THEORY AND METHODS OF SIGNAL PROCESSING

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CONSTRUCTION OF INTELLECTUAL NEURAL NETWORK TO DIAGNOSE LIVER DISEASES

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***Abstract*—*Considered the methods of examination of the liver, namely medical diagnosis of fibrosis-elastography. Improved diagnosis and minimize the time to diagnosis.*

Index Terms—Fibrosis; elastography; liver disease; neural network; medical diagnosis; elastogram.

I. INTRODUCTION

Liver diseases are among the major causes of death. In recent years there has been an upward trend in morbidity and mortality among working-age persons.

The major etiological factors in the development of liver diseases are established to are viral infections and alcohol. Studying of alcoholic liver, as well as viral hepatitis and liver cirrhosis are devoted numerous studies of domestic and foreign authors. By the way alcohol, viral and autoimmune liver disease pathology is not limited to – liver tumors, both primary and metastatic, have a tendency to steady growth.

The main route of progression of chronic diffuse liver disease, regardless of etiology, leading to damage – is the process of fibrogenesis. The final stage of liver fibrosis, which is clinically manifested cirrhosis and its complications (hepatic insufficiency and portal hypertension), largely determines the life of bad prognosis and short survival to date this group of patients.

The rate of progression of fibrosis is markedly different in different patients. Among the known factors that affect the rate of fibrosis development can be identified major infection in older age, male sex, alcohol abuse. At the same time, communication viral load and HCV genotype with the progression of speed is not established. The rate of development of fibrosis in patients with higher immunocompromised. Fatty liver disease, obesity, and diabetes can also contribute to more rapid development of fibrosis.

For the most accurate assessment of the progression of fibrosis should be re-evaluated annually. In these cases it is advisable to use non-invasive methods for assessment of liver fibrosis-informative and accessible (FibroTest, FibroMaks, elastomtry). Experience of test serum fibrosis assessment and ultrasound techniques illustrates the need for a combination of greater diagnostic accuracy.

The conclusion can be drawn on the basis of statistical analysis that the structure of liver damage according to the etiology and nosological groups predominate among alcoholic hepatic fibrosis. Viral alcoholic hepatic fibrosis inferior frequency. The significance of liver tumors in the background of alcoholic and viral fibrosis. Autoimmune diseases and diseases are rare with metabolic disorders. Noteworthy noticeable share in the structure of herpetic hepatitis liver disease, indicating that the growing role of this virus in the etiology of a variety of human diseases. These data confirm the leading role of alcohol as a major etiological factor in the occurrence and development of liver disease [1].

II. FIBROSIS STAGES

To determine the degree of organ damage recommended a liver biopsy. Interpretation of the results is carried out either by Metavir method or index Claudel.

According to these methods, doctors distinguish 5 stages of the disease. You can indicate the degree of liver fibrosis, using the scale ranging from 0 to 4 (Fig. 1).

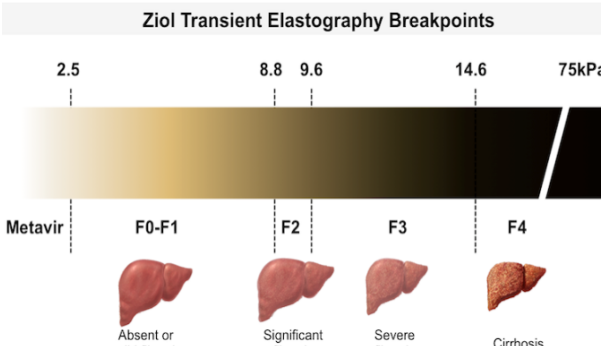

Fig. 1. Stage of fibrosis

1. Zero degree – liver fibrosis is absent.
2. Stage of F1 – the body does not carry out its functions in full, the process of exchange between the

liver and blood cells affected. With proper treatment the forecast favorable.

3. Step F2 – change increase, the damaged area is increased. Treatment is complicated, difficult to control the disease by using drugs.

4. Step F3 – in the liver structures appear seals. If you do not carry out competent treatment, prognosis is poor - the disease goes into the last stage.

5. Step F4 – cirrhosis of the liver. If you want to cure this disease without organ transplantation – it is impossible.

Depending on the prevalence of fibrosis secrete several kinds thereof:

– venular and perivenulyarny fibrosis – hit the central part of the liver lobules;

– pericellular fibrosis – observed around gepatitsitov (liver cells);

– septal fibrosis – characterized by massive necrosis (necrosis of liver tissue). There is an active formation of fibrous septa (connective tissue (it is based on the connective tissue that performs a supporting function and structure in the body) layers), which disrupts the structure of liver lobules;

– periductal fibrosis – is characterized by concentrated proliferating fibrous tissue around the bile tubules;

– mixed fibrosis (the most common form) – has the characteristics of all the other forms.

One of the best types of studies is elastography.

III. Problem Statement

Elastography is the third, after the B method and the Doppler direction in modern ultrasound diagnostics, which allows you to get objective information about the stiffness (elastic) properties of normal and pathological tissues. LSM tool introscopy is similar clinical methods of palpation and percussion [2].

Today, there are 2 main types of ultrasound elastography: compression (high quality) and shear waves (quantitative).

Elastography is prescribed for liver hepatitis, fatty liver, cirrhosis and other diseases involving fibrosis of the liver.

Elastography liver (liver fibro scan, *c*) - a diagnostic technique that allows to assess the state of the liver parenchyma and to identify the place where it was replaced by connective fibrous tissue. Make it allows the ultrasonic waves.

Elastography is very similar to the liver ultrasonography. Similarly, the doctor uses ultrasound transducer to visualize on the screen the liver and "see" her condition. But liver fibro scan involves a study of the body with little exposure to it. It is carried out by means of ultrasonic sensor which is disposed in an intercostal space in the area where the liver is located, and it produces a strong specific mechanical vibrations. Thus the physician can observe on the screen as it is responsive to the liver tissue. The less elastic cloth is, the more pronounced fibrosis [3].

Your doctor may order liver elastography if suspects that this body is a process of replacing the normal tissue by fibrous and wants to find out the degree of organ damage.

Most often liver elastomeric prescribed for:

– chronic hepatitis;

– hepatize fat;

– cholangitis;

– cirrhosis.

Elastography liver in many cases can substitute biopsy. This is especially important in situations where there are contraindications to perform the puncture.

Results fibro scan liver is usually graded on a scale Metavir.

Zero degree of fibrosis (F0). Indicators at least 6.2 kPa (Fig. 2).

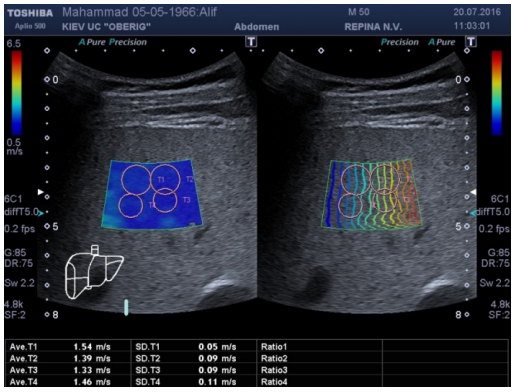

Fig. 2. Zero degree of fibrosis (F0)

First degree of fibrosis (F1). 6.2–8.3 kPa is found minimum seal liver tissue (Fig. 3).

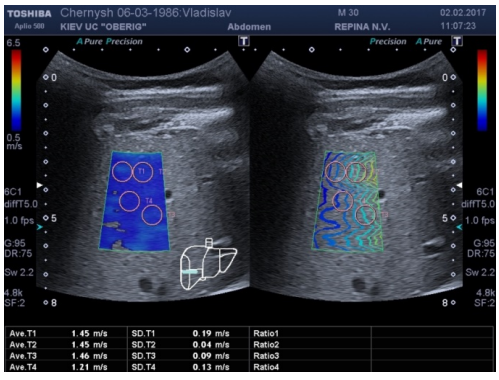

Fig. 3. First degree of fibrosis (F1)

Second degree of fibrosis (F2). 8.3–10.8 kPa is moderate changes of the parenchyma (Fig. 4).

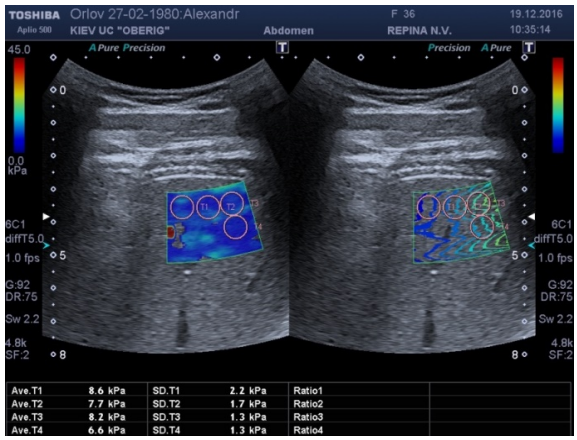

Fig. 4. The second degree of fibrosis (F2)

Third degree of fibrosis (F3). 10.8–14 psi is fibrosis (Fig. 5).

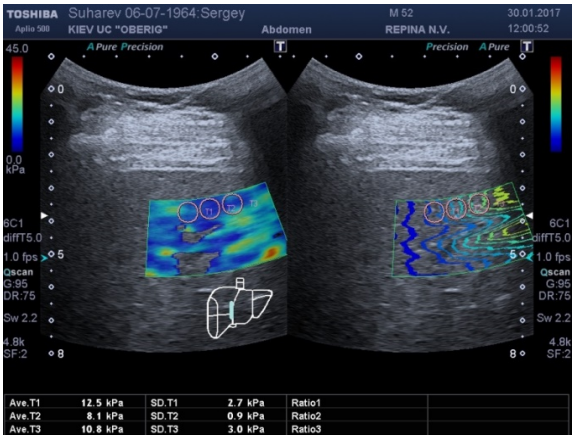

Fig. 5. Third degree of fibrosis (F3)

The fourth degree of fibrosis (F4). 14 and above is cirrhosis (Fig. 6).

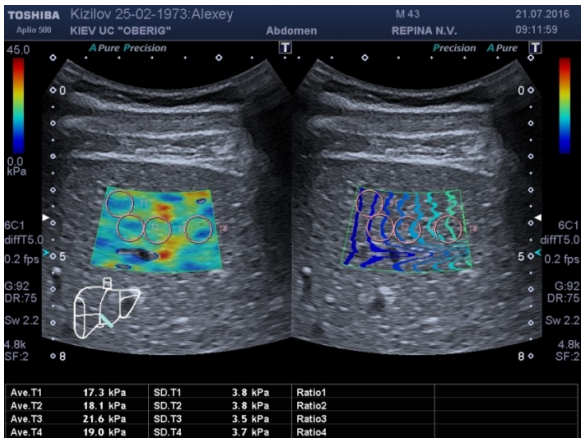

Fig. 6. Fourth degree of fibrosis (F4)

The main supplier of devices clinical quantitative elastography of the liver became firm Ehosens (France) with "Fibro scan" device in Ukraine. The method is based on the definition of liver fibrosis on the propagation of elastic waves from ultrasonic pulses 20–30 and then calculating the average value of the deformation pressure in kilopascals (kPa). The maximum diagnostic accuracy elastomeric achieved in patients with stage F3 and F4 fibrosis of the liver as a result of semi-quantitative assessment of fibrosis (histologic scale Metavir). Informative method according to the stages of liver fibrosis: F0-F1 – 88–90%, F2-F3-90-94, F4-94–98%. Elastography in this way is already being considered as an alternative to liver biopsy, in case of impossibility of its implementation or monitoring the flow of diffuse liver diseases [4].

However, the procedure is not recommended for patients with pacemakers and pregnant women due to the high acoustic power of the pulse, the procedure has a high price, it does not allow pinpointing areas of interest, since performed blind and has a depth limit of 5 cm in size with a fixed sample volume 4 cm.

The maximum diagnostic accuracy elastomeric and FibroTest was observed in patients with stage F3 and F4 fibrosis of the liver, which is comparable with the results of semi-quantitative assessment of fibrosis (scale on histological Metavir). The average sensitivity and specificity elastomeric and FibroTest in the early stages of fibrosis dictate the need for liver biopsy in order to clarify the stage of fibrosis in these patients.

A number of studies on the reliability of this method, showed a number of factors influence the accuracy of the results. It is proved that extrahepatic cholestasis and necroinflammatory processes cause an increase in liver density regardless of the presence of fibrosis. A number of other factors, such as steatosis, an excess BMI also distort densities. Therefore, accurate results can be considered to the range ≤ 6 kPa, which may indicate the absence of significant fibrosis and ≥ 12 kPa, which may correspond to severe fibrosis or cirrhosis [5].

The main parameter elastography studying is a quantitative estimate of the density of the liver tissue, respectively, the ratio of the elastic area to the area in which the density is higher than normal.

According to statistics, on average, highly qualified specialist is needed from the 30 minutes of time to decipher the results elastography liver. With the help of neural networks in the interpretation of the results of liver elastography is necessary fraction of a second of time. This will help save thousands of lives.

IV. Justification for the Use of Neural Networks for Medical Diagnosis

One of the areas in the field of artificial intelligence research, based on trying to reproduce the human nervous system is a neural network. Namely: the ability of the nervous system to learn and correct

mistakes, which should allow to model, although rather crudely, the human brain.

Neural networks are nonlinear systems, enabling better categorize data than the commonly used linear methods. Attached to the medical diagnosis they allow significantly increase the specificity of the method, without reducing its sensitivity.

Neural network technology designed to address the difficult problems, which, in particular, reduce many of the problems of medicine. This is due to the fact that researchers are often given a large number of diverse factual material for which has not yet created a mathematical model.

Diagnosis is a special case of classification of events, the most valuable is the classification of those events that are not in the training set of the neural network. It appears the advantage of neural network technology – they are able to carry out such a classification, summarizing the previous experience and applying it in new cases.

Most of the medical center is very necessary machining tomograms elastogram that will help faster and more correct decisions. Procrastination leads to the death or disability of a costly rehabilitation. If you connect the neural network technology protocols for medical care, you can dramatically reduce mortality from fibrosis. To do this, just need the will and the organizational efforts (Fig. 7).

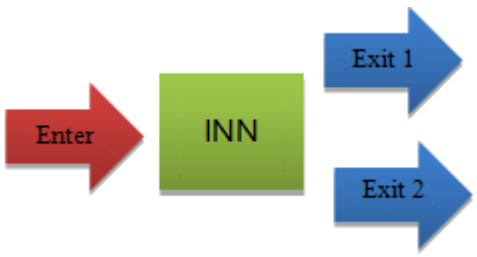

Fig. 7. The scheme of working the program

The advantages of neural network expert systems:

1) Neural networks make decisions on the basis of experience gained by them independently.

2) Decisions made by the neural network is not definitive. The network provides a solution together with a degree of confidence in it, which leaves the user the ability to critically evaluate its response.

3) Neural network can simulate a situation of decision-making.

4) Neural networks provide an answer very quickly (of a second), which allows their use in various dynamic systems that require an immediate decision, such as intraoperative neuro monitoring.

5) Possibilities of neural networks (correction of the classification model, minimizing training and other parameters.) Allow to determine the direction of scientific research.

It is obvious that all of the above proves the necessity, urgency and demand the use of artificial neural networks to solve medical problems. In our opinion, the use of neural network technology opens a qualitatively different level of learning processes in a stochastic system, like the human body [6].

VI. Conclusion

The use of neural networks for diagnosis of liver diseases allows several times to speed up the processes of decoding tomography, elastogram, ultrasound results, analysis PGA-index.

Neural networks directly in the processing of the results of elastography allows you to set the exact diagnosis in the most complex cases.

Thanks to the neural network, doctors can determine the fibrotic changes in the organs and to distinguish benign from malignant neoplasm.

Also, the neural network can determine liver fibrosis in the early stages (1st, 2nd), when it can still be cured.

Neural networks can be used to forecast the further spread of the disease.

In the long term, the neural network can provide a variety of activities developed by means of treatment.

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В. М. Синєглазов, І. О. Вецько. Побудова інтелектуальної нейронної мережі для діагностики захворювань печінки

Розглянуто методи обстеження печінки, а саме медична діагностика фіброзу-еластографії. Покращено діагностику і мінімізовано час на діагностику.

Ключові слова: фіброз; еластографія; захворювання печінки; нейронна мережа; медична діагностика; еластографія.

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В. М. Синеглазов, И. А. Вецько. **Построение интеллектуальной нейронной сети для диагностики заболеваний печени**

Рассмотрены методы обследования печени, а именно медицинская диагностика фиброза-эластографии. Улучшена диагностика и минимизировано времени на диагностику.

Ключевые слова: фиброз; еластография; Заболевания печени; нейронная сеть; медицинская диагностика; эластография.

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Направление научной деятельности: аэронавигация, управление воздушным движением, идентификация сложных систем, ветроэнергетические установки.
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