

The Relationship between Non-Renal Diseases and Renal Parenchymal Echogenicity in Children with Acute Abdominal Pain

Mehdi Maghsoudi¹, Mohammad Reza Esmaeili-Dooki², Mohaddeseh Mirzapour¹, Ali Bijani³, *Rahele Mehraeen¹

¹Department of Pediatric Radiology, Babol University of Medical Sciences, Babol, Iran.

²Non-Communicable Pediatric Diseases Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.

³Non-Communicable Pediatric Diseases Research Center, Amirkola Children Hospital, Babol University of Medical Sciences, Babol, Iran.

Abstract

Background

Few results have shown that renal parenchymal echogenicity increases in pediatric patients with no concurrent renal diseases. This study aimed to investigate the relation between non-renal diseases and renal cortical echogenicity in children with acute abdominal pain.

Materials and Methods

This cross-sectional study was conducted among 100 children referred to Amirkola Children's Hospital (Babol city, Iran) with complain of acute abdominal pain during July 2015-July 2016. Patients with a known history of renal disease or urinary tract infections were excluded. All patients were examined with sonography. The parenchymal echogenicity of kidney was evaluated by comparison with that of liver and was divided into three categories: group 1, renal cortex echogenicity less than liver parenchyma echogenicity; group 2, renal cortex echogenicity similar to that of liver parenchyma; and group 3, renal cortex echogenicity greater than that of liver parenchyma.

Results: Of 93 children finally assessed, 52 (55.9%) were boy; the mean age of patients was 6.45 years old. The diagnosed causes of abdominal pain included acute appendicitis (n=43, 46.2%), mesenteric adenitis (n=8, 8.6%), gastroenteritis (n=4, 4.3%), and invagination (n=2, 2.2%). Eighteen cases (19.4%) had abnormal renal echogenicity (equal to or more than that of liver). A significant relationship was found between non-renal diseases and renal cortical hyperechogenicity (p=0.03). After follow-up of 12 patients with renal hyperechogenicity for 1-2 weeks, all of them had normal findings in re-evaluation.

Conclusion

The results showed that renal hyperechogenicity is a non-specific and transient finding in children with acute abdominal pain and in favor of disorders other than renal diseases.

Key Words: Abdominal Pain, Children, Kidney Diseases, Ultrasonography.

*Please cite this article as: Maghsoudi M, Esmaeili-Dooki MR, Mirzapour M, Bijani A, Mehraeen R. The Relationship between Non-Renal Diseases and Renal Parenchymal Echogenicity in Children with Acute Abdominal Pain. Int J Pediatr 2018; 6(5): 7589-93. DOI: **10.22038/ijp.2017.27400.2361**

*Corresponding Author:

Rahele Mehraeen (M.D), Department of Pediatric Radiology, Babol University of Medical Sciences, Babol, Mazandaran, Iran. Postal Code: 47176-47745

Email: sany_monzavi@yahoo.com

Received date: Nov.12, 2017; Accepted date: Dec.22, 2017

1- INTRODUCTION

Acute abdominal pain (AAP) is one of the most common causes of referrals of children to primary care offices and emergency departments (1, 2). It can be a manifestation of different disorders, such as gastroenteritis, intussusception, constipation, acute appendicitis and viral infections (3-5). An urgent and complete evaluation is the key factor for prevention of life threatening complications in these patients. Abdominal imaging can provide helpful information for physicians to narrow the differential diagnoses (6). Ultrasonography is an important imaging modality for the evaluation of AAP in pediatric patients (7). One of the organs routinely undergo abdominal ultrasonography is kidney. Echogenicity of renal cortex is less than that of liver naturally, and only in neonates and early infancy, renal cortical hyperechogenicity is considered as a normal finding (8). Different surveys revealed that echogenicity of renal cortex increases in various renal abnormalities (9-12). However, some radiologists believe that renal echogenicity can be influenced by other factors, such as AAP, dehydration and low diuresis of patients. Also, a study reported that renal hyperechogenicity can be seen in patients with different abdominal diseases, but without any simultaneous renal disease (13). The purpose of this study was to assess the relationship between echogenicity of renal cortex and non-renal diseases in children with AAP. Given that no enough data are available about this subject, the present study could be a helpful step to clarify this issue, and finally, provide additional insight into abdominal radiographic examinations for the clinicians.

2- MATERIALS AND METHODS

2-1. Study design and population

This cross sectional study was conducted among 100 pediatric patients (3

to 12 years old), with complain of AAP, who were referred to Amirkola Children's Hospital in Babol city (North of Iran), between July 2015 and July 2016.

2-2. Exclusion criteria

The exclusion criteria were as follows: known cases of renal disease or any other specific systemic disorders, traumatic patients, patients with history of urinary tract infection or positive urine analysis or culture, and those with increased blood urea nitrogen or creatinine levels.

2-3. Sample size

We used the following formula to calculate the sample size:

$$n = \frac{Z^2 p(1 - p)}{d^2}$$

Where, Z = the value for the confidence interval = 1.96, P = Prevalence of AAP in children = 50%, and d = Margin of error = 10%.

According to the formula, 96 subjects should be included. But at last, 100 children entered the study for more certainty.

2-4. Measuring tools

All included children underwent comprehensive abdominal sonography, using digital ultrasound scanner (Ultrasonix Sonix SP) by a single pediatric radiologist, and all clinical examination were done by a single pediatrics resident. The images were obtained with 3-5 MHZ transducer. Echogenicity of the renal cortex was compared with liver parenchyma and was divided into three groups: group 1, renal cortex echogenicity less than liver parenchyma echogenicity; group 2, renal cortex echogenicity similar to that of liver parenchyma; and group 3, renal cortex echogenicity greater than that of liver parenchyma (14). The final diagnosis and clinical outcome were collected from the patients' medical record after discharge.

Patients with hyperechogenicity of renal cortex were tested for serum creatinine and urine analysis and reexamined with sonography after 2 weeks.

2-5. Data Analyses

We used SPSS software (version 18.0) for statistical analysis. The collected data underwent descriptive analysis. Also, comparison of groups was done by chi-square test. A p-value of less than 0.05 was considered as significant statistical difference.

2-6. Ethical consideration

This study was approved by Babol University of Medical Sciences Ethics Committee with approved number of 2726/30. Informed consent was obtained from all patients' parents.

3- RESULTS

Of 100 patients initially referred, 93 (93%) were finally included in the study. Seven patients were excluded because of abnormal finding in urine analysis. Fifty two (55.9%) were boy and 41 (44.1%) were girl. The age range was 3-11 years old (the mean age was 6.27 ± 2.87 in boys and 6.67 ± 2.16 in girls). Regarding sonographic results, 40 cases (43%) had normal diagnosis. In abnormal group (n=53), the diagnoses included appendicitis (n=43, 81.1%), mesenteric

lymphadenitis (n=8, 15.1%), and invagination (n=2, 3.8%). Among cases with normal sonography findings, infectious gastroenteritis (n=4), and non-specific abdominal pain (n=36) were finally diagnosed by clinical examinations. **Table.1** presents the final clinical diagnosis and sonographic findings of renal cortex among the included patients. As indicated, 18 sonographic results (19.4%) were consistent with abnormal renal cortical echogenicity, of which 8 (8.6%) were equal to liver parenchyma echogenicity and 10 (10.8%) were greater than that.

Out of 40 patients with normal abdominal sonography and 53 patients with abnormal results, 4 (10%) and 14 (26.4%) patients were associated with increased renal cortical echogenicity, respectively, but the difference was not significant ($p=0.06$) (**Table.2**). In 36 patients with non-specific abdominal pain, only 3 patients (8.3%) had abnormal renal echogenicity, while in 57 patients with final clinical diagnosis, 15 patients (26.3%) had renal hyperechogenicity, and this difference was significant ($p=0.03$) (**Table.2**). Of 18 patients with abnormal renal cortical echogenicity, we could follow 12 patients 1-2 weeks later and all of them had normal finding in re-evaluation.

Table-1: The frequency of final clinical diagnoses and renal cortical echogenicity in children with acute abdominal pain

Clinical diagnoses	Renal cortical echogenicity*		
	Less than liver parenchyma Number (%)	Similar to liver parenchyma Number (%)	More than liver parenchyma Number (%)
Non-specific abdominal pain	33 (91.7)	2 (5.5)	1 (2.8)
Acute appendicitis	33 (71.7)	4 (9)	6 (19.3)
Mesenteric adenitis	5 (62.5)	2 (25)	1 (12.5)
Intussusception	1 (50)	0	1 (50)
Gastroenteritis	3 (75)	0	1 (25)

* Echogenicity equal to or more than that of liver parenchyma was considered abnormal.

Table-2: The relationship between sonographic and clinical diagnoses, and renal cortical echogenicity in children with acute abdominal pain

Diagnostic findings*	Renal cortical echogenicity		P-value
	Normal	Abnormal***	
Abdominal sonography			0.06
Normal	36 (90%)	4 (10%)	
Abnormal	39 (73.6%)	14 (26.4%)	
Final clinical diagnoses			0.03
Non-specific abdominal pain	33 (91.7%)	3 (8.3%)	
Definite diagnosis	42 (73.7%)	15 (26.3%)	

*Excluding renal diseases; Normal: Less than that of liver parenchymal echogenicity; Abnormal: Equal to or more than liver parenchymal echogenicity.

4- DISCUSSION

In this study, we aimed to assess if the renal cortical echogenicity could be affected by pathologies of non-renal origin in children with AAP. It was found that patients with non-renal diseases were associated with renal cortical hyperechogenicity, meaning that conditions other than renal disorders can change echogenicity of renal parenchyma. Additionally, all those patients with renal hyperechogenicity who were followed up had normal reexamination results. Our findings were similar to the results obtained by Wiersma et al.(13), in which the authors stated that increased renal cortical echogenicity isn't only not necessarily a specific indicator of kidney disease, but also can be a transient feature. Until now, the causes leading to increase in renal cortical echogenicity in pediatrics with AAP has not been determined. There are conflicting results concerning the correlation between renal echogenicity and hydration conditions. For example, in their article, Manley and O'Neill (15) declared that renal cortical echogenicity is greater in well-hydrated subjects. Conversely, in the study by Lee et al. (16), in which they investigated the relationship between renal echogenicity and glomerular filtration rate in pediatric solitary kidney patients, increased right kidney-liver echogenicity ratio was closely related to decreased renal function. Regarding our survey, we agree

with the latter article and speculate that some specific dehydration conditions, such as fever, vomiting, poor intake and diarrhea, could potentially result in increased renal echogenicity (13). However, no enough evidence is available and further studies should be performed to clarify this relationship. As mentioned above, no significant difference was seen between the two groups of normal and abnormal sonographic findings in the renal cortical hyperechogenicity. This lack of significance can be explained by the small sample size. If the relation between non-renal pathologic findings and renal hyperechogenicity be confirmed in the future investigations, thenceforth radiologists should suspect those disorders in addition to renal diseases in the patients with increased echogenicity.

4-1. Limitations of the study

This article has some limitations. First, the number of subjects was not enough to assess in detail the association between diagnosed diseases (e.g., acute appendicitis, gastroenteritis) and renal cortex echogenicity. Second, considering that renal echogenicity is compared with that of liver, a pathologic issue in the liver can confound the renal sonographic findings.

5- CONCLUSION

The results of our study revealed that renal cortical hyperechogenicity in

children with AAP can be a non-specific and transient finding which is associated with both renal and non-renal disorders. In other words, any increased renal echogenicity in the pediatric patients would alert the radiologist to search the abdomen more thoroughly for the cause of the acute abdominal illness. However, more studies are needed to be conducted to confirm these results.

6- CONFLICT OF INTEREST: None.

7- ACKNOWLEDGMENT

The authors would like to thank Dr. Abbas Hadipour, Dr. Sohil Osia and Dr. Naeimeh Nakhjavani for advising on study design, and the Research Center of Amirkola Children's Hospital for their cooperation.

8- REFERENCES

- Balachandran B, Singhi S, Lal S. Emergency management of acute abdomen in children. *Indian journal of pediatrics*. 2013;80(3):226-34.
- Reust CE, Williams A. Acute Abdominal Pain in Children. *Am Fam Physician*. 2016;93(10):830-6.
- Kim JS. Acute Abdominal Pain in Children. *Pediatr Gastroenterol Hepatol Nutr*. 2013;16(4):219-24.
- Mehdizadeh M, Memarian S, Khosravi R, Motamed F, Rahmani P, Saidi M, et al. A 13.5-Year Old Boy with Abdominal Pain and Weight Loss and Chronic Intussusception. *Int J Pediatr*. 2017;5(11):6041-46.
- Jamshidnezhad A, Azizi A, Shirali S, Rekabeslamizadeh S, Haddadzadeh M, Sabaghan Y. Evaluation of Suspected Pediatric Appendicitis with Alvarado Method Using a Computerized Intelligent Model. *Int J Pediatr*. 2016;4(3):1465-73.
- Yang W-C, Chen C-Y, Wu H-P. Etiology of non-traumatic acute abdomen in pediatric emergency departments. *World J Clin Cases*. 2013;1(9):276-84.
- Fonio P, Coppolino F, Russo A, D'Andrea A, Giannattasio A, Reginelli A, et al. Ultrasonography (US) in the assessment of pediatric non traumatic gastrointestinal emergencies. *Crit Ultrasound J*. 2013;5(1):S12.
- Konuş OL, Ozdemir A, Akkaya A, Erbaş G, Celik H, Işık S. Normal liver, spleen, and kidney dimensions in neonates, infants, and children: evaluation with sonography. *AJR Am J Roentgenol*. 1998;171(6):1693-8.
- Kasap B, Soyulu A, Türkmen M, Kavukcu S. Relationship of increased renal cortical echogenicity with clinical and laboratory findings in pediatric renal disease. *J Clin Ultrasound*. 2006;34(7):339-42.
- Krensky AM, Reddish JM, Teele RL. Causes of increased renal echogenicity in pediatric patients. *Pediatrics*. 1983;72(6):840-6.
- Chien C-C, Chou Y-H, Tiu C-M, Lin C-C, Yang W-C, Wang H-K, et al. Transient Hyperechoic Renal Cortex Caused by Dehydration and Induced Acute Renal Failure in Two Patients with Intra-Abdominal Infection. *Journal of Medical Ultrasound*. 2012;20(1):43-6.
- Kraus R, Gaisie G, Young L. Increased renal parenchymal echogenicity: causes in pediatric patients. *Radiographics*. 1990;10(6):1009-18.
- Wiersma F, Toorenvliet BR, Ruige M, Holscher HC. Increased Echogenicity of Renal Cortex: A Transient Feature in Acutely Ill Children. *AJR Am J Roentgenol*. 2008;190(1):240-3.
- Moghazi S, Jones E, Schroeppele J, Arya K, Mcclellan W, Hennigar RA, et al. Correlation of renal histopathology with sonographic findings. *Kidney Int*. 2005;67(4):1515-20.
- Manley J, O'Neill W. How echogenic is echogenic? Quantitative acoustics of the renal cortex. *Am J Kidney Dis*. 2001;37(4):706-11.
- Lee YS, Lee M-J, Kim M-J, Im YJ, Kim SW, Lim NL, et al. Is increased echogenicity related to a decrease in glomerular filtration rate? Objective measurements in pediatric solitary kidney patients—a retrospective analysis. *PloS one*. 2015;10(8):e0133577.