On the other hand, the ALV in the largest node did not exceed (15.6 ± 0.8) cm/s with the resistance index of 0.7 ± 0.03 and the pulsatility index of 1.2 ± 0.09 (Fig. 2).

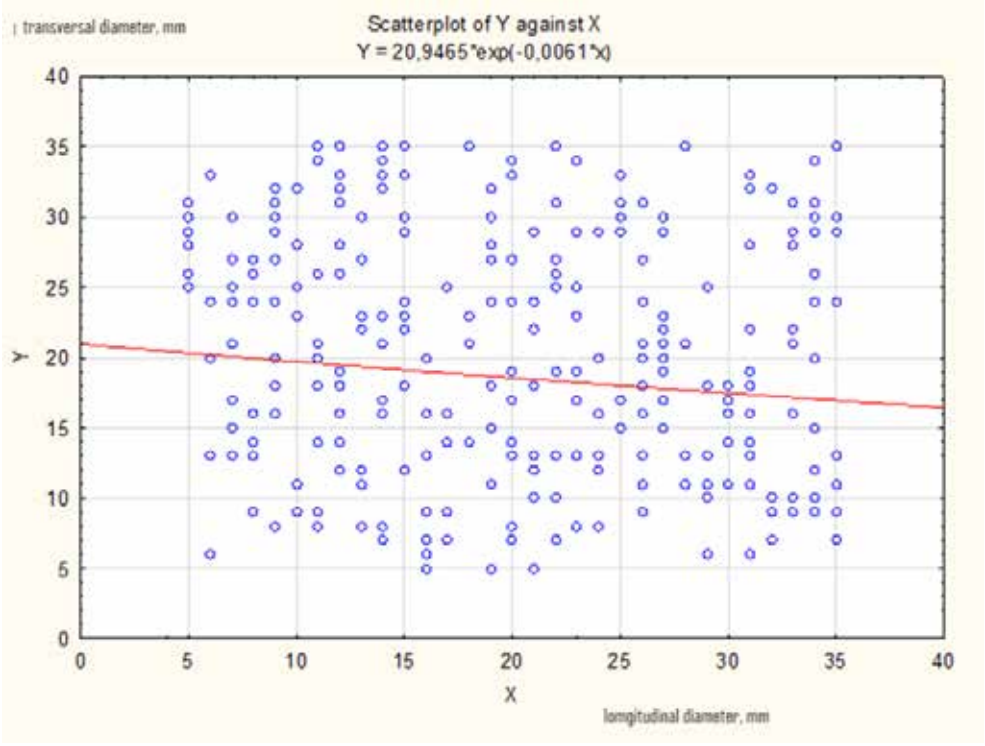

Fig. 1. Sizes of fibroid nodes

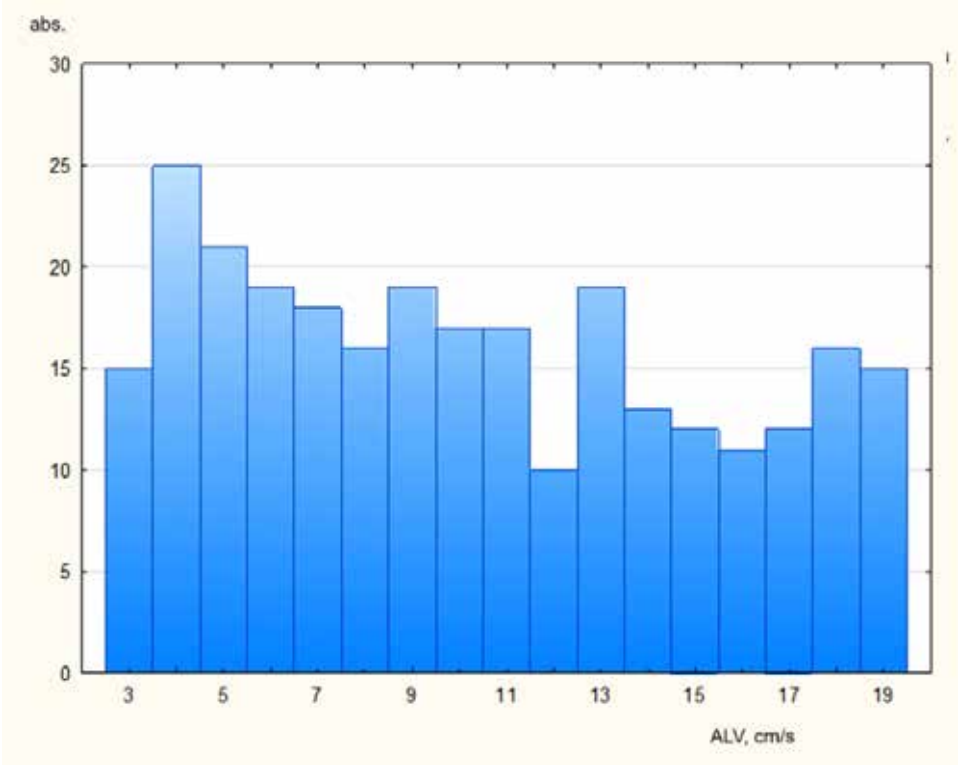

Fig. 2. Distribution of clinical cases according to the ALV in myomatous nodes

The asymmetry of the distribution of Doppler indicators is because the symptoms of UF are usually noted at later stages of the disease, and some symptoms of the disease require a certain volume of "plus-tissue". Indeed, with the largest diameter of 12 cm, the volume of the node is 452.4 cm^3, and with a diameter of 3 cm – 113.1 cm^3. Such a massive node can not only cause pain syndrome, dysuric phenomena and stool disorders, but can also be dangerous for destructive changes in the myometrium perifocally.

Doppler velocity measurements were obtained from the perifibrous (capsular) and/or intrafibrous (nuclear) arteries of the dominant fibrous node when the sensor was placed at an angle of less than 60°.

The degree of vascularization significantly increased with the increase in the volume of the dominant myomatous node ($r = 0.75$; $p < 0.05$). Dominant nodes with both perifibrous and intrafibroid vascularity had a significantly larger mean volume (225.5 ± 12.2) cm^3 than nodes with only perifibroid vascularity (mean volume = (157.2 ± 9.5) cm^3) or avascular nodes (up to 50 cm^3). These differences are statistically significant ($p = 0.004$).

No statistically significant difference was found between the degree of vascularization of fibroids with and without degenerative changes. Similarly, there was no statistically significant difference between the degree of vascularization of dominant myomatous nodes in women with different intensity of clinical manifestations of uterine fibroids. However, all Doppler parameters of perinodal arteries were significantly higher than those of intranodal arteries.

The angioarchitectonics of fibroids depended on the size of the nodes, their localization, and the presence of changes in the adjacent endometrium. According to the results of the performed dopplerometric studies, we suggest considering the following types of nodes depending on their vascularization:

Type I – avascular nodes, which are characterized by the absence of blood flow in the node itself and around the periphery – in 38 (13.8%) patients.

Type II – nodes with peripheral vascularity, i.e. with vessels surrounding the myomatous node on its periphery – 195 (70.9%) patients.

Type III – nodes with mixed vascularity (presence of both enveloping and intranodal vessels) – 31 (11.3%) patients.

Type IV is characterized by nodes with central vascularity (presence of only intranodal vessels) – 11 (4.0%) patients.

In all cases, we assessed the changes in angioarchitectonics as benign.

Doppler imaging of myoma arteries is useful for monitoring the response of leiomyoma to drug treatment, differentiating leiomyoma from adenomyosis, evaluating changes in tumor size in response to uterine vessel embolization, and the use of hormonal drugs [3–5]. In addition, the degree of vascularization is thought to reflect the likely nature of tumor growth and the risk of increased bleeding during surgery.

Our studies confirm the role of ultrasonography in the assessment of local hemodynamics of intranodal and perinodal tissues in UF. At the same time, in contrast to the data of other authors (2019) [4], the size of myomatous nodes had a significant impact on vascularization and ALV. We believe that myomatous nodes, as they grow, have an increasing tendency to hypovascularization of the tumor stroma, that is, the main source of blood supply is small peripheral perinodal arteries. While uterine myoma is a product of monoclonal proliferation, further development

and growth of myomatous nodules may be determined by the peculiarities of local hemodynamics and the production of regulatory compounds by the endothelium, in particular, nitric oxide and growth factors. The obtained indicators can be examined in dynamics, and the prognostic risk of the course of myoma can be estimated based on the results of dynamic observation [12]. However, additional research is needed to test this hypothesis.

Conclusions

1. The average velocity of blood flow in the largest myomatous node does not exceed 15.6 ± 0.8 cm/s with the resistance index of 0.7 ± 0.03 and the pulsatility index of 1.2 ± 0.09, which can be explained by a tendency to hypovascularization.

2. The main type of angioarchitectonics of myomatous nodes are those with peripheral vascularization, that is, with vessels surrounding the myomatous node on its periphery. The angioarchitectonics of fibroids depends on the size of the nodes, their localization, the presence of changes in the adjacent endometrium.

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4. The degree of vascularization significantly increased with the increase in the volume of the dominant myomatous node ($r = 0.75$, $p < 0.05$).

BIBLIOGRAPHY

1. Palheta MS, Medeiros FDC, Severiano ARG. Reporting of uterine fibroids on ultrasound examinations: an illustrated report template focused on surgical planning. *Radiol Bras.* 2023; 56(2): 86–94. DOI: 10.1590/0100-3984.2022.0048.
2. Woźniak A, Woźniak S. Ultrasonography of uterine leiomyomas. *Prz Menopauzalny.* 2017; 16(4): 113–117. DOI: 10.5114/pm.2017.72754.
3. Baird DD, Patchel SA, Saldana TM, et al. Uterine fibroid incidence and growth in an ultrasound-based, prospective study of young African Americans. *Am J Obstet Gynecol*. 2020; 223(3): 402.e1–402.e18. DOI: 10.1016/j.ajog.2020.02.016.
4. Yakovenko K, Tamm T, Yakovenko E. Study of hemodynamics of the uterine body by the method of three-dimensional energy dopplerography of patients with leiomyoma in different age periods. *ScienceRise: Medical Science*. 2019; 5(32): 18–24. https://doi.org/10.15587/2519-4798.2019.180470.
5. Kirschen GW, AlAshqar A, Miyashita-Ishiwata M, Reschke L, El Sabeh M, Borahay MA. Vascular biology of uterine fibroids: connecting fibroids and vascular disorders. *Reproduction.* 2021; 162(2): R1–R18. DOI: 10.1530/REP-21-0087. PMID: 34034234; PMCID: PMC8320308.
6. Taktyka vedennia patsiientok z leiomiomoiu matky klinichna nastanova, zasnovana na dokazakh. DEK, 2022. https://www.dec.gov.ua/wp-content/uploads/2023/01/2022_12_26_kn-lm.pdf (in Ukrainian).
7. ACOG Guideline. Management of Symptomatic Uterine Leiomyomas. 2021. https://www.acog.org/clinical/clinical-guidance/practice-bulletin/articles/2021/06/management-of-symptomatic-uterine-leiomyomas.
8. Tereshkevych HT. Osnovy bioetyky ta biobezpeky. Ternopil: TDMU, 2018. 400 p. (in Ukrainian).
9. Pelvic Ultrasound Imaging: A Cased-Based Approach. Ed. by Rebecca Hall. Ph., Elsevier, 2021 240 p.
10. Gladchuk IZ, Rozhkovska NM, Saleh OS. The relationship between the expression of microrna-29b and -146a with clinical and pathological characteristics of patients with uterine fibroids. *Odesa Medical Journal*, 2023; 2: 26–30 (in Ukrainian). https://doi.org/10.32782/2226-2008-2023-2-4.
11. Fetisov VS. Paket statystychnoho analizu danykh STATISTICA. Nizhyn: NDU im. M. Hoholia, 2018. 114 p. (in Ukrainian).
12. Mykytyn KV. Morphological and immunohistochemical changes of the endometrium in women with hyperproliferative pathology of the uterus and reproductive dysfunction. *Eastern Ukrainian Medical Journal*, 2022; 10(3): 241–246. https://doi.org/10.21272/eumj.2022;10(3):241-246.

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