Management of Pediatric Abdominal Trauma in Countries with Limited Resources: Is Computed Tomography Indispensable for a Good Result?

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Abstract

Background

Abdominal trauma are a common cause of infant morbidity and mortality.

Aim

To assess the relevance of computed tomography scan for the management of abdominal trauma in children in countries with limited resources.

Patients and method:

It was a retrospective and descriptive study over 5 years in patients aged 0 to 15 years.

Results

Twenty four cases of abdominal trauma were collected. There were 14 boys and 10 girls with a sex ratio of 1.4. The average age was 8.7 years with extremes of 18 months and 15 years. The causes found were: road accidents (14 cases), home accident (6 cases), gambling accidents (3 cases) and one aggression. Traumas were divided into 83.3% (20 cases) of abdominal blunt and 16.7% (4 cases) of abdominal wound. Polytrauma accounted for 41.7% (10 cases). No computed tomography scan was ordered. The spleen was the most injured organ (11 cases) followed by the intestines (6 cases). The average length of hospital stay was 12.3 days with extremes of 3 and 15 days. The treatment was non-operative in 13 patients (54.2%) and surgical in 11 ones (45.8%). No deaths were noted in our series.

Conclusion

Abdominal trauma in children are potentially serious injuries. The treatment depends on the damaged organ and the patient's hemodynamic status. Computed tomography scan does not appear to be indispensable in the management of traumatized children in countries with limited resources.

Background

Abdominal trauma are a common cause of infant morbidity and mortality. In recent years, the conservative approach has been prioritized due to advances in pediatric resuscitation and the understanding of the physiological peculiarities of children [1]. This requires a precise clinical and paraclinical diagnosis. Computed tomography (CT) scan has therefore become the gold standard for lesion diagnosis in developed countries [1, 2]. However, developing countries still pay a heavy price for their support [2]. Our country, Benin, is a small West African country with limited resources and overall socio-economic level of the population is low. Indeed, the Beninese population is predominantly rural (80%) and the guaranteed minimum interprofessional wage is around 67 dollars [3]. The average cost for a CT scan is $ 150 while the cost of the ultrasound is about $ 16. The lack of universal health insurance taints the quality of overall patient care. In this context, the recourse to other efficient measures is necessary. Abdominal ultrasound associated to plain abdominal radiography therefore appears as an alternative in the assessment of abdominal trauma in children in these countries with limited resources. Recently, Western literature has shown a desire to abandon or at least limit CT scans in abdominal trauma in children [4–8]. Our work aims to describe our experience of managing abdominal trauma in children without the use of computed tomography.

Patients And Method

This is a retrospective and descriptive study covering a period of 10 years from January 2008 to December 2018. The study population consisted of children (age $\leq$ 15 years) treated for abdominal trauma. The variables studied were: age, sex, mechanism of occurrence of the trauma, explorations, lesion assessment, associated trauma and the results. The American Association for the Surgery of Trauma (AAST) classification was used to describe lesions of the liver and spleen.

OUR PROTOCOL

Our protocol for the management of abdominal trauma in children has two components. For abdominal blunt (see Figure 1), it consisted of conditioning, performing a FAST echography by the emergency doctor in search of an intraperitoneal effusion, blood tests (including rhesus blood grouping, white blood cell count and blood coagulation measurements) and then patient monitoring. The rest of the treatment depends on the patient's hemodynamic status. When the hemodynamic state is stable, follow-up ultrasounds are performed at regular intervals of 72 hours by a radiologist. The ultrasound criteria for healing is the absence of a significant hemoperitoneum. The surgical indications amounted to hemodynamic instability despite a well-conducted resuscitation with a need for transfusion greater than 40 ml/ kg or the occurrence of peritoneal irritation with or without pneumoperitoneum on the plain abdominal radiography. For abdominal wound, surgical exploration is the rule after a systematic tetanus vaccination.

Results

Twenty-four children were treated for abdominal trauma in 5 years, then an annual incidence of 5 cases. These were 14 boys and 10 girls (sex ratio of 1.4). The average age was 8.7 years with extremes of 18 months and 15 years. The circumstances of occurrence were: road accidents (14 cases), domestic accidents (6 cases), gambling accidents (3 cases) and one aggression.

The trauma was divided into abdominal blunt 83.3% (20 cases including 16 cases of solid organ lesions and 4 cases of intestine lesions) and abdominal wound 16.7% (4 cases). Abdominal wounds as far as its concerned, we noted a white laparotomy, an ileal wound, an omental wound and a combination of small intestinal and colic wounds by firearm. In 10 patients (41.7%) it was a context of polytrauma. By the way, the associated trauma are reported in Table 1.

Morphologically, all cases of abdominal blunt benefited from a FAST ultrasound at admission. No CT scan was ordered even if indicated. For patients who received non-operative treatment, the average number of follow-up ultrasounds performed was 2. This time, it was an ultrasound performed by a radiologist. A plain abdominal radiography was performed in 3 patients and objectified a pneumoperitoneum. Indeed, these were patients with persistent abdominal pain despite a normal abdominal ultrasound. Table 2 classifies lesions of solid organs in different grades according to the AAST.

The treatment was non-operative in 13 patients (54.2%). For those who were operated (n = 11 or 45.8%) the indication for surgery was: hemodynamic instability despite well-conducted resuscitation (3 cases), loop rupture (4 cases), surgical exploration for abdominal wound (4 cases). Table 3 shows the different therapeutic modalities. The mean length of hospital stay was 12.3 days with extremes of 3 and 15 days. Postoperative morbidity and mortality were nil.

Discussion

The accuracy of the scanner in exploring abdominal trauma in stable patients has been very well established [4]. However, in recent years, many series have raised the question of its necessity, especially in the pediatric population. Several authors have tried to limit the indications to certain critical situations [5–9]. Halaweich *et al* [10] have indeed noticed a decrease in compliance with guidelines for the use of computed tomography in abdominal trauma in children. The reasons are many. After a literature review, we identified relevant reasons which support us in our protocol excluding computed tomography.

CT and carcinogenic risk

In a cohort of 680,000 patients who underwent computed tomography, Mathews *et al* [11] found an increase in the overall cancer incidence of 27% among exposed subjects with a higher risk in toddlers. This risk was directly related to exposure and depending on the computed tomography site, abdominopelvic and thoracic computed tomography scans had the highest relative risks, 1.61 and 1.162, respectively. The risk after abdomino-pelvic scanner was much higher for certain types of cancer, in particular leukemia (OR: 3.42) and myeloodysplasias (OR: 2.17 to 4.84). There was also a significant increase in the rate of soft tissue, brain and all other solid cancers apart from melanoma and thyroid cancer. More specifically, Pearce *et al* [12] have shown that performing a computed tomography scan in childhood could triple the risk of leukemia when administered with a dose of 50 mGy and brain cancer if administration of 60 mGy. Within 10 years of the first scan, one case of leukemia and one case of brain tumor per 10,000 scans is estimated to occur in patients under 10 years of age [11]. Many other publications alert pediatric practitioners to the carcinogenic risks associated with the use of the scanner in childhood. And even if one might believe that the absolute risk is low and that it is possible to reduce the doses (the risk is not zero even at low doses) or that the clinical benefits should prevail, the conclusion is the same. All the authors recommend alternative solutions which do not involve ionizing radiation [13–17]. This is all the more valid in Africa, which contains 80% of the world's children and where cancer care is still a dilemma [18–20].

False negatives and false positives of CT

While the computed tomography scan allows rapid detection of hepatic and splenic lesions, a large proportion of pancreatic lesions go undetected as well as some lesions of the digestive tract whose presentation may be delayed [21–23]. In fact, the way in which computed tomography is performed has a lot of influence on the results. Sedation is necessary in children [21] but the safety of pediatric anesthesia is not yet effective in our skies and represents an additional cost for parents [24].

Besides, there are many trap images (electrode artifacts, various resuscitation equipment) that are sources of false positives. Edwards *et al* [25] found 2.5% false positives for abdominal computed tomography scan with a direct consequence of an increase in the length of hospital stay. Injecting the contrast products increases the sensitivity of the computed tomography scan but is not without side effects including allergic reactions, although these are mostly minimal. Their overall incidence reported in the literature is 4.3% [26, 27].

CT and prognosis

Almost all lesions will benefit from exclusive medical treatment which will be started upon admission for all patients [1]. For the rest, even if the ultrasound cannot be very precise on the diagnosis, hemodynamic instability will lead to surgery. Moreover, authors have already noted that, injected or not, the interpretation of abdomino-pelvic, computed tomography scans usually do not lead to a change in the therapeutic attitude [28]. Given the nil mortality in our series, we can conclude that not performing computed tomography seems to have no influence on the prognosis.

CT and cost

The relatively high cost of the scanner in a context where health insurance is a luxury, led us to establish this protocol by completely excluding the scanner, the price of which can cover hospital costs in the majority of cases. In fact, the patients remained hospitalized for a dozen days on average with hospital costs amounting to approximately 100 dollars or 2/3 of the cost of computed tomography. In addition, it has recently been proven that even in large trauma centers, 50% of computed tomography scans performed are negative [29], which would constitute a huge loss for our African population where funding for care is problematic. In the sub-region, computed tomography is rarely used in the assessment of abdominal trauma as it is not often available in many centers. When available, the long lead time for lack of financial means inevitably leads to a delay in any surgical intervention [20].

Benefits of abdominal ultrasound

It has the advantage of being able to be carried out in a few minutes in the breakout room or in the patient's bed. It was made systematic at the patient's bed on admission as was the case in our series. Indeed, it is easily renewable and non-irradiating. The results of ultrasound, potentiated by the experience of the operator, are often superior to those obtained in adults due to the thinness of the adipose membrane and the small size of the abdominal cavity in children [30–32].

Ultrasound is an excellent method of monitoring trauma to conservatively treated solid organs [21, 33]. Our 13 patients who had undergone non-operative treatment were monitored by ultrasound until they were discharged from the hospital. Ultrasound exploration is often limited by the inability to mobilize a polytrauma patient. Carrying out this bedside ultrasound helped circumvent this limiting factor in our establishment. The presence of gas linked to the existence of a reflex ileus or subcutaneous emphysema is also a brake. These reservations being made, ultrasound remains an irreplaceable tool in emergency settings, especially when performed by an experienced radiologist 30–32].

Better than conventional ultrasound, several authors have proven the effectiveness of ultrasound after injection of contrast agent comparable to computed tomography in the evaluation of traumatic visceral lesions in children [29, 34–36]. In our country, no contrast agent was used because it would be restrictive in our context with potential side effects. However, it would be a promising method [29] and a good possibility in countries with limited resources since it has the merit of sparing the child radiation, thereby reducing the risk of radiation-induced cancers.

Finally, it should be mindful that certain situations such as high kinetic traumas and polytrauma can justify a CT scan if possible.

Limitations Of The Study

Our study still has some limitations. The small size of our series is the main one. The lack of a control patient group is also a negative factor. Additionally, this is a single-center study in a hospital that is not a trauma center. However, our results seem encouraging.

Conclusion

Computed tomography does not appear to be essential in the assessment of traumatic visceral injuries in children, especially in countries with limited resources. The use of ultrasound after injection of contrast product would be a good option. Our protocol for managing these traumas has allowed us to exclude computed tomography from mandatory imaging explorations with good results. However, large-scale studies could be performed to evaluate this protocol.

Abbreviations

- CT: Computed tomography
- AAST: American Association for the Surgery of Trauma
- FAST echography: Focused Abdominal Sonography for Trauma

Declarations

Ethics approval and consent to participate: The study was approved by the Ethics Committee of National Teaching Hospital Hubert Koutoukou Maga (Cotonou, Benin) and written informed consent was obtained from the parents of each patient and all methods were performed in accordance with the relevant guidelines and regulations. Amoussou Sèdjro Clotaire Roméo HOUEGBAN was granted permission to access raw data by National Teaching Hospital Hubert Koutoukou Maga (Cotonou, Benin).

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Authors' contributions: HOUEGBAN ASCR, ASSAN BR and YASSEGOUNGBE MG conceived the idea, designed the study and participated to data collection. SETO DM, COVI P, KOCO H, ASSOUTO BCU participated to data collection and prepared the figure and tables. FIOGBE MA and GBENOU AS corrected the final version. All the authors interpreted the data and contributed to the preparation of the manuscript. The authors read and approved the final manuscript.

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Tables

Tableau 1: Trauma associated with abdominal trauma

Associated trauma	Abdominal blunt (n=20)	Abdominal wound (n=4)
Traumatic brain injury	2	-
Thoracic traumatism	3	1
Pulmonary contusion	2	-
Hemothorax	1	-
Intra thoracic balls	-	1
Bone traumatism	4	-
Humeral and tibial fracture	1	-
Fracture of forearm and leg	1	-
Leg fracture	1	-
Pelvic fracture	1	
Total	9	1

Tableau 2: Description of solid organ lesions according to AAST

	Solid organs		Total
	Spleen	Liver	
Grade I	3	2	5
Grade II	2	-	2
Grade III	3	1	4
Grade IV	2	2	4
Grade V	1	-	1
Total	11	5	16

Tableau 3: Therapeutic modalities of abdominal trauma in children

	Abdominal blunt (n=20)		Abdominal wound (n=4)	Total (n= 24)
	Lesions of solid organ (n=16)	Intestine lesions (n=4)		
Surgical abstention	13	-	-	13
Conservative surgery	2*	4	4	10
Resection surgery	1**	-	-	1
Total	16	4	4	24

* Liver hemostasis with a surgical absorbable haemostat for 2 grade IV liver lesions

** Total splenectomy for grade V splenic lesion

Figures

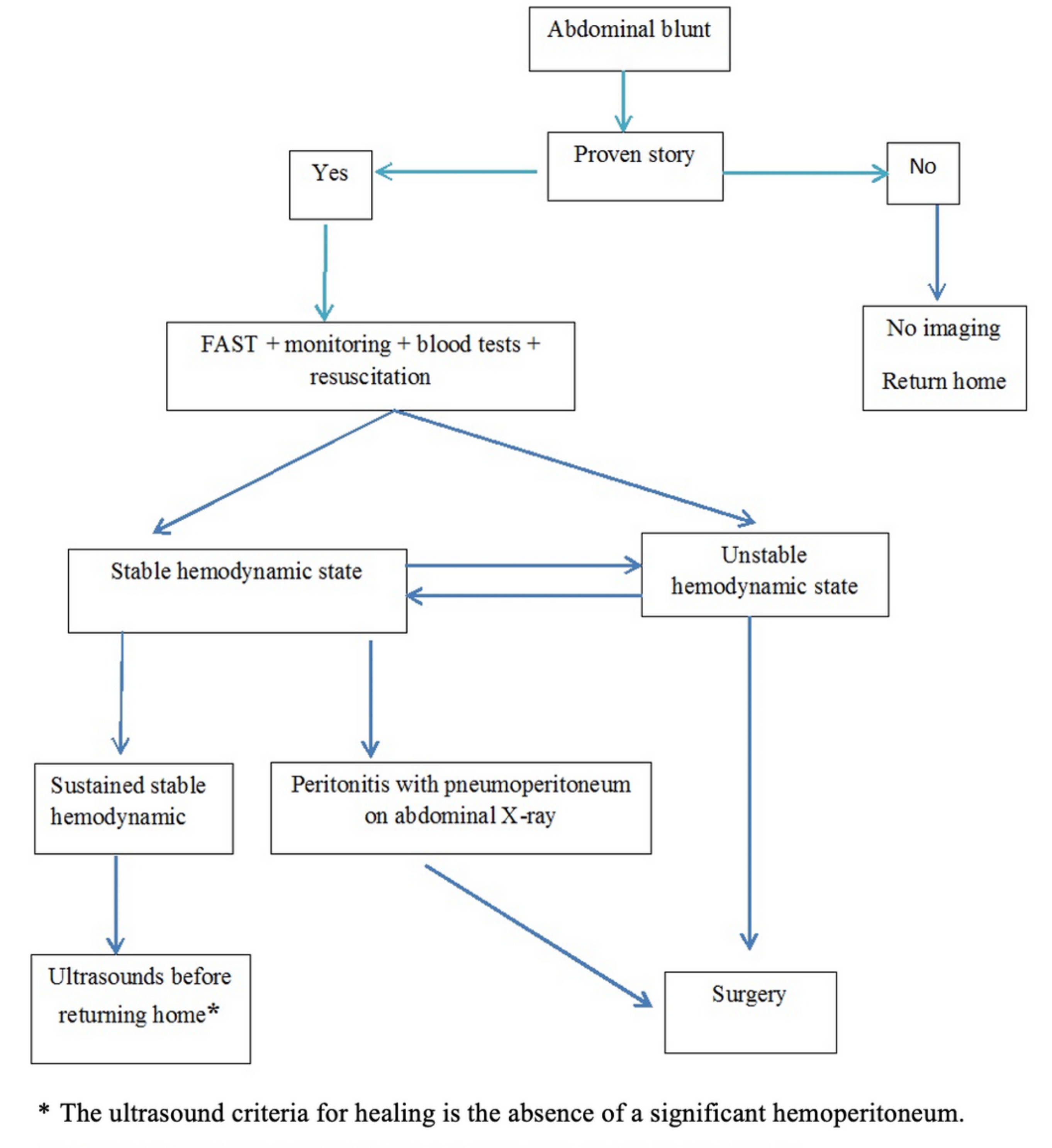

Figure 1

Protocol of management of the child's abdominal traumas in our service