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Point-shear wave elastography predicts liver hypertrophy after portal vein embolization and postoperative liver failure

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Portal vein embolization;
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Shear-wave velocity;
Point-share wave elastography (SWE)

Abstract
Purpose: To correlate point-shear wave elastography (SWE) with liver hypertrophy after right portal vein embolization (RPVE) and to determine its usefulness in predicting postoperative liver failure in patients undergoing partial liver resection.
Patients and methods: Point-SWE was performed the day before RPVE in 56 patients (41 men) with a median age of 66 years. The percentage (%) of future remnant liver (FRL) volume increase was defined as: $\frac{(\%FRL_{post}-\%FRL_{pre})}{\%FRL_{pre}} \times 100$ and assessed on computed tomography performed 4 weeks after RPVE.
Results: Median (range) $\%FRL_{pre}$ and $\%FRL_{post}$ was respectively, 31.5% (12—48%) and 41% (23—61%) ($P < 0.001$), with a median %FRL volume increase of 25.6% (—8; 123%). SWE correlated with %FRL volume increase ($P = —0.510$; $P < 0.001$). SWV ($P = 0.003$) and $\%FRL_{pre}$ ($P < 0.001$) were associated with %FRL volume increase at multivariate regression analysis. Forty-three patients (77%) were operated. Postoperative liver failure occurred in 14 patients (32.5%). Median SWE was different between the group with (1.68 m/s) and without liver failure (1.07 m/s) ($P = 0.018$). The AUROC of SWE predicting liver failure was 0.724 with a best cut-off of 1.31 m/s, corresponding to a sensitivity of 21%, specificity of 96%, positive predictive value 75% and negative predictive value of 72%. SWE was the single independent preoperative variable associated with liver failure.

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Conclusions: SWE assessed by point-SWE is a simple and useful tool to predict the FRL volume increase and postoperative liver failure in a population of patients with liver tumor.

Introduction

Surgical resection is one of the main curative options for patients with primary and secondary liver tumors. However some patients are considered as having unresectable disease because of an insufficient future remnant liver (FRL) volume, which poses the risk of liver failure after resection and is also directly linked to postoperative morbidity [1]. In these patients, percutaneous portal vein embolization (PVE) is a safe and well-accepted technique, which helps induce sufficient liver hypertrophy to allow further surgery [2—6]. PVE consists of occluding segmental portal branches that will be resected thereby redistributing portal blood flow toward the FRL [2,7]. There is no way to accurately predict liver hypertrophy after PVE and only a few factors are known to be associated with liver hypertrophy. They include pre-PVE FRL volume, diabetes and liver fibrosis assessed on biopsy or surgical specimen (which is also associated with postoperative morbidity) [2,4,5]. While pre-PVE FRL volume and diabetes are assessed non-invasively, liver fibrosis staging can be performed by percutaneous liver biopsy, which is invasive and associated with patient discomfort [8] and also suffers from intra- and interobserver variability and sampling errors (4,5). Elastography is a well-documented tool to non-invasively and accurately assess liver fibrosis stage. Among the different elastography systems, shear wave elastography (SWE), compared to Fibroscan®, has the advantage of being directly integrated on standard ultrasonography devices, allowing selection of the site of measurement on real-time B-mode imaging and so avoiding possible tumor lesions [9,10].

Therefore the primary aim of this study was to assess the correlation between the percentage (%) of FRL volume increase after PVE and shear waves velocity (SWV) measured before PVE. Secondary aims were to assess the association between SWV before PVE and postoperative liver failure.

Patients and methods

Study design and patient selection

This retrospective study was approved by the institution's human research committees. Informed patients' consent was waived. During two years, from 2013 to 2015, we included all consecutive patients undergoing right PVE prior right hepatectomy for primary (benign or malignant) liver tumor (on healthy or cirrhotic liver) or liver metastasis. Additional inclusion criteria were:

- patients undergoing SWV measurement during the ultrasound examination performed the day prior PVE to check portal vein permeability;
- patients older than 18 years.

Exclusion criteria were:

- left PVE;
- invalid SWV measurement (interquartile range/median > 60%);
- patients with no imaging examination available for review on our picture archiving communication system (Fig. 1).

Shear wave velocity measurement by point-SWE

Point-SWE imaging is a method of quantifying the mechanical properties of tissues, without manual compression, by measuring the shear wave velocity induced by acoustic radiation and propagating in the tissue [11—13]. This quantitative technique provides a single unidimensional measurement of tissue elasticity like transient elastography. The region is a 1×0.5 cm rectangle, which can be freely moved in the two-dimensional B mode image to a maximum depth of 8 cm from the skin surface. Measurements are expressed as m/s, indicating shear wave speed travelling perpendicular to the shear wave source [14,15].

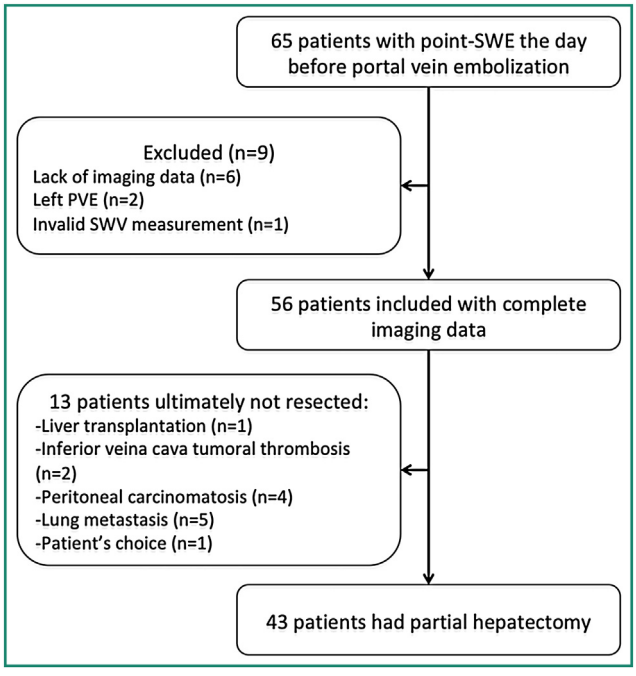

Figure 1. Flow-chart diagram of the study patients. Among the 65 portal vein embolizations performed from 2013 to 2015, 56 patients were included and 43 were ultimately operated on. Point-SWE indicates point-shear wave elastography.