TECHNICAL BRIEF

TruCorr

Improve the Accuracy and Ease of SPECT Imaging with TruCorr® Attenuation Correction

SPECT imaging has long been the technology of choice for noninvasive diagnosis of coronary artery disease and for guiding the appropriate therapeutic strategy. However, the benefits of SPECT imaging have been tempered by the problem of tissue attenuation. The images are generated by the emission and detection of photons from a radiotracer. A portion of the detected photons will be attenuated due to absorption or scattering by the tissue they encounter on their pathway to the detector, causing artifacts in the image.

Attenuation correction is a process that mitigates these artifacts, and it has been shown to increase the accuracy of interpretation and to enable absolute quantification.[1] In Anger camera systems, it is implemented using attenuation maps obtained from a corresponding computed tomography (CT) transmission scan or a Gadolinium-153 (Gd) transmission source. Adding a transmission scan increases the radiation dose. Furthermore, since the emission and transmission images are acquired at different times with the patient potentially in a different position or breathing phase, misregistration and CTAC have the possibility of creating significant artifacts.[2] If there is no access to a transmission scan, additional imaging may be used as an alternative to mitigate attenuation artifacts, such as supine-prone scans. Additional imaging increases procedure time for the patient and the department.

Alternative technologies for the evaluation and diagnosis of coronary artery disease, such as Positron Emission Tomography (PET) and Coronary CT Angiography (CTA) are available; however, these require a sizeable investment from medical practices. CTA requires a high-end CT scanner with costly cardiac packages. It is less valuable in patients with more comorbidities and prior cardiac histories, such as prior bypass or stent. PET/CT, with a diagnostic CT attached, requires on-site availability of a short-lived PET radiopharmaceutical.

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>
> Dr. Timothy Bateman, co-director of the Cardiovascular Radiologic Imaging Program at St. Luke's Hospital

In 2007, Spectrum Dynamics introduced the first digital SPECT system designed for cardiac imaging. The D-SPECT offers high spatial, temporal and energy resolution and higher sensitivity, compared with a conventional Anger camera with sodium iodide scintillation detectors.[3] This breakthrough technology represented the first innovation to truly transform nuclear cardiology.

Recently, a new technology was developed applying a deep learning attenuation correction (DLAC) approach for myocardial perfusion scans. It uses only the SPECT data from a single acquisition, so it doesn't require a CT or Gd-153 transmission scan or additional time beyond D-SPECT standard clinical protocols. As it is a software approach, it can be applied within the typical workflow of any laboratory. This option will be particularly beneficial for sites performing dual position scans, sites where there is no hybrid scanner available or sites where there are advantages in freeing up the required time that staff need to scan and process a CT-based transmission scan.

TruCorr Attenuation Correction technology is expected to increase the accuracy of D-SPECT cardiac imaging and enable more accurate qualitative and quantitative analysis, without additional radiation dose exposure for patients. It also creates workflow optimization possibilities, potentially eliminating the need for rest imaging in low likelihood patients. Attenuation Correction removes artifacts, which increases confidence in stress-first imaging and enables testing to be halted at that point if the stress image is normal.

"In our experience, it has dramatically reduced the perceived necessity to proceed with a rest image," said Dr. Bateman. "It created greater uniformity in the images such that normal is easy to recognize and we can confidently say no, this patient does not need to go on to have a rest image." This spares patients and providers from additional scan times and additional radiation dose in case of equivocal studies. "I can imagine that for a typical patient, we would be seeing the whole test done on the order of 20 to 25 minutes, which is pretty powerful," Dr. Bateman said. He noted that coronary CTA is typically performed in about an hour, and PET is a 45-to-60-minute protocol.

Deep Learning Algorithm Methodology

TruCorr is an attenuation correction technology based on deep learning, a type of artificial intelligence that has brought significant advancements to health care in the areas of data analysis and image classification.[4] A particular benefit is that it requires less guidance from humans and is able to self-verify its decisions. In fact, some convolutional neural networks (CNNs) have demonstrated similar or superior accuracy to humans in diagnostic imaging studies.[4]

The TruCorr is based on a CNN that was trained to correct reconstructed emission data. The development of the deep learning attenuation correction algorithm involved thousands of samples (input) extracted randomly from the myocardial perfusion SPECT imaging (MPI) data. Datasets of 132 D-SPECT myocardial perfusion studies (rest and/or stress), where the patient also had a corresponding CT scan, were collected retrospectively from various sites. As part of the routine clinical practice, each study dataset was reconstructed using the ordered set expectation maximization (OSEM) algorithm with 4.92 mm voxel size both without (i.e. noncorrected – NC) and with attenuation correction (i.e. with CT attenuation correction – CTAC) following spatial alignment of the CT with the MPI reconstructions. Seven studies with CT misalignment were excluded, leaving a final dataset of 125 studies. For DLAC training and testing, the dataset of 125 studies was randomly split into a training set of 100 studies and a testing set of 25 studies. The NC and CTAC images from each patient study were used as the reference for comparison with TruCorr images.

Two experienced nuclear physicians conducted a visual analysis, independently reviewing the images and ranking the TruCorr images according to how similar they were to the corresponding CTAC images.

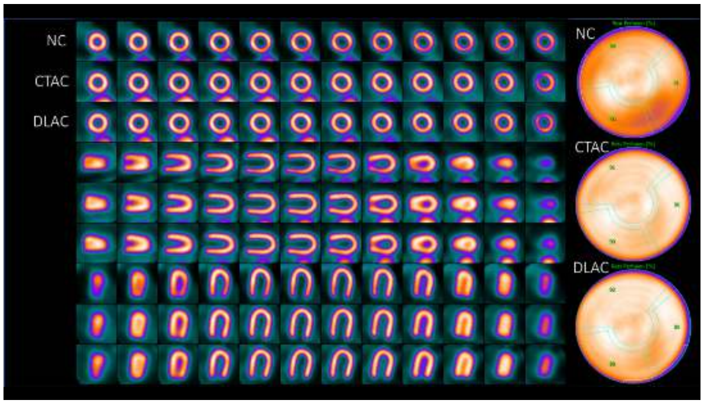
They then assigned a "similarity score" using a 5-point scale. Ordinal variables were described by mean ± SD; Inter-reader agreement was assessed by Kappa test. The visual analysis found TruCorr images were similar to CTAC images.

Visual Analysis Results

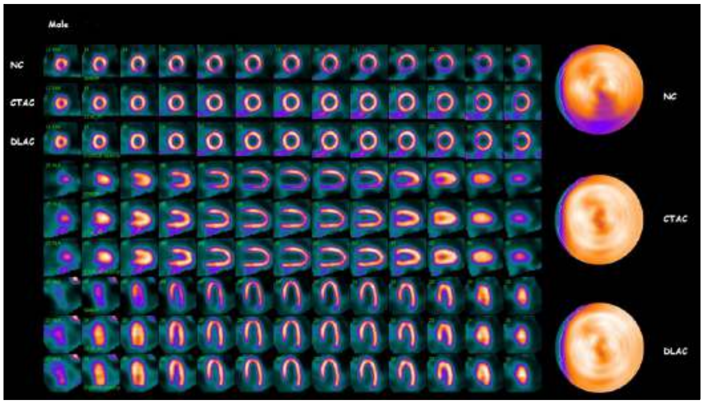
TruCorr similarity to CTAC score summary	Reviewer 1	Reviewer 2
5 – Equal	8	19
4 – Small differences	16	4
3 – Moderate differences	1	2
2 – Major differences	0	0
1 – Unacceptable	0	0
Mean score ± StDev	4.28 ± 0.54	4.68 ± 0.63
Kappa agreement score	**88%**	

Clinical Examples

Anthropomorphic Cardiac Phantom

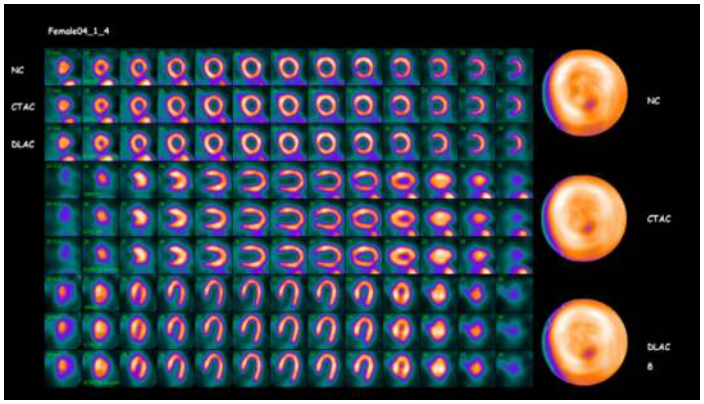


Clinical Case Example 1



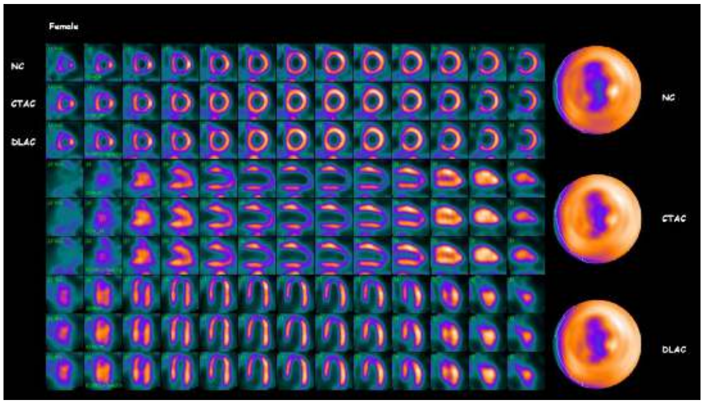
Inferior wall defect appears severe and is corrected by CTAC and DLAC.

Clinical Case Example 2



Non artifactual inferior-apical defect, not impacted by CTAC or DLAC.

Clinical Case Example 3



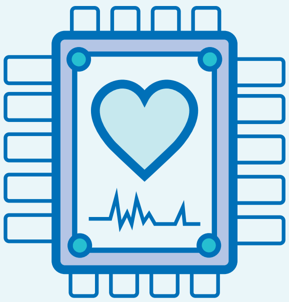
Major apical defect remains constant with no impact of AC, most probably infarct.

Note: *Clinical cases provided courtesy of Dr. Timothy Bateman, St. Luke's Hospital, Kansas City, MO.*

Better CAD Diagnosis

With the growing push toward value-based care and ongoing scrutiny of health care costs, medical imaging practices are under pressure from payers to provide cost-effective payment models and provide greater value to both plans and patients. With rewards increasingly based on efficiency and effectiveness, rather than volume, it is more important than ever to make cost-effective, high-quality imaging investments.[5]

Practices that leverage TruCorr for D-SPECT myocardial perfusion image data will see improvements in quality, efficiency and patient safety.



The Technology

- Eliminates the requirement for a supplementary CT scan, reducing the patient risk associated with additional radiation dose
- Can reduce the number of scan acquisitions required for accurate interpretation: avoid upright/supine or supine/prone dual positioning scanning
- Generates workflow efficiencies by eliminating the need to manually correct for SPECT-CT misregistration issues
- Enables accurate analysis with absolute quantification
- Allows practices to reduce health care costs by freeing CT scanner capacity for use in higher-priority procedures than CT attenuation correction scans
- Enables the possibility of low-dose, stress-only imaging in certain patients

Practices that realize these benefits will have more time and resources to dedicate where they are most needed, as well as more accurate imaging to guide care decisions. They may also find they have more satisfied patients after providing the highest-quality care as quickly as possible.

References

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