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LINEAR ULTRASOUND MEASUREMENTS OF LIVER IN PATIENTS WITH CHRONIC VIRAL HEPATITIS AND CIRRHOSIS

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ABSTRACT — Ultrasound measurements of the liver were performed in 58 healthy volunteers, 31 patients with chronic viral hepatitis and 15 patients with cirrhosis. Statistical differences were detected in anteroposterior diameter of the left lobe, the thickness of the caudate lobe and anteroposterior diameter of the right lobe between healthy volunteers and patients with chronic viral hepatitis and cirrhosis ($p < 0.05$). In healthy volunteers due to the elasticity of the liver parenchyma anteroposterior and craniocaudal diameters of the left lobe and anteroposterior diameter of right lobe significantly differ with quiet breathing and deep breath whereas in patients with cirrhosis these differences was not found ($p < 0.05$) that indicates significant liver`s fibrosis and a loss of ability to change configuration with deep breath.

KEYWORDS — ultrasound, liver, linear measurements of the liver, chronic viral hepatitis, cirrhosis.

INTRODUCTION

Chronic liver diseases frequent causes morbidity, deterioration of the quality of life, disability and mortality worldwide [1, 2, 3, 4]. The liver sizes indicates its condition and they can vary significantly even in healthy people and certainly according to the different pathological processes.

We were interested in whether chronic diffuse liver diseases change the definite linear liver sizes. And also, is it possible at the moment of deep breath to affect changes in the linear measurements of the liver?

The aim of this study is to investigate whether the presence of chronic viral hepatitis and cirrhosis in a patient is reflected in linear measurements of the liver, including their possible changes that could occur in deep inspiration breathing.

Materials and methods. We studied 58 healthy volunteers without pathologies of the hepatopancreatobiliary system, 15 patients with cirrhosis, 31 patients with chronic viral hepatitis (CVH), which included patients infected with hepatitis B virus (HBV), hepatitis C virus (HCV), HBV/HCV coinfection and HBV/HDV (hepatitis D virus) coinfection. All participants were fasting before ultrasound examination.

Liver measurements were performed with convex transducers using Aixplorer (SuperSonic Imagine, France) and SonoScapeS6 (China) ultrasound systems in the supine position of participants on an examination bed with the both arms placed above the head and the stretched legs. All measurements of liver were taken at the widest points. Measurements were started from the left liver lobe with the transducer orientated longitudinally in the midline of abdominal wall just under xiphisternum. The craniocaudal diameter (CC, length), anteroposterior diameter (AP, depth) and caudate lobe (CL) thickness were measured according to the preliminary *frozen* sonographic images. From the same position of the transducer similar measurements were taken in the end of deep inspiration — when the diaphragm takes the lowest position. Before it all participants were instructed to take a deep breath and hold the air for a few seconds in the end of breath.

Measurements of the right lobe began from the positioning of the transducer in a longitudinal orientation in the right midclavicular line (MCL) in the VII-X intercostal spaces during quiet breathing. In a deep breath the liver displaced downward that is why the transducer was moved down from the intercostal access to the right hypochondrium under the costal margin while maintaining its longitudinal position in the MCL. The following parameters were measured on *frozen* ultrasound images: anteroposterior (AP) and oblique maximum craniocaudal (OCC max) diameters. The OCC max is the oblique maximum distance of diaphragmatic dome to the lower edge of the liver [5]. Further similar measurements were carried out with the transducer orientated longitudinally in the right anterior axillary line (AAL) in quiet breathing and in the end of deep breath.

The statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS)

software recommended for analysis of biomedical data. For each parameter studied, the average values and standard error of the mean were calculated. The significance of differences in the mean values of independent samples was evaluated using the nonparametric Mann-Whitney test, p-values of less than 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

We combined all the obtained measurements into tables. Mean linear diameters of the left lobe can be seen in table 1.

with cirrhosis on average are 30–40% higher than in volunteers without liver pathology, and in patients with CVH the values of AP diameter are also more than in healthy volunteers but only 15–25% by an average. The values of the thickness of CL in patients with cirrhosis increase on average by 35–45%, and in patients with CVH on average by 10–20% compared with the group of healthy volunteers.

Holding the air in the end of deep breath for healthy volunteers shown the CC diameter of left lobe elongation by on average of 15% and the AP diameter of left lobe decreases by on average of 10%. While patients with chronic viral hepatitis only had elongation CCS on average also 15%. Cirrhosis was the reason why all these parameters were almost unchanged that indicates significant liver fibrosis and a loss of its ability to change configuration even in a state of deep breath.

Table 1. *Ultrasound linear measurements of the left liver lobe for healthy volunteers, patients with CVH and cirrhosis at the type of breath (M ± m, mm)*

Breath	Diameter	Healthy volunteers	Patients with CVH	Patients with cirrhosis
Quiet breath	CC	91,86 ± 2,58	84,34 ± 3,64	101,93 ± 4,33*
	AP	68,76 ± 1,74	81,48 ± 3,16 ®	101,86 ± 4,29*, ®
	CL	22,28 ± 0,50	24,82 ± 1,21	34,93 ± 1,88 *, ®
The end of deep breath	CC	106,71 ± 1,90 #	98,23 ± 3,77 #, ®	106,57 ± 5,03
	AP	63,74 ± 1,26 #	78,47 ± 3,05 ®	97,21 ± 3,77*, ®
	CL	21,55 ± 0,50	26,3 ± 1,18 ®	34,21 ± 2,79 *, ®

** — statistical significance of differences in average values between patients with CVH and cirrhosis, p < 0.05*
® — statistical significance of differences in average values between patients with CVH and cirrhosis with healthy volunteers, p < 0.05
 # — statistical significance of differences in average values with quiet breathing and in the end of deep breath, p < 0.05

In patients with liver cirrhosis, the following linear measurements of left lobe are statistically significant larger compared with patients with CVH ($p < 0.05$) and compared with healthy volunteers ($p \leq 0.001$): anteroposterior diameter of left lobe, the thickness of the caudate lobe, despite of the phase of the respiratory cycle. The values of AP diameter in patients

Linear diameters of the right lobe are shown in Table 2.

Table 2. *Ultrasound linear measurements of the right liver lobe in healthy volunteers, patients with CVH and cirrhosis at different positioning of the transducer and the type of breath (M ± m, mm)*

Breath	Diameter	Healthy volunteers	Patients with CVH	Patients with cirrhosis
Transducer positioning in the right MCL				
Quiet breath	OCC max	155,95 ± 2,06	155,83 ± 3,35	156,5 ± 7,02
	AP	119,31 ± 1,63	128,63 ± 2,66®	131,79 ± 5,46®
The end of deep breath	OCC max	150,43 ± 2,08	153,79 ± 3,47	146,91 ± 7,68
	AP	112,31 ± 1,59 #	128,00 ± 2,5®	127,09 ± 5,09®
Transducer positioning in the right AAL				
Quiet breath	OCC max	158,17 ± 2,24	159,93 ± 2,97	156,93 ± 7,35
	AP	116,25 ± 1,63	122,73 ± 2,40®	122,07 ± 5,29
The end of deep breath	OCC max	155,28 ± 1,92	157,64 ± 3,14	146,00 ± 7,96
	AP	110,10 ± 1,66#	124,04 ± 2,28®	124,42 ± 4,15®

® — statistical significance of differences in average values between patients with CVH and cirrhosis with healthy volunteers, p < 0.05
 # — statistical significance of differences in average values with quiet breathing and in the end of deep breath, p < 0.05

The linear measurements of the right lobe (OCC max and AP) in patients with CVH and cirrhosis could be considered comparable. In patients with CVH and in patients with cirrhosis, there was no change in these sizes during a deep breath, and also in both groups, the values of OCC max and AP diameters did not change depending on access (according to MCL or AAL). We have previously obtained similar results that at the level of MCL and AAL for the right liver lobe, the average values are comparable ($p < 0.05$) [6].

Comparison of the liver measurement values between patients with CVH, cirrhosis and healthy volunteers shows that only the AP diameter of the right lobe differs statistically significant ($p < 0.05$). This size increases on average by 5–10% in liver pathology.

With a deep breath AP diameter of the right lobe in healthy volunteers decreases on average by 5-6%. In patients with CVH and cirrhosis we did not found statistically significant changes in this size that also confirms organ fibrosis.

Thus, in patients with CVH and cirrhosis, the liver tissue becomes stiffer, which was shown during deep breath including both liver lobes but mainly by left that is more changeable in healthy volunteers.

CONCLUSIONS

1. Anteroposterior diameter of the left lobe, the thickness of caudate lobe and anteroposterior diameter of the right lobe are increased in patients with chronic viral hepatitis and liver cirrhosis.
2. In healthy volunteers due to the elasticity of the liver parenchyma anteroposterior and craniocaudal diameters of the left lobe and anteroposterior diameter of right lobe significantly differ with quiet breath and deep breath. In patients with cirrhosis the differences of liver measurements with quiet breath and deep breath were not found.
3. We propose to use the absence of changes in the liver measurements with quiet breath and deep breath as ultrasound criterion of cirrhosis that reflects the loss of liver elasticity.

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