You might be correct, but it makes no difference: No impact of attenuation correction for SPECT MPI on downstream testing

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Optimizing non-invasive diagnostic imaging in patients with suspected coronary artery disease (CAD) is crucial, given that up to two-thirds of invasive coronary angiograms (ICA) show no evidence of obstructive disease.¹ As most patients presenting with new angina fall into the intermediate risk group, a non-invasive imaging test is usually the first step, and single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) is therefore a frequent gatekeeper to downstream ICA. Although diagnostic accuracy is relatively high for SPECT MPI in this intermediate group (sensitivity 85–90%, specificity 70–75%), the technique can be hampered by several clinical and technical factors.^{2–4} An estimated 17–49% of all SPECT MPI scans will present with some form of artifact—and among these, soft tissue attenuation is one of the most frequent and carries the specific risk of a false-positive result, particularly in obese patients.^{2,5–7}

Attenuation correction (AC) is a process by which photons absorbed by the combination of photoelectric and scatter effects in the patient can somehow be compensated for.⁷ Usually, a transmission scan is used (with sealed radioactive source, X-ray, or CT) to measure attenuation coefficients along the thorax which are then

used to mathematically correct for soft tissue absorption.⁷ This approach is patient-specific, but the correction algorithms are also vendor-specific. AC is therefore a heterogeneous group of software and hardware solutions rather than a single entity. Nonetheless, the collective impact of all AC solutions is the potential to correct for soft tissue attenuation artifact and increase diagnostic accuracy.

The most common finding in prior clinical studies investigating AC in SPECT MPI, is that it significantly improves the normalcy rate and specificity for detecting CAD.^{2,7} Broadly, the weight of evidence across several studies is considered to favor its use, leading to the joint position statement of the American Society of Nuclear Cardiology and Society of Nuclear Medicine recommending AC implementation into daily care; and it is considered a rapidly evolving standard for SPECT MPI.⁸ However, within that statement it is also suggested that both non-corrected and corrected image datasets are still reviewed and integrated into the final report—at least until the reader gains appropriate experience and confidence in the specific AC methodology in use. The latter caveat is based on the caution that although AC is intended to fill-in areas of myocardium with artificially low counts, it may also introduce new artifacts including apical thinning or erroneously reduced left ventricular function size.^{9,10}

The fact that current consensus seems to favor use of AC, makes the results from Singhvi et al. in this issue of *Journal of Nuclear Cardiology*, even more impactful.¹¹ In a propensity matched retrospective cohort of 3928 patients undergoing SPECT MPI for anginal symptoms (50% with AC, 50% without AC) they found no difference in the proportion of abnormal MPI results between the two groups (31.5% vs 30.4%, $P = 0.47$), and although marginally more patients in the AC group

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underwent downstream ICA (< 90 days), this was not a significant difference (10.6% vs 8.7%, $P = 0.05$).

There were of course limitations and problematic confounders in this form of retrospective analysis that could not be controlled for, e.g., referral bias, differential access to on-site catheterization laboratories across AC vs non-AC equipped sites, variable acuity of patients, varied local skill of MPI interpretation, and inpatient versus outpatient status. Nonetheless, the lack of meaningful impact of AC on rate of abnormal MPI or downstream testing in this cohort remains surprising.

If we briefly revisit the existing AC literature though, this latest result is perhaps not that unexpected in the broader context. In fact, both positive and negative conclusions regarding the added diagnostic value of AC in SPECT MPI for CAD detection have been described before. Most of the relevant literature to date is comprised of only small studies (75-150 patients each);^{2,10,12-14} but a meta-analysis of 17 studies using both line-source and CT AC found a small increase in sensitivity (80% to 84%), a larger increase in specificity (68% to 80%) with AC use.¹³ However, several less favorable studies have also been published challenging this incremental diagnostic accuracy of AC.¹⁴ Genovesi et al. found AC only improved specificity for CAD in the RCA in overweight men; but no incremental diagnostic accuracy was observed in other patient groups.¹⁵ Sharma et al. found CT-based AC in SPECT MPI ($n = 171$) led to an increase in specificity at the cost of a decreased sensitivity, resulting in a non-significant improvement in overall diagnostic accuracy.¹⁶ Lee et al. also came to similar results in 68 patients with an intermediate pre-test likelihood of significant CAD.¹⁷ Several explanations may account for these conflicting results and the lingering confusion in the literature.¹⁴ Possibly, older AC algorithms have contributed to the more negative results. The large variety of different AC hardware and software options has also prevented the feasibility of a large definitive multi-center prospective study, and limited direct comparison between studies or their amalgamation. Similarly, despite the signal that specific patient populations may benefit from AC, and that others may be more prone to AC induced artifacts, the heterogeneity of methods in use has not permitted this to be fully explored on a large scale.

As Singhvi et al. point out, AC technology comes at a significant cost and is not widely available as a result.¹¹ The initial investment is substantial and the annual maintenance costs continue to add to the expenditure. As a result, it has been reported that only 5% of installed SPECT systems have AC.¹⁴ Without overwhelming evidence of a substantial clinical benefit or reduction in unnecessary downstream testing it is hard to encourage this to change. So, is this a nail in the coffin

for AC? That would be an extreme conclusion and a write-off of well-developed technology that probably needs to be used more selectively rather than uniformly applied. The lesson here is probably that one-size does not fit all, and our attention is best next diverted into standardizing AC approaches and then defining which specific groups to use AC in for optimal benefit. For example, the value of stress-only imaging in low-risk patients facilitated by AC has previously been described¹⁸; and repeatedly substantially improved diagnostic accuracy with AC in the obese population has been confirmed.¹⁹ Further, the current study specifically only examined the use of line-source Gd-153 scanning line for AC and did not investigate the use of low-dose CT which is now the only form of AC available in a new SPECT camera, so it would be unfair to extrapolate these findings to the latest hardware and software AC solutions without further specific evaluation.

One final thought, in an era of ever-increasing dependency on the latest technological innovation and with AI remaining at the peak of the hype cycle, we often neglect the brilliance of expert human interpretation honed over many years and thousands of screen scrutinizing hours. Most expert high-volume readers arguably have no issue recognizing an attenuation artifact particularly on their own departmental SPECT camera which they know 'inside-out'—in this scenario, it is not surprising the impact of AC may be neutral.

Disclosure

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