УДК 617.55-001-053.2-08
DOI: 10.17816/PTORS6139-44

ISOLATED FREE FLUID IN CHILDREN WITH BLUNT ABDOMINAL TRAUMA: DOES IT ALTERS THE MANAGEMENT APPROACH?

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Received: 17.01.2018 Accepted: 16.02.2018

Introduction. Isolated free fluid (IFF) on abdominal computed tomography in children with blunt abdominal trauma poses a diagnostic dilemma.
The **aim** of this study is to present our experience of the entity and its role in management of these children.
Methods. A prospective study was performed over a period of two and half years on all the children less than 14 years of age admitted to our hospital with blunt abdominal trauma and in whom the CT abdomen was done which demonstrated isolated free fluid with no sign of visceral injury. Demographic data, presenting clinical status, imaging data and management (nonoperative progress and operative findings) were collected and analyzed.
Results. A total of 108 children were admitted with blunt abdominal trauma and who underwent abdominal CT during the period from July 2015 to December 2017. Isolated free fluid (IFF) was found in 26 children (24%). The mean age was 7.8 years with male predominance. Motor vehicle collisions were the most common mechanism of injury. At presentation abdominal tenderness was present in 8 of these children. Twenty two children had small IFF and 2 each had moderate and large fluid collections and the most common site being the hepatorenal pouch. One child each from moderate and large IFF group needed subsequent exploration.
Conclusion. Children of blunt abdominal trauma with isolated free fluid on abdominal CT are managed conservatively. However, they need admission and repeated clinical assessment for early detection of delayed presentation of visceral injury entailing surgical intervention.

Keywords: Children; Blunt trauma; Isolated free fluid; Intraabdominal injury.

СВОБОДНАЯ ЖИДКОСТЬ В БРЮШНОЙ ПОЛОСТИ У ДЕТЕЙ С ТУПОЙ ТРАВМОЙ ЖИВОТА: ВЛИЯЕТ ЛИ ОНА НА ВЫБОР ТАКТИКИ ЛЕЧЕНИЯ?

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Статья поступила в редакцию: 17.01.2018 Статья принята к печати: 16.02.2018

Введение. Обнаружение свободной жидкости в брюшной полости (СЖБП) при компьютерной томографии (КТ) у детей с тупой травмой живота является диагностической дилеммой.
Цель данного исследования — описание нашего опыта в изучении особенностей данной травмы и роли обнаружения СЖБП в лечении детей.
Методы. В данное проспективное исследование, длившееся 2,5 года, включались дети младше 14 лет, поступившие в наш стационар с тупой травмой живота, у которых на КТ было обнаружено наличие СЖБП без признаков висцеральной травмы. Нами были собраны и проанализированы демографические данные пациентов, их клинический статус, результаты обследования, а также особенности лечения (консервативного и хирургического).

■ For citation: Khan RA, Wahab S. Isolated free fluid in children with blunt abdominal trauma: Does it alters the management approach? *Pediatric Traumatology, Orthopaedics and Reconstructive Surgery*. 2018;6(1):39-44. doi: 10.17816/PTORS6139-44

Результаты. В исследование были включены 108 детей с тупой травмой живота, которым была выполнена КТ брюшной полости в период с июля 2015 по декабрь 2017 г. СЖБП была выявлена у 26 (24 %) пациентов. В исследуемой группе преобладали мальчики; средний возраст составил 7,8 года. Чаще всего травмы были получены в автомобильных авариях. При поступлении в стационар у 8 пациентов отмечалась болезненность при пальпации живота. У 22 детей количество СЖБП было незначительным, у 2 — умеренное, еще у 2 — значительное. Свободная жидкость обнаруживалась преимущественно в гепаторенальном кармане. По одному ребенку из групп с умеренным и значительным количеством СЖБП нуждались в дополнительном обследовании.

Заключение. Дети с тупой травмой живота, у которых на КТ была выявлена только СЖБП, нуждаются в консервативном лечении. Тем не менее данных пациентов необходимо госпитализировать и провести повторное обследование с целью раннего выявления возможного повреждения внутренних органов, лечение которого подразумевает хирургическое вмешательство.

Ключевые слова: дети; тупая травма; свободная жидкость в брюшной полости; внутрибрюшная травма.

Introduction

For successful management of the children with blunt abdominal trauma, diagnostic imaging particularly abdominal computerized tomography (CT) plays the major role. Nonoperative management is the standard approach in hemodynamically stable children with CT evidence of peritoneal fluid and associated solid organ injury [1]. Any evidence of hollow viscus injury like pneumoperitoneum and contrast extravasation on CT scan mandates a prompt surgical intervention [2]. However, there is a subset of children with blunt abdominal trauma where CT shows only free fluid with no evidence of visceral injury. It is this subset of patients that pose diagnostic problems because the source of the isolated free fluid in these patients is uncertain [3]. The IFF can be a hemoperitoneum due to missed intraabdominal injury or nonspecific reactionary fluid of no significance.

We **aimed** to study this subset of patients highlighting the frequency of IFF and its management.

Material and methods

This was a prospective study conducted on children <14 years of age with blunt abdominal trauma who underwent abdominal CT during the study period July 2015 to December 2017. The study was approved by the institutional ethics committee. At presentation, a simultaneous resuscitation and primary survey was done. The hemodynamic status (systolic blood pressure) and abdominal examination findings especially abdominal tenderness were noted. After stabilization, CT scan was performed on 16 slice SOMATOM EMOTICON machine with IV contrast (iohexol) in dose of 1.5 ml/kg injected at a rate of 2 ml/sec. Oral contrast (iohexol) was used whenever indicated at a dose of 450 ml 30 min before scanning and additional 250 ml immediately before scanning. Oral and IV contrast was also adjusted according to age and weight of child. 5 mm contiguous CT sections were taken from lung base to pelvis with table speed of 6 mm/sec (pitch 1.2). The CT scan was assessed by the senior radiologist with >10 year experience. The spaces looked for isolated free fluid collections were the right subphrenic (perihepatic), left subphrenic (perisplenic), hepatorenal pouch (Morrison's pouch), left and right paracolic gutters, and pelvis. The grading of fluid collection was done as illustrated by the Federle and Jeffery [4]. A mild (small) fluid collection was defined as fluid collected in any of the above mentioned spaces except pelvis. A moderate fluid collection was defined as fluid collection in any one space and pelvis. A large fluid collection was defined as fluid collection in any spaces and pelvis.

A systolic blood pressure was considered low if less than (70 + 2 times the age) mm Hg for children up to 10 years and less than 90 for children between 11yeas and 14 years.

All the children were evaluated clinically throughout their hospital stay and their course during nonoperative management e.g. requirement of number of blood transfusions or development of peritonitis was documented.

The inclusion criteria were children of <14 years who had history of blunt abdominal trauma and where CT abdomen had demonstrated isolated free fluid in the peritoneal cavity (with no evidence of visceral injury). The children who had other forms

of trauma, associated visceral injury demonstrated on CT or evidence of pneumoperitoneum were excluded from the study.

Results

During the study period, out of the 108 children undergoing abdominal CT for blunt abdominal trauma, a total of 26 (24%) showed isolated free fluid with no evidence of visceral injury and met the study inclusion criteria. The mean age of 26 children was 7.82 ± 3.04. There were 21 (80.7%) males as compared to 5 (19.3%) females (M : F ratio was 4.2 : 1). The most common mechanism of injury was motor vehicle collision which was present in 77% (n = 20) of children. The next most common mechanism of injury was fall from height (11.5%, n = 3). The systolic blood pressure was found to below normal in 4 children (15.3%) while abdominal tenderness was present in 30.7% (n = 8) children. Twenty two children had small IFF, two had moderate and two had large fluid collections. The most common site for IFF in small fluid collection was the hepatorenal pouch (18 out of 22) (Table 1). Among the moderate group, it was hepatorenal pouch and pelvis in one patient while right paracolic gutter and pelvis in another patient. In large fluid patients, one patient had fluid in perisplenic and pelvis in one patient while another patient had fluid in right paracolic gutter and pelvis.

None of the patients having small fluid collection had hemodynamic instability at admission. The four children who showed hemodynamic instability at admission belonged to moderate and large fluid groups. All the children remained hemodynamically stable after initial resuscitation and were put on nonoperative management with none of them requiring emergency laparotomy. Out of 8 children who had abdominal tenderness at presentation, 4 belonged to small IFF and 4 to moderate and large IFF group (i.e. all the children of moderate and large IFF had abdominal tenderness at presentation). Abdominal tenderness increased in two children, one each from moderate IFF and large IFF. These two patients required subsequent laparotomy due to development of peritonitis. The child from moderate fluid collection developed abdominal distension and peritonitis on day 3 of admission while the other child (from large fluid collection) showed features of peritonitis on day 2 of admission. Both the patients had mesenteric injury with resultant small bowel gangrene in ileal region that necessitated resection and end to end anastomosis (Fig 1). Both the children recovered well and were discharged.

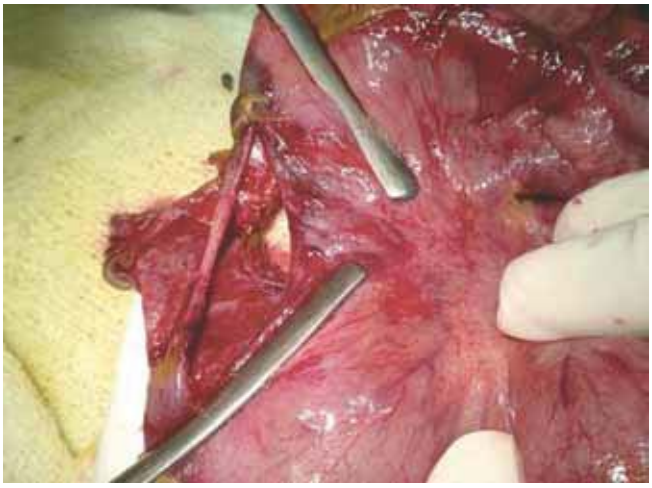

Fig. 1. Damage to the vessels of mesentery

Thus, out of total of 8 children with abdominal tenderness at presentation, two required laparotomy

Table 1

Depicting the parameters in different IFF groups

Parameter	Small IFF (n = 22)	Moderate IFF (n = 2)	Large IFF (n = 2)
Initial hemodynamic instability	0	2	2
Initial abdominal tenderness	4	2	2
Nonoperative intervention (BT required [n])	22 (10)	1 (1)	1 (1)
Operative intervention	0	1	1
Mean hospital stay (days)	4.2	9	10

Note. IFF — isolated free fluid in the abdominal cavity.

i.e. 25%. However, out of 4 children of moderate and large IFF who at initial abdominal tenderness, 50% (2 out of 4) needed subsequent laparotomy. And these were the patients who had IFF at more than one location. Significantly, both the children who needed laparotomy had fluid collection in right paragolic gutter besides having fluid in pelvis.

Besides the two children requiring subsequent laparotomy, all the children responded to nonoperative management. The hospital stay was most in the two children of moderate and large IFF group requiring laparotomy (mean 12 days), followed by the other two children in these groups (mean: 7 days). The mean hospital stay in children of small IFF with initial abdominal tenderness was 4.4 days while those of without initial abdominal tenderness was 3.6 days.

Discussion

With the advent of high resolution, multislice helical CT scanning, there has been a prototypal change in the management of children with blunt abdominal trauma. CT scan has played a major role in changing the perspective of a clinician towards a child with blunt abdominal injury [5]. However, there are major disadvantages of radiation exposure to growing children and costing due to its unnecessary use [6]. Another disadvantage that also comes under the purview of this study is the over diagnosis with resultant over treatment due to over usage of CT scan in these children with blunt abdominal trauma [7]. Our study has shown that 24% ($n = 26$) of the children with blunt abdominal trauma have isolated free fluid in peritoneal cavity and out of these only 7.7% needed operative intervention while the rest 92.3% responded to nonoperative intervention.

The incidence of IFF in children has been variously reported in literature [3, 8]. The free fluid in peritoneal cavity of a patient of blunt trauma can be from multiple sources. In addition to clear cut cases of solid and hollow visceral injury, IFF may be due to an intraparenchymal contusion to a solid organ without capsular disruption with resultant reactionary fluid, a small solid organ injury not visualized on CT scan, pelvic fracture, or the hypovolemic shock syndrome where considerable resuscitation for hemodynamic instability may result in transudation of intraperitoneal and retroperitoneal fluid. In patients who have received oral contrast, areas of unopacified bowel loops may also be erroneously shown as isolated free fluid [8–10].

In the absence of solid visceral injury and telltale signs of blunt bowel and mesenteric injury such as free air, bowel-wall thickening, or mesenteric stranding, a meticulous look out for other signs must be made. Isolated free fluid in the interloop location is more likely to be associated with blunt bowel and mesenteric injury rather than solid visceral injury. These appear as polygonal shaped collections in between the folds of mesentery and bowel [11].

However, even though such injuries are rare, the major concern in such patients of IFF is the chance of missed hollow viscus and delayed diagnosis with consequent increases morbidity. In our study the incidence of hollow visceral injury was 7.7% in children with IFF. In various studies the incidence of hollow visceral injury in pediatric blunt abdominal trauma presenting with IFF has been reported to occur 9% and 66% [3, 10, 12].

In our study, the grading of IFF seems to influence the detection of visceral injury during the admission and observation of these children. Fifty percent of children each from moderate and large IFF collection were diagnosed with subsequent injury. None of the patients from small IFF group required exploration in our study. Other authors have also shown that patients with moderate and large IFF are more likely to have intraabdominal injury [3, 4, 13].

Out of a total of 8 children who showed abdominal tenderness at initial presentation, 25% eventually needed laparotomy. In fact, all the children who demonstrated increase in tenderness on serial examination ($n = 2$) needed exploration. Thus every child once admitted for observation must be given the benefit of serial abdominal examination.

In pediatric trauma, abdominal assessment is often inadequate due to associated head injury over and above the difficulty in examination of an anxious and uncooperative child. Therefore, the findings in such a scenario should be judged with caution and the decision to explore children with suspected intraabdominal should not be centered

exclusively on CT findings but clinical picture should also be taken into consideration before deciding upon the exploration. It is pertinent to admit all such patients who have abdominal pain at presentation and isolated free fluid on CT scan for repeat physical examinations. In some dedicated pediatric trauma centers, it is routine to admit pediatric trauma patients despite normal CT scan [14–16].

The patients of small IFF group were managed conservatively without any patient needing subsequent operative intervention. However, in these children ($n = 22$) a total of 10 blood transfusions were required. No of blood transfusions required has been demonstrated to be strong independent predictor of mortality and hospital length of stay in patients with blunt solid organ injuries [17]. The length of hospital stay was highest in children who required laparotomy while it was least in children of small IFF with absent abdominal tenderness at presentation.

Conclusion

The hollow visceral injuries are rare in children with blunt abdominal trauma. The finding of small IFF at initial CT does not alter the optimal therapeutic approach in pediatric blunt abdominal trauma. However, in cases where moderate or large amount of IFF is detected, the patient should be closely monitored and diligent search for any visceral injury should be made with the help of repeated abdominal examinations and if required with the help of appropriate imaging modality.

Funding and conflict of interest

The funding of scientific work was carried out at the expense of the authors themselves.

The authors declare no obvious or potential conflicts of interest related to the publication of this article.

References

1. Brownstein MR, Bunting T, Meyer AA, Fakhry SM. Diagnosis and management of blunt small bowel injury: a survey of the membership of the American Association for the Surgery of Trauma. *J Trauma.* 2000;48(3):402-407. doi: 10.1016/S0735-6757(01)80141-8.
2. Keller MS. Blunt injury to solid abdominal organs. *Semin Pediatr Surg.* 2004;13(2):106-111. doi: 10.1053/j.sempedsurg.2004.01.006.
3. Hulka F, Mullins RJ, Leonardo V, et al. Significance of peritoneal fluid as an isolated finding on abdominal computed tomographic scans in pediatric trauma patients. *J Trauma.* 1998;44(6):1069-1072.
4. Federle MP, Jeffrey RB, Jr. Hemoperitoneum studied by computed tomography. *Radiology.* 1983;148(1):187-192. doi: 10.1148/radiology.148.1.6856833.
5. Wegner S, Colletti JE, Van Wie D. Pediatric blunt abdominal trauma. *Pediatr Clin North Am.* 2006;53(2):243-256. doi: 10.1016/j.pcl.2006.02.002.
6. Shah NB, Platt SL. ALARA: is there a cause for alarm? Reducing radiation risks from computed tomography scanning in children. *Curr Opin Pediatr.* 2008;20(3):243-247. doi: 10.1097/MOP.0b013e3282ffafd2.
7. Banz VM, Butt MU, Zimmermann H, et al. Free abdominal fluid without obvious solid organ injury upon CT imaging: an actual problem or simply overdiagnosing? *J Trauma Manag Outcomes.* 2009;3:10. doi: 10.1186/1752-2897-3-10.
8. Sivit CJ, Taylor GA, Bulas DI, et al. Posttraumatic shock in children: CT findings associated with hemodynamic instability. *Radiology.* 1992;182(3):723-726. doi: 10.1148/radiology.182.3.1535886.
9. Taylor GA, Fallat ME, Eichelberger MR. Hypovolemic shock in children: abdominal CT manifestations. *Radiology.* 1987;164(2):479-481. doi: 10.1148/radiology.164.2.3602389.
10. Holmes JF, London KL, Brant WE, Kuppermann N. Isolated intraperitoneal fluid on abdominal computed tomography in children with blunt trauma. *Acad Emerg Med.* 2000;7(4):335-341. doi: 10.1111/j.1553-2712.2000.tb02232.x.
11. Levine CD, Gonzales RN, Wachsberg RH, Ghanekar D. CT findings of bowel and mesenteric injury. *J Comput Assist Tomogr.* 1997;21(6):974-979. doi: 10.3348/jkrs.1995.33.4.569.
12. Beierle EA, Chen MK, Whalen TV, Doolin EJ. Free fluid on abdominal computed tomography scan after blunt trauma does not mandate exploratory laparotomy in children. *J Pediatr Surg.* 2000;35(6):990-992; discussion 993. doi: 10.1053/jpsu.2000.6950.
13. Levine CD, Patel UJ, Wachsberg RH, et al. CT in patients with blunt abdominal trauma: clinical significance of intraperitoneal fluid detected on a scan with otherwise normal findings. *AJR Am J Roentgenol.* 1995;164(6):1381-1385. doi: 10.2214/ajr.164.6.7754877.
14. Rodriguez C, Barone JE, Wilbanks TO, et al. Isolated free fluid on computed tomographic scan in blunt abdominal trauma: a systematic review of incidence and management. *J Trauma.* 2002;53(1):79-85. doi: 10.1097/00005373-200207000-00016.
15. Gonser-Hafertepen LN, Davis JW, Bilello JF, et al. Isolated free fluid on abdominal computed tomography in blunt trauma: watch and wait or operate? *J Am Coll Surg.* 2014;219(4):599-605. doi: 10.1016/j.jamcollsurg.2014.04.020.

16. Lansink KW, Cornejo CJ, Boeije T, et al. Evaluation of the necessity of clinical observation of high-energy trauma patients without significant injury after standardized emergency room stabilization. *J Trauma.* 2004;57(6):1256-1259. doi: 10.1097/01.TA.0000145075.51395.C9.

17. Robinson WP, Ahn J, Stiffler A, et al. Blood transfusion is an independent predictor of increased mortality in nonoperatively managed blunt hepatic and splenic injuries. *J Trauma.* 2005;58(3):437-444. doi: 10.1097/01.TA.0000153935.18997.14.

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