Myocardial blood flow: Is motion correction necessary?

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Received Sep 4, 2019; accepted Sep 5, 2019
doi:10.1007/s12350-019-01896-5

See related article, pp. 1334–1346

Quantification of myocardial blood flow (MBF) with PET has been shown to add prognostic value to myocardial perfusion imaging,¹ yet some technical aspects of this promising imaging technique have not been fully examined. Like all other PET studies, myocardial studies are affected by the general limitations of the PET systems, including spill-over effects, non-ideal time-of-flight corrections and artifacts in the attenuation correction maps. One of the most critical technical limitations for myocardial perfusion PET is the possible misalignment between the PET emission data and the attenuation correction maps. In several studies, the PET to CT misalignment have been reported to introduce quantitative errors and affect the diagnostic outcome,^{2,3} introducing false-positive findings^{4–6} or even false-negative findings in some cases.² Cardiorespiratory motion during acquisitions is another issue for MBF examinations, where the cardiorespiratory motion might introduce a general smear of the pathologic area.^{7–9} Related to this issue is the wear-off of the pharmaceutical agents used for stress MBF examinations, resulting in changes of the respiratory depth and frequency^{10–12}—a problem often referred to as “myocardial creep”. This effect causes repositioning of the heart during scans, and consequently affects the time-activity curves used for the MBF evaluations.¹³

Despite the known problems of the myocardial creep, its impact on the MBF assessments is not yet fully understood. In the current issue of the *Journal of*

Nuclear Cardiology, Armstrong et al investigate the impact of the frame-wise motion observed in adenosine ⁸²Rb PET stress scans.¹⁴ The authors evaluated the impact of frame-by-frame motion correction (MC) on MBF assessments obtained from three different PET image reconstructions using; (a) No MC (standard assessment), (b) MC of PET frames, and (c) synchronized MC of both CTAC images and the reconstructed dynamic PET image series. The patient cohort was divided into three subgroups depending on the motion observed during the scans, ranging from mild to severe. In the study, the authors reported most significant changes in the right coronary artery territory, with median changes in the MBF of 23% following MC, which is in concordance to previous studies.^{11,15} Despite motion of up to 25 mm during the scans (myocardial creep), the authors reported that the impact of MC of the CTAC maps prior to image reconstruction resulted in relatively minor changes of the MBF (median change 5%), compared to the impact of the MC for the dynamic PET image-series alone (median change 12%). Although the finding is somewhat contradictory to the intuitive logic, similar findings have been reported for ⁸²Rb stress scans using regadenoson.^{13,16}

Indeed, the findings reported by Armstrong and Van Dijk^{14,16} are in contrast to the growing evidence that misregistration of the PET and CTAC maps introduce artifacts in the static perfusion images.^{2,4,5} One possible explanation might be related to the stress acquisition protocols. The recent joint position paper from the SNMMI Cardiovascular Council and ASNC proposes that stress MPI scans are initiated either by mid-infusion of the stress agent when using adenosine (infusion duration 4–6 minutes) or immediately after injection of 10 mL saline when using regadenoson.¹ Owing to the biological half-lives of the vasodilators (Adenosine < 10 seconds, Regadenoson 2–3 minutes¹⁰), the patient will be experiencing full vasodilation in the first 120 seconds of the acquisition. Several studies have shown that MC of this time period alone might be sufficient to obtain

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J Nucl Cardiol 2021;28:1347–8.

1071-3581/\$34.00

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reproducible MBF assessments.^{15,17} The consistent translation of the myocardium during the first 120 seconds reported by Armstrong et al¹⁴ might be the reason that the impact of synchronous MC of PET and CTAC maps is suppressed when compared to MC of the dynamic PET images alone.

Does this mean that MC of the CTAC map should be completely omitted in the future? Most likely not, as current MBF estimates focus on dynamic reconstructions without corrections for cardiorespiratory motion, which still might introduce significant changes in to the MBF evaluations.¹⁸ The inclusion of cardiorespiratory MC in the clinical practice would require highly specialized reconstruction protocols, in which the corrections are introduced during the PET image reconstructions. Such protocols could be expanded to also include synchronized corrections for both myocardial creep and MC of the CTAC maps. However, because of their complexity, it will not be possible to introduce these reconstruction protocols to the clinical practice without support from the vendors.

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