



ORIGINAL REPORT

Acoustic radiation force impulse imaging elastography is efficacious in detecting hepatic fibrosis in children[☆]



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KEYWORDS

Acoustic radiation force impulse imaging;
Staging hepatic fibrosis;
Elastography;
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Abstract

Objective: To evaluate the diagnostic performance of acoustic radiation force impulse imaging (ARFI) in detecting significant hepatic fibrosis in children.

Material and methods: Our hospital's ethics committee approved the study and all patients or their representatives provided informed written consent. We included 96 children (50 boys, 46 girls; mean age, 8 years). We also studied 16 volunteers without liver disease as controls and 80 patients with diseases that can lead to fibrosis and cirrhosis of the liver. The final sample included 31 patients with biopsies and the 16 controls. All patients underwent abdominal ultrasonography including Doppler imaging and elastography with ARFI. The ARFI value, expressed as velocity (m/s) of shear wave propagation through the tissue, was calculated by averaging 16 measurements in both liver lobes. We used one-way analysis of variance to compare means between groups; we set statistical significance at $P < 0.05$. We used Student's *t*-tests and chi-square tests for categorical data.

Results: The ARFI value in children with fibrosis $\geq F2$ was higher (1.80 ± 0.45 m/s) than in controls and higher than in patients with F0–F1 (1.38 ± 0.22 m/s). The difference was significant ($P < 0.001$) for detecting $\geq F2$. Steatosis was not related with the ARFI value (Student's *t*-test, $P > 0.84$). Necroinflammatory activity was strongly associated with the ARFI value (Student's *t*-test, $P < 0.01$). Fibrosis and necroinflammatory activity were strongly associated with each other (chi-square test, $P < 0.0001$).

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Conclusion: The speed of shear wave propagation is significantly associated with the degree of hepatic fibrosis in children.

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PALABRAS CLAVE

Acoustic radiation force impulse;
Fibrosis hepática;
Elastografía;
Niños

La elastografía mediante técnica Acoustic radiation force impulse es eficaz en la detección de fibrosis hepática en el niño

Resumen

Objetivo: Evaluar el rendimiento diagnóstico de ARFI para detectar fibrosis hepática significativa en la edad pediátrica.

Material y métodos: El estudio fue aprobado por el comité de ética hospitalario, con el consentimiento informado de los pacientes o sus representantes. Estudiamos 96 niños (50 varones, 46 hembras; edad media 8 años); 16 voluntarios sin enfermedad hepática conocida y 80 con patologías que pueden evolucionar a fibrosis y cirrosis hepática. La muestra final incluyó 31 pacientes con biopsia y 16 controles sanos. En todos los casos se realizó ecografía abdominal incluyendo Doppler y elastografía con ARFI. El valor ARFI expresado como velocidad (m/s) de propagación de las ondas transversales a través del tejido se calculó promediando 16 medidas en ambos lóbulos hepáticos. Comparamos las medias con el test de ANOVA de un factor. Los tests t de Student y chi cuadrado se usaron para datos categóricos. La significación estadística se estableció para una $p < 0,05$.

Resultados: La velocidad en niños con fibrosis \geq F2 fue significativamente más alta ($1,80 \pm 0,45$ m/s) que en controles y pacientes con F0-F1 ($1,38 \pm 0,22$ m/s) ($p < 0,001$). La esteatosis no se relacionó con la velocidad. La actividad necroinflamatoria se relacionó muy significativamente con la velocidad ($p < 0,01$). Fibrosis y actividad necroinflamatoria se relacionaron muy significativamente ($p < 0,0001$).

Conclusión: La velocidad de propagación de las ondas ARFI se relacionó significativamente en los niños con el grado de fibrosis hepática.

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Introduction

When chronic diffuse liver disease is assessed, estimating the degree of fibrosis is key for staging the disease, making therapeutic decisions, monitoring the disease and establishing a prognosis. The liver biopsy is a bloody, expensive technique, with associated risks of serious complications,^{1,2} which in addition to inter- and intra-observer variability during the estimation of the degree of fibrosis, may not reflect the disease's global activity.³⁻⁵ On the other hand, serological biomarkers and transitional elastography (FibroScan®, Echosens, Paris, France)⁶ to measure liver rigidity are bloodless methods developed to assess hepatic fibrosis. Both techniques are simple and well tolerated by the patients. But FibroScan® also has limitations and in approximately 5% of the patients, especially in cases of obesity and ascites, it cannot measure reliably.⁷ Among the alternatives there are some imaging techniques being developed today such as the elastography, the magnetic resonance hepatic diffusion, computed tomography digital optical analysis of liver images and real time tissue elastography.^{8,9} Although the preliminary results are encouraging, these techniques are more expensive, they are not available in all healthcare centers and it takes too much time to apply them clinically in hepatic fibrosis.

The *Acoustic Radiation Force Impulse* (ARFI) technique is a method to virtually quantify hepatic rigidity through integrated software (Virtual Touch Tissue Quantification, Siemens, Erlangen, Germany) in a conventional ultrasound scanner. It emits a series of short ($\approx 100 \mu\text{s}$), high-energy, low-repetition frequency pulses (*pulse repetition frequency*) with a modified transducer. The pulses alter the tissue mechanically causing waves that produce local perpendicular (transverse) micro-displacements toward the acoustic pulses. ARFI allows us to measure the wave propagation speed, a biological parameter considered to be analogous to elasticity. Several studies conducted in adults have evaluated ARFI's clinical utility in the estimation and categorization of liver fibrosis,¹⁰⁻¹⁴ in the assessment of thyroid nodes, breast lumps, hepatic and renal tumors, in the characterization of atheroma and in the monitoring of the radiofrequency ablation outcomes.¹⁵⁻¹⁸ In children, a varied group of liver diseases can produce fibrosis and advance into mid- or long-term cirrhosis.¹⁹ Liver fibrosis is not a static lesion^{20,21} and it can go better or worse depending on how active the disease really is this is why its monitoring is warranted.

Studies on the ARFI utility in the follow-up of chronic liver disease in children are scarce.²²⁻²⁷ The purpose of this article is to assess the diagnostic performance of hepatic

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