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Evaluation of ultrasound performance on abdominal trauma

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Abstract
Abdominal trauma is common in Madagascar and is responsible for high mortality due to haemorrhagic complications and digestive perforation. Ultrasound plays an important role in the lesion assessment. The objective of this study is to determine the sensitivity and specificity of ultrasound in the diagnosis of traumatic abdominal lesion. It was a prospective and analytical study over a period of eight months, conducted at the medical imaging centre and emergency department of the CHU-JRA. A total of 408 patients were retained, whose mean age was 26.43 years. Ultrasound was normal in 67% of cases and hemoperitoneum was objectified in 17.40% of cases, so traumatic abdominal lesions represented 19.36% of cases, dominated by hepatic, renal, splenic and pancreatic lesions. No lesions of the digestive hollow organs were diagnosed on ultrasound. Ultrasound has a sensitivity of 60% and a specificity of 99% for the detection of traumatic abdominal lesions.

Keywords: Abdomen, hemoperitoneum, sensitivity, specificity, trauma, ultrasound

Introduction
An abdominal contusion is a trauma without skin continuity solution. A distinction is made between the non-penetrating wound, without breaking the peritoneum [1], and the penetrating wound, which involves breaking the parietal peritoneum [2]. Abdominal injuries are the third most common type of injury during severe trauma, after skull and chest injuries. In Madagascar, the frequency is 2.4 cases of abdominal trauma per 1000 hospitalizations with a mortality rate of 30.3% [3]. After abdominal trauma, two life-threatening risks are involved: hemorrhage of a solid organ and peritonitis secondary to an intestinal wound that has gone unnoticed [4]. We conducted a prospective and analytical study to determine the sensitivity and specificity of ultrasound on the lesional diagnosis of abdominal trauma.

2. Materials and method
It is a prospective and analytical study carried out from January 1, 2014 to August 31, 2014 at the medical imaging center and emergency department of CHU-JRA, Antananarivo Madagascar. Ultrasound examinations were performed on two ultrasound: Toshiba Aplio 400® and Mindray DC6® by senior physicians, interns and radiology assistants. We included patients of both sexes, of all ages with abdominal trauma or multiple traumas, who were referred to the medical imaging department for abdominal ultrasound. We have excluded trauma victims whose evolution or final diagnosis is unknown. The final diagnosis was made on the basis of ultrasound criteria and/or surgical data or clinical progress for unoperated patients. The number of visceral lesions and the amount of hemoperitoneum of the operated patients observed on ultrasound were compared to the lesions observed in the operating room.
The parameters studied were: incidence, demographics (age, gender), etiology of abdo
minal trauma, general condition of the patient, ultrasound results, treatment received, surgical diagnosis and patient fate. The statistical data were entered and analysed in the R 2.9 software. We assessed sensitivity, specificity after calculating the negative predictive value (NPV) and positive predictive value (PPV). The true positives are the lesions seen on ultrasound and confirmed by surgery. We considered as true negatives patients whose ultrasound was normal and who had no abnormalities at the clinic. The false positives were lesions seen by ultrasound but invalidated by surgery. The false negatives were lesions not seen on ultrasound but seen by surgery.
The consent of each patient was obtained orally before the completion of the research protocol forms. Patients had a choice between accepting or refusing to participate in the study, after being clearly informed of the study's goals and conduct.

3. Results
We collected 408 abdomen trauma out of 29401 emergency room visits. The sex ratio was 1.66. The average age of the patients was 26.43 years with a standard deviation of 16.90. The age group between 15 and 30 years was the most represented (146 patients).

Etiologies were dominated by road accidents (239 patients) and civil liability accidents (87 patients). Abdominal pain was the main complaint (300 patients), 48 patients had abdominal wounds, 07 patients had tachycardia and abdominal defenses were perceived in 24 patients. Ultrasound was normal in 67% of cases and visceral lesions of traumatic appearance and/or hemoperitoneum were found in 24.5% of cases including hemoperitoneum (Fig.1) in 17.40% of cases: 24 of high abundance, 25 of medium abundance and 22 of low abundance. Traumatic abdominal injuries accounted for 19.36% of cases or 79 patients. These were hepatic (29 patients), renal (20 patients), splenic (9 patients) and pancreatic (03 patients) lesions. Ultrasound did not diagnose damage to the hollow digestive organs. Hepatic hyperechoic lesions accounted for 68.95% of cases. On ultrasound, these lesions are considered as a laceration (10.34%) or contusion (55.17%) or foreign bodies (3.44%). Hypoechoic lesions (31.05%) evoked either subcapsular hematoma (20.71%) or intraparenchymal hematoma (10.34%) depending on their evolution time (Fig.2). The heterogeneous lesions evoked contusions (Fig.3). The splenic lesions were mainly heterogeneous hyperechoic lesions (04 patients) as well as peripheral hypoechoic lesions (04 patients). We found three pancreatic contusions (Fig.4), which were conservatively treated. Post-traumatic retroperitoneal lesions were dominated by perirenal hematomas (06 cases) and sub-capsular hematomas (06 cases). We diagnosed: 03 cases of renal fractures (Fig.5), 01 cases of intra-parenchymal foreign bodies, 02 cases of renal contusions, 01 cases of intra-parenchymal hematoma, 01 cases of unilateral hydronephrosis. The anomalies of the bladder content were dominated by a decaying or suspended echogenic formation (04 patients). Images of intra-parietal bladder hematoma were found in 02 patients. Of the 408 patients: 72 patients were hospitalized and 25 of them were operated on, 47 were monitored in hospital, but 04 died. Three hundred and thirty-two patients were sent home after receiving emergency first aid and warned of signs of late complications. During the confrontation of ultrasound lesions and intraoperative lesions: 26 lesions were ignored by ultrasound examinations, including 08 hepatic, 04 splenic, 02 bladder lesions and the remaining 12 are lesions of the digestive tract. After calculating the positive predictive value (97%) and the negative predictive value (91%), we obtained a sensitivity of 60% and a specificity of 99% for the detection of traumatic abdominal lesions by ultrasound

4. Discussion

In terms of epidemiological-clinico-echo, we noted an increase (1.38%) in the frequency of abdominal trauma, compared to Raherinantenaina study in 2013 (0.24%) in the same centre [2]. The male predominance (78%) has been described by French and Anglo-Saxon authors [5, 6]. The prevalence of road accidents among etiologies could be linked to the poor quality of road networks and the incivility of road users [2]. The percentage of patients with stable hemodynamic status in this study (98.28%) is higher than that found by Didier Mutter [7] because patients in shock or with an obvious penetrating wound rarely receive an ultrasound examination. This is the interest of the FAST echo in emergencies [8]. Abdominal pain was the main complaint (73.53%) as in the Togola study (91.3%) [9] and Diabaté study (36.1%) [10]. While the abdominal defence rate is low (5.88%), lower than that of Togola (13.0%) [9] and Diabate (44.4%) [11]. Indeed, peritonitis does not appear immediately after the trauma, but secondarily and often goes unnoticed on the initial clinical examination [4] and the high abundance hemoperitoneum has rarely reached the imaging services. In our work, only 24.5% of the ultrasound results were pathological. This rate is lower than that found by Dakouo Iréné (65.4%) [12]. This may be due to non-compliance with ultrasound indications. Depending on the gravity, hemoperitoneum is the first to be eliminated, the detection threshold seems to be between 150 and 250 ml [13]. In this study, it was moderate to high in 49 patients, which is equivalent to the presence of fluid in more than two peritoneal spaces according to Federle's score (table 1) [14]. The most objective technique is the totalization of the points by measuring the thickness of the effusion in each peritoneal space and assigning points according to the presence or absence of effusion (table 2) [15]. Cisse Oumar [16] found 60% liver damage, in this study, 29 patients (36.70%) had hepathic lesions. Heterogeneous hyperechoic lesions or hepatic lacerations (10.34%) corresponded to hepatic wounds during laparotomy. The others were contusions, sub-capsular or intra-parenchymal hematoma. The most serious retroperitoneal lesions were renal fractures (15%) which required nephrectomy. According to the literature, kidney trauma is the most frequent type of traumatic injury to this device: 64% [17]. The best diagnostic test is the abdominal-pelvic scanner with late-time contrast injection to eliminate excretory tract ruptures. However, a renal fracture can be diagnosed on ultrasound in front of a heterogeneous hyperechoic kidney, not vascularized with colour Doppler or with clear continuity solution. Pancreatic injury is found in 3 to 12% of abdominal traumas. As in our case (3.79%), a computed tomography (CT) scan of the abdomen is always necessary for more accuracy. In addition, no digestive lesions were diagnosed by ultrasound in our study. Indeed, the exploration of the wall of the intestinal scoves is often urgently hampered by the paralytic ileus. The CT scan remains the reference test. For a patient suffering from abdominal trauma with an unstable hemodynamic state, surgery is urgent and a priority [17]. Medical treatment is increasingly recommended and practiced [18]. We successfully adopted this attitude in 47 cases (59.49% of parietoparenchymal lesions). Compared to the Cisse Oumar series (37.5%) [16], the non-surgical treatment rate is significantly higher, 81.38% in our study. For the evaluation of ultrasound sensitivity and specificity, all the surgically treated patients (25) had moderate or high abundance of hemoperitoneum which was diagnosed by ultrasound and verified by surgery. According to the literature, the detection sensitivity is 97% for a effusion of around 600 ml [19, 20]. Half (08 lesions) of the 16 hepatic lesions counted during the laparotomy were ignored by ultrasound. Similarly for the spleen, 4 of the 7 lesions were ignored by ultrasound. But 3 kidney fractures were diagnosed by ultrasound. All 12 lesions of the digestive tract were not diagnosed by ultrasound. Thus, in the presence of perforation or traumatic lesion of the hollow organs, ultrasound has little interest, its sensitivity is low, ranging from 26% to 89% but its specificity is good 65% to 100% [19-20]. These differences can be explained by the difference in the number of the population studied, the type of trauma, the definition of the reference examination. Otherwise, factors depending on the operator. In addition, a low sensitivity is due to many false

negatives effets of hollow organ and diaphragm wounds, which are not or incorrectly evaluated by ultrasound [20]. The decrease in specificity in a study is explained by an excessive speed of ultrasound examination (19 seconds) and by the definition of hemodynamic instability [20]. The diagnostic values of ultrasound in abdominal trauma also depend on the standard of comparison as well as the main judgement criterion. Most previous studies compare abdominal ultrasound with clinical follow-up, laparotomy (our case), peritoneal lavage puncture, abdominal CT scan and often all of these items, confusing the analysis of the results.

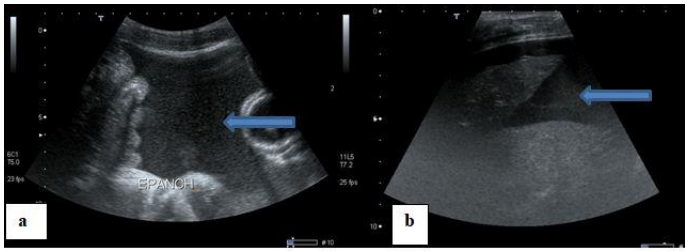

Fig 1: Ultrasound sections of the abdomen passing through the Douglas (a) and Morrison (b) showing a recent high abundance hemoperitoneum (blue arrows)

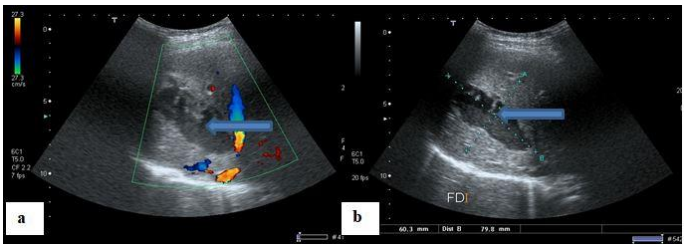

Fig 2: Ultrasound sagittal sections of the right liver in Doppler mode color (a) and bidimensional (b) showing an intraparenchymal hematoma of the right lobe of the liver (blue arrows)

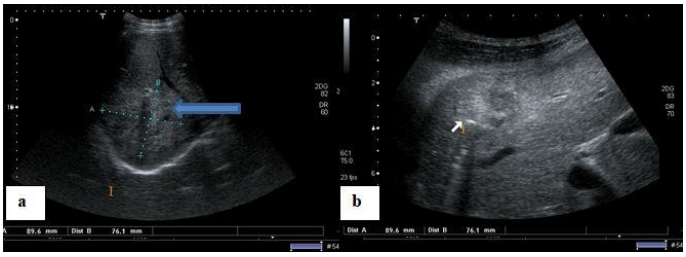

Fig 3: Cross-section ultrasound of the liver showing a heterogeneous hyperechoic lesion : intraparenchymal laceration or hematoma (blue arrow) (a), with an intraparenchymal metal (b) splinter (white arrow).

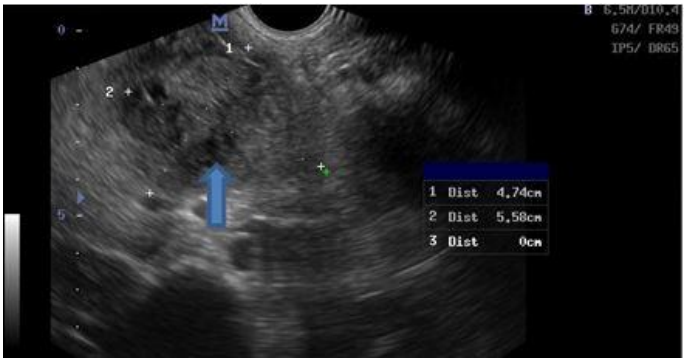

Fig 4: Ultrasound cross-section of the abdomen passing through the head of the pancreas (blue arrow) showing a heterogeneous appearance related to pancreatic necrosis.

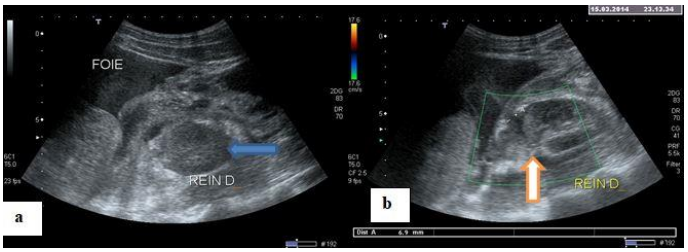

Fig 5: Ultrasound sagittal sections of the right kidney showing heterogeneous hyperechoic appearance (blue arrow) with continuity solution (a) and absence of color Doppler vascular flow (b) in relation to renal rupture (white arrow).

Table 1: Quantification of hemoperitoneum according to Federle and Al.

Number of Peritoneal spaces	Quantity	Quantifiction
0 or 1	0 - 200 cc	Absent Or low abundance
2	200 -500 cc	Medium abundance
≥3	≥ 500cc	High abundance

Table 2: Quantification of hemoperitoneum by thickness

Peritoneal spaces	Hemoperitoneum thickness	Points
Morison's pouch	< 2mm > 2mm	1 2
Pouch of Douglas	< 2mm > 2mm	1 2
Perislenic space	+	1
paracolic gutters	+	1
Infracolic compartiment	+	2

5. Conclusion

Although most of our patients have not had surgery and patients considered true negative have not had a CT scan, which is the reference exam. Ultrasound has proven its performance in the diagnosis of hemoperitoneum and high-grade parenchymal lesions. However, it is limited to traumatic damage of the digestive tract. Thus, other exploration such as computed tomography is very useful for the management of traumatised abdomen.

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