Technical challenges in 99mTc-MAA SPECT and 90Y PET based radioembolisation dosimetry

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From the point of view of acquisition, dosimetry in radioembolization is the easiest among all kind of pharmaceutical, since it requires only one scan. The dosimetric calculation, in its simplest form, is also extremely simple, since no preliminary system calibration is needed, and one simple equation is necessary. On the contrary, lesion and functional liver contouring can be complex. In addition, one of the ^{90}Y microsphere vendors propose a method for the choice of the therapeutic activity which is based on the volume of the lobe to be treated. This requires a volume measure on CT images. The portal phase is used, with the edge between right and left lobe given by the medial sovrahepatic vein. Contouring of liver lobe or of functional liver and lesions may be accomplished by technologists, usually under the supervision of a radiologist.

The definition of the border between tumor and non tumor region may be difficult and often it is impossible. Often HCC shows as a large tumor mass with a necrotic core. Two segmentations methods are possible: SPECT based method, using a threshold on counts, which includes only the perfused tumor region, or CT based method, which includes in the VOI the whole CT lesion volume. According to the analysis of the Milan group[1], the SPECT based segmentation gives better correlation between absorbed dose and response. This can be understood since the response was evaluated with Hounsfield density variation, which is maximal over the active tumor region. No density variation takes place within the necrotic core. On the other side, it goes without saying that necrosis is not a part of functional liver, and should be excluded from functional volume. Therefore both segmentation methods are required to properly define the active lesion portion (^{99m}Tc MAA SPECT) and the functional liver volume (CT). At a more refined investigation, this approach might appears over simplified. An elegant method is proposed by Lam et al[2]. It is based on the fact that sulfur colloid (SC) labeled with ^{99m}Tc (TcSC) is taken up by hepatocytes, and not by liver lesions. The drawback of this method is the need of two sequential SPECT scans: the first after ^{99m}TcSC administration, and the second after ^{99m}Tc MAA administration, with the patient in the same position on the couch. SPECT images have then to be coregistered and subtracted.

Infiltrative lesions cannot be segmented, since often not even CT is able to distinguish between tumor and non tumoral tissue. In these cases, a MRI based segmentation is proposed[3]. FDG PET is not indicated in HCC, but it can be conveniently used to define metastases border, followed by a coregistration of FDG-PET images with ^{99m}Tc MAA SPECT or ^{90}Y PET images[4].

For the determination of the functional liver, large necrotic core has to be excluded, as well as lesion in the non target lobe.

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