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REPLY

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Vena caval blood flow affects the quality of CTPA during pregnancy

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Sir,

We thank Dr. Karabulut for his insightful comments regarding the effects of breathing on caval blood flow in pregnancy and its potential effects on enhancement during CTA of the pulmonary arteries.

We all have seen unexplained failure of contrast-enhancement in CT angiography of the pulmonary arteries. In our practice we can sometimes identify breathing-related effects, especially deep inspiration and Valsalva manoeuvres as the culprit [1]. The precise mechanisms, however, have not yet sufficiently been studied. The work by Kuzo et al. is a starting point [2]. The authors used MR to measure blood flow in the superior vena cava (SVC) and inferior vena cava (IVC) during various respiratory manoeuvres in a small number of volunteers. Kuzo et al. found that deep continuous inspiration, such as performed immediately prior to data acquisition in a typical pulmonary CTA ("take a deep breath"), will increase total venous return and increase the relative contribution of the IVC to venous return. This should lead to dilution of the injected contrast material. Pulmonary CTA in breath-hold, however, will be started exactly by the time this diluted contrast material reaches the lung. This effect could explain the modest enhancement in those patients that are especially compliant with the breathing command and take a very deep breath. The Valsalva manoeuvre, on the contrary, should be good for enhancement because it reduces venous return and therefore should reduce dilution.

Clinical practice, however, teaches that enhancement during a Valsalva manoeuvre is often not optimal, which suggests that there are more influencing factors. When looking at the data published by Kuzo et al., one sees that a potential explanation lies in the substantial interindividual variation of the relative contribution of the SVC and IVC: the ratio of blood flow in the SVC and IVC varies between approximately 1 and 3 for the Valsalva manoeuvre and between 1.1 and 3.6 for the inspiration manoeuvre. The variability in end-inspiration is much less, between 1.2 and 2.2. This suggests that patients react differently to the inspiratory commands (as is known from the ultrasound literature [3]), which in turn may cause substantial variations in contrast enhancement.

While the work of Kuzo provides better understanding of the influence of breathing on caval blood flow, it did not study the effect of injecting fluid during these breathing manoeuvres. It is, for example, not clear whether the increased intrathoracic pressure during the Valsalva manoeuvre also influences the inflow of the injected contrast agent or not.

The loss of hepatic venous pulsatility towards the end of pregnancy indeed suggests continuous forward flow of unopacified blood via the IVC. How this effect interacts with the effects studied by Kuzo et al. will have to be the subject of future studies.

Avoiding deep inspiration before the pulmonary CTA data acquisition appears a good suggestion. Holding the breath during the course of normal respiration may be the answer to this problem. Knowledge about the physiological changes during breathing and their relation to pregnancy is important for further optimization of image qual-

ity in pulmonary CTA. However, reducing interindividual variations and improving patient compliance are probably equally important issues.

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