DIAGNOSTIC CAPABILITIES OF SONOGRAPHY OF THE SOFT TISSUE HEMATOMAS

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INTRODUCTION

The issue of diagnostics and treatment of traumatic soft tissue injuries attracts attention of specialists around the world [1]. Currently in traumatology, highly informative instrumental diagnostic methods are being used [2]. Increasingly, ultrasound diagnosis is applied to study the soft tissue of the musculoskeletal system. A wide range of information obtained, the accuracy of results, simple techniques, the possibility of multiple repetition of the studies, reproducibility, non-invasiveness, safety for both the patient and medical personnel, absence of contraindications and relatively low cost have made the ultrasonography as a method of choice for investigation of patients with soft tissue pathology [3, 4].

Aim of this study is to introduce the potentials of imaging methods for diagnosis of traumatic soft tissue hematomas.

MATERIALS AND METHODS

139 patients (61.5%) with liquid hematoma and 87 patients (38.5%) with imbibition hematoma have been identified among 226 patients with traumatic hematomas (Table).

Traumatic hematomas clinically manifested by the presence of soft tissue ache at the site of tumor formation, change in skin color, increased local temperature, impaired function of the injured area. One of the major clinical manifestations of the hematoma is discoloration of the skin in the form of "bruise." Severity of these manifestations depended on the duration of hematoma, depth of localization of the hematoma, and the ability to change its location.

We observed patients with hematomas that lacked signs of skin discoloration. Clinical manifestations in

Fig. 1. Traumatic hematoma with severe clinical picture

Table

Anatomical location of hematomas

Location of hematoma	Liquid	Imbibition
Tibia	65	41
Thigh	37	29
Shoulder and forearm	12	7
Ankle joint	10	2
Gluteal area	9	6
STAT *	5	1
Neck	1	1
Total	139	87

* soft tissue of the abdomen and thorax

Fig. 2. Deep intermuscular hematoma with mild appearances

Fig. 3. Appearance of the traumatic hematoma as imbibition: buttock (**a**); shoulder (**b**)

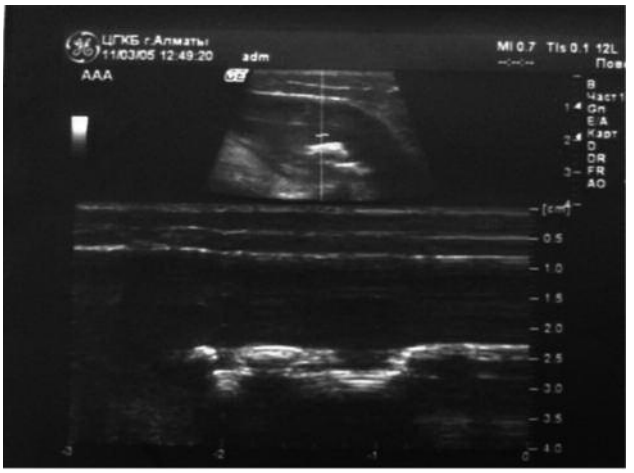

Fig. 4. M-mode apparatus for estimating muscle contractility

the form of hematoma imbibition did not differ from liquid hematoma. The data collected from external examination did not allow us to distinguish hematoma in the form of liquid from the imbibition hematoma (Fig. 3).

Ultrasound examination of hematomas was carried out by the sector or linear sensor device with an operating frequency of 3.5 MHz up to 12 MHz. Sensor device selection depended on the size of hematoma, depth of its occurrence and anatomical localization area of the hematoma. The survey was conducted considering the principle of the poly-positionality of the study.

To assess the effectiveness of the treatment, it is necessary to re-study, the researcher repeating the initial examination, in other words it is necessary to use the sonography in the same projection with the same technical scanning modes.

Hematoma reduces muscle contractility; the technique which allows recording those reductions is an M-mode.

RESULTS AND DISCUSSION

Different types of hematomas differ in their content and complications, and require different treatments. This explains the importance of clear identification of different types of hematomas. One of the methods to help identify those types is ultrasound diagnosis. Ultrasound semiotics of hematomas was investigated on the basis of the study of 226 patients with traumatic soft tissue hematomas. Liquid blood flowing into the soft tissue surroundings leads to certain changes that disrupt the function and causes pain, swelling, discoloration of the skin. Blood, consisting of uniform elements and the liquid portion in the lumen of the vascular tube and beyond behaves differently. At the exit from the vascular tube, the uniform corpuscles are destroyed (hemolyzed) and the protein part is coagulated.

Based on the ultrasound examination of 226 patients, there was a task to study the ultrasonic semiotics according to the classical skialogy used when describing a shadow-formation. This took into account

the localization, shape, number, size, structure, echogenicity, contours, etc. [5]. All these signs had their manifestations in the ultrasonic picture. On the basis of symptoms of hematoma, we tried to explain the emergence of a symptom, i.e. the substrate of the current ultrasound picture. Ultrasonic manifestations of each hematoma were a complex of symptoms on their own.

During the ultrasound study, localization was supposed to be the depth of hematoma in the soft tissues. Hematoma often localized in the subcutaneous fat — 56.1%. Intermuscular hematoma localization was found in 37.4% of cases. Clinical manifestations of this localization are less seen because they may not change the color of the skin and swelling may not be detected. Liquid hematoma was detected by the ultrasound in the form of hypo-and anechoic formation the lower contour of which had the effect of acoustic echo-amplification the effect which is typical to any liquid formation (Fig. 5)

The superficial hematomas were located in the adipose tissue, echogenicity of which exceeded echogenicity of the liquid formation, so, the boundary between two media differing in echogenicity was clear and not merging.

That formed a hematoma as a linearly elongated, oval or irregularly shaped hematoma due to the pressure of the surrounding soft tissues (Fig. 6).

Dimensions of the hematomas identified by ultrasonography were divided into three groups of 1-4 cm, 5-10 cm and 10 cm or more. In this case, the size of the hematoma with 4 cm is found among 63.3% of the patients; 5-10 cm size hematoma among 30.2% and 10 cm 6.5% of cases respectively.

Structure of liquid hematoma was inhomogeneous in 49.6% of cases; 29.5% was homogeneous and mixed in 20.9% of cases. Identification of the hematoma with mixed structure is due to the fact that the inhomogeneity of the structure can be caused by various factors. Mixed structure implies a liquid hematoma in combination with imbibition.

The structure of a liquid hematoma, depending on the contents of its morphological substrate, may be different. The fluid effusive into the soft tissues should be anechoic with dorsal echo enforcement, but as the blood is an inhomogeneous composition of organic matter, it contains red blood cells, white blood cells, protein fraction, interstitial fluid, pigments, has a certain Ph – environment and as a biological substance has the ability to clot and so on. In ultrasound picture of liquid hematoma, there appeared echo inclusions, combination of fluid with imbibition, lumps of fat, bright echo thick inclusions, partitions as well as muscle fibers.

Ultrasound examination conducted in the dynamics allowed to evaluate the effectiveness of conservative or surgical treatment of hematomas.

Dynamic ultrasound showed that also the liquid portion of the hematoma changes the location depending on the influence of gravitational forces.

Patient stated that the injury was in one place, and after some time, the "bruise" went down and showed itself below the spot of action of the traumatic factor.

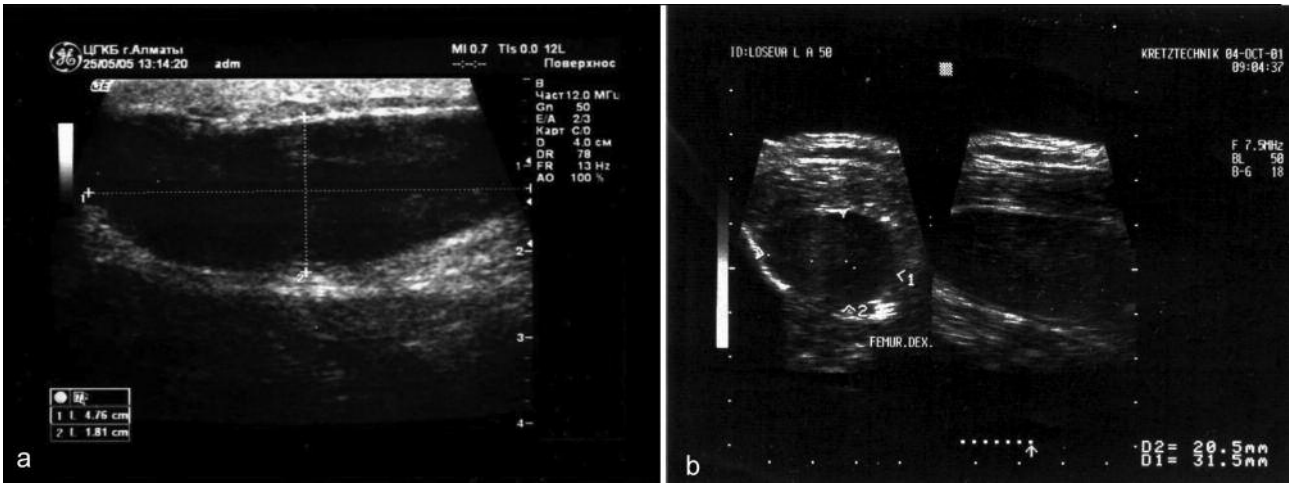

Fig. 5. Liquid hematoma located in the subcutaneous fat (**a**); sonogram of deep intramuscular hematoma (**b**)

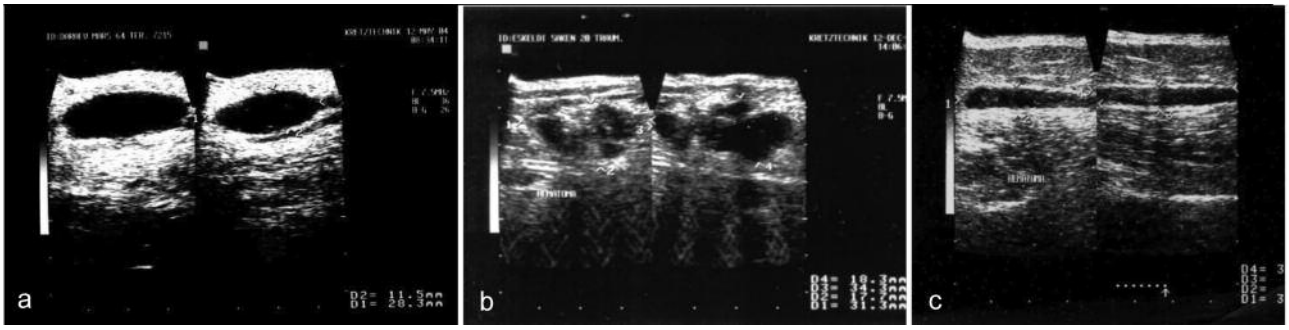

Fig. 6. Oval hematoma (**a**); irregular shaped hematoma (**b**); linearly elongated shape hematoma (**c**)

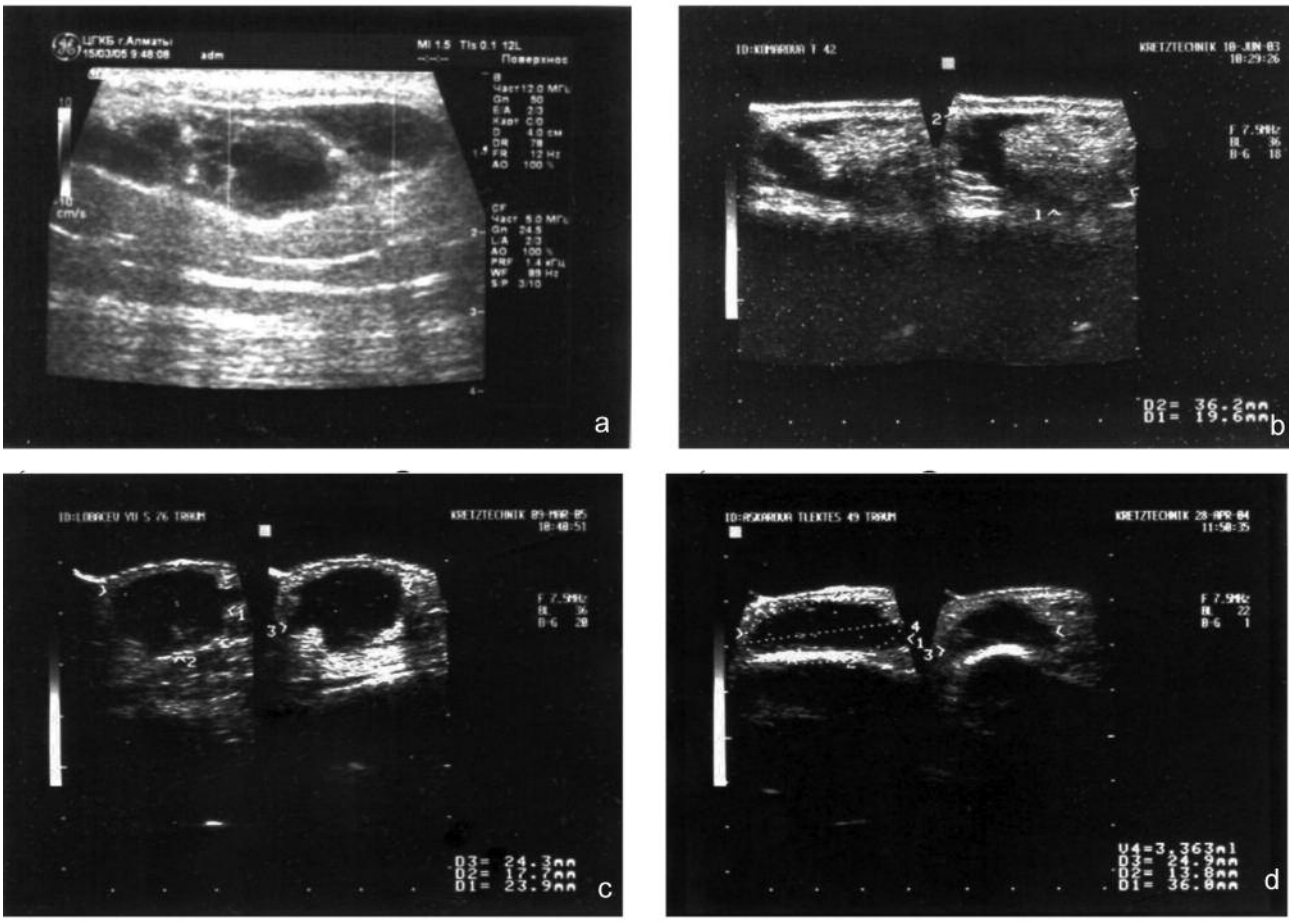

Fig. 7. Hematoma with partitions (**a**); tissue impurities (**b**); bright point-like inclusions (**c**); bright linear inclusions (**d**)

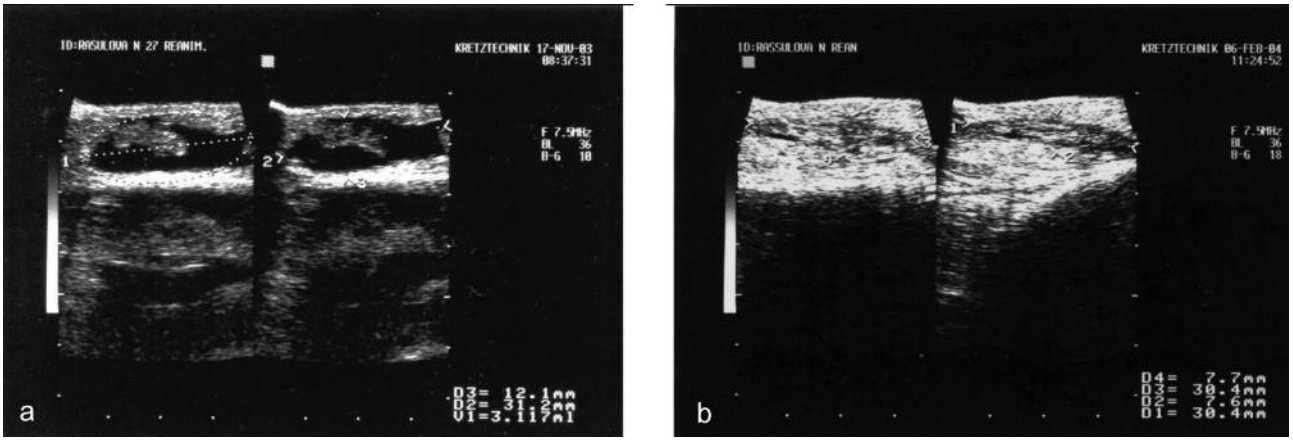

Fig. 8. Illustration of the dynamic observation over the hematoma:
before treatment (**a**); in the process of treatment (**b**)

The illustrations above clearly show that the hematoma goes down under the influence of gravity.

When there is an intramuscular hematoma, separation of muscles and a partial tear of the muscle lead to a decrease in muscle contractility. Contractile ability of the muscles was evaluated by us using M-mode ultrasound device.

The poorly known type of hematoma is hematoma as imbibition or impregnating the soft tissue with blood. According to our data, the proportion of hematomas as imbibition was 38.5%. For this type of hematoma, the soft tissue absorbs the effusive blood like a sponge. Clinical manifestations of the imbibition hematomas did not differ from liquid hematoma. There was a task to examine the echo semiotics of traumatic hematomas of soft tissues in the form of imbibition. Among 226 patients with traumatic hematomas, 87 (38.5%) were identified to have the type of imbibition hematoma. While studying the echo semiotics of the imbibition hematomas, we found the some features of the ultrasound picture with this type of hematoma which differ significantly from liquid hematomas.

Fig. 9. Trauma in the middle third of the tibia, a hematoma is located at the level of ankle joint

The process of impregnating the tissues with blood leads to certain changes in the sonographic picture where the hematoma changes the usual structure of the tissues which it impregnates. According to the data of the sonography, we established that imbibition of the hypodermic tissue was observed among 37 patients (Fig.10). During the localization of a hematoma in the hypodermic fat tissue, it changes the thickness of the fat tissue and extrudes in the more compliant part of the tissue towards the skin. At the same time, the cellular structure of the subcutaneous fat tissue of low echogenicity changes in the direction of increased echogenicity.

Intermuscular localization of the imbibition hematoma was identified among 33 patients (37.9%) where the muscle tissue was being impregnated with the effusive blood. During the ultrasound there was a change of the conventional structure of the muscle tissue; there was a further reduction in its echogenicity; there was a separation of the layers of muscle bundles and thickening of the muscle fibers (Fig.10).

The form of the hematoma as imbibition mostly was of irregular shape. The hematoma with an irregular shape can be explained by the fact that, as with the liquid hematoma, the free liquid uniformly exerting pressure on the surrounding soft tissue acquires a more or less regular shape, whereas the imbibition hematoma shape will depend on the degree of the soft tissue impregnation with liquid.

The imbibition hematoma located in the intermuscular layers was acquiring quite correct oval shape — this shape is usually given by the presence of muscle fascia that fringes around with imbibition portion of the muscle tissue. In rare cases there was an imbibition hematoma with a linear shape.

When the location of hematoma was in the subcutaneous fat, the sonography revealed an increase of the thickness of the fatty tissue and echogenicity. Increasing of the thickness of subcutaneous fat resulted in pushing back the surrounding soft tissues. While observing by the ultrasound, there was detected a thin layer of liquid on the background of imbibition.

The results of our study showed that the hematoma as imbibition often had an irregular shape — 64.4%, rarely oval shape — 33.3% and in a few cases, linear shape 2.3%.

The imbibition hematoma structure differs from liquid hematoma. When imbibition, the tissue structure in which there is bleeding, it determines echogenicity of hematoma. So when hematoma is localized in subcutaneous fat, the hematoma structure can have high echogenicity which was 29.9% in our study data. When it is an imbibition hematoma, the structure is usually inhomogeneous.

When it is imbibition, a medical tactic is aimed at conservative treatment, puncture of that area leads at best to obtaining of a minimum amount of blood, but often you can get nothing. Any injury to the skin carries a risk of bringing infection in followed by suppuration of the hematoma.

Its structure in the majority of cases was inhomogeneous in 87.4%. Homogeneous structure was found only in 12.6% of the observation. Echogenicity was low in 36.8% of cases, it was increased in 29.9%, isoechoic — 12.6% and mixed — 20.7%. Imbibition contours were clear in 29.9%, fuzzy — 70.1%, often uneven — 74.7%.

Dynamic study of the state of soft tissues after traumatic hematoma showed that absolute recovery of anatomical structures is rare. The places after hematomas are seen as hardening of the soft tissues and changes of their usual structures.

CONCLUSION

1. Ultrasonic semiotics of liquid and imbibition hematomas of soft tissues has been developed. The

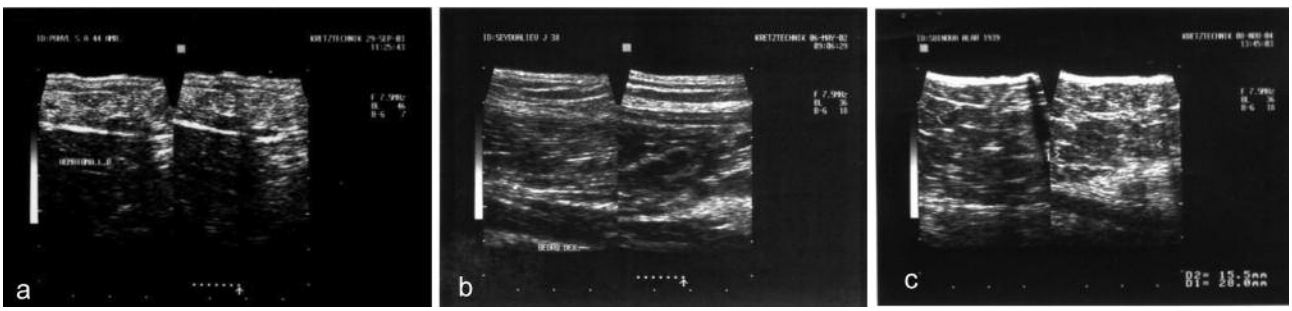

Fig. 10. Localization of the hematoma in the subcutaneous fat (**a**); imbibition intermuscular (**b**); imbibition all layers of soft tissue (**c**)

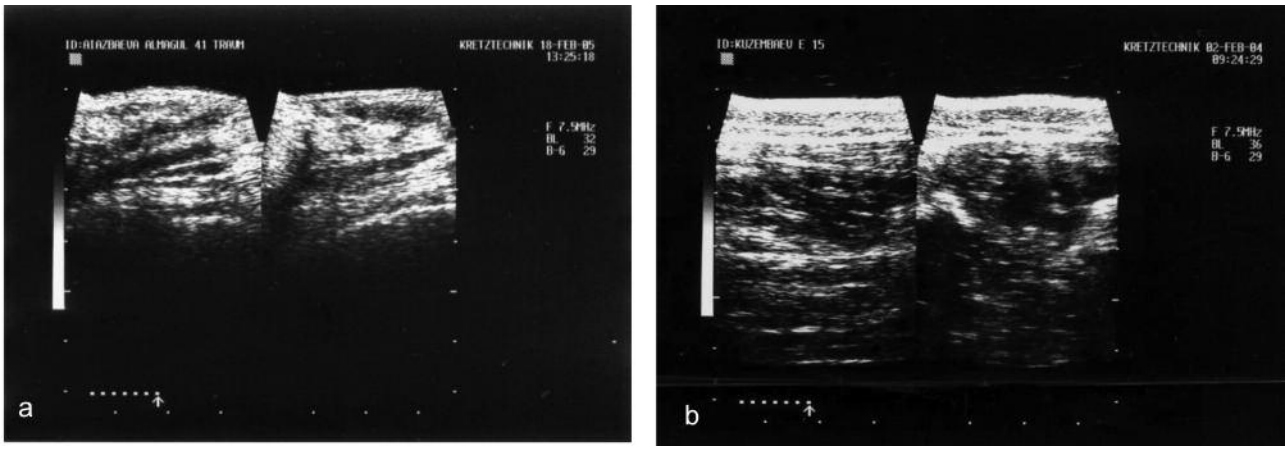

Fig. 11. layer of liquid on the background imbibition (**a**); linear impurities of transversely striated muscles (**b**)

dependence of the echo-graphic signs on its location, time after injury, changes of echo-semiotics of hematoma during treatment has been identified.

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***Summary**. There are presented results of imaging diagnostics of traumatic soft tissue hematomas of 226 patients, 139 of whom were identified to have liquid hematoma and 87 had imbibition hematoma. All participants underwent ultrasonography. Semiotics of their manifestations and evaluation of the therapy efficiency over the liquid and imbibition hematomas have been assessed.*

ДІАГНОСТИЧНІ МОЖЛИВОСТІ СОНОГРАФІЇ ГЕМАТОМ М'ЯКИХ ТКАНИН

Мухамедянов К.Х., Аміров Б.Б., Аділбаєв Г.Б., Лі Е.Л.

***Резюме**. Представлено результати візуалізації травматичних ушкоджень м'яких тканин, а саме гематом у 226 пацієнтів, 139 з яких були визначені як рідинні гематоми і 87 гематоми з імбібіцією тканин. Всі учасники дослідження пройшли ультрасонографію. Під час дослідження були оцінені ультразвукова семіотика прояву гематом м'яких тканин та ефективність терапії різноманітних ушкоджень м'яких тканин.*

ДИАГНОСТИЧЕСКИЕ ВОЗМОЖНОСТИ СОНОГРАФИИ ГЕМАТОМ МЯГКИХ ТКАНЕЙ

Мухамедянов К.Х., Амиров Б.Б., Адилбаев Г.Б., Лі Е.Л.

***Резюме**. В статье представлены результаты визуализации травматических повреждений мягких тканей, а именно гематом, у 226 пациентов, 139 из которых были оценены как жидкостные и 87 как свернувшиеся. Все участники исследования прошли ультразвуковую диагностику. Проведена оценка ультразвуковой семиотики проявления гематом мягких тканей и эффективности терапии различных видов повреждения мягких тканей.*