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Original Article

Comparison of Spleen, Liver and Kidney Volume and Span using Multiplanar CT Scan vs. Ultrasonography in 1-12 year-old Patients

Hasan Mohamad Rezaie[1], Parisa Hajalioghli[2], Amirreza Jahanshahi[2], Iman Yazdani nia[1], Armin Zarrintan[3]*, Mohammad Mirza Aghazadeh[4]

[1]*MD, Radiologist, Department of Radiology, Imam Reza Hospital, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran*
[2]*MD, Assistant professor, Department of Radiology, Imam Reza Hospital, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran*
[3]*MD, 3rd year Radiology Resident, Department of Radiology, Imam Reza Hospital, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran*
[4]*5th year medical Student, Department of Radiology, Imam Reza Hospital, Faculty of Medicine, Tabriz University of Medical Sciences*

Corresponding Author: Armin Zarrintan, E-mail: zarrintanarmin@gmail.com

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ABSTRACT

Background: Evaluating of internal organs of abdomen in clinical assessments especially in children is so important. Ultrasonography is useful, safe, and available method for evaluation of size of abdomen internal organs. Also computerized tomography (CT) scan is accurate method in evaluation of children problem. The aim of present study was to compare of spleen volume and span and liver and kidney span using multiplanar CT scan vs. ultrasonography in 1-12 years old patients at Tabriz Children Hospital. **Methods and Materials:** In a descriptive analytical study, 35 children whom candidate for pelvic & abdomen CT scan and referred to Children Educational Medical Center of Tabriz University of Medical Sciences, were included the study and evaluated. Children were evaluated also by ultrasound modality. Age, sex, spleen span, spleen width, spleen thickness, length of right & left kidney, liver span in midclavicular line, and spleen volume based on ultrasonography & CT scan findings, were evaluated. **Results:** Based on CT scan report, spleen span, liver span, and spleen width were 101.31±32.28 mm, 101.57±29.25 mm, and 70.28±23.14 mm respectively, and based on ultrasonography report were 99.65±31.77 mm. 102.02±29.47 mm, & 68.31±22.04 mm. There were no significant differences in spleen span (P=0.063), liver span (P=0.609), and spleen width (P=0.082) between ultrasonography & CT scan findings. **Conclusion:** Based on the findings of present study; due to no significant differences between ultrasonography & CT scan findings in evaluating right and left kidney, liver & spleen span, and spleen width, they can use alternatively.

INTRODUCTION

Assessing the size of liver and spleen is of high importance in the physical examination of pediatric patients. Almost 15% of hospitalized pediatric patients have underlying conditions and disorders that results in an enlarged liver (1). Using only physical examination to assess the size of the liver is of little accuracy. Transabdominal ultrasonography has been able to estimate the size of the liver in cases of autopsy with a margin of error of only 1.58 percent (2).

Splenomegaly is also an important finding for physicians, and like hepatomegaly, physical examination is of low sensitivity and specificity in diagnosing it (3). And alike, biomedical imaging is of importance.

Ultrasonography is one of the methods utilized to estimate the size of internal organs and also to assess the existence of abnormal structures inside body cavities. Studies have shown that compared to other imaging techniques, ultrasonography is a cheaper method for imaging and it does not pose a proved threat to the safety of the patient as it does not emit any harmful particles or waves (4, 5). Also USs are more available than other imaging methods (6). Another merit of ultrasonography is its ability to produce live images which is of importance in specific fields of medicine such as obstetrics (7).

Computed tomography (CT) is another imaging method in which using X-rays, and computerized image processing, virtual cross sectional images of sections of body are produced. Ct scan is generally proven to be one of the most accurate imaging technique in estimating the size of various parts of the abdomen (8), but it costs more than a sonography and its usage is limited in pediatric patients because of the harmful X-rays used in the method (9).

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Previous studies have investigated if sonography can be used instead of CT scan in various clinical contexts (10). There are factors such as cost-effectiveness, sensitivity and specificity, possible harm to the patient, availability and accuracy and precision involved in deciding which method to use (11). Regarding the paucity of information in the clinical context of this study, the present study was done to compare the length and size of the spleen and length of the liver and kidneys estimated using multi-planar CT scan and ultrasonography in pediatric patients aging 1-12 years old presenting to the children's hospital of Tabriz University if Medical Sciences for imaging purposes.

METHODS AND MATERIALS

Patients

The present descriptive analytical study was conducted on 35 pediatric patients presenting to the biomedical imaging department of children's hospital of Tabriz University of Medical Sciences with a prescription of an abdominal and pelvic CT scan between June 2016 and June 2017. Because no similar study existed, sample population was estimated in a pilot study of 10 patients, with a confidence interval of 95 percent and power of 80 percent. The minimum sample size needed was estimated to be 34 patients. Convenience sampling was used afterwards to choose the sample population.

Inclusion and Exclusion Criteria

Inclusion criteria consisted of patients being aged 1-12 years, having a prescription of abdominal and pelvic CT scan, and signing written informed consent. Exclusion criteria consisted of aging more than12 years and less than one year, unstable patients, patients being referred from emergency departments of the hospital, and lack of interest.

Ultra-sonography

After the patients were included in the study, before performing the requested CT scan, patients were requested to take part in performing an ultra-sonography. An experienced sonographist used a Sonix-Op (Ultrasonix- Sasex, United Kingdom) model machine with a linear 5-14 Mega Hz probe and a convex 5-9 MgHz probe to conduct the imaging. Volume, length (span), width and thickness of spleen and the midclavicular span of the liver, and the length of the kidneys were measured.

CT Scan

Right after the sonography was performed, the patients were transferred to have a CT scan taken. Axial 2.5mm slices were obtained by a multi-slice CT scan (Somatom Balance, Siemens Medical Solutions, Forchheim, Germany) and multiplanar reformatting was done to produce sagittal, coronal and oblique views. volume, length, width and thickness of spleen and midclavicular span of liver and length of both kidneys were measured.

Measurement

In the sonography span or length of spleen was measured in a coronal view of spleen where the hilum of it was obvious; the widths and thickness of spleen were measured at the same place just by rotating the probe 90 degrees where the hilum of spleen was in the view. In the CT scan, the dimensions of the spleen were recorded in the portal phase. The conventional formula (length*width*thickness*0.52) was used to estimate the volume of the spleen (12). To assess the span of liver, the length between the diaphragm and inferior margin of the liver in the midclavicular line was measured. Span of kidneys was assessed by pole to pole length where the pelvis of kidney was in the view.

Blinding Protocol

To ensure a blinded evaluation; Patients first underwent a sonography, and the sonographist reported the results right after the procedure, and was blind to the results of the CT scan. The Radiologist responsible for reporting the CT scan was also blind to the results of the sonography. Patients were assigned two numbers one for the CT scan and the another for the ultrasonography, as to prevent further information leak between the Sonographist and the CT scan reporter. After both modalities were reported, they were collected and transferred for analysis.

Statistical Analysis

Statistical analysis was performed by SPSS (SPSS Inc., Chicago, IL). Data was presented as mean ± standard deviation. Paired T-test was used to compare the CT and Sonography values. P less than 0.05 was considered statistically significant. Power of the study was set at 80 percent.

Ethical Considerations

Protocol of the study was confirmed by the local ethics board of Tabriz University of Medical sciences. Legal Guardians of all patients signed written informed consent. The protocol of the study was in compliance with the Helsinki Declaration.

RESULTS

From all of the patients being studied, 22 (62.9%) were male and 13 (37.1%) were female. The mean age of the patients was 6.31±3.30 years.

Table 1 shows the results of the two method of measuring the length, width, thickness and volume of spleen. As it could be understood from the results, there was no significance between the two methods in measuring the span and width of the spleen (P=0.063 and 0.082 respectively). But the results showed that the measurement of thickness and volume of the spleen using CT scan is much higher than these measurement using sonography; and there was a meaningful difference between these two method of measuring the thickness and volume of the spleen (P=0.003 and P=0.001 respectively).

Table 2 present the results of the two method of measuring the length of liver and two kidneys. There was also no

Table 1. Comparison of measurement of length, width, thickness and volume of spleen using CT scan and sonography

	Method of imaging	Mean±SD	Maximum	Minimum	*P* value
Length of spleen	CT scan	101.31±32.38	213	47	0.063
	Sonography	99.65±31.77	199	75	
Width of spleen	CT scan	70.28±23.14	136	33	0.082
	Sonography	68.31±22.04	127	28	
Thickness of spleen	CT scan	34.02±12.55	82	16	0.002
	Sonography	31.82±13.18	80	16	
Volume of spleen	CT scan	141.32±119.72	26.40	554	0.001
	Sonography	126.88±120.46	25.20	553	

Table 2. Comparison of measurement of length of liver and kidneys using CT scan and sonography

	Method of imaging	Mean±SD	Maximum	Minimum	*P* value
Length of kidneys					
Right	CT scan	82.71±18.99	126	47	0.204
	Sonography	83.45±19.07	127	49	
Left	CT scan	85.45±18.74	124	50	0.945
	Sonography	85.48±18.45	123	51	
Span of liver	CT scan	101.57±29.25	165	55	0.609
	Sonography	102.02±29.47	163	55	

significant difference in determining the size of the kidneys (P=0.945 for left and P=0.204 for the right kidney). Measurement of span of liver in the midclavicular line has not any significant difference comparing two methods (P=0.609).

DISCUSSION

Assessment of internal organs using imaging modalities has a very important role in diagnosis and following of disease especially in children who cannot explain the symptoms appropriately. Sonography and CT scan are two main modalities which are used to investigate internal organs; echo of them has its own advantages and disadvantages. Sonography is a very useful method to investigate internal organs including liver, spleen and kidneys; it is cheap, safe and fast modality which does not use ionizing radiations. On the other side CT scan used ionizing radiation, more expensive but it is more accurate and has the ability to reconstruct images in multiplane views. When the patients are children it is very important to decide which modality to use. In this study we compared the results of measuring the length, width, thickness and volume of spleen and span of liver and kidneys using these to modalities in 1 to 12 years old children.

Our results showed that there is a significant difference measuring thickness and volume of spleen using sonography or CT scan; in which the measurement using CT scan was larger compared to sonography. On other hand, there was not any significant differences measuring the length (span) and width of spleen, span of liver in midclavicular line and span of kidneys between sonography and CT scan; which can be conclude that, we can use these two modalities instead of each other for measuring the length (span) and width of spleen, span of liver in midclavicular line and span of kidneys in children.

In a study by Gotzberger et al to compare sonography and CT scan in measuring liver span which was done on 241 patients; mean span of liver of patients using sonography was 107 ± 21 millimeters (mm) and using CT scan was 114 ± 37 mm. As results of our study, in this study there was not any significant differences in measuring liver span using these two modalities too (13). In another study done by Adibi et al in Isfahan, Iran, results showed that using sonography for measuring liver span was similar to CT scan so sonography can be used as an alternative method for CT scan for measuring liver span which is in concordance with our study's results (14).

The study of Thapa et al on 272 children including 152 boys and 120 girls aging from 1 month to 180 months showed that there is meaningful relationship between age and height of children and size of internal organs; this study also showed that as ours; there is not any significant differences between sonography and CT scan in measuring span of liver and kidneys (15).

In order to evaluating the volume of spleen by sonography and comparing the measurement with CT scan, Yetter et al did a study on 142 patients and measured the length, width thickness and craniocaudal length of spleen by sonography and volume and mentioned dimensions of spleen by CT scan. In this study the volume of spleen using sonography was calculated by a new formula (thickness*width* (span + craniocaudal length)/2 * 0.524). The results showed that results of measuring dimensions and volume of spleen by two methods are similar and had not any statistically meaningful differences (16). However, the results of our study showed that there is significant difference between CT scan and sonography measurement of spleen volume and thickness, which was larger using CT scan. As our study, the study of Lamb et al

on 50 patients revealed that there is a concordance between CT scan and sonography measuring the length and width of spleen; however, unlike our study, in this study there was also a concordance between CT scan and sonography measuring the thickness and volume of spleen (17).

In another study done by Bakker et al in order to compare volume of kidneys calculated by sonography and MRI on 20 volunteer patients aging from 19 to 51 years; the results showed that the volume of kidneys calculated using sonography is significantly lower that volume of kidneys using MRI (18). In our study also, the volume of spleen calculated by conventional formula using sonography was significantly lower than the volume of spleen measured by CT scan. This similarity between the results of two studies, can suggests that the volume of internal organs calculated by conventional formula using sonography is lower compared to other more accurate modalities.

In the study of Kang et al on 125 kidney donor patients, aimed to compare accuracy of various imaging modalities on measuring kidneys length; the dimensions of kidney were measured using sonography, intravenous pyelogram, CT scan and after nephrectomy. The results showed that the normal kidney of an adult has a 110.8 ± 9.6 mm length, 62.5 ± 6.7 mm width, 47.3 ± 6.5 mm thickness and 196.3 ± 41 grams weight. Compared to actual length of kidney, intravenous pyelogram measured 12 mm more, sonography measure 7 mm less and CT scan measured 5 mm less. The results of this study revealed that CT scan is a more accurate modality for measuring kidneys dimensions; unlike our study which showed that there is not any meaningful difference between CT scan and sonography on measuring kidneys length (19). In another similar retrospective study done by Larson et al on 76 patients the results showed that sonography measured kidney's length 5.6 ± 1.5 mm less than CT scan; which is in inconsistency with our study results (20).

Generally, majority of studies showed concordance between CT scan and sonography as two major imaging modalities in assessing internal organs' dimensions. So they can be used alternatively according to patient and disease conditions and available facilities. However, we recommend more studies in this regard with larger number of patients and various modalities. And also we recommend to involve patients' conditions in comparing different modalities.

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