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Difficulties in differentiating the nature of ascites based on ultrasound imaging

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Keywords
ascites, greater omentum, tumor implants

Abstract

Transabdominal ultrasound not always allows to determine the nature of ascites based solely on its characteristics. **Aim**: The aim of the study was to present difficulties in determining the nature of ascites using transabdominal ultrasonography solely based on extra-organ lesions as well as, after the inclusion of the overall abdominal assessment and the clinical picture. **Materials and methods**: A total of 18 patients with non-neoplastic ascites and 62 patients with neoplastic ascites whose final diagnosis was based on cytological and histopathological findings were evaluated between 2005 and 2015. Abdominal ultrasound was performed to detect the presence of fluid in all accessible spaces, and, additionally, to determine the presence of potential peritoneal tumor implants as well as to evaluate the parietal peritoneum and the greater omentum. Different digital ultrasound machines equipped with 3–6 MHz and linear 7–12 MHz transducers were used in the study. Double-sided Fisher's exact test with statistical significance at $p < 0.05$ was used for the analysis of the obtained results. **Results**: Statistically significant differences between benign and neoplastic ascites were found for: anechoic peritoneal fluid (<0.0001); fluid and thickened omentum with smooth surface (<0.0001); fluid and thickened omentum with smooth surface and varices (0.01); fluid and thickened omentum with hypoechoic foci (0.049); fluid and thickened omentum with tumor implants (0.009). The inclusion of the overall assessment of abdominal organs and the clinical data allowed for an improvement in ultrasonographic diagnostic accuracy in benign and neoplastic ascites from 83.3% and 67.7% to 94.4% and 93.5%, respectively. **Conclusions**: When used alone, an assessment of acoustic fluid characteristics and extra-organ peritoneal lesions limits the possibility to differentiate between benign and malignant ascites. These results improve after the inclusion of sonographic assessment of all abdominal organs in combination with clinical data.

Introduction

Ascites usually indicates the end stage of a disease, but it also affects further treatment and worsens the prognosis in both, benign and malignant processes. Cirrhosis and neoplastic diseases are the most common causes of ascites, accounting for 81% and 10% of cases, respectively[1]. It is a known fact that the presence of peritoneal fluid is an initial sign of cancer in about 50% of cancer patients[2]. Previous works on the differentiation between benign and malignant ascites using imaging techniques indicate that there is no a single symptom with a decisive discriminatory value [2–10]. Therefore, the aim of the study was to analyze our own clinical material. First, only extra-organ lesions observed in transabdominal ultrasound were evaluated, followed by an overall assessment of abdominal lesions along with the clinical data.

Materials and methods

A total of 62 patients with neoplastic ascites were included in the study between 2005 and 2015. All patients had a final diagnosis based on cytological and histopathological findings. Paracentesis was performed in 41 patients (in duplicate or triplicate in 13 patients), laparoscopy was performed in 53, and laparotomy in 32 patients. The other group included 18 patients with non-neoplastic ascites (13 patients with cirrhosis, 3 patients with heart failure, and 2 patients with chronic pancreatitis and splenic vein thrombosis). Patients with peritoneal fluid due to the so called 'acute abdomen' (e.g. appendicitis, pancreatitis, pelvic inflammatory disease, etc.) were excluded from the study. A consent was obtained from the Head of Department as well as the patients prior to the study. In addition to a standard ultrasound assessment of abdominal organs, we also attempted to detect fluid in all accessible spaces, as well as to determine its acoustic characteristics (anechoic, heterogeneous). Furthermore, we distinguished the following pathology categories: thickened peritoneal wall; dorsally oriented intestines; peritoneal fluid and tumor implants (peritoneal nodules of varying echogenicity); fluid and thickened omentum with smooth outline (smooth omental surface); fluid and thickened omentum with smooth outline and enlarged veins (varices within the thickened omentum); fluid and thickened omentum with irregular outline (nodular surface of the thickened omentum); fluid and thickened omentum with hypoechoic foci (omentum with distinctive focal lesions of low echogenicity); fluid and thickened peritoneum, omentum and tumor implants (nodular implants); honeycomb-like and gelatinous ascites (multiple, shapeless clusters of reflections with a structure similar to that of a honeycomb are present in a dense fluid; the structure exhibits oscillation under repeated transducer compression). Different digital ultrasound machines equipped with 3–6 MHz and linear 7–12 MHz transducers were used in the study. Each detected lesion was assessed for vascularization using color Doppler. Double-sided Fisher's exact test with statistical significance at $p < 0.05$ was used for the analysis of results.

The second stage of the analysis focused on the evaluation of all internal organs, with particular attention being paid to gallbladder wall thickness, signs of cirrhosis and liver congestion, portal hypertension, splenic size, pancreatic lesions, etc.

Furthermore, we analyzed laboratory findings (blood and urine), such as the level of protein, tumor markers, bilirubin, urea, creatinine, etc.

Results

Detailed results of the preliminary analysis are shown in Table 1. The table contains 11 characteristics associated with ultrasonographic evaluation of extra-organ lesions (Figs. 1, 2, 3, 4, 5, 6, 7). The data indicates that statistical significance was observed for anechoic peritoneal fluid (<0.0001); fluid and thickened omentum with smooth surface (<0.0001), fluid and thickened omentum with smooth surface and varices (0.01); fluid and thickened omentum with hypoechoic foci (0.049); fluid and thickened omentum with tumor implants (0.009). Based on these findings, benign ascites was diagnosed in 15 out of 18 patients (83.3%), while neoplastic ascites was diagnosed in 42 out of 62 (67.7%) patients. Gallbladder wall thickening was found in 9 out of 13 patients with cirrhosis, but in none of the patients with peritoneal carcinomatosis. An assessment of the appearance of the liver, pancreas and spleen was also important. Furthermore, primary tumors were diagnosed in 15 patients (ovarian cancer in 8, gastric tumor invasion in 3, colorectal cancer in 2 and pancreatic cancer in 2 patients). Additional important information included current laboratory findings, such as tumor markers; serum protein levels; liver, pancreas and kidney biochemistry, ab-

Parameter	**Neoplastic ascites *n* = 62**	**Percentage**	**Non-malignant ascites *n* = 18**	**Percentage**	***p***
Anechoic fluid	7	11.3	17	94.4	<0.0001
Heterogeneous fluid	12	19.3	1	5.5	NS
Dorsally oriented intestines	10	16.1	0	0	NS
Fluid and peritoneal thickening	7	11.3	0	0	NS
Fluid and peritoneal tumor implants	9	14.5	0	0	NS
Fluid and thickened omentum with smooth outline	0	0	7	38.9	<0.0001
Fluid and thickened omentum with smooth outline and enlarged veins	0	0	3	16.7	0.01
Fluid and thickened omentum with irregular outline	8	12.9	0	0	NS
Fluid and thickened omentum with hypoechoic foci	11	17.7	0	0	0.049
Fluid and thickened peritoneum, omentum and tumor implants	23	37.1	0	0	0.009
Honeycomb-like and gelatinous ascites	4	6.4	0	0	NS
NS – Not Statistically Significant					

Tab. 1. *Statistical analysis of parameters in the group of patients with benign and malignant ascites*

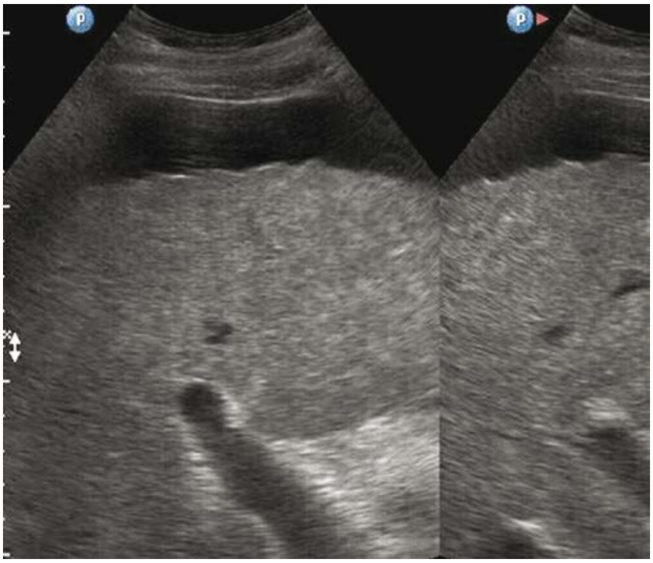

Fig. 1. *Two cross-sectional images showing anechoic fluid around a cirrhotic liver*

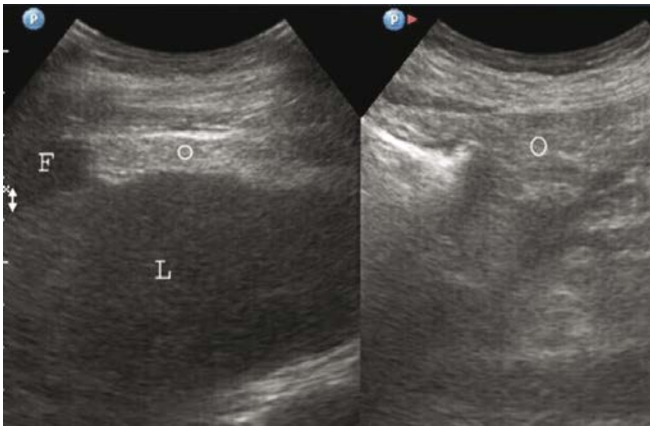

Fig. 3. *Cirrhosis. Two cross-sectional suprahepatic images (L) show the greater omentum with smooth outline surrounded by fluid (F)*

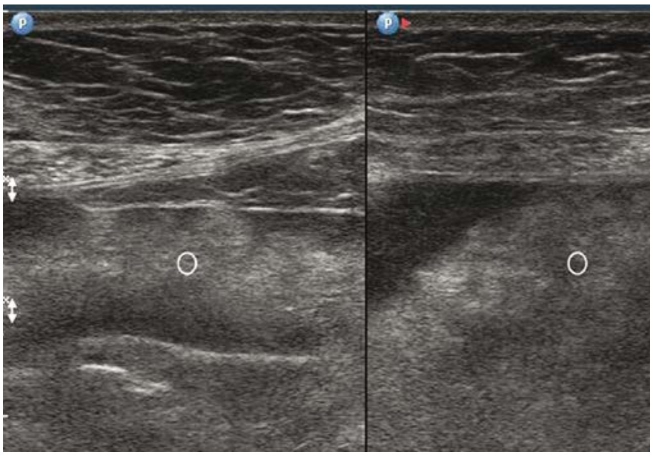

Fig. 5. *Ascites in gastric cancer. Multiple hypoechoic foci in the infiltrated greater omentum*

Fig. 2. *Ovarian cancer. Anechoic fluid in the upper ascites (F), echogenic fluid in the lower ascites (E). Adhesion of dorsally oriented small intestinal loops (B)*

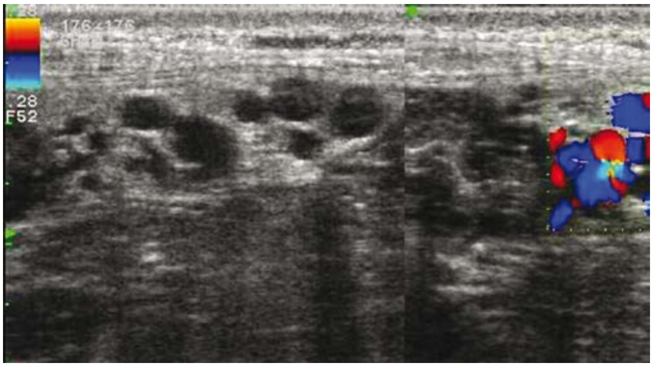

Fig. 4. *A tangle of veins in a thickened greater omentum in a patient with chronic pancreatitis and splenic vein thrombosis*

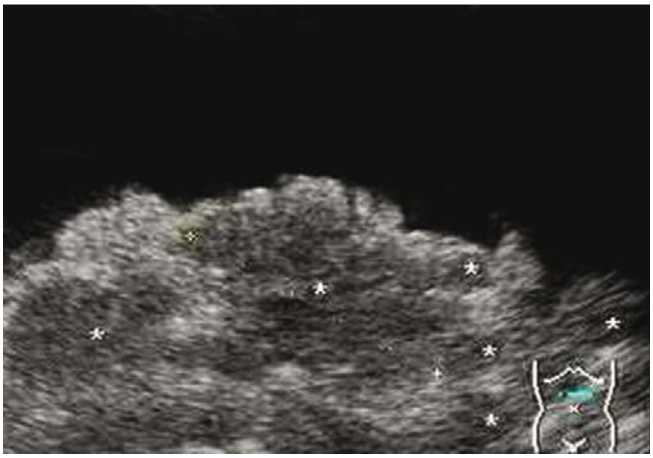

Fig. 6. *Ovarian cancer. Two cross-sections show thickened greater omentum with irregular outlines immersed in fluid*

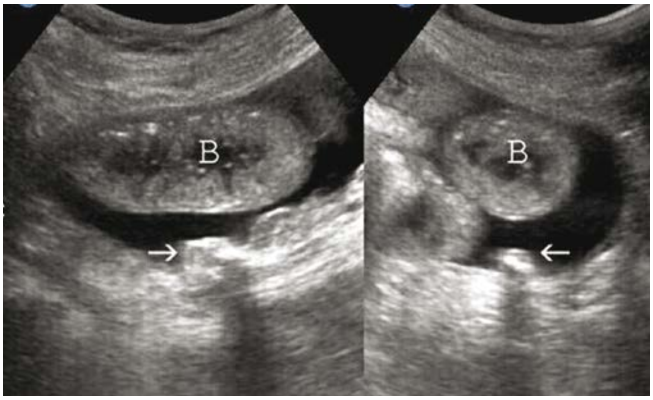

Fig. 7. *The same patient as in the Fig. 6. Partially calcified peritoneal tumor implants (arrows) are seen behind the intestine (B)*

sence of changes after treatment in previous scanning, etc. All these data were unreliable in 5 cancer patients with a small amount of fluid in the surgical site and/or patients with concomitant radiotherapy. Laparoscopy revealed recurrence in 3 patients, including a woman treated due to ovarian cancer. The second stage of analysis involved an overall assessment of abdominal organs and clinical data, which allowed for an enhanced accuracy of ultrasound diagnosis of 94.4% (17/18) and 93.5% (58/62), respectively. It was impossible to determine the nature of ascites, even based on a comprehensive analysis, in 5 postsurgical and/or post-radiation therapy patients with minor local ascites.

Discussion

Under normal conditions, the peritoneum contains 25 up to 100 mL of transparent fluid, with its daily replacement of about 5 mL[10,11]. In 1993, Nichols and Steinkampf[12] showed that even pelvic fluid volume of 0.8 mL is detectable during transvaginal ultrasonography. A small amount of pelvic fluid is a permanent symptom in healthy women of childbearing potential. The use of high-frequency transducers may detect small amounts of fluid in the right iliac fossa of young healthy men, which should not be considered a symptom of pathology. The fluid is collected mainly in this area as well as in the right paracolonic groove, while its resorption takes place in the subphrenic region[13,14]. This is confirmed by our long-term observations; a similar picture is also seen in this region in young women and children (Fig. 8). However, it is necessary to assess the fluid detected at this site in the clinical context so as not to overlook an ongoing disease process. Yoshikawa et al.[15] detected the presence of small amounts of pelvic fluid in 3.8% of healthy men and 16.8% of postmenopausal women using magnetic resonance. In this situation, the presence of fluid in the Morison's pouch, epigastrium, between the loops of the small intestine and, in larger amounts, in the pelvis of young women, should be considered as its secondary nature. The presence of fluid in this area will typically be an abnormal symptom in men. The widespread use of endoscopic ultrasonography has enabled obtaining not only fluid from minor ascites, but also cytological material using transgastric biopsy[10,16–18]. Our research is consistent with previously published studies, which differentiated between benign and malignant ascites based on the acoustic characteristics of fluid, the appearance of the greater omentum and the peritoneum as well as the presence of tumor implants[2–5,7–10]. Our results for ultrasonographic efficacy were worse at this stage of assessment. This results from the research assumption as only extra-organ lesions were initially analyzed. The inclusion of organ-related and clinical data in the analysis allowed for a suspicion of benign ascites in 94.4%, and malignant in 93.5% of cases. Gallbladder wall thickness was one of important indicators in these inquiries[19–21]. Goerg and Schwerk demonstrated high diagnostic efficacy of transabdominal ultrasound in patients with ascites, whose evaluation included peritoneal metastasis, adhesion of intestinal loops, echogenic ascites, lesions within the greater omentum and lymphadenopathy. Using these criteria, the investigators were able to determine the malignant nature of ascites in 92% of cases[3]. Topal et al. diagnosed malignant ascites in 98% of cases based on the presence of ascites with peritoneal and greater omental thickening, as well as tumor implants[7]. Allah et al. included the following aspects in the differentiation between benign and malignant ascites: the nature and location of fluid, the presence of peritoneal wall and parietal peritoneum thickening, tumor implants, greater omental thickening and structure, mesenteric thickening and structure as well as abdominal lymphadenopathy[9]. The authors achieved a sensitivity of 80.7% for malignant lesions, and a specificity of 75% for benign lesions. The sensitivity of ultrasound improved after transabdominal fine-needle biopsy and was 88.5% and 88.9%, respectively. Another problem are cancer patients after different, often combined, therapeutic interventions. They represent the most challenging diagnostic dilemma due to complications after various chemotherapeutics; some of these medications (those with hepato-, pancreatic or nephro-toxic effects) contribute to excessive water accumulation[22,23]. For example, fluid accumulation occurs after the use of protein tyrosine kinase inhibitor[22]. This often leads to both ascites as well as the presence of fluid in other body cavities.

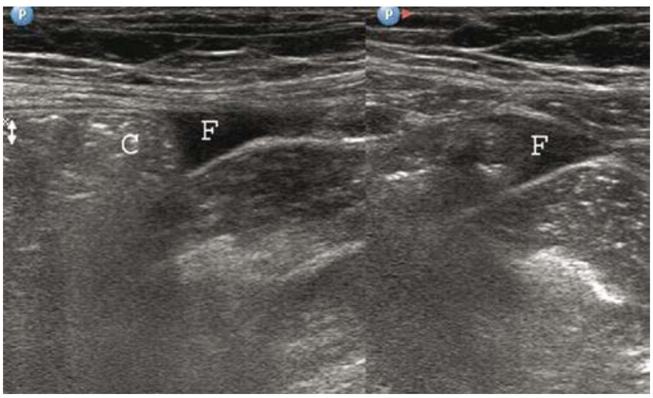

Fig. 8. *A healthy 35-year-old woman. A small amount of free fluid (F) is seen at the caecal bottom (C)*

Our study was limited by a small sample of patients with benign ascites. Cases of tuberculous peritonitis, which are common in Asia and Africa[9,12,24,25], would be particularly useful – these morphological lesions are very similar to peritoneal cancer spread. In our demographic circumstances, these are only case reports, which may however soon change with the influx of refugees.

Conclusions

When used alone, the assessment of acoustic fluid characteristics and extra-organ peritoneal lesions limits the possibility to differentiate between benign and malignant ascites. These results are, however, improved by the use of sonographic assessment of all abdominal organs along with the clinical data.

Conflict of interest

Authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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