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EDITORIAL

Point of care ultrasound in the acute abdomen: the value of assessing free fluid

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Abstract

Acute abdomen represents about 50% of admission in developed countries. It comprises different etiologies, each with a distinct clinical presentation and evolution. Irrespective of the cause, it is related to high morbidity and a non-negligible mortality rate. Prompt diagnosis and treatment are essential to decrease morbidity and mortality and the cost-efficiency of health systems. Point-of-care ultrasound (POCUS), a bedside ultrasound performed by a non-radiologist, has shown great potential in many clinical conditions, including the acute abdomen. It allows, first of all, to quickly assess the abdomen in what we call a rule-out modality, and in more experienced hands can be used for a more focused examination which we call rule-in modality. The findings of free fluid POCUS in patients with acute abdomen should guide the assessment of the severity, the diagnostic workflow, and the timing for surgical consultation.

Keywords

Acute abdomen; Point of care ultrasound; Free-fluid; Bedside ultrasound; Emergency surgery

1. The gist of the problem

For practical purposes, we find it helpful to describe acute abdomen (AA) as any non-traumatic abdominal pain severe enough to make the patient seek urgent medical attention.

The causes of the acute abdomen are many: acute appendicitis, acute diverticulitis, bowel obstruction, perforated gastroduodenal ulcer, complicated hernia, acute cholecystitis, and acute mesenteric ischemia, accounting probably for more than 60% of them.

Approximately 35% is made up, luckily enough, of the patient with non-specific abdominal pain (NSAP) [1]. These are a group of patients where you will not be able to reach a diagnosis and will generally do well.

The remaining 5% of AA are caused by various conditions ranging from a ruptured aortic aneurysm and ectopic pregnancy, which should be and can be promptly suspected and recognised, and a miscellaneous of witnessed-only-once-by-a-colleague diseases for which no medical text prepares us but which usually show up in the poster sessions of many congresses.

The clinic of AA is initially specific to the causing condition ranging from localised tenderness first, followed by localised peritonitis in the "-itis" conditions (apendic-itis, cholecyst-itis, diverticul-itis, *etc.*) or colic pain, sickness, and distension in the obstructions and hernias.

At a later stage, irrespective of the cause, when the process is no longer localised, the pathophysiology has a common element: the accumulation of fluid (reactive fluid, pus, bowel content, *etc.*) in the peritoneal cavity, which clinically corresponds to acute peritonitis in most of the cases. This progression of symptoms is almost a rule in AA from localised to generalised. As all rules have exceptions, the exceptions are acute pancreatitis and acute bleedings such as ruptured aneurysms and ectopic pregnancies.

Emergency treatment focuses on recognizing and treating what jeopardises the patient's life more rapidly. This culture is already well-grounded in medical emergencies, and trauma patients and the Advanced Cardiac Life Support (ACLS) and the Advanced Trauma Life Support (ATLS) should suffice as good examples.

Unfortunately, regarding AA, we still commonly see an approach where the focus is on diagnosing the cause instead of assessing the severity. To put it differently, at least from the surgeon's perspective, appendicitis with acute peritonitis is translated as acute peritonitis caused by appendicitis. Peritonitis is what matters most in AA and is usually a clinical diagnosis; appendicitis is a clinical suspicion that can be confirmed only with ultrasound (US)/Computed Tomography (CT) or at the surgery.

Interestingly enough, the predictor of morbidity and mortality and the type of treatment are only the type and the severity of the peritonitis (absent, localised, generalised) and the physiological status of the patients. For example, acute purulent generalised peritonitis has the same morbidity and mortality, whether it is caused by acute appendicitis or acute diverticulitis.

If we wanted to oversimplify, we could say that all cases of mild "-itis" without peritonitis can be managed conservatively; many cases of "itis" with localised peritonitis can be managed conservatively or with emergency surgery at a convenient time; all cases of "-itis" with generalised peritonitis need an emergency operation as soon as possible.

2. Time matters

Furthermore, it has been well documented that in the case of sepsis, peritonitis is always sepsis, except when caused by acute pancreatitis; the sooner the treatment is started, the lower the morbidity and mortality will be. Therefore, the cardinal therapy for sepsis is a broad-spectrum antibiotic, source control, and supportive therapy to prevent or limit secondary complications due to organ system failure [2].

Broad-spectrum antibiotics and supportive therapies can be administered rapidly, ideally as soon as a septic process is suspected. Since the diagnosis of peritonitis is clinical, our patients should be started on antibiotics after the clinical examination and before any laboratory test. The same applies to the initial supportive measures, which will then be tailored to the physiological derangement shown in the blood tests.

Regarding source control, we have more problems to solve. In AA source control can be achieved by different means. Some cases will require only antibiotics, others will require UC/CT-guided drainage, and some will need to be operated upon. Almost invariably an US or a CT scan is needed to establish the diagnosis and grading the peritonitis (null/localised/generalised) and define the source control required.

From a very simplistic surgical perspective, once broad-spectrum antibiotics and supportive measures have been started, you can wait up to 6–8 hours to do percutaneous drainage or to operate on a localised disease. But it would be best if you did not wait so long in cases of generalised peritonitis (remember you have pus or faeces all around the peritoneum).

In most medical books, the time from clinical exploration to the US/CT scan is measured in a few lines. From those few lines, we are presented with a logical sequence of activities that begins with the clinical suspicion and finishes with the definitive diagnosis. Unfortunately, those few lines may take hours to happen, even in the more advanced health systems.

If you don't believe it, try to see if the numbers below regarding a previously healthy 55 years old man with Hinchey III acute diverticulitis (pus everywhere) are very far off your reality:

(1) Ongoing symptoms before going to Emergency Department (ED): 3 hours.

(2) Clerking: 15 minutes.

(3) Emergency nursery triage and lines: 15 minutes.

(4) Waiting time before doctor assessment: 30 minutes.

(5) Waiting times before blood works completed: 60 minutes.

(6) Doctor review: 15 minutes.

(7) Waiting time to get a CT scan: 30 minutes.

(8) Waiting time to get the CT report: 15 minutes.

(9) Waiting time for surgical review: 15 minutes.

(10) Waiting time for the operating room (OR): 60 minutes.

Total time from symptoms to OR: 7 hours 15 minutes.

Total time from arriving to Emergency to OR: 4 hours 15 minutes.

The times in the example above are extraordinarily optimistic, and it would be auspicable to be able to reproduce them as they are in every case we attend. In a recent study by Lemma and colleagues, the overall median interval from admission to OR was greater than 12 hours [3]. As doctors and nurses, we have to deal with many patients simultaneously, and most patients with AA can wait 4 hours to complete the workup. While this patient is waiting, maybe we are treating a life-threatening arrhythmia or dealing with an unstable polytrauma in the next box.

But of course, we as surgeons know very well that getting this patient to the OR a few hours before would be better. Remember that all the studies that show that you can safely wait 6 or 10 or 12 hours to do an operation (or anything in medicine) have never shown that it is better to wait 6 or 10 or 12 hours. So the sooner, the better is still the most logical and science-proof strategy. We agree that resuscitation is, in many cases, necessary before surgery, but we are talking about 1–2 hours tops.

In the real world, we have to deal with many patients simultaneously in a busy ED. So, how can we improve the outcome of patients with AA, identifying the ones with acute peritonitis and in need of surgery ASAP at the same time that we use the hospital resources consciously (cannot go through a CT scan just after clerking).

3. The role of ultrasound

We can find the same problem if we go back to when the Focused Assessment with Sonography in Trauma (FAST) protocol was proposed for trauma patients. We needed to identify unstable patients who were bleeding to death from those who were not bleeding. We couldn't wait for a CT scan (unstable trauma patients tend to die in CT scans). We couldn't go to OR for all of them (unacceptable morbidity and mortality of white laparotomy and waste of valuable resources). Back then, we looked for free fluid in the abdominal cavity and the pericardium with the US performed by a non-radiologist. In real life, free-fluid after trauma is blood and not ascites.

If we could rule out free-fluid, we wouldn't need to rush to OR, and we could further investigate (CT) the patient who maybe would still need an operation but not immediately upon arrival. But, conversely, if unstable and with free-fluid, they go straight to OR.

It has been suggested by different authors to use the same tool and concept and apply it to AA.

When the peritoneum is irritated (inflamed viscera, perforation, bowel content, *etc.*), it produces fluid at the site of the irritation. When the patient's defences cannot contain the process anymore, the peritonitis goes from localised to generalised, which means more fluid. The fluid is initially reactive, but it gets contaminated in all the cases where the bowel is involved. So it is common to find sterile "reactive" free fluid in early localised peritonitis, purulent free-fluid, or faecal contamination in generalised peritonitis. However,

there is always one exception to keep in mind, which is, of course, acute pancreatitis.

Acute peritonitis does not always present with a board-like rigidity septic state and which is easily diagnosed at a glance. This clinical presentation is extreme in the evolution of peritonitis. Many patients with generalised acute peritonitis present at the onset with mild clinical signs; conversely few patients with board-like abdominal rigidity have not acute peritonitis.

The exceptions to the rules seem to increase in numbers the more you have been around.

The goal is to identify those patients with generalised or evolving peritonitis to prioritise them when completing the workup (early CT or US, early involvement of the surgeons, *etc.*).

Point-of-care ultrasonography (POCUS) has been defined in many ways, but basically, it is the US performed by non-radiologist (or sonographers). For example, it is performed by ED doctors, surgeons, anaesthetists, gynaecologists, and in some cases also by nurses. In recent years, POCUS has been safe, precise, and cost-effective in emergency medicine. While it is not meant to replace the US done by a radiologist, in many cases, it is self-sufficient to answer clinical questions, make a diagnosis, and guide the resuscitation. We have always loved POCUS as surgeons, but mostly when dealing with localised peritonitis. CT, in many instances, gives more information when dealing with generalised peritonitis, and it is still the modality of choice for the surgeon.

With the use of POCUS, acute cholecystitis is easily diagnosed, and common bile duct dilatation is straightforward to rule out or confirm in many cases. If you are moderately experienced, you can do POCUS for right-lower-quadrant pain with reasonable accuracy at diagnosing acute appendicitis. Also, we know how easy it is to diagnose small bowel obstruction.

For us surgeons, POCUS is maybe an easier technique than for other specialists. This is because we have an in-depth knowledge of the topographic anatomy which helps us to get the sonographic image more easily. In any case we appreciate that POCUS is far more difficult than FAST, which is easily mastered with practice. But as much as it is appealing to diagnose the cause of the AA, we surgeons are still more concerned with assessing the severity of the condition, namely the characteristic of the peritonitis. For these reasons, identifying patients with abdominal pain and free fluid is extremely useful.

One of the questions we may ask is how much free-fluid is common in localised peritonitis versus generalised peritonitis. Unfortunately, there is no answer to this question, but suffice to say that the difference is much. While in localised peritonitis, we can find just, for example, a few cubic centimeters (cc) around an inflamed acute appendicitis, in generalised peritonitis, we always find the pelvis filled with fluid with a very variable quantity at the level of the other quadrants. This is because all the liquid will accumulate first in the lowest part of the body, which is the pelvis, then it will progressively accumulate in the other quadrants.

For example, when we operate on acute appendicitis with localised peritonitis by laparoscopy, we may find a small amount of fluid around the inflamed appendix and usually no fluid in the pelvis (or just a few cc).

When we operate on acute appendicitis with generalised peritonitis we always find free fluid in the pelvis (the pelvis is filled up) plus a small quantity of purulent fluid in all the other quadrants or a large amount of purulent fluid everywhere.

In both the latter cases, we are dealing with diffuse peritonitis. Both have in common the free fluid in important quantities in the pelvis, which is always present. The pelvis is where the free fluid always goes.

Free fluid can be visualised also in the other views of the FAST: Morrison's pouch and splenorenal space. When its volume increases it becomes visible in more windows. We still stress the importance of the pelvic space because it is where we usually have less artefacts, since in cases of bowel perforation, free air can make it difficult to perform a POCUS in less experienced hands.

Modern US machines can detect small quantities of free-fluid. In a study in 2003, the median amount of free fluid for ultrasound detection in the pelvis pouch was 100 cc [4]. This value is certainly not reproducible in all patients, and depends on the machine used, the Body Max Index (BMI) of the patients and other factors. You will undoubtedly be able to see Free Fluid (FF) when the pelvis is filled up by it.

The issue is whether it makes sense or not to look for free fluid in patients with AA at what time and by whom.

There is no agreement in the medical literature. Some authors have shown a correlation of FF with the necessity of surgery, others have not.

In 2019 Erkek *et al.* [5] presented the results of a single institution prospective study on the significance of free fluid detected by the US performed by radiologists in patients with abdominal pain. They concluded that the presence of intra-abdominal free fluid alone was not useful in guiding the clinical decision regarding the diagnostic evaluation of patients with abdominal pain. Interestingly they state that 87% of patients discharged without surgical consultation had no free fluid in the US; that there was no FF in the majority of patients with nonspecific abdominal pain, that there was no FF in the majority of patients who were discharged home.

In our opinion the limitation of their study is that FF is assessed during a US performed by a radiologist. They did not look only for FF, because they do a complete evaluation of the abdomen to establish a diagnosis. Therefore, it seems reasonable to expect, as they concluded, that an ultrasound with only FF without having identified a cause is in many cases diagnostic of a non surgical problem.

A completely different approach is to do POCUS in the early evaluation of acute abdomen aiming at identifying the problem (many times you can) or at least the presence/absence of free fluid as an indicator of acute peritonitis. Those patients where POCUS has not been able to identify the cause of the abdominal pain, but has shown the presence of FF can benefit from an early CT and surgical review because they are at risk of having or developing diffuse peritonitis.

Those are the patients who are very sick (pus/faces everywhere) or still not too unwell (pus only in the pelvis and a tiny film elsewhere in the abdomen) but will deteriorate in the next 6 hours. The former is easy to pick even without POCUS. The latter group is the ones who wait 4–6 hours before being

diagnosed because they do not look too unwell. They are also the ones who, if operated on promptly, will usually have a spectacular recovery.

The POCUS approach to AA is being encouraged in all settings, and it is becoming a part of many post-graduate curricula.

There is widespread agreement that when only FF is detected, irrespective of the reasons (patient habitus, operator skills, *etc.*) it can be used as an indicator of a possible peritonitis and should warrant a high degree of suspicion of the risk of deteriorating the clinical condition [6]. The same is true if free air is detected although, unfortunately, it is more difficult to detect.

It must be kept in mind that FF not necessarily is an indirect sign of a disease but may be physiological mostly in female patients in reproductive age, but also in men. We know also that many non-surgical conditions can produce FF, and that FF alone is not a replacement of a complete workup.

On the other hand, we find the POCUS detection of FF an easy and harmless examination, which can be used as an adjunct to the conventional workup. A positive result (FF) in the right clinical contest could help in speed-up the workup and surgical review without causing any detriment to the system. More importantly a negative result (no FF) in a patient with a mild abdominal pain should give some reassurance in following the standard process of work-up and surgical review.

The ultrasound can also be performed at the time of triage by a nurse who has been trained in FAST, albeit there is still no study assessing its use in non-traumatic patients [7, 8].

4. Conclusions

In mature health systems we are good at providing fast and high-quality assistance only when we recognize the need for it. Unfortunately, we are not able to speed-lane more mundane cases, which sometimes hide more-serious-than-expected problems.

POCUS is a very useful tool in ED which is able in many cases to speed up diagnosis and tailor the treatment of patients with AA.

Identifying FF is maybe the easiest ultrasound skill to learn and its presence alone, without having identified the cause, should be considered as a potential indirect sign of acute peritonitis after consciously taking into account the possibility of getting a false positive diagnosis.

Even though POCUS-FF detection is already used by many of us to assess patients with AA, well conducted studies are still needed and strongly encouraged in order to better define its roles and limitations.

AVAILABILITY OF DATA AND MATERIALS

Not applicable.

AUTHOR CONTRIBUTIONS

LP, PCG, AGJ and CJYB—designed the study and performed the bibliography review. LP and CJYB—wrote the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

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