

Ultrasound

Clinical case study

# Diagnosis and management of pediatric steatosis using ultrasound

# Background

Ultrasound shear wave elastography (SWE) has emerged as a non-invasive imaging technique that shows promising reliability and clinical utility in the quantitative assessment of liver tissue stiffness in children. The basic underlying premise in quantitative SWE measurements is that shear wave velocity through the liver increases as liver parenchyma becomes stiffer under pathologic conditions, such as fibrosis. This tool is being increasingly used by clinicians who treat patients not only with non-alcoholic fatty liver disease (NAFLD) but also other liver diseases in children such as Alpha-1 antitrypsin deficiency, autoimmune hepatitis, biliary atresia and congenital heart disease.

NAFLD is the most common cause of chronic liver disease in children, affecting one in ten children, but this rate can be as high as 70–80% among those children who are considered obese.1 If left untreated, the condition can scar the liver (fibrosis and cirrhosis) and increase the risk of developing liver failure or liver cancer as an adult. NAFLD is currently the second-leading indication for liver transplantation in adults in the US, and is projected to be the most common indication in the next decade.<sup>1</sup>

#### Presentation and assessment guidelines

NAFLD and non-alcoholic steatohepatitis (NASH) are considered silent diseases because they often have no symptoms. For many pediatric patients, the only symptoms are feeling tired or having discomfort in the upper right abdomen.<sup>2</sup> A diagnosis of NAFLD is based on a combination of medical history, physical examination and blood tests. Patients who are obese and have higher-than-normal levels of certain liver enzymes on routine blood tests are more likely to have NAFLD. Ultrasound SWE is used to measure liver stiffness and the amount of liver fat.  $^{\scriptscriptstyle 3}$ 

- There is no clinically significant fibrosis present with SWE values under 1.37 m/s
- SWE values 1.38 2.1 m/s indicate the need for further work-up and/or follow-up
- Advanced fibrosis/cirrhosis is suspected with SWE values over 2.2 m/s

A needle biopsy is sometimes necessary to assess fat buildup and scarring in the liver to identify the presence of simple NAFLD or NASH.

#### **Patient management**

While there is no medication to reverse or cure fatty liver disease, lifestyle changes can have a major impact on disease progression in both the short and long term.

- Encourage healthy eating and weight loss
  Maintain tight control of blood sugar levels
- for patients with diabetes

  Monitor the patient for complications or progression
- from NAFLD to more severe NASH

If not brought under control, cirrhosis can lead to complications that include portal hypertension, as well as liver failure or liver cancer, and may require liver transplantation.

The following four clinical case studies from Phoenix Children's Hospital use Philips EPIQ Elite ultrasound system. They highlight the effectiveness of elastography in providing high-quality images for managing pediatric patients suspected of liver disease.

# Case 1

A 12-year-old obese male (>99 percentile BMI) with abnormal glucose and elevated liver enzymes was referred for ultrasound of the liver with Doppler and SWE. Ultrasound revealed an echogenic liver most likely due to fatty infiltration. Doppler values were within normal limits. The average elasticity of the liver measured 1.14 m/s, revealing no clinically significant fibrosis was present. No further imaging or biopsy was required. Patient was scheduled for an annual elastography exam to ensure no further development of fibrosis.

An echogenic liver with normal Doppler values. SWE of the liver revealed no clinically significant fibrosis.



Right lobe of liver in transverse view





Transverse view of liver using SWE

## Case 2

An 11-year-old overweight male with elevated liver enzymes and concerns for NASH was referred for ultrasound of the liver with Doppler and SWE. Ultrasound revealed mild hepatomegaly with a diffusely echogenic liver compatible with hepatic steatosis. The mildly elevated main portal vein velocity on Doppler examination and a liver elasticity average of 2.03 m/s suggest fibrosis. No further imaging or biopsy was required. Patient was referred to a registered dietician for weight loss as well as a three-month follow up with repeat lab tests.

## Doppler and the degree of liver stiffness shown by SWE indicate the need for possible further evaluation.



Right lobe of liver in sagittal view



### Right lobe of liver in transverse view



Transverse view of liver using SWE

ElastQ imaging provides a highly accurate, fast, cost-effective, reproducible and non-ionizing solution for managing pediatric patients suspected of liver disease.

# Case 3

A 6-year-old male with complex congenital heart disease presented post-Fontan procedure to the ultrasound department for an ultrasound of the liver with Doppler and elastography. The ultrasound examination revealed an echogenic, slightly heterogeneous liver texture. Doppler waveforms were within normal limits. Elasticity average was 2.6 m/s. Based on SWE values, advanced fibrosis or cirrhosis was suspected. No further imaging or biopsy was required. The findings are consistent with cardiac cirrhosis and will likely require a liver transplant. Since the results are more consistent with cardiac etiology, the patient was continued to be managed by an interprofessional team, including a pediatric cardiologist.

Note the echogenic and slightly heterogeneous liver texture. Elasticity average was 2.6 m/s, suggestive of advanced disease.



Right lobe of liver in sagittal view



Right lobe of liver in sagittal view



Transverse view of liver using SWE

# Case 4

A 22-month-old female with biliary atresia after a Kasai procedure was referred for an ultrasound of the liver with Doppler and SWE. Ultrasound revealed a heterogeneous echogenic appearance of the liver; these findings are consistent with a history of biliary atresia and Kasai procedure. Developing fibrotic changes are possible. Mildly elevated resistive indices were found within the main hepatic artery duplex study. The right lobe elasticity average was 2.05 m/s, suggesting that the liver was not in an advanced stage of fibrosis. No further imaging or biopsy was required. Post-Kasai procedure, bile has drained and patient is doing well and has been removed from the transplant list.

Note the heterogeneous echogenic appearance of the liver. Right lobe elasticity indicates need for possible further work-up.



Right lobe of liver in transverse view



Right lobe of liver in sagittal view



Transverse view of liver using SWE



#### About the author

Monique Riemann, RMDS, RVT is an ultrasound technologist at Phoenix Children's Hospital with over 30 years of experience in the field. Her registries include Abdomen, OB/GYN, Vascular, Neuro and Pediatric. After many years in a lead sonographer position she transitioned to a research position where she has helped to create ultrasound exams that were once radiation-based by utilizing the "Think Ultrasound First" motto. In 2020 she became a published author with her article on sonography of magnetically controlled growing rods.

# **Technology** perspective

Since its introduction, ultrasound SWE has served as a primary diagnostic modality when assessing pediatric liver steatosis. The use of liver elastography has decreased the number of liver biopsies necessary to diagnose levels of liver disease. Advancements in ultrasound and transducer technology allow clinicians to quickly assess patients for levels of liver steatosis. The Philips EPIQ Elite pediatric solution offers clinically tailored tools designed to elevate diagnostic confidence.

### nSIGHT Imaging architecture



Frame rates Focused Penetration beam

This imaging architecture features a multi-stage precision beamformer with massive parallel processing.

- Improves frame rates in all imaging modes
- Improves beam focusing throughout the image to visualize superficial vessels as well as deeper veins
- Provides better penetration with resolution at depth

## C5-1 PureWave transducer

PureWave transducers enable imaging versatility with extraordinary levels of detail, offering an increase of up to 76% in penetration and 213% in temporal resolution.\* They aid >85% completion rate for technically challenging exams.\*\*

Compared to conventional transducer technologies, the C5-1 PureWave transducer resulted in significant advantages.\*\*\*

- Exam times reduced by 2% to 38%
  Reduction in pain and fatigue from
- scanning in 29% to 85% of the cases • Marked improvement in color
- sensitivity in 31% to 86% of the cases

## ElastQ Imaging

With EPIQ Elite, ElastQ Imaging provides a noninvasive, easy-to use technique to create detailed measurements of liver stiffness in real time

- Color-coded stiffness and velocity map allows the assessment of liver tissue stiffness
- Real-time feedback through quantitative measurements
- Accurate and reproducible stiffness
   results



\* 2013 quantitative engineering study comparing Philips iU22 ultrasound system with EPIQ 7.

\*\* Summary of results from EMEA technically difficult patient study (EPIQ), 2014.

\*\*\* https://www.usa.philips.com/c-dam/b2bhc/us/feature-details/purewave/45229112881\_EPIQ\_PureWave\_DataSheet\_FNL\_lr.pdf

### Additional reading

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Results from case studies are not predictive of results in other cases. Results in other cases may vary.

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