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LETTER TO THE EDITOR

Response to the Letter: Shear wave velocity might correlate with portal venous perfusion if correct portal venous perfusion techniques are used

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Dear Editor,

We read with interest the comments of Drs. Tsushima and Taketomi-Takahashi with respect to the magnitude of PVP values in our patient cohort.

We admit that the absolute PVP values found in our study were comparably lower than those in reports cited by the two colleagues, and also significantly lower compared to our own experience in non-cirrhotic patients.

First, we want to clarify how these measurements were performed. The SW we employed was indeed based on the dual-input maximum slope model using the "direct" method as originally proposed by Blomley [1], but with the simplification suggested by Dr. Tsushima himself [2]. That means: splenic peak enhancement was used to separate arterial and portal phases, and the maximum slope in both phases was divided by peak aortic and portal-venous enhancement, respectively, but without subtracting a scaled splenic time-attenuation curve. This approach has frequently been used in different previous reports on liver perfusion. In fact, our scan protocol (temporal resolution, scan time), injection protocol (50 ml in 10 s), and SW were identical to those used in a study on normal livers [3], which resulted in ALP values of about 10 and PVP values of 80–100 ml/100 ml/min, respectively. The measured PVP values in our cohort ranged between 1.6 and 34.3 ml/100 ml/min, whereas the ALP values reached values up to 46 ml/100 ml/min, but we also had outliers with very low perfusion values that ultimately resulted in a low mean PVP. We have no simple explanation for the obvious discrepancy; there are very limited data on PVP in cirrhosis. In comparison to the two papers quoted that also used the dual maximum slope method, there are several differences that might be responsible. We used 3-mm slices with whole liver coverage with registration, i.e., we were always able to select a portal-venous branch without partial volume effects. In single scanning or scanning with few slices, this might not be the case, leading to lower portal-venous enhancement and higher PVP values. Both papers also used shorter injection times (5 s, 8 s), providing better separation, and calculated values only from ROIs and not from voxel-based parameter maps. This has almost no noise and allows correcting for the arterial component in portal-venous phase. All these effects tend to raise PVP values. In retrospect, there might also have been a problem with the patient selection, i.e., including many cirrhotic livers with severe macronodular changes due to chronic alcohol consumption, leading to severe portal hypertension and consecutively decreased portal-venous supply to the liver. However, we did not consequently assess all factors potentially influencing the magnitude of portal-venous flow to the liver (e.g., portal flow direction and velocity, the degree of portal-venous shunting for instance by patent umbilical vein). As indicated in the M and M section, we had 74% patients with HCC in our cohort, which was the primary indication for liver perfusion CT, and this might indirectly have influenced the ALP/PVP quantification, although we set the ROIs knowingly centimeters apart from tumor-involved liver areas. Nonetheless, an increased arterial supply towards involved liver lobes or caused by occult tumor parenchymal infiltration could not be entirely excluded. Moreover, the

Concerning our paper entitled: Correlation between acoustic radiation force impulse (ARFI)-based tissue elasticity measurements and perfusion parameters acquired by perfusion CT in cirrhotic livers: a proof of principle.

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liver areas used for quantification of perfusion on the generated maps were chosen analogously with those used for ARFI quantification in the anterior liver segments 4a/2/3, which knowingly also show lower levels of perfusion [3]. Wm T et al. [4] described the declining magnitude of PVP values with advancing cirrhosis with ranges between 20 and 40 ml/100 ml/min.

But in summary, we do not have a clear explanation for the discrepancy.

Respectfully,

Michael Esser.

Compliance with ethical standards

Conflict of interest Michael Esser declares that he has no conflicts of interest.

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