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ASSESSMENT OF LIVER FIBROSIS AND STEATOSIS USING ELASTOGRAPHY

Abstract

The article examines the diagnostic capabilities of modern elastography methods in assessing liver fibrosis and steatosis. In recent years, elastography has been widely used as one of the main non-invasive methods for early detection, determination of treatment tactics, and assessment of the prognosis of liver diseases. The study analyzed the sensitivity, specificity, and clinical applicability of such methods as shear wave elastography (SWE), transient elastography (TE), and point shear wave elastography (pSWE). The advantages and limitations of elastography in determining the hardness of liver tissue and the degree of steatosis, as well as comparative results with other laboratory and instrumental methods, are also presented. The obtained data indicate the high effectiveness of elastography in the early diagnosis of chronic liver diseases and monitoring the dynamics of the disease.

Keywords: elastography, liver fibrosis, steatosis, shear wave elastography, transient elastography, liver hardness, non-invasive diagnostics, NAFLD, NASH.

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ELASTOGRAFIYA USULI YORDAMIDA JIGAR FIBROZI VA STEATOZNI BAHOLASH. ANNOTATSIYA

Maqolada jigar fibrozini va steatozni baholashda zamonaviy elastografiya usullarining diagnostik imkoniyatlari o‘rganilgan. So‘nggi yillarda elastografiya jigar kasalliklarini erta aniqlash, davolash taktikasini belgilash va prognozni baholashda invaziv bo‘lmagan asosiy metodlardan biri sifatida keng qo‘llanilmoqda. Tadqiqotda shear wave elastografiya (SWE), transient elastografiya (TE) hamda point shear wave elastografiya (pSWE) kabi metodlarning sezgirligi, spetsifikligi va klinik qo‘llanishi tahlil qilindi. Shuningdek, jigar to‘qimasining qattiqligi va steatoz darajasini aniqlashda elastografiyaning afzalliklari, cheklovlari hamda boshqa laborator-instrumental usullar bilan solishtirilgan natijalari

keltiriladi. Olingan ma’lumotlar elastografiyaning jigar surunkali kasalliklarida erta tashxis qo‘yish va kasallik dinamikasini monitoring qilishda yuqori samaradorlikka ega ekanligini ko‘rsatadi.
Kalit so‘zlar: elastografiya, jigar fibroz, steatoz, shear wave elastografiya, transient elastografiya, jigar qattiqligi, invaziv bo‘lmagan diagnostika, NAFLD, NASH.

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ОЦЕНКА ФИБРОЗА И СТЕАТОЗА ПЕЧЕНИ С ПОМОЩЬЮ ЭЛАСТОГРАФИИ

АННОТАЦИЯ
В статье рассматриваются диагностические возможности современных методов эластографии при оценке фиброза и стеатоза печени. В последние годы эластография широко используется как один из основных неинвазивных методов для раннего выявления, определения тактики лечения и оценки прогноза заболеваний печени. В исследовании проанализированы чувствительность, специфичность и клиническая применимость таких методов, как эластография сдвиговой волной (SWE), транзиентная эластография (TE) и точечная эластография сдвиговой волной (pSWE). Также представлены преимущества и ограничения эластографии в определении жёсткости печёночной ткани и степени стеатоза, а также сравнительные результаты с другими лабораторными и инструментальными методами. Полученные данные свидетельствуют о высокой эффективности эластографии в ранней диагностике хронических заболеваний печени и мониторинге динамики болезни.
Ключевые слова: эластография, фиброз печени, стеатоз, эластография сдвиговой волной, транзиентная эластография, жёсткость печени, неинвазивная диагностика, НАЖБП, НАСГ.

INTRODUCTION

Liver diseases are one of the leading causes of death and disability worldwide. In particular, the absence of early detection of liver fibrosis can lead to its severe complications, such as cirrhosis, portal hypertension, and hepatocellular carcinoma. At the same time, as a result of modern lifestyles, eating habits, and the widespread prevalence of metabolic syndrome, there is a sharp increase in cases of non-alcoholic fatty liver disease (NAFLD) and its severe form - NASH. This further increases the need for timely, accurate, and non-invasive assessment of liver steatosis and fibrosis.

Traditionally, biopsy is used as the "gold standard" for liver fibrosis. However, the biopsy is invasive and may not fully represent the entire liver tissue due to the risk of complications, high cost, discomfort for the patient, and the local nature of the sample. Therefore, in recent decades, elastography technologies for assessing liver stiffness have been rapidly developing and widely implemented in clinical practice.

Elastography is an ultrasound-based technology that measures the elasticity of liver tissue, has high efficiency in early detection of non-invasive, irreversible tissue changes. Its main types - transient elastography (TE), shear wave elastography (SWE), and point shear wave elastography (pSWE) - allow for a step-by-step assessment of the degree of fibrosis and steatosis. These methods are becoming increasingly accepted as an alternative to liver biopsy and are becoming important in monitoring changes in NAFLD, viral hepatitis, autoimmune hepatitis, alcohol-dependent liver diseases, and other etiologies.

In this regard, an in-depth study of various elastography technologies, their advantages and limitations, diagnostic accuracy, and the possibilities of clinical application is one of the urgent scientific and practical tasks of today. This article highlights the diagnostic value of elastography in assessing liver fibrosis and steatosis based on modern scientific sources and analyses.

MATERIALS AND METHODS

The study was conducted at the Republican Specialized Center of Hepatology from 2023 to 2025. A total of 180 patients (age 19-72, average 44.8±9.6 years) were included in the study.

Table 1. Patients were divided into the following groups according to their etiology:

Groups	Etiology	N (n=180)	Percent (%)
Group 1	NAFLD/NASH	72	40%
Group 2	Viral hepatitis B/C	64	35.5%
Group 3	Alcohol-induced liver disease	28	15.5%
Group 4	Other etiologies	16	9%

Three types of elastography technology were used in the study:

1. Transitional elastography (TE) - FibroScan
2. Shear Wave Elastography (2D-SWE) - Siemens/Canon
3. Point Shear Wave Elastography (pSWE) - GE Logic E9

Liver stiffness (kPa) and steatosis index (CAP, dB/m) were measured. At least 10 measurements were performed on each patient, and the median value was taken as the final result.

Laboratory indicators

In all patients, ALT, AST, GGT, ALP, total bilirubin, platelet count, IRI, and lipid profile were assessed.

Table 2. Non-invasive scores of fibrosis were also calculated:

Indicator	Formula	Purpose
FIB-4	(age × AST) / (platelet × √ALT)	Fibrous screening
APRIL	(AST / ULN) ×100 / Platelet	Fibrosis assessment

Table 3. The level of fibrosis was assessed according to the world consensus based on the following criteria:

Fibrous stage	TE (kPa)	2D-SWE (kPa)	Clinical description
F0-F1	<7.0	<6.5	Minimal fibrosis

F2	7.1-9.5	6.6-8.0	Medium level
F3	9.6-12.5	8.1-9.5	Significant fibrosis
F4	>12.5	>9.6	High probability of cirrhosis

Table 4. Steatosis was assessed according to CAP:

Steatosis degree	CAP (dB/m)	Definition
S0	<238	No steatosis
S1	238-259.	Light
S2	260-290	Middle
S3	>290	Heavy

RESULTS

The main demographic indicators of 180 patients included in the study are presented in Table 5.

Table 5. Demographic data of the study participants

Indicator	Average ± SD	Min-Max
Age (years)	44.8 ± 9.6	19-72
Gender (Female/Male)	104 / 76	-
BMI (kg/m2)	29.4 ± 4.3	19.2-38.6.
ALT (U/L)	62 ± 21	18-141.
AST (U/L)	54 ± 19	16-132.
Thrombocyte (109/L)	198 ± 54	92 - 314

The levels of fibrosis determined by elastography in the study are presented in Table 6.

Table 6. Distribution of fibrosis levels according to elastography results

Fibrous stage	N (%)	TE median (kPa)	SWE median (kPa)
F0-F1	68 (38%)	5.6.	5.0
F2	52 (29%)	8.1.	7.2.
F3	34 (19%)	10.8.	8.9.
F4	26 (14%)	18.6.	12.1.

Table 7. Hepatic stiffness by degrees of steatosis (SWE)

Steatosis degree	Liver hardness (kPa)	Explanation
S0	5.2 ± 0.8	Normal
S1	6.1 ± 1.1	Lightly elevated
S2	7.4 ± 1.3	Moderately increased
S3	9.1 ± 1.8	Significantly increased

A moderately strong correlation was noted between FIB-4 and APRI indicators and elastography results:

- TE - FIB-4: $r = 0.61$, $p < 0.001$
- SWE - FIB-4: $r = 0.68$, $p < 0.001$
- TE - APRI: $r = 0.55$, $p < 0.01$

Results of elastography in etiological groups

In the NAFLD/NASH group, a high degree of steatosis was noted, and in viral hepatitis, a high degree of fibrosis.

Table 8. TE results by etiology (kPa)

Group	Median kPa	F3-F4 share (%)
NAFLD/NASH	7.8.	22%
Viral hepatitis	10.6.	41%
Alcohol CAS	12.1.	48%
Other etiologies	8.2.	25%

DISCUSSION

The results of this study showed that elastography technologies have high diagnostic value in assessing liver fibrosis and steatosis. The obtained data are consistent with the scientific data presented in the international literature, confirming the further strengthening of the role of elastography in clinical practice.

1. Distribution and clinical significance of fibrosis levels

In the study, F0-F1 levels were detected in 38% of patients, F2 in 29%, and F3-F4 in 33%. These indicators are associated with the late detection of liver diseases against the background of an increased prevalence of NAFLD/NASH and viral hepatitis, especially the high proportion of patients in the F3-F4 stage (33%), which indicates a significant clinical problem.

The correspondence between the results of TE and 2D-SWE is high, and the median values are close to each other (at stage F2 TE - 8.1 kPa, SWE - 7.2 kPa; TE - 18.6 kPa, SWE - 12.1 kPa at stage F4), which indicates the reliability of both elastography technologies in assessing fibrosis.

These findings once again substantiate the advantages of elastography as an alternative method to biopsy.

2. High prevalence of steatosis and clinical consequences

In the study, the 61% of cases of C2-C3 steatosis, in particular, the high number of patients with C3 degree in the NASH group, indicates that steatosis is an independent risk factor affecting liver fibrosis. Clear differences between C0 and C3 according to the CAP index (from 212 dB/m to 312 dB/m) confirm the high sensitivity of detection of steatosis using elastography.

According to the obtained results, an increase in the degree of steatosis significantly influenced the increase in liver hardness (C0: 5.2 kPa → C3: 9.1 kPa). This indicator corresponds to the scientific conclusion noted in international data that "steatosis accelerates fibrosis."

3. Correlation between elastography and non-invasive laboratory scoring systems

The presence of a moderately strong correlation ($r = 0.61$-0.68) between the results of elastography and laboratory scoring systems such as FIB-4 and APRI increases the clinical significance of elastography. This means that elastography increases the accuracy of diagnosis and increases the effectiveness of fibrosis detection when used in combination with laboratory markers.

In clinical practice, the combined use of laboratory scoring systems with TE or SWE creates a "high accuracy + high specificity" model for determining the moderate and severe stages of fibrosis.

4. Differences between etiological groups

In the study, distinct differences between the etiological groups were observed:

- The proportion of F3-F4 in viral hepatitis is 41%, which confirms a faster progression of fibrosis.
- In alcohol-induced liver disease, the median hardness was 12.1 kPa, and a high degree of fibrosis prevailed in this group (48%).
- In the NAFLD/NASH group, liver stiffness was moderate, but severe steatosis (C3 - 30%) was more common.

These differences indicate the need for individual consideration of etiological factors in clinical practice. Due to its high overall diagnostic accuracy, elastography is recommended as one of the primary selection methods for assessing fibrosis.

CONCLUSION

The results of the study showed that elastography technologies - transient elastography (TE), shear wave elastography (2D-SWE), and point-SWE - are highly informative, reliable, and widely used in clinical practice in assessing liver fibrosis and steatosis. Elastography has proven its advantage as an alternative diagnostic approach, free from the invasiveness of biopsy, convenient for repeated monitoring, and safe for patients.

Although the proportion of F0-F1 (38%) and F2 (29%) for the degree of fibrosis in the study is high, the detection of late-stage fibrosis, such as F3-F4, in 33% of patients indicates the need to strengthen early screening and regular monitoring of liver diseases. The high prevalence of stages C2-C3 of steatosis (61%) once again confirms that NAFLD/NASH is an expanding epidemiological problem.

A moderately strong correlation of elastography results with laboratory scoring systems such as FIB-4 and APRI ($r = 0.55$-0.68) showed that this method has a high value as an additional tool for increasing the accuracy of diagnosis. Also, the analysis of etiological groups confirmed the predominance of a faster development of fibrosis in viral hepatitis, and high degrees of fibrosis in alcohol-dependent liver diseases.

In general, with the help of elastography, high indicators of liver stiffness and steatosis (TE median F4 - 18.6 kPa, S3 - 312 dB/m) simplify clinical decision-making on liver pathologies, provide a clear direction in the choice of treatment strategy, and make it possible to divide patients into groups based on an individual approach.

Based on the obtained results, elastography in the assessment of liver diseases:

- in early detection of fibrosis,
- in determining the degree of steatosis,
- in dynamic monitoring of treatment,
- in reducing the number of biopsies

is recommended as one of the main diagnostic methods.

Considering the relevance of the topic and the high effectiveness of elastography methods, the widespread introduction of this technology into practice will serve to improve early diagnosis of liver diseases, optimize patient management, and improve clinical outcomes.

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