US in the evaluation of abdominal pain in a department of internal medicine

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KEYWORDS

Ultrasonography;
Abdomen;
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Abstract *Introduction:* US (US) examination of the abdomen has acquired a growing role in the investigation of abdominal pain; however its role in the diagnosis of some important causes of abdominal pain is still under investigation. The aim of this study was to evaluate the role of US of the abdomen in the diagnosis of abdominal pain in patients referred to a department of internal medicine.

Materials and methods: A retrospective analysis was carried out on 248 US examinations performed in our department due to abdominal pain. For each examination the data written on the request form were registered as well as US findings which could be correlated with abdominal pain.

Results: In 105 patients (42%), US examination of the abdomen resulted in a relevant clinical finding and was thus considered *positive*. A high percentage of patients were elderly (>65 years; 52%) and very elderly (>80 years; 24%); these patients showed a significantly higher percentage of positive US scans. The proportion of positive scans was not significantly different between localized and non-localized pain. Specific pain location was associated with US findings such as hepatic masses, ovarian masses and renal stones, whereas non-localized pain was associated with abdominal free fluid and fluid-distended bowel loops.

Discussion: A high percentage of US examinations identified conditions that could possibly cause abdominal pain. Diagnostic yield of abdominal US was higher in elderly and very elderly patients. When a US examination is requested, it should always be evaluated within the clinical context. The physician should be aware of the great value of abdominal US in the diagnosis of the various causes of abdominal pain, but also of its possible limitations.

Sommario *Introduzione:* L'ecografia dell'addome sta acquistando un ruolo sempre maggiore nell'iter diagnostico del dolore addominale, tuttavia il suo ruolo nella diagnosi di alcuni importanti quadri di dolore addominale è ancora in corso di studio. Scopo del nostro studio è stato valutare il ruolo dell'ecografia nella diagnosi differenziale di dolore addominale in un reparto di medicina interna. *Materiali e metodi:* Abbiamo condotto un'analisi retrospettiva di 248 ecografie addominali eseguite per dolore addominale nel nostro centro. Per ogni esame, sono stati registrati i dati inseriti nel modulo di richiesta e i reperti ecografici che potevano essere

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considerati correlati a dolore addominale. **Risultati:** In 105 pazienti (42%) l'ecografia dell'addome ha rilevato un reperto ecografico rilevante ed è stata quindi considerata positiva. Un'alta percentuale di pazienti era anziana (>65 anni, 52%) e grande anziana (>80 anni, 24%): questi soggetti avevano percentuale significativamente maggiore di esami ecografici positivi. La percentuale di indagini positive non è risultata significativamente diversa tra quelle eseguite per dolore addominale localizzato e non localizzato. Specifiche localizzazioni di dolore addominale erano associate a determinati reperti ecografici, come masse epatiche, masse ovariche e calcoli renale, mentre dolore addominale non localizzato era associato a reperti ecografici di versamento liquido addominale e anse intestinali distese da fluido.

Discussione: Un'alta percentuale di indagini ecografiche ha identificato condizioni che potrebbero causare dolore addominale. Il valore diagnostico dell'ecografia addominale è stato maggiore in pazienti anziani e grandi anziani. Quando viene richiesta un'ecografia addominale, l'esame dovrebbe sempre essere valutato nell'ambito nel contesto clinico. Il clinico dovrebbe essere consapevole della grande potenzialità dell'ecografia addominale nella diagnosi delle diverse cause di dolore addominale, ma anche dei suoi possibili limiti.

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Introduction

An old but true proverb says that "*the abdomen is the physician's grave*". Abdominal pain can indeed be a challenging and difficult condition to diagnose. US examination of the abdomen has acquired a growing role in the diagnosis of abdominal pain, because it is a non-invasive, safe, inexpensive, readily available and repeatable technique for abdominal imaging. US has radically changed the emergency approach to patients with acute traumatic abdominal pain; the protocol used is focused assessment with sonography in trauma (FAST). US is furthermore increasingly used in the assessment of acute non-traumatic pain, because it can image many intra-abdominal pathologies correlated to abdominal pain. However, also in emergency situations, the role of US in the diagnosis of some important causes of abdominal pain (such as appendicitis) is still under investigation. The benefit of US examination in abdominal pain has been evidenced in studies conducted mainly in emergency departments [1,5–7]. However, a wrong US diagnosis can be misleading and cause treatment delay. The value of US, particularly in non-emergency settings, still needs further evaluation [2]. It should be noted that the current Italian guidelines for US imaging in gastroenterology do not directly address the issue of US in abdominal pain [3]. This study was thus aimed at evaluating the role of abdominal US in the diagnosis of abdominal pain in a department of internal medicine.

Materials and methods

The present study is a retrospective analysis of abdominal US examinations performed in this department from 2007 to 2009. A complete systematic US examination of the abdomen was performed irrespectively of the pain location. US examination was performed using a Toshiba Aplio XV scanner and a 5–2 MHz convex probe. All examinations were carried out by the same physician with a long experience in this field.

For each examination the following information was recorded: the patient's gender and age, full text of the request form, pain location, associated clinical data or symptoms as

indicated on the request form, and the findings that could be considered correlated to abdominal pain, such as abdominal free fluid, pleural effusions, abdominal aortic aneurysm, cholelithiasis, bile duct stones, bile tree dilatation, Wirsung's duct dilatation, hydronephrosis, US signs of cholecystitis, renal stones, fluid-distended bowel loops, hepatic masses, renal masses, pancreatic masses, ovarian masses and urinary bladder overdistension. Also other relevant findings not directly related to abdominal pain were recorded, such as hepatic steatosis, hepatomegaly, inhomogeneous hepatic echostructure, splenomegaly and lymphadenopathy.

US examination was considered as "positive" if a condition was detected which could be correlated to abdominal pain. Statistical analysis was performed using the χ^2 test; $p < 0.05$ was considered to be significant.

Informed consent was obtained from all patients.

Results

In the period of the study, 2375 examinations were carried out, 248 of which (10.4%) included abdominal pain among the indications. The patients' mean age was 62 years (range 14–95 years); 152 female patients (62%) and 96 male patients (38%).

US examination of the abdomen was considered positive in 105 (42%) patients. The most common findings concerned the upper bile tract: cholelithiasis in 27 patients (11%) and bile tree dilatation in 22 patients (9%) (Fig. 1); other findings and the relative percentages are summarized in Table 1.

A high percentage of patients were elderly (>65 years: 104 patients, 52%) and very elderly (>80 years: 47 patients, 24%); 50 patients were excluded from this count as their age was not specified in the request form.

Elderly patients had a significantly higher percentage of positive US findings: 49% versus 21%, $p < 0.001$, odds ratio (OR) 3.56. Also very elderly patients had a significantly higher percentage of positive US outcome: 57% versus 29%, $p < 0.001$, OR 3.28.

Correlation between clinical data indicated on the request form and specific findings was analyzed. No single associated clinical data was sufficiently numerous to significantly identify specific significant associations, but there was a statistically

Fig. 1 Summary of US images according to the most frequent findings in patients undergoing US for abdominal pain: gall bladder stone and bile tree dilatation (due to obstructing biliary stones).

Table 1 US findings in patients examined for abdominal pain.

Finding	Number	Percentage
Positive Examination	105	42%
Cholelithiasis	27	11%
Bile tree dilatation	22	9%
Abdominal free fluid	21	8%
Ovarian mass	14	6%
Hepatic mass	14	6%
Pleural effusion	9	4%
Renal stones	9	4%
Renal mass	8	3%
Abdominal aorta aneurysm	7	3%
Pancreatic mass	6	2%
Cholecystitis	5	2%
Wirsung's duct dilatation	4	2%
Fluid-distended bowel loops	4	2%
Bile duct stones	3	1%
Hydronephrosis	3	1%
Urinary bladder overdistension	2	1%

significant correlation between associated clinical data indicated on the request form and the presence of cholecystitis, hepatic masses and splenomegaly. χ^2 -values, p -values and OR-values are summarized in Table 2.

The pain was localized in one or more abdominal quadrants in 134 (54%) patients, whereas pain was non-localized in 114 (46%) patients. Difference in the proportion of positive US scans (34% in localized pain versus 40% in non-localized pain) was not statistically significant.

Specific localization of pain were associated with specific US findings: the finding of hepatic masses was associated with pain localized to the right hypocondrium; the presence of renal stones was inversely associated with pain localized to the right and left flank; pain localized to the lower abdominal quadrants was significantly associated with the finding of ovarian masses (Fig. 2). There was a statistically significant association between non-localized pain and the finding of abdominal free fluid, and of fluid-distended bowel loops (Fig. 3). χ^2 -values, p -values and OR-values are summarized in Table 3.

Discussion

In this study, a high percentage (42%) of US examinations identified conditions that could possibly cause abdominal pain. The proportion of positive examinations was similar to that of previous studies conducted in a general hospital setting (45% in a study by Raman et al) [2] and in emergency departments (42% in a study by Testa et al.) [4]. Other studies conducted in emergency department settings reported a higher percentage of positive US findings (66% in a study by Nural et al.) [5]. In contrast to these studies, our population included patients from an internal medical department with a high proportion of elderly and very elderly patients (52% and 24%, respectively) presenting with a range of characteristic pathologies, as elderly patients are usually polypathological.

In contrast with other studies [5], it was not possible to correlate the positive findings with the general clinical picture and further evolution of the patients, such as subsequent imaging studies and final diagnosis, as follow-up was not carried out in this department. For this reason it was not possible to assess if potentially positive findings were the real cause of pain.

It was decided to adopt a strict definition of "positive" US (i.e. detection of findings possibly related to abdominal pain). This definition might have led to overestimation of "true" positive examinations, but in our opinion this describes the "real-life" use of abdominal US in our clinical practice. Initial US findings probably had an impact on the further evaluation and differential diagnosis in the patients evaluated for abdominal pain. "Positive" findings might not necessarily have been the cause of the abdominal pain, but

Table 2 US findings significantly correlated with the report of associated clinical data.

Finding	χ^2	p value	Odds Ratio
Cholecystitis	6.75	0.0094	10.73
Hepatic mass	6.12	0.0133	3.70
Splenomegaly	4.54	0.0331	2.77

Fig. 2 Summary of US images according to US findings significantly associated with localized pain: renal stones, hepatic mass (abscess) and ovarian mass.

all findings were likely to directly influence the further diagnostic workup of the patient.

Consistently with previous studies [2] diagnostic yield of abdominal US was higher in elderly and very elderly patients.

The fact that cholecystitis, hepatic masses and splenomegaly had a higher probability of being detected in patients with reports of associated clinical data, suggests that the US operator is guided by the knowledge of the complex clinical picture. However, it has to be taken into account that liver,

Fig. 3 Summary of US images according to US findings significantly associated with non-localized pain: fluid-distended bowel loops and abdominal free fluid.

spleen and gall bladder are organs which are easily examined at US examination. Nevertheless, there was no significant correlation identified between clinical condition, laboratory tests specified on the request form and US findings; this is possibly due to insufficient sample size (type b statistical error) and/or incomplete or inaccurate compilation of request forms prescribing abdominal US examination.

Unlike previous studies [2] the proportion of positive scans did not show a significant difference between localized and non-localized pain. However, specific pain location was associated with specific US findings: non-localized pain with abdominal free fluid and fluid-distended bowel loops, pain localized to the right hypocondrium with hepatic masses, pain localized to the right and left flank with renal stones, and pain localized to the lower abdominal quadrants with ovarian masses. All these associations correlate with clinical practice, but other hypothesized associations (particularly that of pain localized to the right hypocondrium linked to cholecystitis, cholelithiasis and bile duct stones) could not be statistically demonstrated. This might again be due to insufficient sample size (type b statistical error), difference between the present study population and other populations (internal medicine department patients and not emergency department patients) and incomplete or inaccurate compilation of US request forms.

Table 3 US findings significantly correlated with localization of abdominal pain.

	Localization	X ²	p value	Odds Ratio
Abdominal free fluid	Non-localized	3.96	0.047	2.54
Fluid-distended bowel loops	Non-localized	4.78	0.029	7.33
Renal stones	Non-localized	4.57	0.033	0.14
Renal stones	Right or left flank	29.95	0.0000	20.76
Hepatic masses	Right hypocondrium	8.24	0.004	4.57
Ovarian masses	Lower quadrants	9.43	0.0021	5.35

Some relevant causes of abdominal pain that could have been identified by US examination (e.g. pancreatitis, hematoma, bowel stenosis) were not frequently detected in the present study. This may have occurred for several reasons: the incidence of these pathologies among the in-patients of a department of internal medicine is probably lower than average because patients with these causes of abdominal pain are usually hospitalized in other departments; secondly sensitivity of the US technique is low in the investigation of some important causes of abdominal pain, and a negative US outcome does not exclude computed tomography (CT) examination of the abdomen; lastly it is possible that the request form did not specify abdominal pain even if this was part of the clinical picture.

One limitation to our study is that the characteristics and timing of abdominal pain were not always clearly stated on the request form, so in many cases it was not possible to assess if the pain was acute or chronic. This limitation reflects the retrospective nature of data collection but it is a realistic picture of what happens in real clinical practice, where the low cost and easy availability of US examinations lead to an elevated number of unnecessary or at least non-specifically requested examinations. While the acute setting and limited time availability of an emergency department can positively rationalize the diagnostic workup of patients [6,7], the different scenario of a department of internal medicine can sometimes lead to an overflow of diagnostic examinations, particularly when they are easily available.

Information not stated on the request form can sometimes be provided by the direct interaction between the examining physician and the patient with abdominal pain, both in terms of medical history and physical examination (particularly the possibility of correlating US findings with the point of maximum tenderness). From this point of view, US is different from CT, where the interaction between the physician and the patient is limited. Even though our findings cannot be compared with subsequent imaging studies such as CT scanning, our overall experience was that abdominal US did not substitute CT (with the exception of selected pathologies such as cholecystitis), but US outcome rather prompted and oriented CT examination in several unclear clinical pictures. US scan has several advantages over CT such as real time examination, interaction with the patient, low cost, no iodinated contrast medium and no ionizing radiation. However due to its large field of view, CT has a high diagnostic accuracy in patients presenting with abdominal pain [6,7], and CT is therefore the technique of choice in such cases.

In our opinion [8] if a US examination is carried out “to see if we find something” instead of being requested in order to test a clinical hypothesis based on good clinical reasoning, the advantage of US (i.e. ready availability, repeatability, and low cost) may be turned into a disadvantage [2].

Conclusion

This study has further clarified the role of US examination of the abdomen in the evaluation of patients referred to a department of internal medicine for abdominal pain. When requesting a US examination, the request form should state all the relevant data useful for the interpretation of the clinical picture. There should always be a close relationship between the requesting physician and the US operator, and when a physician performs a US examination on his own patient using a portable device, he/she should be well aware of the great value of abdominal US for diagnosing causes of abdominal pain but also of its possible limitations.

Conflict of interest statement

The authors have no conflict of interest to declare.

Appendix. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.jus.2011.05.001.

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