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Early radiological diagnostics of gastrointestinal perforation

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Background. *The goal is to present the possibilities of radiological procedures and the early detection of gastrointestinal perforation as a common cause of acute abdomen.*

Methods. *During one year period, in emergency conditions, we evaluated 20 patients with gastrointestinal perforation. Native x-ray, ultrasound and CT of abdomen were performed on all patients, and on some of them with per os administration of 250 ml contrast, ultrasound was performed with 3, 5 MHz probe on a Siemens machine. CT scans were done on the multi row detector computed tomography (MTDC) »Volume Zoom«, Siemens with four rows of detectors and 2.5 mm width. All patients were admitted with clinical symptoms of acute abdomen.*

Results. *A group of 20 evaluated patients consisted of 8 (40%) women and 12 (60%) men of 41 as average age. The youngest patient was 14, and the eldest 67 years old. 7 (35%) had stomach perforation and 10 (50%) duodenum perforation. There was also a traumatic colon transversal perforation in one case, in the second was stitches rupture after the stomach operation and the third was the sigma perforation caused by the malign process. Out of all above mentioned cases, in 18 (90%) cases perforation occurred spontaneously and in 2 (10%) cases artificialy. Native x-ray of abdomen showed free air in the abdominal cavity in 16 (80%) cases. Ultrasound gave positive results on free liquid in 18 (90%) and CT scan revealed both free liquid and air in 20 (100%) cases.*

Conclusions. *The significance of an early and reliable discovery of gastrointestinal perforation is very important, because it usually requires the surgical intervention. Along with anamnesis, native x-ray of abdomen was and is traditionally the first procedure, especially in the detection of free air. With the development of digital techniques such as ultrasound and CT, we have a new diagnostic procedure at our disposal, especially in detecting free liquid and air as early signs of digestive perforation. According to our researches, ultrasound proves to be very useful in examining free liquid, while CT was more sensitive to the combination of liquid and minimal amount of free air, which was undetectable to ultrasound and x-ray.*

Key words: stomach-injuries-radiography; intestinal perforation-radiography- ultrasonography; CT scan

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Introduction

Gastrointestinal perforation is a common cause of acute abdomen. Spilled contents can consist of air, liquid of gastric and duodenal secretion, bile, food and bacteria.[1] Free

air or pneumoperitoneum is formed when the air leaves the gastrointestinal system. It occurs after perforation of stomach, oral part of duodenum and large intestine.[2] In case of perforation of small intestine, which in normal circumstances does not contain air, very small amount of air is released. The free air occurs in the peritoneal cavity 20 minutes after the perforation.

Causes of gastrointestinal perforation are: peptic ulcers, inflamed sigmoid colon diverticul, trauma damages, changes in case of Crohn's disease, ulcerous colitis and malign tumours in gastrointestinal system. The most common perforations are those of peptic stomach ulcer and of duodenum. Statistically, duodenum ulcers and most often in males, are the ones that perforate the most. The perforation can occur in the abdominal cavity *(perforatio libera)* or the adhesion of created pocket *(perforatio tecta)*.[2]

In 1799 clinical symptoms of perforated ulcers were recognized for the first time, although only in 1892, Ludwig Hensner, German, was the first one to perform surgery due to peptic ulcer of stomach. In 1894, Henry Percy Dean performed surgery due to perforated ulcer of duodenum small intestine.[3]

Patients and methods

This paper included 20 patients with gastrointestinal perforation, who were examined as urgent patients at our Institute in the period of one year. There were 8 women and 12 men, the youngest was 14 and the eldest was 67 years old. The average age was 41. They all had native x-ray of abdomen, ultrasound exam and native CT scan done. We applied 'Ultravist' dissolvable contrast substance on 3 patients in the amount of 250 ml orally. The exams were done with the ultrasound Siemens machine with 3, 5 MHz probe in the supine position and the position of left and right decubitus. CT scan was done on MTDC Somatom «Volume Zoom, Siemens machine with four rows of detectors and 2, 5 mm width, natively, in supine position and position of left and right decubitus.

Results

As depicted in Table 1, we can see that, out of 20, patients there were 8 women (40%) and 12 men (60%). Duodenal *bulbus* is to perforate the most 10 (50%) and stomach 7 (35%). We also had 1 (5%) sigma perforation caused by the malign process. In one case of a male child, colon transversal perforated after trauma and in other male patient there was stitches rupture after the stomach perforation surgery. With 18 (90%) of the patients the perforation was spontaneous, and with 2 (10%) patients it was a case of artificial duodenum perforation after ERCP and case of percutanous punction of pancreas pseudociste done by the ultrasound punction (Figure 1).

With 18 patients (90%) the native x-ray of abdomen in the standing position was positive on free air, and CT was positive on free air and liquid with all 20 patients (100%).

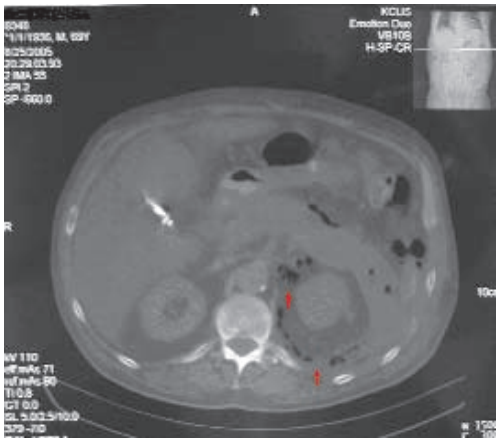

Figure 1. Artefitial perforation of duodenum with perirenal air collection.

Table 1. Frequency of gastrointestinal perforation according to localization and radiological findings

Patient	Sex	Native x-ray air	Location	Ultrasound fluid	CT Air/fluid
1.	female	neg	sigma	neg	pos
2.	female	pos	gaster	pos	pos
3.	female	neg	gaster	neg	pos
4.	female	pos	bulbus	pos	pos
5.	female	pos	bulbus	pos	pos
6.	female	neg	gaster	pos	pos
7.	female	pos	bulbus	pos	pos
8.	female	pos	bulbus	pos	pos
9.	male	pos	gaster	pos	pos
10.	male	pos	gaster	pos	pos
11.	male	pos	gaster	pos	pos
12.	male	pos	gaster	pos	pos
13.	male	pos	bulbus	pos	pos
14.	male	pos	bulbus	pos	pos
15.	male	neg	bulbus	pos	pos
16.	male	pos	bulbus	pos	pos
17.	male	pos	bulbus	pos	pos
18.	male	pos	bulbus	pos	pos
19.	male	pos	colon tr.	pos	pos
20.	male	pos	gaster-deh.	pos	pos
Total		**80%**		**90%**	**100%**

Discussion

The significance of early and reliable discovery of gastrointestinal perforation is very important, because it usually requires the surgical intervention. The radiologist has a significant role in helping the surgeon to choose the diagnostic procedure and to decide whether the patient will be operated. The detection of minimal pneumoperitoneum with patients with acute abdominal pain caused by gastrointestinal perforation is one of the most important diagnostic tasks in the urgent state of abdomen. An experienced diagnostician can, by using radiological techniques, detect such small amount of air as 1 ml. While doing so, he uses classic x-ray techniques of native abdomen in the standing position and the position of left lateral decubitus (Figure 2).

Despite of recent increased use of modern diagnostic techniques, an x-ray scan is still one of the most important initial tests

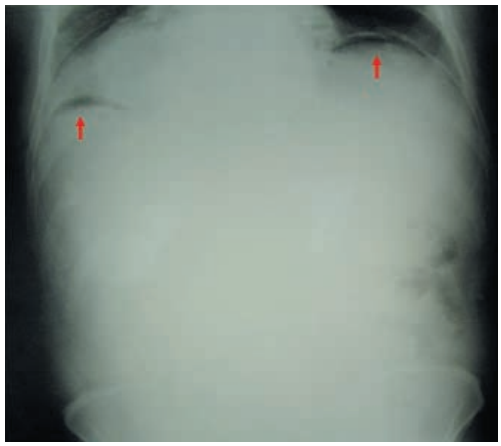

Figure 2. Subdiagraphragmal sickle- like air collection in native plain x-ray in standing position (gastrointestinal perforation).

and its analyses are sometimes a big challenge for a radiologist. Radiography is easily available, fast and cheap method. In order to see the free air and make the radiological interpretation reliable, the quality of the exposed film and correct positioning of the patient is very important. Every patient needs to take an adequate position 10 minutes before the exposition, so that, in that moment, the free air could reach the highest point in abdomen. Still, the appearance of pneumoperitoneum in case of the organ perforation can sometimes be difficult and unreliable.

Many researches show that its appearance is visible in just 75-80% of cases, but classic native x-rays of abdomen are still important procedures. Free air appears in the standing position or the position of left lateral decubitus. In case of trauma rupture, perforation can be insidious and masked by other pathological surgical conditions. The supine position reveals pneumoperitoneum in just 56% of cases.[4] About 50% of patients have collection of airs in right upper abdomen, either subhepatically or in hepatorenal space (Morison). A small oval or linear collection of air can be visible here. The small triangular collection of air is also visible between intestine meanders.

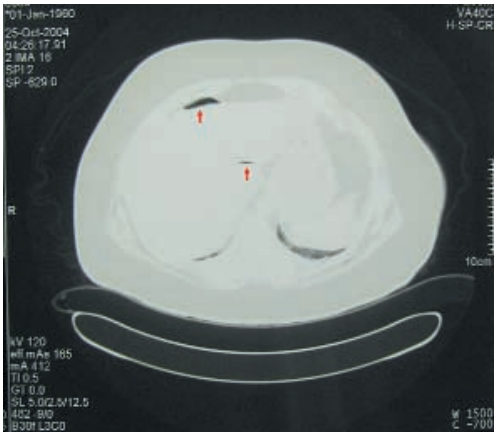

Figure 3. Air collection after gastrointestinal perforation (CT window for lung parenchyma).

Though, it is mostly visible in a shape of »dome« as a half-moons collection of air under the diaphragm in the standing position. A »football« sign represents the presence of free air above fluid collection in the middle part of abdomen. Our study has shown the presence of free air in standing x-ray of native abdomen in 80% of the cases, which is close to other authors' results (Sutton 76%). The ultrasound is an initial method for most acute abdomen conditions. It is useful for the detection of free liquid of various densities depending on the colour of grey scale, which in these cases, is very inhomogeneous because of the intestine contents.[5] It is especially precise in the detection of free liquid in small pelvis using the full urinary bladder technique. Mostly, ultrasound can not detect free air, which is not only barely detectable, but it also makes artefacts and limits this procedure. Still, some authors say that the detection of pneumoperitoneum is possible using ultrasound as the first procedure, and that they managed to see the air in the right upper quadrant when the patient is in the left lateral decubitus position. The echoes, which appear due to pneumoperitoneum, correspond to lung echoes during

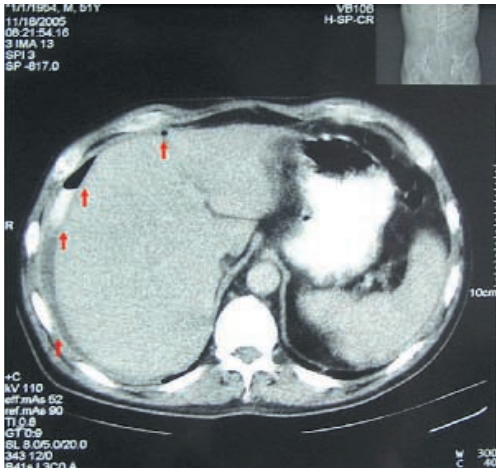

Figure 4. Air and contrast agent on CT scan after gastrointestinal perforation.

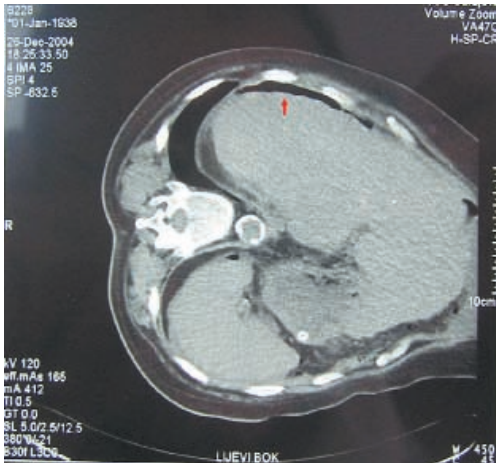

Figure 5. Movement of air collection ventraly on CT scan at lateral decubitus position.

Figure 6. Fluid collection in Douglas space on CT scan of pelvis after gastrointestinal perforation.

the inspiration, but are separated during the expiration.[6] They also say that the echographic determination of perforation is possible as discontinuity of stomach wall or *bulbus* of hyper echoing aspect.[1]

In our study of 20 patients, we found free liquid in abdomen in 90% of cases, which is in coordination with other authors' researches (from 93% - 98%).[7, 8]

CT scan of abdomen is a much more sensitive method in detection of air after the perforation, even when it appears as a bubble and when the native x-ray is negative.[9] Therefore, CT is very efficient in the early detection of gastrointestinal perforation. While doing so, we need to adjust the window so that we could distinguish fat from air, because both of them appear as hipodense areas with negative densities. The window for lung parenchyma is best for solving this problem (Figure 3).

When the CT is done in the supine position, air bubbles on CT scan are mostly located on the front parts of abdomen (Figure 4). We can see air bubbles move if a patient afterwards takes the position of left decubitus (Figure 5). CT is also much better in detecting fluid collections located in bursa omentalis and retroperitoneal.[10]

Despite the great sensitivity, CT is not always necessary due to high cost and the radiation dose. In doing so, the possibility of locating the perforation is poor.[11] If we suspect that the patient has perforation, and the free air is not visible on classic native scans, we can apply nonionic contrast substance to prove our doubts. One of the ways is to apply air through nasogastrical tube 10 minutes before scanning.

The second way is to give orally the minimal 250 ml dissolvable contrast substance 5 minutes before scanning, which helps to show contrast but not the air. Barium compounds can not be given in this situation because they can cause granuloma formation and peritoneum adhesion.[1,2] CT has proved as very sensitive with our 20 patients, discovering free liquid and air in abdomen in 100 % of cases (Figure 6). Some authors claim that CT can be precise up to 95%.[12]

Conclusions

We can conclude that, along with clinical finding, complementary methods are: standard native abdomen x-ray in the standing position, ultrasound on full urinary bladder,

native CT scan and CT with orally given dissolvable contrast substance. If x-ray and ultrasound findings are uncertain, we should not hesitate to use CT, considering that it can detect fluid and very small collections of air which are undetectable by previously mentioned methods.

References

1 Salihefendić N, Zildžić M, Ličanin Z, Muminhodžić K, Zerem E, Mašić I. *Akutna abdominalna bol. [Acute Abdominal Pain].* Sarajevo: Avicena; 2005. p. 53-4.

2 Plavšić B. Radiologija probavnog kanala. *[Radilogy of Digestive Canal].* Zagreb: Školska knjiga; 1989. p. 176-7.

3 Lau WY, Leow CK. History of perforated duodenal and gastric ulcers. *World J Surg* 1997; **21:** 890-6.

4 Sutton D. *Textbook of radiology and imaging. Seventh edition.* Vol 1. 2003. p. 663-8.

5 Haga JR, Lanzieri ChF, Giekeson CR. *CT and imaging of the whole body.* Forth edition. Vol 2. St Louis: Mosby; 2002. p. 456.

6 Lee DH, Lim JH, Ko YT, Yoon Y. Sonographic detection of pneumoperitoneum in patients with acute abdomen. *AJR Am J Roentgenol* 1990; **154:** 107-9.

7 Poletti PA, Kinkel K, Vermeulen B, Irmay F, Unger PF, Terrier F. Blunt abdominal trauma: should US be used to detect both free fluid and organ injuries. *Radiology* 2003; **227:** 95-103.

8 Branney SW, Wolfe RE, Moore EE, Albert NP, Heining M, Mestek M, et al. Quantitative sensitivity of ultrasound in detecting free intraperitoneal fluid. *J Trauma* 1995; **39:** 375-80.

9 Lee FT Jr, Leahy-Gross KM, Hammond TG, Wakeen MJ, Zimmerman SW. Pneumoperitoneum in peritoneal dialysis patients: significance of diagnosis by CT. *J Comput Assist Tomogr* 1994; **18:** 439-42.

10 McGahan JP, Goldberg BB. *Diagnostic ultrasound a logical approach.* Philadelphia: Lippincott-Raven Publishers; 1998. p. 541-2.

11 Chen CH, Huang HS, Yang CC, Jeh YH. The features of perforated peptic ulcers in conventional computed tomography. *Hepatogastroenterology* 2001; **48:** 1393-6.

12 Ma OJ, Kefer MP. Ultrasound detection of free intraperitoneal fluid associatied with hepatic and splenic injuries. *South Med J* 2001; **94:** 54-7.