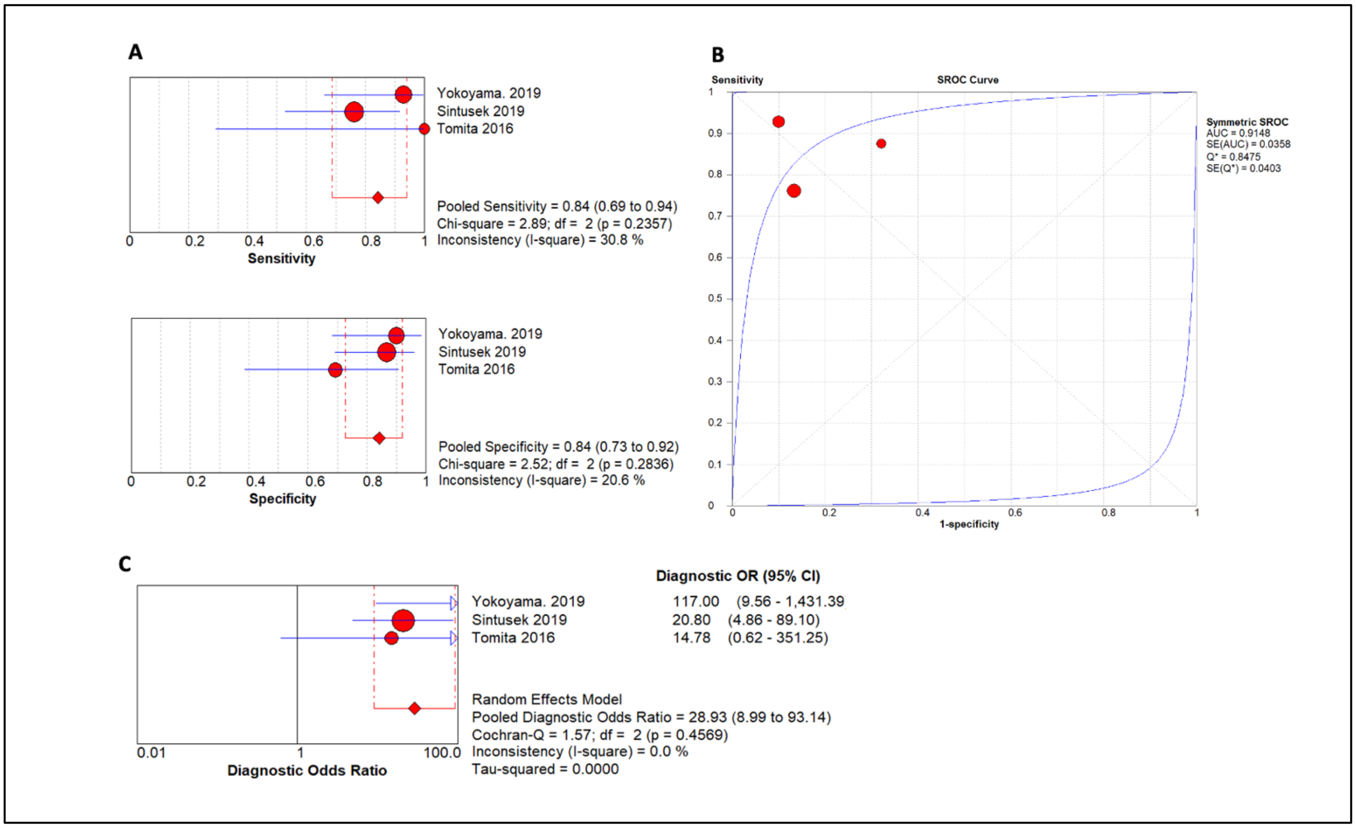
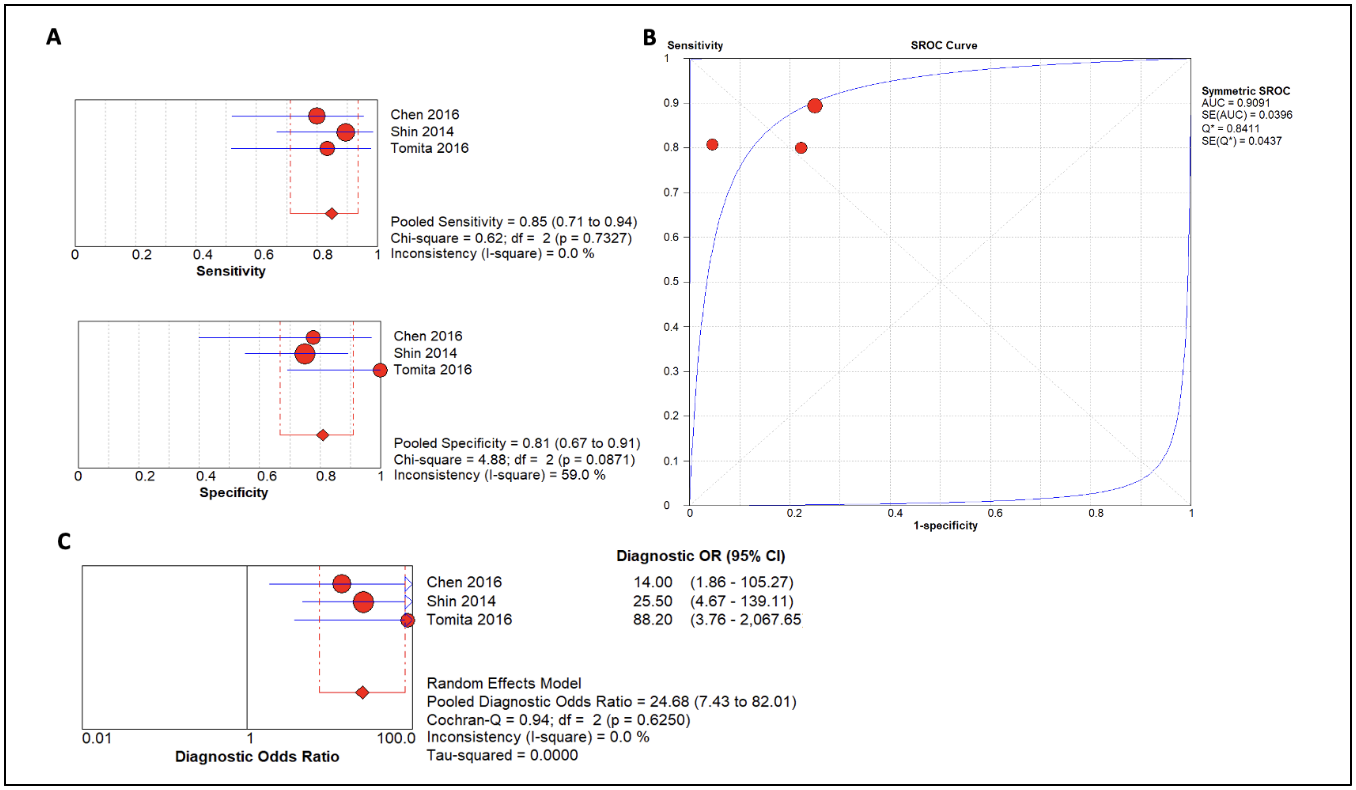
Supplementary material



Supplementary Figure 1. *Forest plot of spleen stiffness value measured by SWE to predict the presence of varices in post-Kasai patients. A: diagnostic sensitivity and specificity; B: summary receiver operating characteristic curve; C: diagnostic odds ratio.*



Supplementary Figure 2: *Forest plot of liver stiffness value measured by SWE to predict the presence of liver fibrosis F3-4 (Vs F0-2) in post-Kasai patients. A: diagnostic sensitivity and specificity; B: summary receiver operating characteristic curve; C: diagnostic odds ratio.*

Supplement data.

Ultrasound elastography is an imaging technology sensitive to tissue stiffness, developed and refined to enable quantitative assessments of tissue stiffness. Elastography assesses tissue elasticity, which is the tendency of tissue to resist deformation with an applied force.

The below concept was adapted from Sigrist et al., 2017.

Shear modulus is one of several quantities for measuring the stiffness of materials. All of them arise in the generalized Hooke's law: (1) **Young's modulus [*E*]** (when a normal stress produces a normal strain), (2) **Bulk** modulus [*K*] (when a normal inward force or pressure produces a bulk strain), and (3) **Shear modulus [*G*]** (when a shear stress produces a shear strain). Poisson's ratio connects these moduli for isotropic materials.

Poisson's ratio [*ν*] describes the response in the directions orthogonal to this uniaxial stress (the wire getting thinner and the column thicker)

$$E = 2G\,(1 + \nu) = 3K\,(1 - 2\nu)$$

In addition to the above equations which describe static deformations, the elastic modulus Γ also characterizes the propagation speed of waves

$$C = \sqrt{\frac{\Gamma}{\rho}}$$

where ρ is the material density and C is the wave speed

Shear waves have particle motion perpendicular to the direction of wave propagation, and are defined using the shear modulus *G* as:

$$C_S = \sqrt{\frac{G}{\rho}}$$

where the shear wave speed (C_S) is approximately 1-10 m/s in soft tissues. The low wave speed in soft tissues allows for high differences in G between tissues, giving suitable tissue contrast for elastography measurements.

The relationships between Young's modulus *E*, shear modulus *G*, and shear wave speed C_S are important because different parameters are reported according to the elastography technique

$$E = 2G\,(1 + \nu)$$

Given the high-water content of soft tissue, the Poisson's ratio (v) is near 0.5 of an incompressible medium:

$$E = 3G$$

$$C_S = \sqrt{\frac{G}{\rho}}$$

$$G = \rho\ C_S^2$$

$$E = 3\ \rho\ C_S^2$$

Considering the mean hepatic density is 1.051 ton/m^3 as per Overmoyer 1987, when rounded to 1 ton/m^3, the equation can be simplified as $\boldsymbol{E = 3C_S^2}$

Hepatic Density	ρ	ton/m^3
Shear Wave Speed	C_S	m/s
Stiffness (Young's Modulus)	E	kPa

Units Conversion

$$\begin{aligned}
LHS &= kPa \\
RHS &= ton/m^3 \times (m/s)^2 \\
&= 1{,}000\ kg/m^3 \times (m/s)^2 \\
&= 1{,}000\ kg.m^2 / (m^3.\ s^2) \\
&= 1{,}000\ kg.m^{-1}.s^{-2} \\
&= 1{,}000\ (kg.m/s^2)/m^2 \\
&= 1{,}000\ N/m^2 \\
&= 1{,}000\ Pa \\
&= kPa
\end{aligned}$$

References:

Sigrist RMS, Liau J, Kaffas AE, Chammas MC, Willmann JK. Ultrasound Elastography: Review of Techniques and Clinical Applications. *Theranostics*. 2017;7(5):1303-1329. Published 2017 Mar 7. doi:10.7150/thno.18650.

Overmoyer BA, McLaren CE, Brittenham GM. Uniformity of liver density and nonheme (storage) iron distribution. Arch Pathol Lab Med. 1987 Jun;111(6):549-54. PMID: 3579513.