

Free Abdominal Fluid without Obvious Solid Organ Injury?

Another Gift from Pandora's "CT" Box!

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Abstract

The presence of free fluid in the abdomen without evidence of solid organ injury not only presents a challenge for the treating emergency physician but also for the surgeon in charge. In this short review we aim to provide the reader with an overview of the current literature with specific emphasis on the diagnostic and therapeutic approaches to this problem. A search of the literature has made it apparent that there is no straightforward answer to the question of what to do with patients with free fluid on CT scanning but without signs of organ injury. Based on the available literature, we present a “question- based” approach and suggest three algorithms, which might help with the adequate treatment of such patients.

Review

In Greek mythology, Pandora was the first woman on earth. The gods endowed her with many talents. Pandora carried a jar with her, which she was not to open under any circumstances. Impelled by her natural curiosity, Pandora opened the jar, and all the evil it contained escaped and spread over the earth. She hastened to close the lid, but the entire contents of the jar had already escaped. Only Hope remained.

The introduction of routine computed tomography (CT) in trauma is comparable to the myths around the famous box. CT exposes us to a plethora of new information, sometimes leaving us with more information than we had bargained for. Had we not “opened this box” we might not be faced with a problem we did not know existed in the first place.

CT scanning of the abdomen and pelvis is the procedure of choice to evaluate the hemodynamically stable patient who has sustained blunt or penetrating trauma. CT has replaced Diagnostic Peritoneal Lavage (DPL) as the first method of choice in many trauma centers worldwide. Its major advantage is that it is not only capable of revealing the presence of intra-abdominal or intra-thoracic hemorrhage but can to some extent also identify the involved organ [1].

CT exhibits very high sensitivity and specificity in detecting the majority of solid organ injuries, but unfortunately misses up to 15% of small bowel and mesenteric injuries as well as some acute pancreatic injuries [2,3]. In centers where a CT scan is not available or limited to office hours, frequent re-evaluation of the patient's condition, repeated sonography and diagnostic peritoneal lavage remain the cornerstones of the diagnostic work-up of abdominal trauma. In centers where a positive DPL is regarded as the gold standard when deciding on an intervention, diagnostic laparotomies are performed routinely. The downside of this strategy is a potentially high number of unnecessary or non-therapeutic operations [4]. Where CT scanning is readily available, up to 85% of abdominal solid organ injuries are treated conservatively [5].

Fortunately, the majority of these patients have direct or indirect signs of organ damage, which guide the trauma surgeon through the jungle of different decision pathways [6]. Even in patients with gun shot wounds to the abdomen, for whom operative management has, until recently, been viewed as mandatory, abdominal CT scanning has proven itself to be a safe and useful method for selecting patients for non-operative treatment [7-9]. In general, there is no doubt that CT is extremely useful in patients with suspected abdominal solid organ injuries. A trauma surgeon's life without CT is nowadays inconceivable, especially for the new generation, trained in an era when CT has always been available [10].

But what should be done if the "almighty CT scanner" does not give us a conclusive answer to our questions?

One such diagnostic challenge is the presence of free fluid in the abdomen without evidence of solid organ injury. In order to find an answer to our question we searched Pubmed for "free fluid (without) solid organ injury"

The literature on this topic, which cites more than 50 publications in English alone, gives us an abundance of options to deal with this dilemma.

Recommendations vary from sole observation with serial abdominal examinations, to further evaluation with additional radiological studies, to DPL and to surgical intervention [11-18].

A major limitation of all studies is the inclusion of a low number of full thickness hollow organ injuries, which can be the source of the free abdominal fluid. In some studies, the number of patients presenting with free fluid but without obvious organ injury is as low as 0.5% [14]. The low incidence of such injuries may be one reason why no randomized prospective controlled trials have been performed. One of the largest systematic reviews, conducted by Rodriguez and co-workers, found 10 articles in which isolated free abdominal fluid was seen without organ injury [11]. The study included 463 (2.8%) patients - out of a total of 16000 patients - with signs of free intra-abdominal fluid without obvious solid organ injury who had received a CT scan for blunt abdominal trauma. A therapeutic laparotomy was performed in only 122 patients and the authors concluded that a laparotomy is not warranted if the patient is alert and can be monitored with repeated physical examination.

In a more recent single centre review of 2651 trauma admissions, only 14 (0.5%) patients showed free fluid without organ injury in the initial CT scan. Eleven of these 14 patients underwent therapeutic laparotomy based on the presence of hypotension, peritoneal irritation or additional findings on CT associated with non-solid organ injury. In their discussion, Yegiants et al. stressed that the decision on whether to operate or not is too often made by solely relying on the surgeon's personal experience - with the amount of free fluid detected rarely playing a role [14].

Some authors suggest that traces of free fluid in the pelvis with no other signs of injury are not associated with significant intra-abdominal injury and can be safely managed non-operatively [13]. The presence of more than "just a trace" is rare, but is a significant indicator of intra-abdominal injury [13].

Others, like Malhotra and colleagues, suggest that the number of additional positive findings, rather than the actual amount of free fluid, can be used to increase the accuracy of the CT scan [17]. In a series of 8112 scans, they found only seven patients with false negative scans. In addition to free fluid signs of a pneumoperitoneum, mesenteric streaking, thickened bowel wall and extravasation of contrast material were associated with visceral hollow organ injuries. Once again, the small number of patients included with free abdominal fluid without solid organ injury limits the conclusions of this study. Unfortunately, missed intra-abdominal hollow organ injuries have a high morbidity, with mortality reaching 31% if undiagnosed for more than 24 hours [19-21].

Even improvements in diagnostic equipment, such as contrast-enhanced ultrasound or new generation multi slice CT scanners, have not been able to prove their efficacy yet. Both ultrasound and CT-based diagnostic algorithms have been proposed, but unfortunately visceral hollow organ injuries can be missed by both radiological examinations. Neither repeated clinical follow-up nor repetitive CT scan imaging revealed hollow organ injury in the case series of Permentier et al. [21]. The authors were disappointed by the possibilities of modern imaging technology and suggest traditional DPL, accompanied by the determination of the cell count ratio, to reveal any injuries at an early stage. In hemodynamically stable patients, DPL should incorporate analysis of the cell

count ratio, amylase and alkaline phosphatase levels and the presence of food fibers or bile. In hemodynamically unstable patients, explorative laparotomy should be carried out [21].

Otomo et al. and Hennemann et al. have tried to refine the criteria for positive DPL [22-23]. The ratio of white blood cells (WBC) to red blood cells (RBC) can be used, where a ratio of 1 WBC : 150 RBC is regarded as being a positive finding [22]. Hennemann corrects the WBC in the lavage fluid for the WBC in the peripheral blood [23]. Unfortunately, both studies lack the statistical evidence required to make DPL a valid tool in the setting of abdominal trauma with evidence of free fluid and without obvious solid organ injury. Another hailed imaging tool, ultrasound, has also failed as the diagnostic method of choice. Hollow visceral organ injuries do not tend to bleed extensively so that unless large volumes of fluid have leaked out of, for example the perforated bowel, positive predictive values remain very low (38%) [26]. CT has proved to be equally unreliable in this setting with a sensitivity ranging between 0% and 85% [27]. Even combinations of additional positive predictive signs, such as the presence of a pneumoperitoneum and visceral organ wall thickening, are not able to increase CT sensitivity and specificity beyond 80%. The only obvious sign of a hollow organ perforation remains extravasation of oral contrast [28-29].

In alert and non-comatose patients, physical examination (presence of peritonitis) is the method of choice to rule out significant abdominal injury. However, signs of peritonitis may take hours before becoming clinically evident, which is an important downside of this strategy. If the patient is intubated, intoxicated or suffers from impaired neurological function (e.g. tetraplegia), any clinical examination loses its value and the decision to carry out a surgical intervention (or not) becomes unreliable. [30-31]. In his series of 90 patients with free fluid but without solid organ injury, Livingston showed that 19% of patients without abdominal tenderness actually had an abdominal injury [30]. One indirect sign, which seems to be associated with hollow organ injury (if free fluid without solid organ injury is found) are seat belt marks, which increase the likelihood of an abdominal injury 2- to 4-fold [24-25].

In a study by Chandler et al., 117 victims involved in a motor vehicle accident were evaluated for the use of seatbelts and the presence or absence of a

seatbelt mark [24]. 14 of 117 (12%) patients had a seatbelt sign. Three of these patients (21%) had a small bowel perforation. In contrast, in the group of 103 patients without a seatbelt sign, only two (1.9%) patients had small intestine perforation. The authors concluded that the presence of a seatbelt mark is associated with an increased likelihood of abdominal and especially intestinal injuries and mandates a heightened level of suspicion [24].

In an older study, Appleby and co-workers investigated 36 patients with seatbelt marks who underwent laparotomy after a motor vehicle accident [25].

A high incidence of gastrointestinal injuries (67%) was noted in this group.

But again, the small sample size limits the value of this study [25].

Summary:

In accordance with the literature and to the best of our knowledge, we suggest the following approach, which involves asking the following five questions:

1. How hemodynamically stable is the patient?
2. How much fluid is present and where is the fluid located?
3. How alert is the patient and how reliable is the clinical examination?
4. Are there seat belt marks?
5. Have we been able to read the CT scan correctly?

In the hemodynamically unstable patient, there is no place for any academic discussions and the source of bleeding should be sought aggressively. If there is evidence of free intra-abdominal fluid and the patient is stable and not requiring urgent and immediate surgical exploration of the abdomen, a laparoscopy may be the diagnostic method of choice.

The technique chosen (laparotomy versus laparoscopy) obviously depends on the surgeon's experience and the overall hospital culture. In Europe laparoscopy is considered the surgical technique of choice, although it has its downsides [32]. It is expensive, stretching the theatre after-hour resources to the limit and is unreliable in the hands of the inexperienced surgeon.

We suggest distinguishing between small (minimal amount in one region), medium (larger amounts in one region) and large amounts of free fluid (large amounts in multiple areas). According to the literature, over 70% of patients will fall into the first category, and conservative treatment of these patients is thought to be safe in the vast majority of cases [12].

As might be expected, the pouches of Douglas and Morrison are the two most common locations for free fluid. No other inter-peritoneal location seems to be associated with organ injury [12].

Question number five is probably the most challenging question to answer. Once the above questions have been addressed, three scenarios are most probable:

Scenario one: The non-comatose, cooperative and neurologically examinable patient with a negative physical examination:

Negative for seatbelt marks -> small amount of fluid -> !

Positive for seatbelt marks -> small amount of fluid -> Patient must be carefully monitored!

Positive or negative for seatbelt marks -> intermediate/large amount of fluid -> Consider a laparotomy!

Scenario two: The non-comatose, cooperative and neurologically examinable patient with a positive physical examination:

Although the literature shows that patients with a painful abdomen on examination will not automatically have an intestinal injury, we do not believe that it is safe to wait and watch, considering the mortality of 10% if treatment is delayed for more than 8 hours [19].

Scenario three: The comatose, uncooperative, neurologically not examinable patient

Negative for seatbelt marks -> small amount of fluid -> Await developments!

Positive for seatbelt marks -> small amount of fluid -> Consider possible laparotomy!

Positive or negative for seatbelt marks -> intermediate/large amount of fluid -> Consider laparotomy!

Conclusions

A thorough literature search has made it apparent that there is no straightforward answer to the question of what to do with patients with free fluid on CT scanning but without signs of organ injury. All studies, whether they are prospective or retrospective, lack the statistical power to provide a definite answer. Furthermore, the studies are difficult to compare, as there are significant differences in imaging equipment, laboratory workup and surgical experience. The majority of the studies investigated inhomogeneous groups of patients or had methodological or statistical problems.

Fortunately this kind of injury is very rare, which unfortunately means that one is only exposed to very few such cases in the course of one's career.

Competing interests

The authors do not have any financial or non-financial competing interests to declare.

Author's contributions

VB designed the study and drafted the manuscript, HZ coordinated and helped to draft the manuscript, AE conceived of the study, participated in the design of the study and helped to draft the manuscript. All authors read and approved the final manuscript.

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