19 Astonish Reconstruction

If you have the Astonish license, Astonish appears as one of the reconstruction methods available.

The Astonish method consists of performing Ordered Subsets Expectation Maximization with compensation for the blurring effects of your collimator built into the reconstruction. We frequently refer to this compensation as Resolution Recovery, because it allows the recovery of some of the original resolution of the activity distribution. To model the point spread of the activity distribution at the time of acquisition, Astonish uses the distance from the detector to the object of interest recorded as a function of angle by your camera during acquisition, and the geometric properties of the specific collimator used.

Astonish uses specific information from your camera to model the collimator performance. It expects acquisition-specific information in the DICOM header for each image. Only the following versions of acquisition software provide the necessary data to support the use of the Astonish reconstruction method:

- SKYLight version 3.1 or later
- Forte version 2.0 or later
- CardioMD version 2.0 or later
- Precedence (all versions)
- BrightView and BrightView XCT (all versions)

For Astonish to work properly, the collimator must be correctly specified in the data. If the collimator information is missing or incorrect, use Edit Image Details from the Patient Directory to correct the information.

300006344181_A/881 * 2021-02-28

When to use Astonish

The accurate modeling performed by Astonish leads to excellent image quality for all images. Philips recommends using this method for most nuclear medicine SPECT reconstruction.

Using the Astonish SPECT reconstruction method will enhance the resolution of your SPECT images, and improve the signal-to-noise ratio. The improved noise properties and appearance of the background of your images may change the appearance of the images. You may need to read several Astonish images in order to become comfortable with the appearance of these reconstructed images.

The image below shows a patient study reconstructed according to typical clinical practice (bottom), and the same study reconstructed with Astonish (top). The improved resolution results in clearer separation and detail in the vertebrae. This is especially apparent in fine structures such as the breastbone.

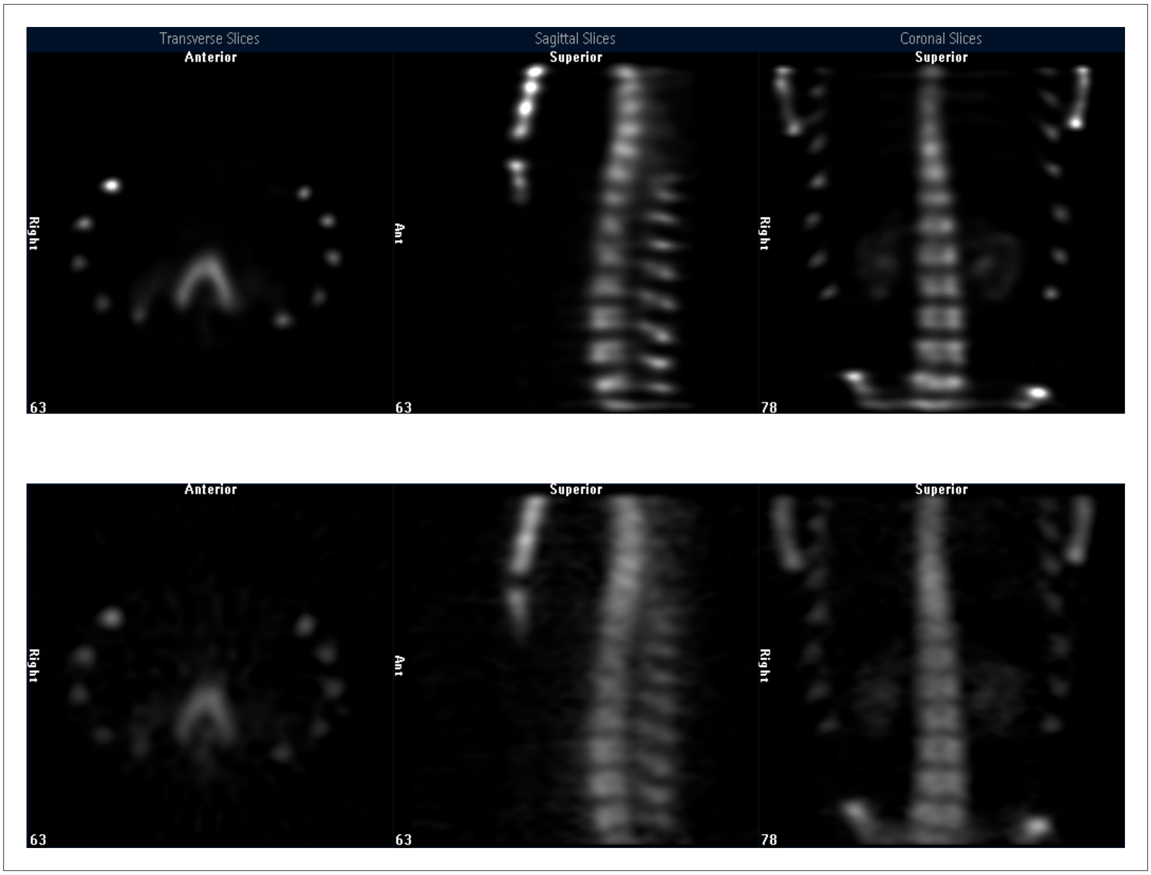

Fig. 58: A comparison of Astonish reconstruction (top) with FBP reconstruction (bottom)

300006344181_A/881 * 2021-02-28

Important

When using Astonish reconstruction for Cardiac images, use an Astonish database for your quantitation. AutoQUANT 7.0 provides an Astonish database, or you can use its database tools to generate normals databases specific to your site, your imaging preferences, and Astonish reconstruction with your preferred parameters (filtering, AC, scatter correction, etc.).

Using Astonish Reconstruction

You use Astonish in the same way as the other reconstruction methods: by selecting it from the Reconstruction pull-down menu or by using Astonish defaults. This section describes how to set reconstruction parameters such as Filtering, Iterations, and Subsets in order to optimize image quality when you use Astonish.

Filtering and Noise

With many iterative reconstruction methods, the noise in the reconstructed image increases with iterations. For this reason, the number of iterations is kept small to avoid having an overly noisy image. Astonish incorporates collimator effects so as to prevent this accumulation of noise, allowing you to use more total iterations while maintaining an acceptable image.

However, if your images are noisy to begin with—for instance, for gated cardiac datasets, rest perfusion imaging, or for general nuclear images acquired a long time after injection—it is helpful to pre-filter the data both prior to and during reconstruction. For this reason, Philips provides you with a Hanning pre-filter to use with Astonish for noisy data.

The two images below show the effect of filtering on an Astonish reconstructed image. The left image shows a Maximum Intensity Projection (MIP) display of an Astonish image reconstructed with 4 iterations and 16 subsets, with no pre-filter. The right image shows a similar display of an image reconstructed with the same parameters, but after applying a Hanning pre-filter with a cutoff of 1.0. The image has become smoother without losing the fine detail available as a result of the Astonish reconstruction

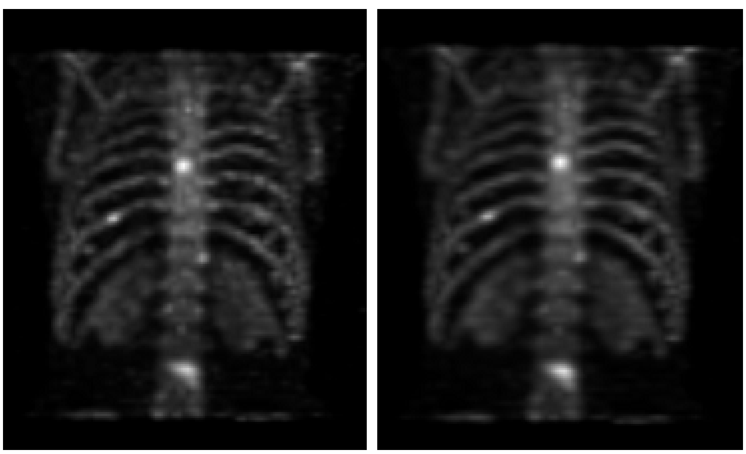

Fig. 59: Astonish reconstruction without Hanning filter (left) and with Hanning filter (right)

Iterations and Subsets

To take full advantage of the resolution recovery provided with Astonish SPECT reconstruction, the expectation maximization algorithm must converge, which requires a large number of updates to the activity estimation for noisy data. Whereas for MLEM the number of updates is identical to the number of iterations, for OSEM, the subsets and iterations are multiplied together to calculate the total number of updates. The higher this number of updates is, the more likely the software is to have achieved convergence. Although it is possible to achieve an acceptable nuclear medicine reconstructed image using 2-3 iterations and 8-16 subsets, even better image quality may be achieved by iterating more. This may cause processing times to be extended, so your site must determine the acceptable number of iterations. While there is no maximum number of iterations, the maximum number of subsets is the number of projections in the data. Philips recommends starting from a Uniform estimate and using at least 24 updates for most nuclear medicine data, which can be achieved by performing 3 iterations with 8 subsets.

The two images below show the effect of iteration number on an Astonish reconstructed image. The left image shows a Maximum Intensity Projection (MIP) display of an Astonish image reconstructed with 2 iterations and 16 subsets, with no pre-filter. The center image was reconstructed with 3 iterations, and the far right image with 4 iterations. More fine detail becomes available with additional iterations, but the images also become noisier.

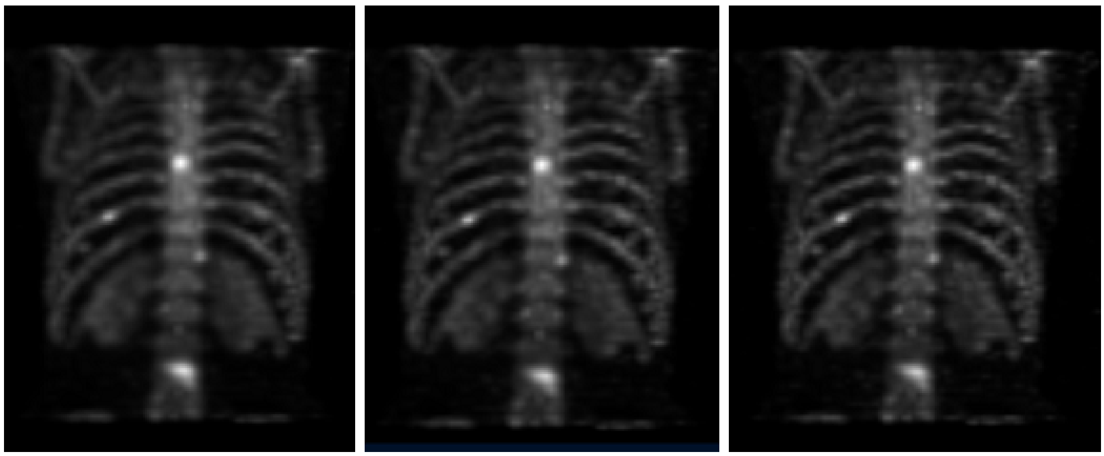

Fig. 60: Astonish reconstruction with 2 iterations (left), 3 iterations (center), and 4 iterations (right)

Applying Other Corrections

As with other iterative methods, Astonish allows you to apply attenuation and scatter correction during reconstruction when transmission data is used along with the usual emission data. AutoSPECT Pro accepts CT data, Vantage transmission data, or a previously generated attenuation map to use in performing these corrections.

Further Reading

To learn more about reconstruction using Resolution Recovery and other corrections, you may wish to read the following abstracts and papers:

Almquist H, Arheden H, Arvidsson AH, Pahlm O, and Palmer J. *Clinical implication of down-scatter in attenuation-corrected myocardial SPECT*. J Nucl Cardiol 1999; 6:406

Information on OSEM reconstruction

Hudson HM, Larkin RS: *Accelerated image reconstruction using ordered subsets of projection data.* IEEE Trans Med Imag 13, 601-609, 1994.

Information on resolution recovery

Younes RB, Mas J, Pousse A, Hannequin P, Bidet R: *Introducing simultaneous spatial resolution and attenuation correction after scatter removal in SPECT imaging*. Nucl Med Comm 12, 1031-1043, 1991.

Liang Z, Jaszczak R, Coleman R: *A 3D model for simultaneous compensation of nonuniform attenuation and collimation divergence of SPECT image reconstruction.* J Nucl Med 32, 917 (abs), 1991.

Liang Z, Turkington TC, Gillard DR, Jascczak RJ, Coleman RE: *Simultaneous compensation for attenuation, scatter and detector response for SPECT reconstruction in three dimensions.* Phys Med Biol 37, 587-603, 1992.

Floyd CE Jr, Jaszczak RJ, Manglos SH, Coleman RE: *Compensation for collimator divergence in SPECT using inverse Monte Carlo reconstruction.* IEEE Trans Nucl Med NS-35, 784-787, 1988