CONTRAST-ENHANCED ULTRASOUND ASSESSMENT OF THE MICROCIRCULATION OF SPASTIC CALF MUSCLES PRIOR TO BOTULINUM TOXIN TYPE A INJECTION IN PATIENTS WITH LONG-STANDING LOWER LIMB SPASTICITY

(INITIAL EXPERIENCE)

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Botulinum neurotoxin type A (BoNT-A) injections are used in the treatment of muscle spasticity and in the prevention of contractures. Activation of the peripheral stretch reflex changes the position of the limbs at rest and decreases passive function, thus leading to structural alteration of the muscles, increased muscle stiffness, and aggravated clinical symptoms of spasticity. Rational use of BoNT-A injections decreases muscle hyperactivity and corrects postural deformity. Muscle contracture developing due to spasticity and restriction of passive muscle stretching are the factors that limit the efficacy of BoNT-A injections. There are pathomorphological data demonstrating development of degeneration and deterioration of the microcirculatory bed in spastic muscle that worsen with time.
Study goal: Explore the possibility for qualitative assessment of the microcirculation disturbances in the medial head of a spastic gastrocnemius muscle (GCm) by means of low mechanical index contrast-enhanced ultrasound (CEUS).

Methods:

CEUS imaging of the GCm was carried out after intravenous administration of a contrast medium containing phospholipid-stabilized microbubbles filled with sulfurhexafluoride. The ultrasound contrast medium does not leave the bloodstream and thus helps visualize the microvascular organization and tissue perfusion. B-mode ultrasonography findings for the tested muscle had been assessed before hand. The study was conducted in 9 patients with post-stroke and post-traumatic spastic hemiparesis that lasted 3 to 5 years.The passive stretch angle of the spastic GCm did not exceed 15%. The CEUS imaging results obtained for the GCm muscles in the spastic and the healthy limb were compared. Disorders of the main blood vessels in the lower limbs had been ruled out in all study subjects in advance.

Results:

B-mode ultrasonography demonstrated that the maximum muscle size of the spastic GCm was decreased in all patients by 4.5 mm on the average (4.2 - 5.1 mm) as compared to the contralateral healthy muscle. The spastic muscle presented hyperechoic, with diffusely decreased or absent muscle fiber differentiation, which is typical for muscle fibrosis. CEUS with tomography of the healthy GCm revealed a rich, well-organized microcirculation pattern in all study subjects: alternating small vessels with steadily moving contrast medium microbubbles were situated at an angle to a larger blood vessel. In the spastic GCm, blood flow in the microcirculatory bed was significantly reduced, consisting of isolated, chaotic and unevenly distributed spots of preserved blood flow showing slower movement of the contrast medium microbubbles and a misshapen microcirculatory bed pattern (Figure 1).

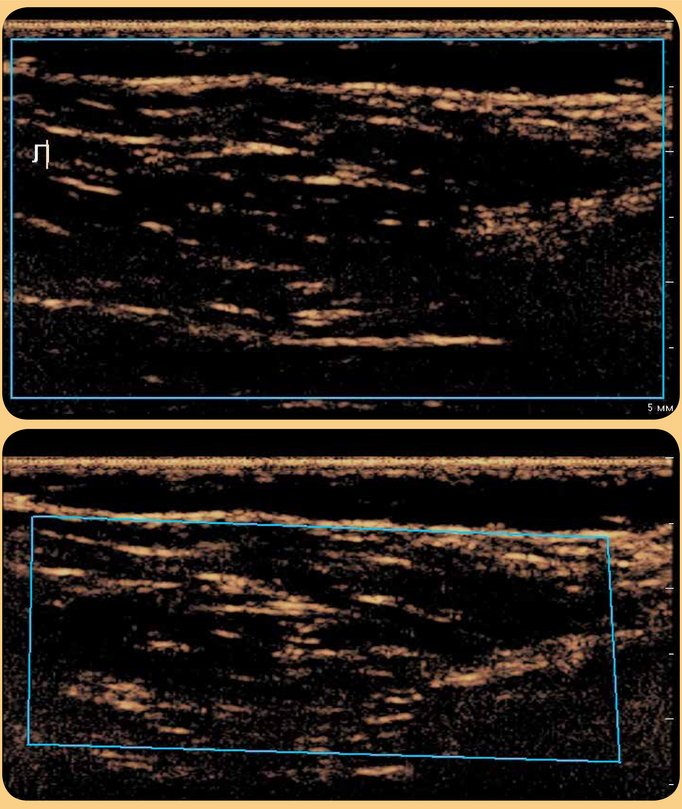

Figure 1. Patient Ch., male, 27 years old, with a five-year history of left spastic hemiparesis.CEUS with tomography of the GCm muscles: R) – microcirculatory bed of the healthy GCm; L) deteriorated microcirculation of the spastic GCm with isolated spots of preserved blood flow.

Conclusion:

Direct, complex, non-invasive ultrasound imaging of the spastic muscle, including contrast-enhanced ultrasound, allows not only evaluation of morphological abnormalities but also assessment of the microcirculatory bed condition, which determine the severity of fibrosis. The choice of target muscles and feasibility of botulinum toxin therapy may have additional objective justification and thus help optimize the process of rehabilitation

Key words:

Contrast-enhanced ultrasound – CEUS, spasticity, microcirculation, botulinum toxin therapy.

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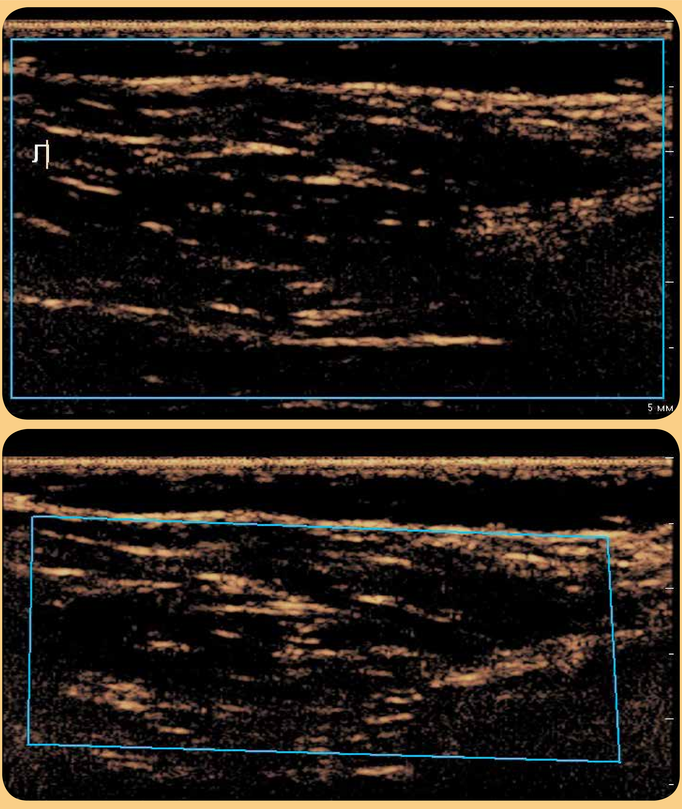

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