

## **DIAGNOSTIC POTENTIAL OF REAL-TIME ELASTOGRAPHY UPON PANCREATIC DISEASES OF DIFFERENT GENESIS**

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**Key words:** pancreatic diseases, elastography, methods, informativity, diagnostic potential

Incidence of pancreatic cancer has been steadily increasing in Ukraine. This is caused by inappropriate diets, alcohol abuse, environmental degradation, increasing pathology of hepato-biliary system and duodenum attacks viral infections, using drugs and a number of other reasons.

The incidence of chronic pancreatitis (CP) was marked by more than two-fold increase for 30 years. On average, in recent years the prevalence of CP among the Ukrainian population is 2530 people per 100 thousand population. CP peculiar sluggish current prolonged inflammation with periodic exacerbations of the process, thus there is a change in diffuse parenchymal atrophy and replacement of fibrous glandular tissue of the organ. According to modern concepts fundamental to the disease progression of fibrosis is continued even after the expiry of the etiological factor. Lack of morphological recovery leads to functional pancreatic insufficiency, causing imbalance of many body systems.

Tissue deconstructurization with foci of fibrosis, impaired regenerative processes underlie the formation of cysts and cancer of the pancreas. The share of the latter accounting for about 10% of all tumors of the digestive system. In Ukraine, each year about 2.5 thousand new cases of pancreas cancer. Adenocarcinoma of the prostate every year carries more than 250 thousand of lives around the world, occupying the 13th place on the frequency of all types of malignant tumors and the 8th place among the most frequent causes of cancer death.

The situation is complicated due to the fact that the diagnosis of diseases of the pancreas is one of the most problematic in the national gastroenterology. The main reason — the difficulty of visualizing the body using instrumental methods. Therefore, the average time of diagnosis of CP depending on the etiology of two to five years. Thus, the time of diagnosis of cancer of pancreas tumor limited authority only 15% of patients, 25% of persons determined by its extension to regional lymph nodes, the remaining 60% of cases it metastasizes. Furthermore lymph nodes, most commonly defined prostate cancer metastases in the liver, lungs and the peritoneum. Also observed metastasis of other tumors in the pancreas (lung cancer, breast cancer, melanoma), which may manifest as cancer of pancreas.

In this regard, particularly urgent improvement of imaging the pancreas. One such option is the static (compression) elastography provides increasing information content, sensitivity and specificity of ultrasound method. At the moment method is widely used in medical centers in the U.S., Japan, Western Europe.

Development of static (compression) elastography engaged several leading companies — manufacturers of ultrasound equipment Premium-class, each of which has patented its own name for it: at Hitachi — is Real-Time Elastography (RTE) — elastography in real time; Toshiba — succinctly Elastography; Ultrasonix denotes technique Free Hand RTE. Without going into the debate over terminology, we emphasize that it is synonymous names for the same technique. Later in this article we denote it RTE.

At this day, Ukrainian doctors clearly understand the nature and diagnostic capabilities RTE due to limited availability in our country equipment to carry it out. Unfortunately, some academics have a misconception about elastography. In particular, the incompetence in this matter can be seen in statements that modern devices to conduct ultrasound option "elastography" give a color image of different tissue elasticity without any quantitative indicators, or that the results of this study depend on the degree of pressing on the sensor abdominal wall. Such statements in

oral presentations or publication of such errors in the scientific press are not valid, because in the absence of doctors' experience in this area form a false judgment that causes harm to the undeniable progress of medical science in Ukraine.

Based on this, in this article we would like to introduce a wide audience of physicians with the procedure and its potential RTE in the diagnosis of prostatic diseases examples of discussion of the results obtained by foreign scientists and their own research data.

RTE is a variation of the ultrasonic method to study the orientation of tissue elasticity in real time. Technology research is based on identifying signs of lesions in the prostate-mode, then about the study mode RTE. RTE execution allows you to get both qualitative and quantitative indicators of tissue elasticity without additional manual compression. The methodology laid rhythmic physiological compression, which, like other organs, the pancreas undergoes due to pulsation of the heart and near major arteries. In this soft piece of cloth pancreas deformed to a greater extent dense — less. Reflected echoes captured sensor and used by the computer to calculate the moving parts of the body tissue, and then displays a representation of the distribution of its deformation mode of color mapping.

Adequacy clicking sensor projected pancreas on the anterior abdominal wall, the doctor-produced sonologomy controlled by the corresponding indicator on the monitor screen (green circular chart in the lower right corner of the screen, see Fig. 2, 3, 4). This guarantees a minimum amount of image artifacts. Due to that the color pattern of Elastograph image is not stable for a long time, for 5 seconds it produced a video, which is then used for the qualitative and quantitative evaluation.

Each plot of Elastograph image by numerical value of elasticity is associated with a particular state of tissue (normal tissue, fibrosis, focal prostatic parenchyma education, etc.) and visually identified by the color. For example, firms in the ultrasonic scanner Ultrasonix (Canada) are the least elastic fabrics painted in dark red, medium elasticity fabric — yellow-green, stretchy fabrics — the colors of the sky-

blue spectrum. Looking through the color range of images, judge the homogeneity of the structure of pancreatic availability, location and characteristics of detected changes. Dignity RTE, facilitating interpretation of results is the synchronous execution of gray-scale imaging in the pancreas B-mode image in real-time mode and color mapping of the same tissue sites (displayed on the screen at the same time the two images Fig. 2, 3, 4).

RTE does not provide absolute numbers density pancreas in kPa. However, thanks to a computer program in a study performed automated calculation of elasticities — elastic strain ratio (ESR) — for individual sections of the pancreas parenchymatous tissue. For this purpose, the resulting film is selected so-called loop. zone of interest — regions of interest (ROI): A plot, the problem from the standpoint of diagnosis (ROI-A), and the site-In standard (ROI-B). ROI-A is as large as possible seizure of focal lesions or areas of lower elasticity according to the color pattern — "hard" fabric. ROI-B is selected from the tissue surrounding the ROI-A, corresponding to elastic — "soft" to the color pattern. As this site, usually using an unmodified region of the body. The coefficient of elasticity is the ratio of ESR values of B / A, quantitatively characterizing the elasticity of the problem area. Given that the choice of different ROI-B around the lesion, ESR values may differ slightly, the average rate is applied between the three measurements of the same ROI-A and three different ROI-In. Thus, the researcher receives no absolute figures tissue elasticity and ratio "pathology / norm". Thus comparative figures currently favored as variants of the norm in absolute numerical values have a wide range, especially with regard to the evaluation of research results pancreas in children.

Results RTE recorded as clips or still images and can be used in the future if necessary dynamic observation. Technique easily reproducible and independent of the constraints of patients such as obesity IIIIV Art. Expressed cholestasis, acute hepatitis, ascites.

So, the modern generation of ultrasound equipment when the RTE allows both qualitative and quantitative analysis of the elasticity of the tissue examined organ.

What is the clinical significance in diseases of the pancreas RTE?

First of all, RTE can successfully address issues of its focal pathology. In case of B-mode focal lesion of the prostate doctor sonolog using RTE estimates hearth with the position of "benign / malignant growth" spending so presumptive assessment histo structure hearth. If necessary, a biopsy determined area, which is under the control of the implementation of RTE makes research more precise.

It should be noted that since the time of Hippocrates low elasticity of tumors was seen as an indicator of its malignancy Some recent studies indicate that RTE is a promising technology with a high degree of reliability and accuracy in the differential diagnosis of lesions of the solid pancreas. In particular, homogeneous or heterogeneous pattern Elastograph color pattern, as well as the dominance of a certain color, significantly correlated with the histological characteristics of the pancreas. Therefore, despite the fact that RTE is a relatively new technique, it has been dubbed the "virtual biopsy". In the study of regional lymph nodes RTE allows differential diagnosis between their inflammatory and metastatic changes. Therefore, the procedure can be used to confirm the stage of the malignant process of hepato-pancreatic-duodenal area. Thus, the technique RTE expands our diagnostic capabilities.

The first work in the field of ultrasound pancreatic elastography refers to the period 2005-2008 years. High diagnostic value of high-quality access RTE with transcutaneous ultrasound signal in the diagnosis of focal formations of the pancreas was noted immediately. In particular, comparing investigations data only in the B-mode and B-mode combinations and RTE, Uchida H. et al. showed increased frequency of correct diagnoses in general from 73 to 97%, including prostate adenocarcinoma — from 66 to 93%, and in the case of tumors of the endocrine pancreas — from 66 to 100%. Diagnostic potential of RTE has increased significantly

with the advent of the possibility of its implementation endoscopically. Traditional endoscopic sonography began to spend with RTE by using endoscopic linear sensor. This study was called "endoscopic ultrasound palpation" and is already included in national and international consensus on the diagnosis of diseases of the pancreas along with contrast sonography and endoscopic biopsy under endoscopic ultrasound guidance.

In the works of J. Iglesias-García et al. are provided data sensitivity and specificity RTE pancreas performed endoscopically. Statistical indicators of quality elastography evaluation of the color pattern in the diagnosis of focal formations of the pancreas sensitivity reached within 99,1-100,0%, while the specificity was 71.43% on average. ESR showed a coefficient of elasticity averaged statistics 99.5% sensitivity and 99.5% specificity.

An important benchmark for the characterization of "benign / malignant growth" is the calculation of the coefficient of elasticity of the digital value of ESR Sc. cut-off point (cut-off level). For example, at the very "soft" malignant tumors — adenocarcinoma of the pancreas — the figure is 6.04, with neuroendocrine cancer — 26.63 (sensitivity and specificity of 91.7 and 83.3%, respectively). This is the most accurate method to localize the zone of maximum probability of a pathological process. However, endoscopic examinations performed under general anesthesia, are regarded as invasive. So now the emphasis shifts to transcutaneous technology. In the last 3 years research efforts have focused on the creation of technical ways to improve information quality component RTE — color pattern. Objectification color characteristics allowed to achieve development in «Computer-aided artificial neural network dynamic analysis» — software «off-line» evaluation of the resulting image. It includes program «Statistic Neural Networks v. 4.0 E »(production StatsoftInc, Tulsa, Okla), as well as software for image processing and analysis« ImageJ Software »(production NIH, Bethesda, MD. ImageJ). Last prepared by the staff of the National Institute of Health (USA) and distributed in the public domain without licensing

restrictions. Programs cover a wide range of image processing tasks, which opens new opportunities for research purposes. In particular, discrete analysis' density and geographical location 256-pixel color palette allows virtual histoscaning pancreas parenchyma. It is this technology is regarded as a tool for non-invasive study of diffuse pathological processes in the pancreas.

Today, many questions remain open pathogenesis of fibrosis and cirrhosis of the pancreas, their diagnosis, estimate the amount of functionally intact pancreas parenchyma. "Diffuse changes in the pancreas," referred to ultrasound summary, often hide her fibrotic changes, some of which is opened only during the RTE. This is due to the fact that not only detects RTE hypo-or hyperechoic structural elements, but also isoechoic that conventional ultrasound N. However, the determination of the early stages of prostatic lesions is crucial. RTE technique gives a clear assessment of the extent and degree of fibrosis in the parenchyma of the pancreas on the basis of which one can study the relationship development of fibrotic changes and severity of failure of exo-and endocrine functions of organ. Observing the dynamics of changes in correlation stored and damaged tissue by color pattern on background treatment gives objective indicators to measure the effectiveness of various conservative complexes antifibrotic therapy organ. For example, how quickly and fully occurs stabilization of pancreatic morphological changes under the influence of any impact, as appropriate use, what doses and how long enzyme preparations, protease inhibitors, or drugs of any other groups. At the surgery it is important to preserve the maximum functioning organ parenchyma. For surgeons localization and extent knowledge of damaged pancreatic tissue lets get closer to the development of techniques of organ type operations Fray and Begger and by clearly defining areas of the pancreas parenchyma to be resected.

RTE is recommend to use for screening in certain risk groups. For example, annual screening for patients with severe fibrosis neo process pancreas. It does not take a lot of time and requires a lot of money, but it saves small health efforts. In

recent years, medicine has made decent performance in the treatment of many cancers. Some of them are being diagnosed early, can be cured completely.

Thus, the analysis of the results obtained by different researchers, suggests that RTE is a highly informative method of diagnosis of focal and diffuse parenchymal changes in the pancreas. Clarifying the nature of focal education, revealing fibrosis pancreas, determine the characteristics of the flow of these processes is crucial for diagnosis, treatment and determine the amount of ordering representations about the prognosis of chronic pancreatic diseases regardless of their etiology.

In our work, ultrasound pancreatic elastography performed transcutaneous method Free Hand RTE ultrasound scanner Sonix Touch firm Ultrasonix (Canada) with a linear L14-5 (5-14 MHz) or C5-2 Convex (2-5 MHz) sensors. The study involved 20 people aged 30 to 75 ( $46,6 \pm 3,5$ ) years c diagnosed CP, equally men and women. To compare the performance of RTE Free Hand held eight persons without signs of pathology on the results of the prostate comprehensive survey based on clinical, laboratory and instrumental data (control group).

Assessing the state of the pancreas consistently used in routine ultrasound B-mode gray-scale mode and RTE (see description above). Analysis was conducted on the nature of the color pattern (color uniformity distribution on a color scale) and the coefficient of elasticity of ESR. Statistical analysis of the results of research carried out by methods of variation statistics, with the standard software package SPSS 13.0 for Windows. We obtained the following results. Practically all people from the control group (7 out of 8 people) color pattern the pancreas was presented a homogeneous distribution of the blue. Quantitative parameters ESR elasticities ranged from 0.39 to 1,43 ( $0,92 \pm 0,09$ ), not differing significantly in the parenchyma of the head ( $0,90 \pm 0,08$ ), body ( $0,97 \pm 0, 11$ ) and a tail portion ( $0,92 \pm 0,11$ ) body. The coefficient of elasticity ESR periductal zone cancer was ( $0,98 \pm 0,11$ ).

Diffuse changes in the pancreas identified 20 people monitoring group in the standard B-mode ultrasound, evident heterogeneity of the parenchyma of varying



severity with changes in acoustic density. In the RTE (Fig. 1) in the color spectrum in the whole group was observed predominance (n = 11 — 55%) of the heterogeneous distribution of the type of blue-green color (blue-green color). 7 patients had (35%) in the color pattern, besides the blue-green, had red (type blue-green-red color). In the rest of the patients (2 persons — 10%) the pancreas looked as a heterogeneous distribution of shades of blue (type blue color).

Quantitative parameters ESR index were determined depending on the color of the pattern. In type blue-green color (n = 11), the coefficient of elasticity compared to ESR control parameters increased in the head region is 1.5 times to ( $1,40 \pm 0,09$ ) ( $<0,001$ ), in the rear — 1, 3 times ( $1,23 \pm 0,08$ ) ( $<0,05$ ), in the periductal zone — 1.6 times ( $1,54 \pm 0,09$ ) ( $<0,001$ ). In the body of the pancreas showed a trend to an increase in the coefficient of elasticity to the ESR ( $1,26 \pm 0,1$ ) ( $> 0,05$ ). n type blue-green-red color (n = 7) recorded the highest values of the coefficient of elasticity of ESR, which compared with the control group increased by 2.1 times in the head, making ( $1,92 \pm 0,23$ ) ( $<0,001$ ) 1.9-fold — in a body region ( $1,80 \pm 0,19$ ) ( $<0,001$ ) and the tail section — ( $1,71 \pm 0,10$ ) ( $<0,001$ ), 2 times — in periductal areas ( $1,95 \pm 0,27$ ) ( $<0,001$ ).

For illustrative purposes, there is a separate description of 2 cases of this examination.

Woman K., 44, in the last five years has been observed regarding CP. In gray-scale ultrasound B-mode — diffuse changes in the pancreas. In the RTE colors pancreas parenchyma represented heterogeneous distribution of blue and green hues in the periductal area identified red. Elasticity coefficient of ESR in the head region was 1.81; body — 1.69, the tail section — 1.73. Periductal zone different ESR values increase to 2.98, which was the basis for the diagnosis of periductal fibrosis (Fig. 2).

Woman G., 47, sick with CP for about 10 years, in the beginning of disease abdominal pain of varying intensity mainly disturbed her, currently she focuses on constant complaints of dyspeptic manifestations. In gray-scale ultrasound B-mode —

a slight diffuse changes pancreas. In the RTE color spectrum parenchyma pancreas characterized by heterogeneous distribution of blue, green and red colors. Elasticity coefficient of ESR in the head region was 2.69; body and periductal area — 2.64. The data obtained allow to conclude that the presence of CP fibrosis pancreas parenchyma (Fig.3). Individuals with established type blue color ( $n = 2$ ), the coefficient of elasticity of ESR in the pancreatic head was ( $0,99 \pm 0,31$ ), body ( $0,81 \pm 0,29$ ), the tail section ( $0,73 \pm 0,37$ ) in the zone periductal ( $0,67 \pm 0,0$ ).

Take into consideration fact that CP in the observation group as a whole ( $n = 20$ ) was accompanied by the development of fibrosis predominantly periductal area, the second most frequent localization was head of pancreas fibrosis. Perhaps there is a need for a deeper study of these facts.

Thus, our first experience with Free Hand RTE in CP involving integrated assessment of the color images and quantitative analysis yielded qualitatively new information on changes in the structure of the pancreas, their localization, the degree of deformation of tissue, and therefore better reflect the severity of organ.

As for focal lesions, we provide a description of the case. The woman, 64 years old, 4 years ago, it was revealed the tumor, determined by palpation in the right mesogaster, last year its size increased significantly. Clinical examination showed the palpated large tumor formation, which is visualized by ultrasound as a non-homogeneous hearth solid-cellular structure size 123h98 mm capsule having irregular contours. Doppler color mode in the outbreak registered intro dular hypovascular blood type, blood flow in the capsule was not detected. Organ appurtenance of formation is clearly not possible to determine. It was assumed that it proceeds from the tumor or pancreatic head or located outside near.

RTE registered color pattern in the form of a massive area of homogeneous red ESR value of the index which reached 4.41, for comparison — in the body of the pancreas ESR elasticity coefficient was equal to 1.32 (Fig. 4). Such changes were considered as matching transition, potentially malignant tumors form. After

performing surgery, the patient, by histological examination of surgical specimens patient mucinous cystadenoma pancreas verified. Presented clinical illustrations confirm the usefulness of RTE in complex diagnostics as diffuse and focal lesions of the pancreas.

Thus, the technique RTE transcutaneous access is a promising new tool for investigating additional pancreas. It distinguishes high informative, non-invasive nature, the possibility of dynamics, versatility (also used for diffuse and focal lesions), the ability to assess the alleged histostructure hearth (benign / malignant growth) with access to perform targeted biopsy.

Undoubted, despite the rapid development techniques RTE, in the ultrasonic diagnosis of diseases of the pancreas are still many unsolved problems. In particular, they should include the need to systematize the results of qualitative and quantitative parameters RTE compared with histologic evaluation of biopsy specimens of the prostate parenchyma, as well as the modern classification of CP for certain types of pathology and nosology forms. It requires a certain time. However, the accumulation of experience in the application in diseases of the pancreas RTE will not only improve diagnostic capabilities, but also to justify the new advanced therapeutic and surgical methods for the treatment.

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**Diagnostic potential of real-time elastography upon pancreatic diseases of different genesis**

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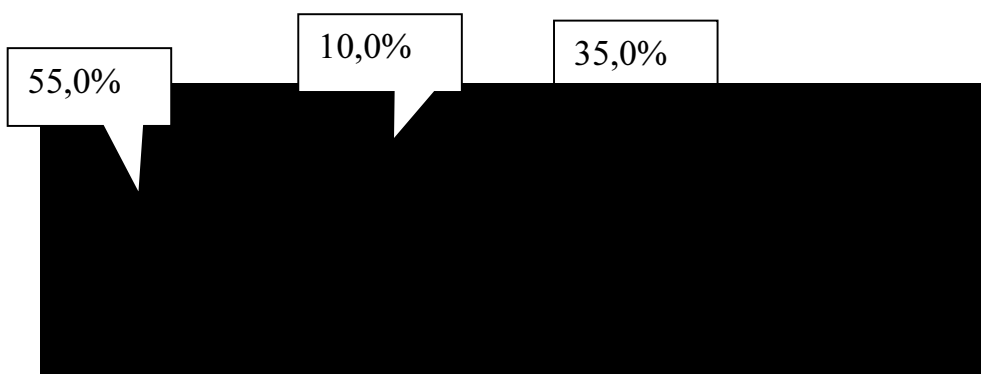


Fig. 1. Distribution of patients with diffuse changes in the pancreas by the color spectrum mode RTE

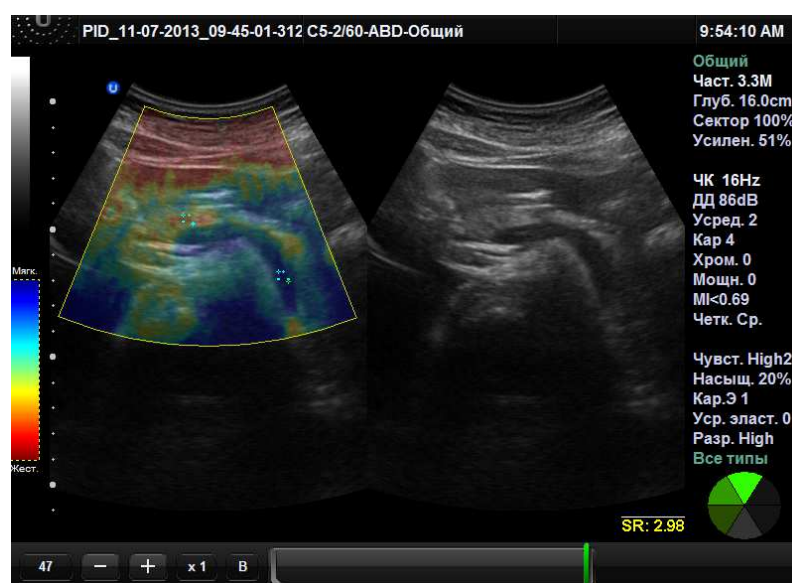


Fig. 2 Elastogram of the fibrosis of pancreatic periductal area

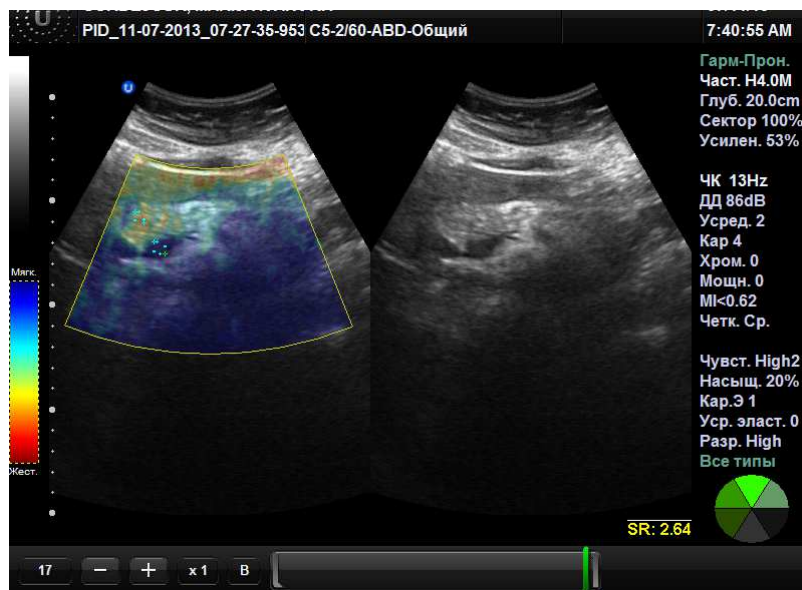


Fig. 3. Elastogram upon the fibrosis of the pancreas

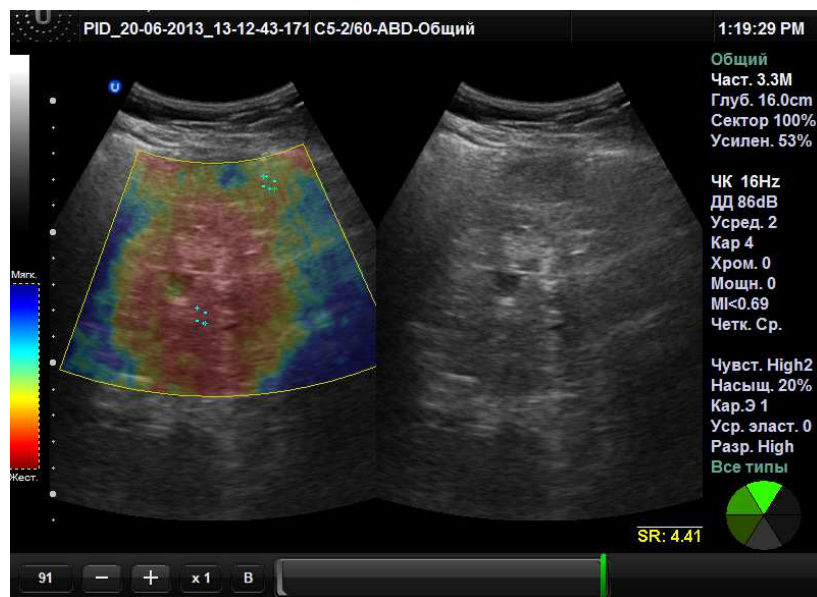


Fig. 4. Elastogram of focal pancreatic formation