To study ultrasound and chest X-ray findings and their role in the diagnosis of dengue fever in children

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Abstract

Introduction: Dengue fever is a fatal viral illness affecting almost all age groups and is seen in almost all tropical countries. Ultrasonography (USG) can be a useful tool for the assessment and diagnosis of dengue fever. **Objectives:** The study aimed to evaluate X-ray and ultrasound findings in children with dengue fever. **Material and Methods:** This was a prospective and cross-sectional study that was carried out in a hospital in Mumbai for over one year. All relevant data were collected, validated, and analyzed statistically on the software Epi Info 7. **Results:** Abnormal X-ray findings noticed were pleural effusion, pneumonia, and bilateral nodular opacities. Pleural effusion and respiratory complications were more common in severe dengue ($P < 0.05$). Out of the 37 patients on whom USG was done, 33 (89.18%) had abnormal and 4 (10.81%) had normal USG findings. Of the 17 patients with dengue who showed warning signs, 16 (89.9%) had abnormal USG findings. Plasma leakage in the form of ascites and effusion was commonly seen. One hundred percent of patients with severe dengue had abnormal USG findings. The abnormal USG findings were more commonly detected between 5–7 days and were more commonly associated with IgG + IgM–positive serology. **Conclusion:** Ultrasonography is a good modality for the diagnosis and evaluation of dengue patients. Serial ultrasound should be done for the assessment and evaluation of said patients.

Keywords: Abdominal ultrasound, ascites, dengue fever, dengue serology, pleural effusion

Introduction

Dengue is the most common viral illness seen in tropical countries.[1] If not recognized on time, it may eventually lead to shock and death.[2,3] Studies have shown that ultrasound findings can be used as a diagnostic tool in the absence of positive serological markers.[4] Ultrasound is an easily available, cost-effective, and non-invasive modality for the evaluation of dengue illness.[5,6] Serial ultrasonography can identify plasma leakage.[7,8] Studies on the role of chest X-ray and ultrasound in children who have dengue fever have been very limited since most of the data have been taken from adult populations. The index study was done to analyze various ultrasound and chest X-ray findings and diagnostic values in children with dengue fever.

Methodology

This study was done in the pediatric ward and intensive care unit of a tertiary care hospital in Mumbai; it enrolled a total of 100 patients with confirmed dengue fever. It was a comparative, cross-sectional study. The study included patients aged between 3 months and 14 years and who clinically presented or had laboratory reports confirming dengue. Full clinical details,

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examination findings, complications, and relevant laboratory and radiological investigations were done. Ultrasonography of the abdomen was done in patients within 3 days of admission and between 5–7 days of illness.

Data collection and analysis

All relevant data were collected, validated, and analyzed statistically on the software Epi Info 7. To compare the observations, the Chi-squared, correlation, and paired *t* tests were used. A *P* value less than 0.5 was considered significant.

Observation

There were a total of 57 male and 43 female patients, and the mean age of presentation of all participants was 7.97+ 3.84 years. Out of a total of 85 patients whose chest X-ray were done, 48 were men and 37 were women. A chest X-ray was performed on 85 patients, out of which, 11 had abnormal X-ray findings and 74 had normal X-ray findings. Out of the 11 patients who had abnormal X-ray findings, 6 had pleural effusion, 3 had pulmonary edema and ground glass opacities, and 2 had pneumonia. The distribution of the patients according to the grades of severity and chest X-ray findings are shown in Table 1. Out of 11 patients, 5 were tested positive for NS1, 1 for IgG, 2 for IgM, and 3 for both IgG and IgM. Three patients presented with acute respiratory distress syndrome (ARDS), and all had abnormal chest X-ray findings.

Out of a total of 37 patients who underwent ultrasonography, 21 were men and 16 were women. Out of these 37 patients, 4 (10.81%) had normal USG scan and 33 (89.18%) had abnormal ultrasound findings. Nine patients had dengue without warning signs, out of which 7 had abnormal findings in the form of gallbladder wall edema (pseudo thickening) only. Eighteen patients had dengue with warning signs, of which 16 (89.9%) had abnormal USG findings.

Plasma leakage in the form of ascites and effusion was seen in eight (21.62%) patients. Overall ascites was seen in 24 (64.86%), pleural effusion in 12 (32.43%), and gallbladder wall edema with ascites in 18 patients, as shown in Table 2. Some USG reports showed multiple abnormal findings involving more than two organs simultaneously.

Out of the 72 patients who were positive for NS1 antigen in our study, around 16.16% showed abnormal USG findings.

Abnormal USG findings were found in 6/10 (60%) patients who had tested positive for both IgG and IgM serology. The abnormal ultrasound findings were more commonly associated with NS1 positivity, followed by IgG, IgM, and IgG + IgM positivity. However, the positivity rate was more commonly associated with combined IgG and IgM serology, as shown in Figure 1. In some cases, both NS1 antigen and IgM or IgG were collectively positive.

Correlation with abnormal USG findings according to day of illness is shown in Table 3.

Discussion

Chest X-ray findings were abnormal in overall 11 patients, and in 54.5% of patients with severe dengue. The most common X-ray abnormality was pleural effusion, which is a sign of plasma leakage and which was significantly associated with severe dengue. All patients who presented with ARDS showed abnormal X-ray findings in the form of radiopacities/ground glass opacities and pulmonary edema. In our study, we noted that while a chest X-ray is less sensitive than a USG of the abdomen in diagnosing and assessing the severity of dengue illness, it is still a reliable tool in the diagnosis and early detection of ARDS. A chest X-ray is a good evaluation modality of investigation to assess the course of illness in dengue fever and should be done after the first week of the illness.[9]

The main key modality for determining the severity of dengue is USG of the abdomen. Motla *et al.*[10] and Chatterjee *et al.*[11] reported on the efficiency of USG in the diagnosis of dengue sickness before the positivity of serology. The most common finding in the index study was ascites and gallbladder edema. Gallbladder edema and ascites were found to be more sensitive, whereas pleural effusion and pericardial effusion were found to be more frequently associated and specific markers. In our study, no patient had pericardial effusion.

Although most studies show edema, ascites, pleural effusion, and hepatosplenomegaly as common findings in dengue patients, pericardial effusion is generally not commonly seen in dengue.[12] Our study also did not find pericardial effusion. One similar study by Khurram *et al.*[13] and Sahana *et al.*[14] showed that USG was a sensitive marker of plasma leakage, ascites, and pleural effusion. Ascites were also a common finding in our study, followed

Table 1: Association of chest X-ray and ultrasound findings with severity of dengue fever					
Final diagnosis		**Dengue with no warning signs**	**Dengue with warning signs**	**Dengue severe type**	**Total**
Chest X-ray	Abnormal	0 (0.0%)	5 (16.1%)	6 (54.5%)	11 (12.9%)
	Normal	43 (100%)	26 (83.9%)	5 (45.5%)	74 (87.1%)
	Total	43	31	11	85
X²=25.57; *P*<0.001; significant association					
USG abdomen	Abnormal	7 (77.8%)	16 (88.9%)	10 (100%)	33 (89.2%)
	Normal	2 (22.2%)	2 (11.1%)	0 (0%)	4 (10.8%)
	Total	9	18	10	37
X²=2.420; *P*=0.0299; significant association					

by gallbladder edema and then by pleural effusion. The USG findings of various studies are shown and compared in Table 4.

Abnormal USG findings were more commonly associated with IgG and IgM. These antibodies are detected after one week in the blood. By that time, abnormal USG findings also start to appear, and so the timing of doing an ultrasound in dengue is more crucial as it is better correlated with serological findings. Thus, USG can be used as a diagnostic tool in some of the more severe cases when laboratory reports are not available or awaited.

To assess the severity and serositis of severe dengue, a dengue score was developed by Suwarto S *et al.*[15] Variables like ascites or pleural effusion, hemoconcentration, hemoglobinemia, and thrombocytopenia were included because they could predict the severity of the disease.[15,16] Fluid leakage could be detected earlier than hematocrit.

In our study, it was found that 95.65% of the cases evaluated by USG showed abnormal findings when done between 5 and 8 days, in comparison to 78.57% in the first three days of life.
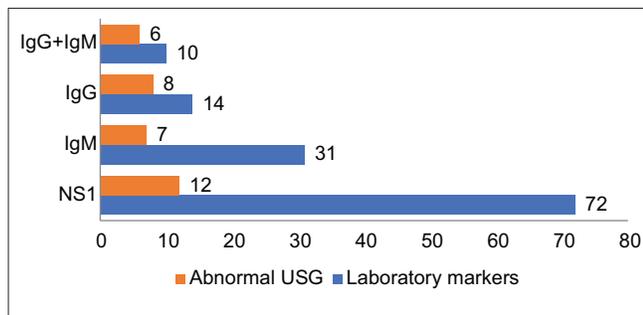

Figure 1: Correlation of positive serology with abnormal USG findings

Table 2: Distribution of various abdominal ultrasound findings in dengue fever

USG findings*	n (%)
Ascites with pleural effusion	8 (21.62%)
Pleural effusion	12 (32.43%)
Gallbladder edema wall thickening with ascites	18 (48.64%)
Overall ascites	24 (64.86%)
Splenomegaly	10 (27.02%)
Pericholecystic fluid	1 (2.70%)
Hepatomegaly	8 (21.62%)
Overall cases with abnormal findings	33 (89.18%)
Total USG cases	37 (100%)

P value is 0.2501

Table 3: Correlation with abnormal USG findings according to the day of illness

	USG done on Day 3	USG done on Days 5–7	P
Abnormal	11 (78.57%)	22 (95.65%)	0.0104
Normal	3 (21.42%)	1 (4.16%)	0.0104
Total USG	14 (37.83%)	23 (62.16%)	

A similar type of study conducted by Venkata Sai *et al.*[7] found that on the seventh day of illness, USG was more suggestive. Gallbladder edema, pleural effusion, and ascites are more easily detected later in the illness.

Other authors have also shown the role of conducting a serial ultrasound of the abdomen and the ideal timing as it has a higher predictive value at the end of the first week.[4,8,10] The positivity value is lower when it is done in the first three days of the illness. One possible reason might be that in the early days of illness, complications are not as common and vascular permeability and plasma leakage are not yet established. The other possible reason is that early reporting of the patient to the health facility and receiving early treatment means the patient may not develop some of the complications and that the maximum complications are seen in the second week only. Though USG findings are not specific for the diagnosis of dengue, if serological markers are inconclusive or unavailable, then USG can be used as a marker for the evaluation and progression of dengue illness.

Conclusion

Chest X-rays are a reliable test to rule out complications of dengue fever, especially plasma leakage and pneumonia. Ascites, pleural effusion, gallbladder edema, and hepatomegaly were the most common USG findings in our study. Abnormal USG findings were more commonly associated with severe dengue, were better detected at end of the first week, and were more commonly associated with IgG + IgM–positive serology. Ultrasonography is a good bedside modality for the diagnosis and evaluation of dengue patients.

Key points

- The mean age of presentation of patients in our study was 7.97+ 3.84 years.
- Abnormal X-ray findings noted were pleural effusion, pneumonia, and bilateral nodular opacities.
- Pleural effusion and respiratory complications were more common in severe dengue ($P < 0.05$).
- Out of 37 patients where USG was done, 33 (89.18%) showed abnormal and 4 (10.81%) showed normal USG findings.
- A total of 89.9% of patients had abnormal USG findings where the patient presented with warning signs. The most common ultrasonographic findings seen were plasma leakage in the form of ascites and effusion.
- Patients with severe dengue had almost 100% abnormal USG findings.
- Abnormal USG was more commonly seen between 5 and 7 days of the illness ($P < 0.05$), and patients with IgG + IgM– positive serology had more abnormal USG findings.
- The serial ultrasound is a must for the assessment of severity and evaluation of children suffering from dengue illness. Ultrasonography performed at the end of the first week was more sensitive.

USG findings	Motla et al.[10]	Chatterjee et al.[11]	Venkata Sai et al.[7]		Balasubramaniyan et al.[6]	Gupta V et al.[12]	Sahana et al.[14]	Our study
			2-3 day	5-7 day				
Ascites	74.6%	77.08%		96%	71.42%	50.6%	48.1%	64.86%
Pleural effusion	39.6%	45.8%	6.25%	87.5%	71.42%	32%	39.5%	32.43%
Gallbladder wall thickening	72%	83.77%	100%	100%		87.6%	53.1%	48.64%
Hepatomegaly	46.2%	87.5%	21%	21%		18.5%	51.9%	21.62%
Splenomegaly	39.1%	35.41%	6.25%	7%		20.9%		27.02%
Pericholecystic fluid	37.3%	83.33%	100%					2.70%
Others:								Ascites + effusion=21.62%
Pericardial effusion			28%	28.5%	31.42%			
Hemoconcentration					51.14%			
Hypoproteinemia								

Table 4: Comparison of abnormal USG findings in various studies

Take-home message for treating physicians

Studies on the role of chest X-rays and ultrasound in dengue fever are very limited in children. Abdominal sonography is a useful diagnostic tool in suspecting and diagnosing dengue fever. It can also predict the severity of the illness and complications like early leakage, pleural effusion, ascites, edema of the gallbladder wall, splenomegaly, hepatomegaly, and pericardial effusion. A single finding is generally less reliable because findings may evolve with the progression of the disease; thus, repeated USG should be done after one week. The ideal timing of conducting USG in dengue fever is 3–5 days after the onset of the fever. All sick dengue patients should undergo serial USG examinations for early diagnosis and to assess the severity and progression of the disease. The ultrasound findings will help in deciding the line of treatment and will help in the outcome of sick patients.

Novelty

Ultrasound can be used as a tool to determine severity of dengue fever in conjunction with other parameters when other serology reports are awaited. It has good diagnostic value in the assessment of severity of the patient. This will help in the early and timely identification and picking up of complications earlier in dengue patients, which will result in better patient outcome. It can be used as a bedside modality for the assessment of cardiac function, organ dysfunction, complications of dengue, the status of the inferior vena cava, and to assess fluid responsiveness in a state of shock.

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Conflicts of interest

There are no conflicts of interest.

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