



International Journal of Surgery Science

E-ISSN: 2616-3470

P-ISSN: 2616-3462

© Surgery Science

www.surgeryscience.com

2021; 5(4): 68-70

Received: 15-07-2021

Accepted: 02-09-2021

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Accuracy of ultrasonography for the diagnosis of acute generalized peritonitis in children: A two-year review

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DOI: <https://doi.org/10.33545/surgery.2021.v5.i4b.761>

Abstract

In atypical presentations, ultrasonography may be helpful to confirm the diagnosis of acute generalized peritonitis. Our study aimed to evaluate its accuracy at Albert Royer National Children's Hospital Centre of Dakar, in Senegal. We conducted a two-year (2018-2020) retrospective cross-sectional study, with an analytical aspect. Fifty-one patients were included in our study. In 56.7% of cases, a radiologist realized the ultrasonography. The sensibility and specificity of ultrasonography for the diagnosis of acute generalized peritonitis were 70 and 75% respectively. Accuracy of diagnosis was reduced proportionally to the operator's experience, ranging from 82% for radiologists, 66% for interns in radiology to 46% for trainees in radiology ($p=0,0145$). In our environment, the accuracy of ultrasonography for the diagnosis of acute generalized peritonitis is poor, and largely influenced by the operator's experience, which relegates this investigation to the second line, behind clinical suspicion.

Keywords: Acute generalized peritonitis, children, ultrasonography accuracy, Albert Royer, Senegal

Introduction

Acute generalized peritonitis (AGP) is the widespread inflammation or infection of the peritoneum^[1]. This is a medico-surgical emergency in which mortality remains high, despite the development of diagnostic investigations, management, and resuscitation^[2, 3]. It is reported that this condition is more common in low and middle-income countries (LMICs), mainly in sub-Saharan Africa^[4]. In children, AGP is a common condition, accounting for approximately 25% of gastrointestinal diseases^[1]. In the diagnosis of AGP, clinical suspicion is an essential element. It is based on the interrogation and the results of the physical examination. The purpose of imaging tests is to investigate the etiology of AGP that has been evoked clinically. These should never take precedence over clinical suspicion^[5]. The preoperative knowledge of the etiology of AGP has the advantage of guiding the surgical approach if this one is carried out by an open approach, as is the case in the majority of the LMICs. Compared to radiography, ultrasound (US) showed better sensitivity in the diagnosis of AGP by detecting fluid in the peritoneal cavity^[5, 6]. Our retrospective review has the aim is to determine the contribution of ultrasound in the positive and etiological diagnosis of AGP at the pediatric surgery service of the Albert Royer National Children's Hospital Center in Dakar, Senegal.

Materials and Methods

Study Design

This is a retrospective descriptive cross-sectional study with an analytical component. We recruited patients treated in our department from January 2018 to January 2020. Data collection was done retrospectively, February and March 2020. The study was carried out at Albert Royer National Children's Hospital Center in Dakar, Senegal.

Participants

The inclusion criteria were: (a) patients aged less than 16 years, (b) in whom a clinical suspicion of AGP was raised, and (c) in whom an abdominal ultrasound has been performed before surgical exploration. The exclusion criteria were: (a) patient medical records without sufficient information despite attempts to complete them.

Variables and Data Management

The variable collected were: age and sex of the patients, the place of the ultrasound’s realization (university teaching hospital, public health establishment, and private clinics), the profile of the ultrasound’s operator (radiologist, trainee in radiology, intern in radiology), diagnosis evoked by the US, etiology suggested by the US, intraoperative diagnosis and etiology.

Information was collected from the emergency register as well as the operating room register of our service. Data collection was carried out on a survey sheet. To reduce the risk of information and registration bias, data were collected by two people and the final data was the result of merging the original lists. The sample size was determined by the number of patients who met the inclusion criteria without having an element of the exclusion criteria.

Statistical Analysis

The purpose of the analyzes was to determine the means of the quantitative data (age) and the frequencies of the qualitative data (sex, US operator, place of US’s realization, presence of peritoneal effusion, diagnosis evoked by the US, intraoperative diagnosis). We assessed the sensitivity and specificity of the ultrasound, as well as its positive predictive value (PPV) and negative predictive value (NPV) for the diagnosis of AGP. The intraoperative diagnosis was considered to be the gold standard.

The differences between ultrasound and intraoperative exploration (definitive and etiological diagnosis), between the results of different operators and different establishments, were analyzed with the variance, with $p < 0.05$ as the threshold for statistical difference. Data entry and storage were performed using Microsoft Office Excel 2010 software and analysis with Epi Info version 7.2.

Results

During our study period, we collected 71 patients treated for PAG within our department. Twenty patients were excluded because of records without sufficient information to support our study.

Our study population includes 51 patients whose mean age at diagnosis was 9 years with extremes of 3 months and 15 years. A frequency peak was observed at 12 years. Our series consisted of 38 boys and 13 girls.

Regarding the performance of the ultrasound, the most frequent operator was a radiologist (56.7%). The vast majority of ultrasounds were performed in a university teaching hospital (UTH), i.e. in 72.5% of cases. Free peritoneal effusion was identified in 25 patients (49%), localized effusion found in 16 patients (31.4%) and no effusion in 10 patients (19.6%). The diagnosis of AGP was evoked in 66.7% of cases. The definitive diagnosis was made intraoperatively and retained AGP in 92.1% of the cases. These general data on the US are shown in Table 1.

Table 1: General characteristics of realized US exams among included patients (N=51)

Characteristics	Category	Number	Percentage
Profile of US’s operator	Radiologist	29	56,9
	Trainee in radiology	13	25,5
	Intern in radiology	3	5,9
	Not mentioned	6	11,7
Site of US realization	UTHs	37	72,6
	Private Clinic	9	17,6
	PHEs	5	9,8
Peritoneal effusion	Free	25	49
	Localized	16	31,4
	Absent	10	19,6
US’s Diagnosis	AGP	34	66,7
	Appendicular Abscess	8	15,7
	Not mentioned	4	17,6
Intraoperative Diagnosis	AGP	47	92,1
	Localized Peritonitis	3	5,9
	Appendicular Mass	1	2

AGP: Acute Generalized Peritonitis, PHEs: Public Health Establishments, US: Ultrasound, UTHs: University Teaching Hospitals

Abdominal ultrasound evoked the diagnosis of AGP in 34 of 51 patients (66.7%). In 17 patients, no AGP was suspected. Of these 17 patients, 14 presented with AGP on surgical exploration, which means 14 false negatives. The three others remaining patients had a healthy peritoneum, which means three true negatives. In our series, the sensitivity of abdominal ultrasound for AGP is 70% and its specificity is 75% with a PPV of 97% and an NPV of 17.6%. The concordance between US and intraoperative diagnosis of AGP varied depending on the experience of the operator. In the case where the US was performed by a radiologist, the diagnosis was concordant in 82% of cases. This percentage drops to 66% if the operator is an intern in radiology and to 46% when the operator is a trainee in radiology. The difference between these three operators was statistically significant, with p equal to 0.0145.

Among the 37 ultrasounds performed in the UTHs, 26 cases of AGP (70%) were confirmed intraoperatively. In 30% of the remaining cases, the ultrasound data did not match with the

intraoperative data. Seventy-eight percent of private ultrasound results and 60% from other PHEs were confirmed with surgery. Analysis of the variance between these 3 groups showed that the most consistent results are those of private clinics, followed by those of UTHs, and finally, those of PHEs (Table 2).

Table 2: Comparison of diagnosis matching between ultrasound and intraoperative diagnosis in our population study.

Compared hospitals	Matching Results	p
UTHs	70%	0,005*
Private Clinics	78%	
UTHs	70%	0,003*
PHEs	60%	
Private Clinics	78%	0,009*
PHEs	60%	

* Statistically significant difference PHEs: Public Health Establishments, UTHs: University Teaching Hospitals

Discussion

Over two years, our study included 51 patients in whom a suspicion of AGP was clinically evoked. We found 70% sensitivity and 75% specificity of ultrasound in the diagnosis of AGP. Ultrasounds performed in private establishments were the most consistent with the intraoperative diagnosis, followed by those performed in UTHs, and finally, those performed in other PHEs.

AGP is a medico-surgical emergency. Its overall intra-hospital frequency is estimated at 9.3 per 1000 admissions [7]. Its annual frequency in our study is 18.5 cases per year. Various African studies in the pediatric population have reported an annual intra-hospital frequency varying from 9.9 to 30.3 cases [1, 8, 9]. Our results are included in this range, which could be explained by the fact that the referring centers have a much higher intra-hospital frequency.

The diagnosis of AGP is firstly clinical. But in a doubtful situation such as unusual presentation and to determine the cause, imaging is used. Among these, the US is accessible, non-invasive, and non-irradiating means, which helps in the diagnosis of AGP [6, 10]. Ultrasound may show peritoneal fluid effusion. It was present in 80.4% of cases in our series with a free in 49% of the whole sample. These data are similar to those of the literature [10-12]. Indeed, the presence of fluid effusion is an important US sign to consider an AGP. Some authors have shown that free fluid effusion in the peritoneal cavity was the most consistent result in patients with peritonitis [10-12].

In our study, the US was consistent with intraoperative exploration in 66.7% of cases. Previous studies reported a correct diagnosis in 70 to 83.3% of cases [5, 6, 12]. These higher rates than ours can be explained by the fact that in the cited studies, radiologists performed these all US, which is different from our context where only 56.7% of ultrasounds were performed by radiologists. The rest was done by interns and trainees in radiology.

Our results show that the sensitivity of abdominal ultrasound for AGP is 70% and its specificity is 75% with a PPV of 97% and an NPV of 17.6%. Some authors have reported a sensitivity of 90% and specificity of 89 to 98%, a PPV of 86 to 91%, and an NPV of 96 to 98% [13]. Other authors state that ultrasound in children has a sensitivity of 94% and a specificity of 95% for diagnosing AGP [14, 15]. Our rate is lower than those reported in the literature. The qualification of the US operator seems to be a determining factor in the diagnosis of AGP by ultrasound. Indeed, our results confirmed the operator-dependent character of the ultrasound by demonstrating a statistically significant decrease according to the experience of the operator, going from 86% match if the operator is a radiologist, to 46% in the case of a trainee in radiology. And in our case, radiologists only performed 56.7% of USs, the sensitivity of the ultrasound can only be reduced.

Limitations

The main limitation is the fact that this study is retrospective, this implies missing data, such as the etiologies of peritonitis diagnosed on ultrasound and intraoperatively. However, this does not reduce the quality of the information provided by this study.

Conclusion

Acute generalized peritonitis is a common condition in our community and its diagnosis is essentially clinical. In our environment, the sensitivity of ultrasound is low compared to clinical suspicion, which reaffirms the place of the latter in the

positive diagnosis of AGP. Having the ultrasound performed by experienced operators would improve its sensitivity.

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