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Performance of the ultrasound in the diagnosis of acute appendicitis

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Abstract
Context: Acute appendicitis is the most common abdominal surgical. This study has a medical interest because of this frequency and urgency. Our aim was to determine the current sensitivity of ultrasound in the diagnosis of acute appendicitis
Materials and method: It was a prospective descriptive study; from December 2016 to April 2017 at the Joseph Ravoahangy Andrianavalona Hospital Center, Antananarivo Madagascar. The sensitivity was calculated by the formula TP x 100 / TP + FN. The results of the ultrasound examinations were compared with those of the anatomopathological examinations of the operating pieces.
Results: The average age of the study population was 31.11 years with a sex ratio of 1.61 in favor of men. Alvarado scores were 1 to 4 in 11.76%, 5 to 6 in 35.3% and 7 to 10 in 52.94%. Ultrasound sensitivity was 91.18%. In 88.23% of cases, appendicitis was diagnosed by visualization of the appendix and, in 11.76%, suspected by evidence of infiltration of peri-appendicular fat. The 8.82% of cases that escaped ultrasound were non-visualized appendages due to their position in the retro-cecal without indirect signs of appendicitis.
Conclusion: Despite its operator dependent nature and its limits in the non-visualization of appendages, ultrasound remains a sensitive examination to diagnose appendicitis.

Keywords: acute appendicitis, sensibility, ultrasound

Introduction
Acute appendicitis is the most common abdominal surgical condition [1]. This study has a medical interest because of this frequency and urgency. Before the advent of additional morphological examinations, patients were operated on a strong clinical presumption [2]. The absence of an anatomo-clinical correlation limits the clinical diagnosis of certainty and encourages the use of other diagnostic tools, available and reliable in emergencies, thus enabling rapid and effective treatment. Ultrasound is an easy-to-access imaging technique that explores pains in the right iliac fossa and provides a positive diagnosis of appendicitis and eliminates other causes of pain in this region. [3]. Our aim is to determine the current sensitivity of ultrasound in the diagnosis of appendicitis.

Materials and method
Subject
This monocentric study was carried out at the Center d'Imagerie Médicale, within the Center Hospitalier Universitaire Ravoahangy Andrianavalona, Ampefiloha, Antananarivo (CHUJRA), Madagascar, for a period of 04 months from December 2016 to April 2017. This prospective descriptive and analytical Study was conducted on subjects entering the surgical emergency department of CHUJRA for abdominal pain without clear localization and suspected appendicitis after the clinical examination.
Those included were patients whose ultrasound evoked appendicitis and subsequently surgery with anatomopathological examination of the operating room was performed. But also, patients, in whom the abdominal ultrasound did not evoke appendicitis but that appendicitis was discovered during the surgical intervention with anatomo-pathological examination of the operating room. On the other hand, ultrasound results showing a chest plate and other causes of right iliac fossa pain, signs of acute appendicitis but which were not operated on

Imaging technic
The ultrasound scanner used by the SIEMENS® brand, ACUSON X 300, put into service in December 2015. The examination was carried out by abdominal transparietal access using high frequency CH-13 Mhz and low frequency CH- 5Mhz probes. The exploration was carried out by senior and junior radiologists during training in the medical imaging specialty, for the latter the examinations were validated by the seniors.

Method

A comparison between ultrasound result, biological data and operating reports was carried out, as well as with the results of the anatomopathological examinations of the operating parts for the diagnosis of certainties.

The socio-demographic, clinical parameters, delay between the ultrasound examination and surgery, ultrasound and surgical results as well as anatomopathological were studied.

Statistical tools and analysis

The data were entered and collected using the EXCEL® 2016 software. The descriptive and analytical results were processed using the EPI Info® 2017 software.

Relative to sensitivity, the mathematical formula was used, Sensitivity (%) = TP x 100 / TP + FN.

Results

In this study, 94 patients presented with pain in the right iliac fossa; 79 were mentioned on ultrasound as acute appendicitis including 11 cases of appendicular bib.

Thus, he was selected, 31 of whom were diagnosed with appendicitis on ultrasound and who had undergone a surgical intervention with an anatomopathological examination of the operating parts. The remaining patients were lost to follow-up. Three cases of appendicitis were not discovered on ultrasound but during surgical exploration with supporting pathology examination.

The male gender was the most affected with a sex ratio of 1.6; or 21 cases. As for age, the average age was 30.11 years (Figure 1). The average time for ultrasound diagnosis was 62.07 hours with limit values between 12 to 192 hours, and the time between ultrasound examination and surgery was 6.29 hours with limit values between 2 to 11 hours (Table 1). Clinically, the high Alvarado score between 7 and 10 was 52.94%. For ultrasound results, the visualization of the acute appendix on the right iliac fossa was 91.2%. Acute appendicitis was mentioned in the results in 91.20% (Figure 2a and b). Direct signs of appendicitis were 85.3% with a diameter greater than 6 mm and a thickening of the appendix walls. Indirect signs were present in 76.47% predominantly by infiltration of peri-appendicular fat. The presence of stercolite was 11.75% of the cases. Regarding surgical results, Mc Burney's incisions made up 64.7% (n = 22) and the midline incision made up 35.3% (n = 12) of the cases. The positions in latero-coecale were discovered in 85.29% and retro-caecal in 14.71%. In anatomopathology, it confirmed in 100% the appendicular inflammations. The acute forms were 82.35%. In the 34 cases of appendicitis confirmed by anatomical pathology, 31 cases were mentioned ultrasound, conferring a sensitivity of 91.18% for the sensitivity of ultrasound in the diagnosis of this lesion.

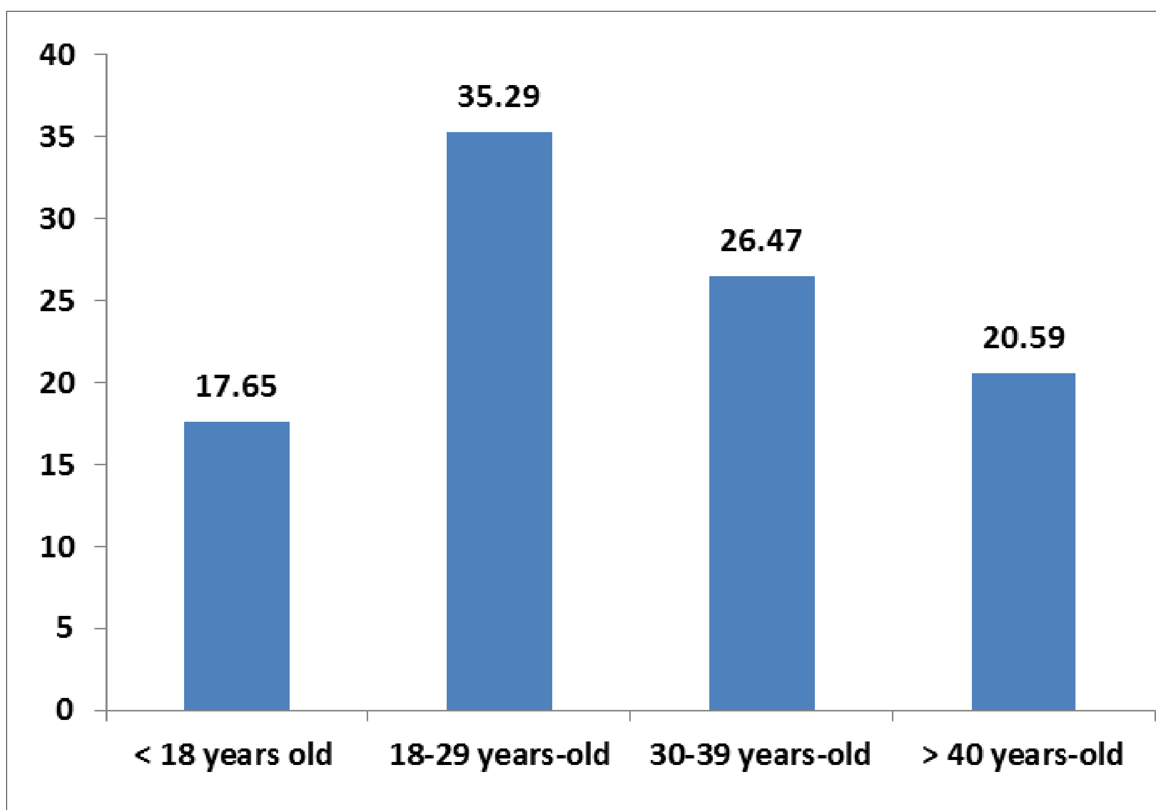

Fig 1: showing the age distribution of the population (%)

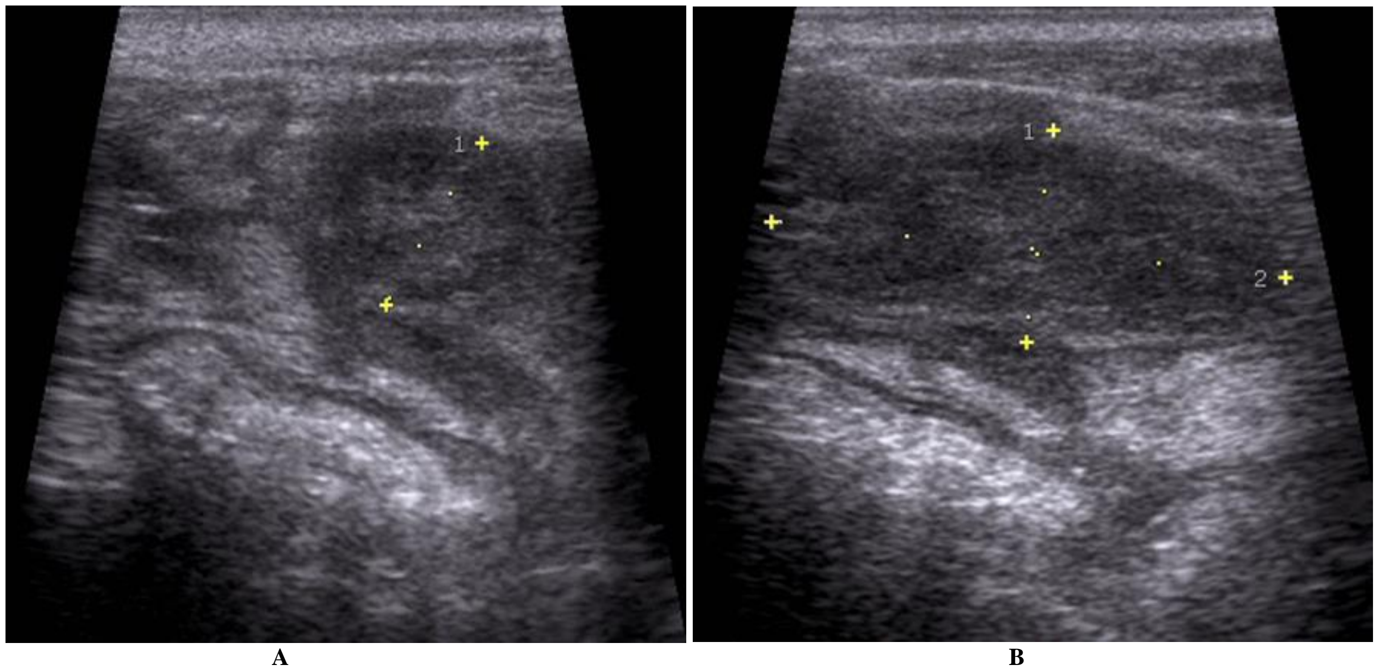

Fig 2: (A) ultrasound axial cut showing a thickness appendix hypoechoic and a fat infiltration arround the appendix. (B) ultrasound longitudinal cut showing a thickness appendix hypoechoic

Table 1: delay between the ultrasound exam and the surgery

	Average	Limit value
Delay ultrasound diagnosis (Hours)	62,07	12-192
Delay between the ultrasound exam and the surgery (Hours)	6,29	2-11

Discussion

Acute appendicitis is a predominantly male inflammatory condition. It joins literature and thus shows this male predominance. The closest is that of the study by Ebrahim K *et al*. [4]. It has been hypothesized that the proportion of lymphoid tissue is greater in men than in women. These lymphoid tissues are the main constituents of the appendicular submucosa while they play a large role in the mechanism of appendicitis, especially in cases of hyperplasia [5]. In our study, the average age of the patients was 30.11 years. The extreme ages were 7 and 67. The most common age group was between 18 and 29 years old (35.29%). This average age was close to the study of Uzunosmanoğlu H *et al*. [6]. which was 30.3 years old and that of a retrospective study carried out in the Netherlands with an average age of 32 years old [7]. All these results would highlight the fact that appendicitis is more common in young people aged 18 to 35 than in other age groups.

Regarding the delay between the onset of the disease and the time of ultrasound, abdominal pain was the first symptom represented by the patients. This duration between the onset of symptoms and the time of ultrasound represented 26.47% of cases in less than 24 hours, between 24 hours and 48 hours, and finally more than 72 hours. This duration is from 48 hours to 72 hours in 20.60% of the remaining cases. The average of this duration is 62 hours. Studies have found an average duration of 44.4 hours [8]. and 46 hours [9]. The average duration between the onset of the disease and the time of ultrasound during our study is significantly higher compared to these two studies. This duration reflects the time it takes for patients and their families to decide whether to go to the hospital or the general practitioner to decide to refer them to the hospital. Abdominal pain, particularly in the right iliac fossa, is often overlooked at the start and patients first self-medicate with common pain relievers and / or empirical methods using natural products such as applied chew tobacco at the level of the navel very applied at home. It is only in the event of failure by persistence and accentuation of the pains, that they consult a doctor. In turn, the doctors begin medical treatment first. It is only after the medical treatment has failed that they plan to refer the patient. However, this average duration is not high compared to the literature. The study by Kong YV *et al*. [10]. on appendicitis cases in black South African populations found an average delay of 100.8 hours or 4.2 days, most of the patients living in rural areas very far from the hospital.

The average time between ultrasound and surgery was 6.29 hours in our study. This time interval would depend on two factors. First, the availability of operating theaters and surgeons based on surgical emergencies would remain the main factor.

It is true that appendicitis is a surgical emergency, but before other emergencies surgeons should know how to prioritize even more urgent cases than others in order to preserve the vital and functional prognosis of each patient according to their pathology. In the case of appendicitis, appendicular abscess and appendicular peritonitis are the most urgent because they can be life-threatening in the short term. Then this duration also depends on the availability of the drugs and consumables necessary for the surgical intervention which are totally chargeable to each patient. This response time has an impact on appendicular lesions. In terms of pathophysiology, appendicitis begins with the catarrhal phase, then the abscess phase, then the gangrene phase and finally the perforation phase. Although the technical platform, like the number of operating theaters, within the Joseph Ravoahangy

Andrianavalona University Hospital Center does not equal that of the developed countries, nor the number of surgeons during daycare hours and even if the population does not seem financially easy, this duration is not so long compared to that of other studies in other countries. Mittal MK *et al.* [11], in the United States, found an average duration of 5.9 hours (3.7-9.9) which is obviously quite close to ours. This American study was focused on a study population of 3 to 18 years old and in the slightest diagnostic doubt, even after ultrasound, they carry out CT scans which prolong this intervention period. Lee JH *et al.* [12], in a South Korean study, found an average duration further below that is 5 hours (3-5). The graduated compression technique with posterior manual compression was evaluated during this study and the number of appendices viewed was increased by this technique, thereby reinforcing diagnostic certainty and limiting the use of computed tomography and investigation time. This time between the time of the ultrasound and the surgical procedure would therefore depend on the other surgical emergencies present, the patient's financial availability and the preoperative diagnostic certainty.

About the ultrasound results, we diagnosed 91.18% of appendicitis confirmed intraoperative and on pathology. Eight percent escaped ultrasound. All the results of the pathology examination were acute appendicitis. There were no false positives. So, in our study, we have an ultrasound sensitivity of 91.18%.

Ultrasound still has a dependent operator character and many traps can lead to false negatives and false positives like those described by Jeffrey RB *et al.* [13]. Thus its sensitivity varies according to the authors.

One of the lowest values observed in the literature is that found by Sammalkorpi HE *et al.* [14]. which is 48% with a specificity of 94.4%. The authors explained that ultrasound examinations performed in patients with a low clinical probability of appendicitis produced more false positives than true positives, thereby considerably reducing this sensitivity. This was not the case in our study because patients with a low probability of appendicitis with the Alvarado score were diagnosed on ultrasound either by direct sign or by infiltration of peri-appendicular fat and we did not have not had a false positive.

Retrospective studies often have lower sensitivity and specificity than prospective studies. According to the authors, retrospective studies more reflect the reality of the performance of ultrasound in the diagnosis of appendicitis where the operators are often overwhelmed and, with variable abilities, face patients with, sometimes, multiple comorbidities; in prospective studies, operators are often specialists or in specialization courses and they are more attentive to the search for or the elimination of appendicitis. In our study, the operators were certainly Specialists and doctors in a specialization course, but the conditions of the ultrasound exams and the clinical presentation of the patients represent the daily reality in abdominal emergencies and imaging.

Our study showed a high sensitivity of ultrasound (91.18%) compared to those cited in the literature, especially that of Karimi in 2017 (4) with a sensitivity of 83.78% in a prospective study.

By taking as confirmation condition the confirmation of the diagnosis by an anatomo-pathological examination, we have 100% certainty of the final diagnosis. The inflammatory nature of the lesion is thus confirmed and the other appendicular lesions such as the tumor were eliminated. In practice, rare are the appendages removed and considered normal by the surgeons and benefiting from anatomo-pathological examinations. The selection of patients is thus limited by the fact that only patients with a high probability of appendicitis intraoperative benefit from appendectomies. Appendices asserted as normal on ultrasound are therefore not confirmed on pathology examination and appendicitis asserted on ultrasound but considered normal by surgeons may not be taken into account.

Conclusion

Despite its dependent operator nature and its limits in the non-visualization of the appendages, ultrasound remains a sensitive examination and an effective examination for the diagnosis of acute appendicitis. Also, the comparison of different clinical, biological and imaging examinations allows the diagnosis to be made.

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