

Original Research Article

Ultrasound in a Pediatric Surgical Environment in Abidjan

Debato Tina Gnaoulé^{*1,2}, Abdoulaye Toure^{1,2}, Ange Eric Zouzou^{1,2}, Ange Patrick Ndja^{1,2}, Anicet Le Dion^{1,2}, Nguessan Ebeys Fatto^{1,2}, Gogoua Casimir Gbazi^{1,2}

¹Radiology Department-University Hospital of Cocody, BP V13 - Abidjan (Côte d'Ivoire)

²School of medicine -Félix Houphouët-Boigny University, BP V166 Abidjan 01 - Abidjan (Côte d'Ivoire)

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Abstract: Purpose: To contribute to a better diagnostic and morphological management of surgical pathologies in the pediatric environment using ultrasound. **Material and methods:** This was a mono-centric, retrospective, descriptive and analytical study carried out in the pediatric surgery department of the University Hospital Center of Cocody over a period of four (04) years and six (6) months (January 1, 2016 to June 30, 2020). We proceeded to a sampling of all the patients who had undergone a pediatric ultrasound that met our inclusion criteria. **Results:** The mean age of the patients was 6.7 years. The age range 0 to 3 years was predominant (36%), followed by the age range 12 to 15 years (25%). There was a male predominance with a sex ratio of 2.03. Musculoskeletal ultrasound was the most represented (50%) with osteoarticular swelling as the main indication (71.6%) followed by abdomino-pelvic ultrasound (42%) with abdominal pain as the main indication (63%); acute bursa was the main indication for genitourinary pathologies (71%). 64% of the ultrasound scans performed were pathological of a great variety divided into 3 large groups: musculoskeletal infections dominated by osteoarthritis (55%), abdomino-pelvic pathologies dominated by appendicular pathologies (53%) and genitourinary pathologies dominated by testicular ectopy (15%). **Conclusion:** Ultrasound can be considered as a gold standard in the exploration of surgical conditions in children. The practice of pediatric ultrasound requires competent medical staff, the availability of efficient equipment associated with optimal examination conditions adapted to the child.

Keywords: Ultrasound, children, pediatrics, abdominal pain, osteoarticular infection

Abbreviations: AI: acute intussusception, HMG: hepatomegaly, HN: hydronephrosis, HPS: hypertrophic pyloric stenosis, PKD: polycystic kidney disease, RA: renal atrophy, RP: renal pain, UAXR: unprepared abdominal X-Ray.

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INTRODUCTION

Ultrasound is the most widely used cross-sectional imaging technique in Côte d'Ivoire [1]. Its expansion is linked to its safety. Moreover, it is adapted to pediatric imaging. Unfortunately, it is practiced far from the reference centers by personnel with little or no qualification in pediatric radiology.

This situation is responsible for diagnostic errors or delays that expose patients to life-threatening complications. It is in this context that we decided to carry out this study in collaboration with the pediatric surgery department of the University Hospital Center of Cocody, whose general objective is to contribute to a better diagnostic and morphological management of surgical pathologies in the pediatric environment.

MATERIAL AND METHODS

This was a mono-centric, retrospective, descriptive and analytical study conducted in the pediatric surgery department of the University Hospital Center of Cocody over a period of four (04) years and six (6) months (January 1, 2016 to June 30, 2020).

We consulted the patients' medical records of the pediatric surgery department and selected 300 files. These concerned children from 0 to 15 years of age, all sexes, hospitalized in the pediatric surgery department, who had undergone ultrasound scans at the medical imaging and radiodiagnostic department of the University Hospital Center of Cocody. Epidemiological (age, sex, indications) and sonographic (type of ultrasound, pathologies found) parameters were studied.

Quantitative variables were expressed as means (standard deviation and extreme values) and qualitative variables as proportions. Correlations were made between the pathologies observed according to sex and age. The comparison test used was the chi2. Significance was defined by the value of $p < 0.05$. The examinations were performed by pediatric radiologists on ultrasound scanners equipped with a superficial probe.

RESULTS

Age

The mean age of the patients was 6.7 years. The age group from 0 to 3 was the most represented

with 108 patients (36%), followed by age group from 12 to 15 years with 76 patients (25.3%). The age group from 4 to 7 years represented 18.7% and for the age group from 8 to 11 years, 20%.

Sex

There was a male predominance at 67% with a sex ratio of 2.03. Ultrasound parameters Over 300 examinations, 264 were pathological (88%). The musculoskeletal and abdominal pathologies were predominant respectively with 50 and 42%, Indications (Table I).

Table-I: Summary table of ultrasound indications per device

Indications by device	Frequency	Percentage (%)
Musculoskeletal	151	100/50
Osteoarticular: - Swelling	101	67
Lameness	39	26
Vicious attitude	01	1
Soft tissue*	10	6
abdomino-pelvic	125	100/42
Functional digestive disorders		
Abdominal pain	79	63
Others**	16	13
Abdominal contusion	15	12
Abdominal-pelvic mass	14	11
Malformative assessment	1	1
Genito-urinary	24	100/8
Acute bursa	17	71
Urinary functional signs***	5	21
Bladder injury	1	8

* para-vertebral mass 3, lumbar swelling 2, sacrococcygeal mass 1, palmar swelling 1, swelling of the inner side of the arm 1, soft occipital swelling 1, swelling of the breast 1.

**Abdominal bloating 10, vomiting 4, caustic burns 2.

***Urine leak 2, hematuria 2, urinary retention 1.

Ultrasound parameters

Of 300 examinations, 264 were pathological (88%). Musculoskeletal and abdominal pathologies

were predominant with 50 and 42% respectively (Table II) (Figures 3, 4, 5 and 6).

Table-II: Summary distribution of pathologies by device

Pathologies	Frequency	Percentage (%)
Musculoskeletal	131	100/50
Osteo-articular: - Osteo-arthritis	72	55
-Osteomyelitis	29	22
Soft parts: - Myositis	25	19
-Others*	5	4
Abdomino-pelvic	99	100/42
Appendicular pathologies :	52	53
Acute appendicitis	28	(54)
Complications :	24	(46)
Appendicular abscess	(11)	
Peritonitis	(8)	
Appendicular plastron	(5)	
AI	14	14
Liver disease (abscess 9, HMG 1))	10	10
Lymph node pathology (adenolymphitis 5, inguinal adenomegaly 5)		
Hemoperitoneum	10	10

Occlusive pathology (intestinal obstruction 2, colon volvulus 1) HPS Others**	4 3 3 3	4 3 3 3
Genito-urinary Pathology of bursa : - Testicular ectopy -Others***	34 17 5 12	100/8 50
Renal and urinary tract pathology -HN 2, PKD 2, RP 2, RA 2 - Bladder (Contusion 2, rupture 1, lithiasis 1)	12 (8) (4)	35
Utero-adnexal pathology: - ovarian (Cysts 2, oophoritis 1) - hematocolpos 1, hydrometrocolpos 1	5 (3) (2)	15
GENERAL TOTAL	264	100

* Scalp nodule 1, sacrococcygeal teratoma 1, sebaceous cyst 1, Abscess collected from breast 1, Lipoma from hand 1.
 ** subphrenic abscess 1, septate ascites 1, umbilical hernia 1.
 *** Inguino-scrotal hernia + vaginal hydrocele 4, orchi-epididymitis 3, testicular torsion 2, testicular contusion 1, testicular mass 1, bilateral testicular hematoma 1.

AI: acute intussusception, HPS: hypertrophic pyloric stenosis, HMG: hepatomegaly, HN: hydronephrosis, PKD: polycystic kidney disease, RP:

renal pain, RA: renal atrophy Correlation between the occurrence of osteomyelitis and sex (Table III).

Table-III: Correlation between the occurrence of osteomyelitis and sex

		Osteomyelitis		p
		Non	Oui	
Sex	Female	43	4	0.024
		91.49%	8.51%	
	Male	79	25	
		75.96%	24.04%	

The frequency of occurrence of osteomyelitis was related to sex (p = 0.024), predominant in the male

population. Correlation between the occurrence of osteoarthritis and age (Table IV)

Table-IV: Correlation between the occurrence of osteoarthritis and age

		Osteoarthritis		p
		Non	Oui	
Age	0 - 3 ans	34	24	0,002
		58.62%	41.38%	
	4 - 7 ans	19	21	
		47.50%	52.50%	
	8 - 11 ans	12	16	
		42.86%	57.14%	
	12- 15 ans	14	11	
		56.00%	44.00%	

The frequency of occurrence of osteoarthritis was related to age (p = 0.002), predominant in the 0 to 3

year age group. Correlation between the occurrence of appendicular pathology and sex (Table V).

Table-V: Correlation between the occurrence of appendicular disease and sex

		Appendicular disease		P
		Non	Oui	
Sex	Female	22	27	0.0139
		44.90%	55.10%	
	Male	51	25	
		67.11%	32.89%	

The frequency of occurrence of appendicular disease was linked to sex ($p = 0.0139$), predominant in the female population.

DISCUSSION

Age

The mean age of the patients in our study (6.7 years) was similar to that of the study by Kouamé *et al*. [2] (6.8 years), both performed in Côte d'Ivoire.

It was much higher than those reported in the studies of N'timon *et al*. [3] in Togo (2.16 years) and Traoré *et al*. [4] in Mali (1.72 years).

Apart from any scientific explanation, was it necessary to question the early onset (before 3 years of age) of pediatric pathologies in Mali and Togo? Particularities existed according to age group and according to the device explored.

The 0 to 3 years age group was the most represented in our study (36%), all pathologies included, against 52.8% in the study by Traoré *et al*. [4]. This overrepresentation of 0 to 3 years old in the Traoré study was explained by the width of these age groups (0 to 5 years old versus 0 to 3 years old in our study).

This distribution of explorations according to age varied according to the organ affected: In our study, the frequency of occurrence of osteoarthritis was related to age ($p = 0.002$) reaching mainly the 0 to 3 years (41.4%) (Table IV) against 83% in the study of EL Hamdi [5].

This confirmed the fact that osteoarthritis was essentially an infection of infants and small children. Only 17% of cases occurred after the age of 4 years according to Métaizeau [6].

Concerning abdominal pathologies, in our study we found a clear predominance of appendicular pathologies in the 12 to 15 years age group (70%). While AI was predominant in the age group of 0 to 3 years (27.50%) followed by the age group of 4 to 7 years (16.67%). No cases of AI were detected beyond 8 years of age. This finding was corroborated by several studies in the literature review [3, 5].

Sex

The strong representation of the male sex in our study (sex ratio of 2.03) was noted by most of the authors of the literature review [3, 4, 7, 8]. On the other hand, authors like N'timon *et al*. [3], Traoré *et al*. [4], Chapelière *et al*. [7] noted a lower sex ratio between 1.4 and 1.6. This could be explained by the method of patient recruitment, as these different authors recruited all pediatric ultrasounds for medical and surgical indications.

In our study, the frequency of occurrence of appendicular pathology was significantly linked to sex ($p = 0.0139$), predominant in the female population (55%) (Table V).

No etio-pathogenic or anatomical explanation has been found; would this fact be linked to the law of series? This female predominance is seldom found. In their studies on abdomino-pelvic ultrasound, Manal [9] in Egypt found a female predominance of 55.4% when Sanogo [10] and Diarra [11] in Mali, found respectively 59 and 65, 33% of male predominance.

The frequency of occurrence of osteomyelitis was related to sex in our series ($p = 0.023$) (Table III), predominant in boys (24%); El Hamdi [5] found 70% male involvement; this predominance was explained by the turbulence of the boys, the more exposed to trauma.

Indications

Osteo-articular inflammatory pathologies (swelling and feverish lameness) were, in our study, the first indication (93%) of musculoskeletal ultrasound performed in 50% of the cases, and the abdominal pains were the main indication (63%) of the abdomino-pelvic ultrasounds performed in 42%.

The authors such as N'timon [3] and Traoré *et al*. [4] placed the abdominal examinations for pain at the first place among the pediatric ultrasound indications in 92% and 69.5%.

The explanation probably lay in the organization of the patient's circuit. In fact, at the University Hospital Center of Cocody, patients were received in a grouped medico-surgical emergency department. The surgical pathologies were referred to pediatric surgery and the others were referred to the medical pediatrics department, which initiated the diagnostic process. Surgical cases were secondarily redirected to the pediatric surgery department when the etiology was established.

The pathologies found on ultrasound

Musculoskeletal pathologies were dominated by osteoarthritis (55%) and accounted for 45% in the study by EL Hamdi [5].

All the articulations could be affected. The ultrasound was of undeniable benefit for the deep articulations (shoulder and hip). For lesions of superficial articulations such as the knee, with a good clinical examination (patellar shock) and biology, one could easily make the diagnosis of arthritis of the knee. In our daily practice, in the case of a knee injury, treatment was started immediately after clinical examination, x-ray, and biology. Ultrasound was used as part of treatment monitoring. Hence the predominant involvement of the hip and shoulder in our study compared to the literature (Table VI).

Table-VI: Comparative table of the different topographies with the studies in the literature review

Locations	R El Fezzazi [12]%	JD Nelson [13]%	S. Timsit [14]%	E. Grimprel [15]%	A. Afifi [16]%	EL Hamdi [5]%	Our Study%
Knee	35.48	30	49	30-33	46.43	45	11
Hip	38.71	15	19	15-38	45.24	39.05	57
Ankle	19.35	16	12	16-18	11.9	1.,05	4
Elbow	3.23	-	2	-	5.95	3.55	6
Shoulder	-	-	2	-	2.32	2.38	14

In our study, arthritis was not represented unlike the other studies [5]; this was linked to the fact that the patients were seen at the stage of complication (osteoarthritis). Also in our context, febrile episodes with stiffness and joint pain were most often labeled as malaria attacks with self-medication from the outset; it was the installation of functional impotence that prompted the consultation with the specialist.

To corroborate this delay in consultation, we objectified 3 cases of myositis associated with osteoarthritis, a complication that was no longer found in the Western series.

Abdomino-pelvic pathologies represented 42% of all lesions in our study. Acute appendicitis and its complications were the leading disease entity (53%) followed by acute intussusception (14%) and liver (10%) and lymph node (10%) pathologies.

This distribution was not found in most of the studies in the literature review. The study by Traoré [4] found mesenteric adenolymphitis (33.3%), acute appendicitis with its complications (2.78%). No case of AI has been found.

N'timon B's study [3] found liver damage (37.8%) followed by splenic (16.4%) and kidney damage (12.2%). No AI case has been found.

The study of Manal [9] in Egypt, whose objective was to research the etiologies of abdominal pain in children, revealed that 32.9% of pain was related to functional digestive disorders followed by postoperative pain (18.6%) and lithiasis causes (16.1%) AI and acute appendicitis were implicated in 3.2% and 1.4% of cases.

While we agree that our type of study differed from that of the other studies, this could not explain the absence or under-representation of appendicular pathologies and AI even in studies in Togo and Mali.

Regarding neonatal occlusive pathologies, only 3 cases (3%) were objectified in our study and no cases were identified in those carried out in Togo and

Mali. This was not due to the rarity of these conditions in our country but rather to the method of exploration used (unprepared abdominal X- Ray or UAXR), to establish this diagnosis.

Indeed, the delay in consultation brought the children to the referral centers, at the stage of clinically obvious evolving complications explored with the UAXR making ultrasound exploration unnecessary.

The under-representation of adenolymphites (5%) in our study versus 33% in the Traoré study [4] was explained by our method and our patient recruitment circuit. These simulating an appendicular pathology were wrongly oriented in pediatric surgery.

Regarding appendicular lesions in our study, the diagnosis was made at the acute stage in 28 children (54%) versus 24 children (46%) at the complication stage.

The high number of progressive complications was the result of delayed diagnosis. This was at odds with the availability, widespread and inexpensive nature of ultrasound. This situation posed the problem of the practice of radio-pediatrics in clandestine practices set up even in Abidjan, where medical staff not trained in radio-pediatrics and sometimes paramedical staff was often employed.

In our series, 14 cases of AI were identified and all treated surgically, as in the Konan study [17], because they were diagnosed at the stage of complications, no longer meeting the criteria for radiolucency guided disinvagination.

The cause, according to Konan [17], is ignorance of the signs of acute intussusception, often mistaken for a picture of amoebic dysentery.

Unfortunately, we discovered the case of a child who was brought to hospital after having expelled his intussusception tube rectally (Figure 1). This situation was favored by an anatomical predisposition to the type of attachment defect of the left colon, observed intraoperatively. In this kind of situation, morphological exploration no longer has its place.



Fig-1: Acute intussusception complicated by rectal expulsion of the intussusception bladder. (Personal collection)



Fig-2: Simple device used in the radiology department of Cocody University Hospital for air disinvagination on an ultrasound table: a urinary catheter, a syringe with a conical tip, a 10 cc syringe and a clamp. (Personal collection)



Fig-3: Osteoarthritis of the left hip: intra-articular liquid effusion (red arrow) of purulent appearance measuring 36 X 36 X10 cm, i.e. a volume of 7.30 cm³; in a 3-year-old boy, who consulted for febrile lameness.



Fig-4: Ultrasonographic aspect of a subperiosteal abscess of the left femur: purulent liquid effusion with bone fragments (red arrow) with an estimated volume of 9 ml; indicating osteomyelitis; in a 4-year-old girl who came for a painful swelling of the left thigh + Fever.

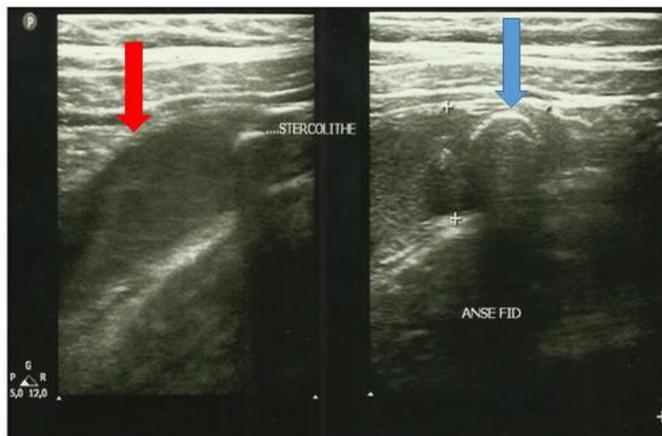


Fig-5: Acute appendicitis; 13 mm distended appendix (red arrow) that has echogenic, heterogeneous contents with the presence of a stercolith (blue arrow), in a 05-year-old boy explored for right iliac fossa pain.

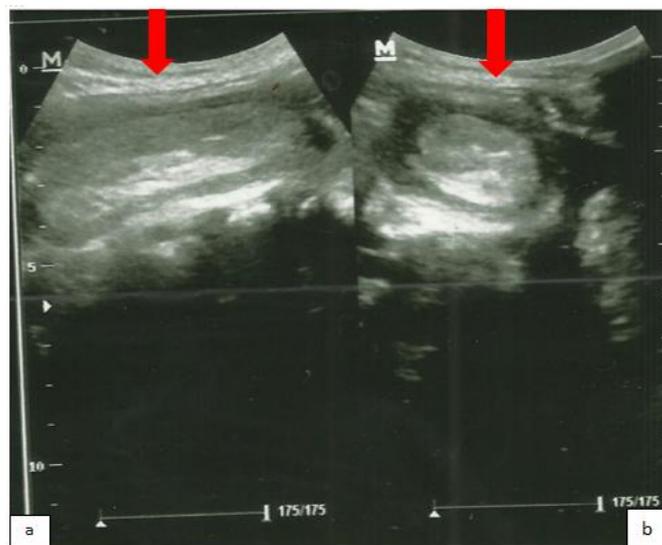


Fig-6: Acute intestinal invagination (red arrows): sandwich image on the longitudinal section (A) and cocoon image on the transverse section (B) in a girl aged 02 years 08 months explored for abdominal pain + bedwetting.

However, the radiology department of the University Hospital Center of Cocody had a team trained in air disinvasion under ultrasound with inexpensive equipment whose cost did not exceed 10,000 CFA francs (about 15 euros) (Figure 2) and was derisory compared to the cost of hospitalization and surgery.

Genito-urinary investigations were few (34 cases, 8%) and all pathological, thus demonstrating the good sensitivity of ultrasound in the exploration of urogenital pathologies, as recognized by all the authors of the literature review.

They were dominated by pathologies of the bursa, in particular testicular ectopia (15%), considered nowadays as a disorder of sexual development. The other bursal pathologies (inguinal hernia and vaginal hydrocele) represented 12% of the cases and are the same nosological entity related to a defect of closure of the peritoneo-vaginal canal.

We are surprised by the under-representation of testicular torsions which were found 2 times out of 34 cases and by the presence in these 34 cases of purely medical pathologies such as nephropathy, renal suffering, renal atrophy and renal multicystosis.

CONCLUSION

Ultrasound can be considered as a gold standard in the exploration and management of surgical conditions in children. However, in order to maintain this value and to reduce the high frequency of serious complications, it requires a trilogy that is essential for its good practice:

- A competent operator qualified and trained in the practice of radiopediatrics.
- A high-performance ultrasound equipment
- Optimal examination conditions adapted to the child.

Unfortunately, in our context, the delay of consultation, source of evolutionary complications, relegates ultrasound to the background in favor of the clinic and radiography.

DECLARATIONS

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Conflicts of interest/competing interests

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and

analysis were performed by DEBATO TINA GNAOULE, and ABDOULAYE TOURE. The first draft of the manuscript was written by DEBATO TINA GNAOULE and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL

Ethical approval was waived by the local Ethics Committee of Félix Houphouët-Boigny University in view of the retrospective nature of the study and all the procedures being performed were part of the routine care.

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