

ULTRASOUND EVALUATION OF INTESTINAL PERISTALSIS WITH ADDITIONAL DUPLEX-DOPPLER ULTRASONOGRAPHY FOR PATIENT POSTOPERATIVE MONITORING AND EARLY DETECTION OF INTRA-ABDOMINAL COMPLICATIONS

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ABSTRACT

Present study was aimed to determine the role of ultrasound and Doppler examination of intestinal peristalsis disorders in some abdominal postoperative complications.

A total number of 37 patients aged 18-60 have been studied. In the control group 15 subjects who had no abdominal pathology but were undergoing preventive examinations were studied. Among the other examined patients 13 were patients, who had undergone operation on gastrointestinal pathology, without postoperative complications. Nine examined patients had postoperative complications and subsequently underwent relaparotomy, the final diagnosis was established during surgery. In control group no swelling and extension of the loops was revealed, the intestinal wall was visualized in the form of a two-layer structure, an external hypoechoic layer (muscle tissue) and an internal hyperechoic layer (mucous membrane in contact with the gas in the intestine) was determined. Peristaltic contractions were recorded in the form of multi-coloured flickering in colour duplex studies and also in the form of high amplitude and a frequency above 1 kHz Doppler signals of intestinal wall contraction. Among operated patients without postoperative complications, the recovery of normal intestinal peristalsis was observed within 3-5 days after surgery. Postoperative intestinal paresis with ultrasound examination was presented in the form of weak contractions of intestinal wall. There was no strongly marked swelling of intestinal loops. In group of patients with developing distributed peritonitis, intestinal loops were markedly inflated with gas and intestinal contents. No contractions of the intestinal wall were observed during colour duplex scanning. Monochrome signal interference associated with the patient's respiratory movements and gas content in the intestine were only detected. Ultrasound examination of patients with developing mechanical intestinal obstruction revealed a marked swelling of intestinal loops with liquid content, intense pendulum movements. Reinforced intestinal peristalsis at the sites proximal to the site of obstruction was detected, in the form of multi-coloured flickering, and high amplitude Doppler waves.

The data suggests that ultrasound examination of intestinal peristalsis with additional Duplex-Doppler ultrasonography may have its important impact for early evaluation of some intra-abdominal complications. It provided both qualitative and quantitative data about intestinal peristalsis, allowing differentiation between mechanical and paralytic ileus.

KEYWORDS: paralytic ileus, intestinal peristalsis, Duplex-Doppler evaluation of intestinal peristalsis

INTRODUCTION

Postoperative peritonitis is a severe complication with a high mortality rate. According to the literature, mortality from postoperative peritonitis is 33-60% [Zhebrovsky V et al., 2006; Seguin P et al., 2010; Traore A et al., 2014]. Recently, encouraging data have been published in favour of "Relaparotomy on demand" strategy for the treatment of severe patients with postoperative peritonitis [Lamme B et al., 2004]. However, the application of "Relaparotomy on-demand" strategy requires intense monitoring of the patient's laboratory tests, clinical condition and the active

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use of instrumental diagnostic methods. The prognosis and outcome of patients with severe postoperative complications such as peritonitis and bowel obstruction are directly related to early diagnosis and stringent treatment interventions. The delay in performing relaparotomy in postoperative peritonitis leads to multiple organ failure. Current criteria for performing relaparotomy in complicated clinical cases are non-explicit and area based on non-quantitative, subjective arguments, surgeons experience or hospital doctrines. This kind of subjective approach undoubtedly affects the effectiveness of treatment.

The diagnosis of postoperative peritonitis is based on clinical examination data (patient complaints, physical examination, pathological discharge from abdominal cavity drainage, presence of paralytic ileus and hemodynamic disorders, body temperature measurements etc.), laboratory tests (general blood tests, biochemical blood tests, determination of lactate dehydrogenase, C-reactive protein levels, acid-base balance etc.) and additional instrumental examination findings (abdominal X-ray, ultrasound, CT scanning etc.). Physical examination has a limited value in the diagnosis of postoperative peritonitis and is rarely crucial in decision whether to produce relaparotomy or not. The traumatic nature of surgical intervention, presence of painful postoperative wound, patient support under mechanical ventilation, and the administered drugs significantly reduce reliability of the physical examination. The rigidity of the abdominal wall is determined only in half of patients with postoperative peritonitis [Holzheimer R, Gathof B, 2003; Lamme B et al., 2006; Bader F et al., 2009]. Laboratory tests have high sensitivity, but low specificity in the diagnosis of postoperative peritonitis. Analysis of laboratory infection parameters such as leucocytosis and C-reactive protein are not the direct indicators of the developing postoperative peritonitis. In severe abdominal inflammation such as peritonitis, other sources such as catheter infections, pulmonary or urinary tract infections have to be considered in critically ill patients. Diagnostic and prognostic potential of procalcitonin in abdominal sepsis has been of a great interest. Even though existing data support the sensi-

tivity and specificity as an early marker for sepsis, its value is controversial [Reith H et al., 2000; Rau B et al., 2007; Lam M et al., 2008].

There are many publications about high sensitivity and specificity of CT scanning, supporting the use of CT-scanning in the diagnosis of postoperative peritonitis. However, the routine and frequent application of CT scanning is limited with high cost of the procedure, radiation exposure and general severe condition of the patient, restricting their transportation. Ultrasound examination has a number of advantages for patient monitoring in the postoperative period, it's non-invasive and available for frequent use.

One of the main and early signs of developing postoperative peritonitis is persistent paralytic ileus. The detection of paralytic ileus is of great practical importance in the complex diagnosis of postoperative peritonitis. In the literature, several methods for studying intestinal peristalsis have been proposed. However, some methods can be used only under experimental conditions (electromyography, manometry, radionuclide scanning). Other methods, such as auscultation have low sensitivity [Summers R et al., 1983; Corazziari E, Torsoli A, 1988; Gustavsson S, Thcker R, 1988; Soper N, Sarr M, 1988; Von der Ohe M, Camilleri M, 1992]. Auscultation of bowels alone might not accurately reflect small-intestinal motility because determination of localization, frequency, duration, volume, and pitch of bowel sounds is subjective. Assessment the bowel sounds as truly hypoactive or hyperactive is also difficult in practice [Baid H, 2009]. The barium contrast meal procedure is quite informative, but its frequent use is limited by certain contraindications in acute abdominal pathology and limited mobility of the patients who have just undergone operation.

In some published works which are of a practical interest, authors applied an ultrasound Duplex-Doppler examination to study the intestinal mobility [Gimondo P, Mirk P, 1996; Makino Y, Myoung-Ae Ch, 2017]. The data presented in the authors' works suggest to use ultrasound Duplex-Doppler examination in clinical practice as a non-invasive technique in the study of intestinal peristalsis.

The study aimed to determine the role of Duplex-Doppler examination of intestinal motility for evaluation of some abdominal postoperative complications.

MATERIAL AND METHODS

A total number of 37 patients within the age range of 18-60 were studied. In the control group 15 volunteers who had no abdominal pathology and were undergoing preventive examinations were studied. Among the others, 13 patients were operated with gastrointestinal surgical pathology, without postoperative complications. Nine patients examined had postoperative complications and subsequently underwent relaparotomy and the final diagnosis was established during surgery. The clinical and intra-operative findings of patients who had undergone relaparotomy suggested a diagnosis of acute intestinal obstruction in 2 patients and peritonitis in 7 patients. The distribution of the examined patients into groups is presented in table 1.

All the patients underwent ultrasound examination of the abdominal cavity before surgery and over the postoperative period. An ultrasound examination of the patients was performed using Toshiba-Aplio 400 (Japan) scanner with a 3.75 MHz curved array transducer for abdominal and vascular examinations. To exclude respiratory artefacts, the patients were asked to hold their breath. During ultrasound examination of the abdominal cavity, the general condition of the intestinal loops and the presence of movements of intestines were visually determined. The presence of free or locally distributed fluid in abdominal cavity was also checked. During the scanning of intestinal move-

ments by duplex, the abdominal regions with the presence of intestinal peristalsis were detected. The frequency and amplitude of the intestinal peristalsis signals were detected. Based on the findings of the previous research [Gimondo P, Mirk P, 1996], we divided the results of Duplex-Doppler examination into two main signals – peristaltic (P waves) and non-peristaltic. The peristaltic waves had high amplitude and the frequency >1 kHz, the duration of the peristaltic waves was about 2-6 seconds (Fig. 1). Uncoordinated, low amplitude waves with frequency lower than 1 kHz were considered not peristaltic waves (Fig. 2).

RESULTS

In examined 15 healthy subjects the intestinal loops contained a moderate amount of gas, fecal mass. No swelling and extension of the loops was found. The intestinal wall was visualized in the form of a two-layer structure, an external hypoechoic layer (muscle tissue) and an internal hyperechoic layer (mucous membrane in contact with the gas in the intestine) was determined. The ultra-

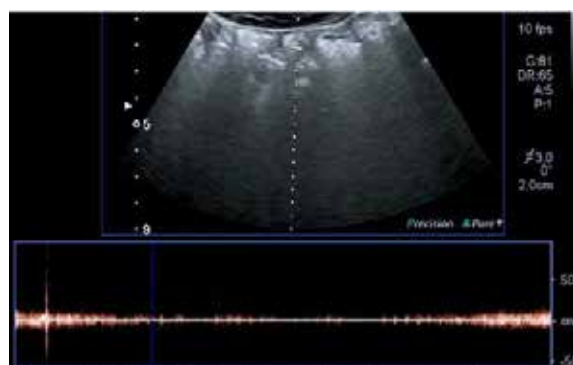


FIGURE 1. Doppler signal of a healthy subject intestinal peristalsis

TABLE 1

The distribution of the patients into study groups		
Distribution of patients into groups		Number of patients
Control	Healthy subjects, without any clinical data on the presence of diseases of gastrointestinal tract.	15
I group	Patients who had undergone surgery on abdominal pathology, without complicated postoperative course	13
II group	Patient who had undergone surgery with postoperative intraabdominal complications	9

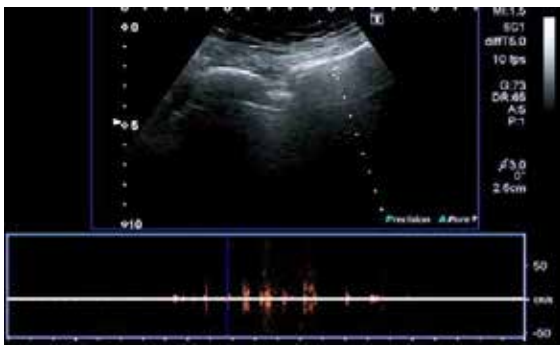


FIGURE 2. Absence of Doppler signal of intestinal peristalsis in a patient diagnosed with diffuse peritonitis and paralytic ileus

sound picture of the intestine changed significantly depending on the degree of its filling, the amount of fluid, fecal masses and gas. Peristalsis was usually defined in the small intestine in the form of characteristic moving echo structures. Peristaltic contractions were recorded in the form of multi-coloured flickering in colour duplex mode studies and also in the form of Doppler signals of intestinal wall contraction (Fig. 3a, b). The peristaltic wave had a high amplitude and a frequency above

1 kHz, the signal duration was approximately 2-6s.

Among the patients of I group, ultrasound signs of complete recovery of intestinal peristalsis were observed only on 3-5 days after surgery. On the 1-2 days after surgical interventions ultrasound examination revealed intestinal paresis, which was presented in the form of weak intestinal motility. Intestinal loops contained a moderate amount of gas and liquid contents, but the significant distention of the intestinal loops was absent (Fig. 4A). During the Duplex-Doppler examination of intestinal peristalsis, the multi-coloured flickering usual for peristaltic contraction was absent in the field of vision, only uncoordinated waves of low amplitude associated with intestinal wall weak movements were recorded (Fig. 4).

Duplex examination of intestinal wall revealed not peristaltic spasmodic signals of low amplitudes. Patients with a postoperative complication were included in II group. A clinical picture of an acute abdomen was present. All the patient subsequently underwent relaparotomy. Two patients of

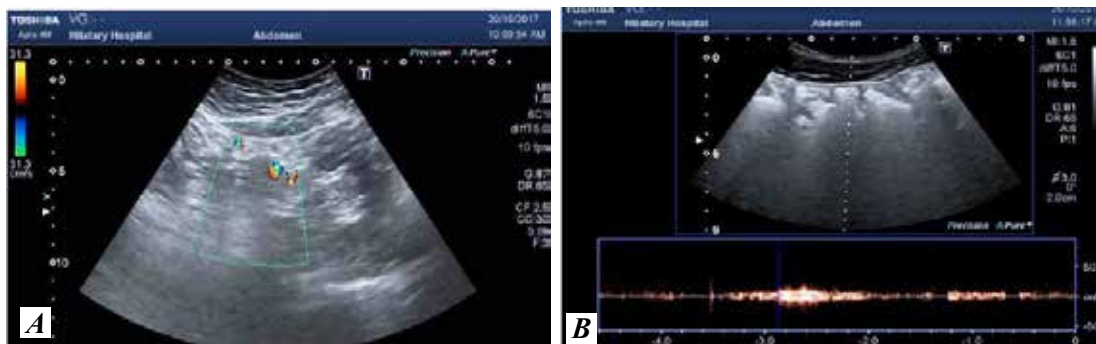


FIGURE 3. Duplex-Doppler examination of healthy subject intestinal peristalsis in control group
A – Peristaltic contractions in the form of multi-coloured flickering
B – Ultrasound image and Doppler signals of small-intestinal peristalsis in a healthy adult

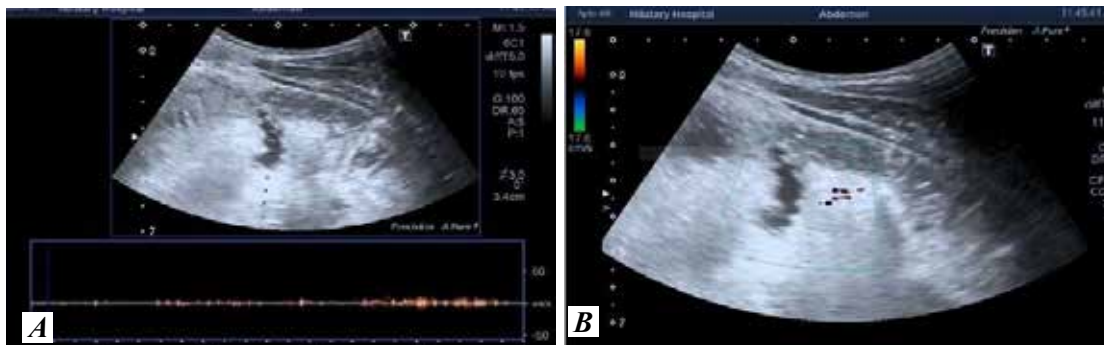


FIGURE 4. Duplex-Doppler examination of intestinal peristalsis in I group patients
A – Moderate amount of gas in the intestinal loop and absence of multi-coloured flickering in colour duplex scanning mode
B – Doppler examination of intestinal wall detected uncoordinated, low amplitude non-peristaltic waves

II group were diagnosed with postoperative distributed peritonitis. Diagnosis was confirmed during surgical exploration. Ultrasound examination of these patients revealed accumulation of free fluid of high echogenicity in the pelvis and near intestinal loops, ultrasound picture of paralytic ileus was present (Fig. 5A). Intestinal loops were markedly inflated with gas and intestinal contents, slight pendulum movement of intestinal contents was observed. There were no contractions of the intestinal wall during Duplex-Doppler examination. We only detected monochrome signal interference associated with the patient's respiratory movements and gas content in the intestine (Fig. 5B).

In two patients from (II group) with a clinical picture of an acute abdomen in postoperative course, mechanical intestinal obstruction was diagnosed. Diagnosis was based on data of ultrasound examination, and later in was confirmed during re-laparotomy. Ultrasound examination of patients with developing intestinal mechanical obstruction revealed a marked swelling of intestinal loops with liquid content, an intense pendulum movement (Fig. 6A). Reinforced intestinal peristalsis at the sites proximal to the site of obstruction was detected, in the form of multi-coloured flickering, and high amplitude Doppler waves (Fig. 6B).

The remaining 5 patients of II group had local

postoperative infectious complications of the abdominal cavity (abscess, biloma etc.). They also underwent relaparotomy. For the early diagnosis of these complications, the detection accumulation of fluid of increased echogenicity in the abdominal cavity was more crucial, which was found in all 5 patients of this group. Persistent intestinal peristalsis disorders were detected only in 3 patients having these complications.

CONCLUSION

Ultrasound examination has its important contribution to the early detection of postoperative intra-abdominal complications. Modern ultrasound scanners are well equipped and have high resolution, which certainly raises their diagnostic capabilities. The main advantages of ultrasound examination also are non-invasiveness and the possibility of this method of being repeatedly applied for the examination of critically ill patients.

In presented work we studied the intestinal peristalsis disorders in various postoperative intra-abdominal complications and revealed the main ultrasound examination criteria for early diagnosis of these complications.

Our data suggest that ultrasound examination of intestinal peristalsis with additional Duplex-Doppler ultrasonography may have its important impact for early evaluation of some intra-abdominal complications. It provided both qualitative and

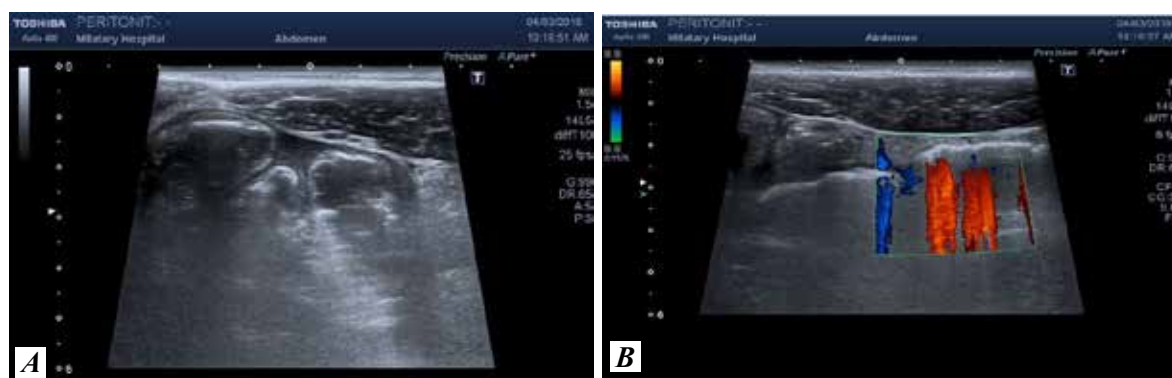


FIGURE 5. Duplex- Doppler examination of intestinal peristalsis in II group patients, diagnosed with postoperative distributed peritonitis.

A – Accumulation of free fluid of high echogenicity in abdominal cavity, intestinal loops are markedly inflated with gas and intestinal contents.

B – Contractions of the intestinal wall are absent, monochrome signal interference is associated with the patient's respiratory movements and gas content in the intestine.

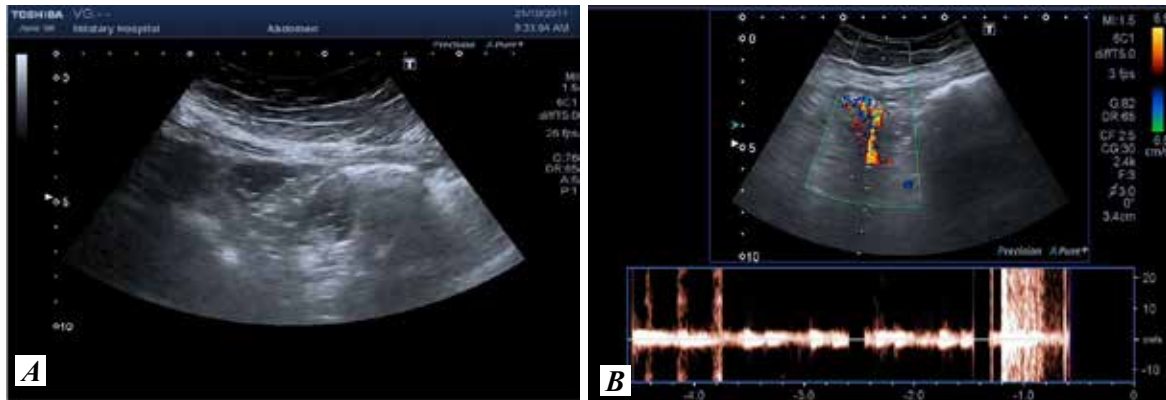


FIGURE 6. Duplex- Doppler examination of intestinal peristalsis in II group patients with developing post-operative mechanical intestinal obstruction

A – Marked swelling of intestinal loops with liquid content and intense pendulum movements of content
B – Reinforced intestinal peristalsis at the sites proximal to the site of obstruction

quantitative data about intestinal peristalsis, allowing differentiation between mechanical and paralytic ileus. The visualization of intestinal segments having different degrees of peristaltic activity proved useful in localizing the site of mechanical obstruction. The data of ultrasound examina-

tion of intestinal peristalsis in combination with other laboratory and instrumental methods may be important in future for a more objective and accurate assessment of the condition of patients with abdominal pathology and early detection of the intra-abdominal complications.

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