Detection of Small Lesions Using a State-of-the-Art TOF PET/CT System and Small-Voxel Reconstruction

A major challenge of 18F-fluoro-deoxyglucose positron emission tomography (FDG-PET) is the reliable detection of small lesions of less than 5-10 mm and the accurate measurement of an uptake value in such lesions. These issues can make the decision-making process for appropriate therapy and follow-up difficult. A recently published paper from the Isala Hospital in Zwolle, The Netherlands, describes a study whose aim was to determine the impact of a small-voxel reconstruction on the detectability of small lesions using a state-of-the-art TOF PET/CT device [1]. The results show that for small lesion detection with FDG-PET, in the vast majority of cases physicians prefer small 2 mm voxel image reconstruction in a system using time-of-flight technology, such as available on the Philips Ingenuity TF PET/CT.

HOSPITAL-INDUSTRY PARTNERSHIP
Situated in the city of Zwolle in the central belt of The Netherlands, the Isala hospital is one of the largest non-academic hospitals in the country and offers general care services as well as top-level specialisation in cardiology, oncology, and other fields. The hospital recently entered into a collaborative partnership with Philips to further improve its overall patient care and the accuracy of diagnostic imaging. A key reason for choosing Philips for this partnership was the access that Isala’s clinicians could gain to the latest research and technological developments which could be of significant help for their medical imaging programs. As part of this agreement, the Nuclear Medicine department in Isala has been using a Philips Ingenuity TF PET/CT system for almost two years. The Nuclear Medicine department at Isala carries out about 14 PET/CT exams a day, among which there are many lung cancer cases.

INCREASING SUV AND SNR FOR SMALL LESION DETECTION
Whole-body 18F-FDG PET integrated with CT is a widely used imaging modality for primary tumor analysis and mediastinal lymph node staging in patients with non–small cell and small cell lung cancer [1].

However conventional PET/CT technologies have limited spatial resolution and relatively large image voxels (approximately 4 mm) which increase the impact of the partial volume effect (PVE) in PET images containing small lesions. One approach for improved imaging of small lesions is to increase the image contrast (i.e. increasing the signal to noise ratio, SNR) as well as to increase the spatial resolution of images by using smaller voxels for the image reconstruction. The technology in the Ingenuity TF time-of-flight system from Philips provides enhanced lesion contrast and small voxel reconstruction that can improve spatial resolution to support the assessment of small lesions. One aim of the recently published article [1] was to evaluate this technology in a clinical practice environment.

IMPROVING DIAGNOSTIC CONFIDENCE AND REDUCING WAITING LISTS
The Nuclear Medicine department at Isala chose the Ingenuity TF system not only to improve the diagnostic confidence in their FDG-PET scans but also to minimize the lengthening waiting lists. The system delivers high-resolution reconstructions of 2 mm voxels very quickly compared to conventional PET/CT technologies thanks to the proven Time-of-Flight (TOF) technology. TOF improves contrast by up to 30% compared to non-TOF systems and improves the signal-to-noise ratio, resulting in high image quality, increased speed, and enhanced accuracy. A whole body scan with a 2 mm high-resolution reconstruction can now be done much faster than scans of smaller areas on previous systems. The number of exams being carried out in the Isala hospital per day is now steadily increasing.
STUDY RESULTS SHOW PREFERENCE FOR 2 MM VOXL IMAGE RECONSTRUCTION

The results of the recent study [1] showed clear physician preference for the use of 2 mm voxel reconstruction on the Ingenuity TF PET/CT system to detect small lesions in FDG-PET exams. In the study, FDG PET scans of two image-quality phantoms (sphere sizes 4-37 mm) were analyzed as well as 39 consecutive patients with lung cancer. When using a small 2 mm voxel reconstruction, there was a significant increase in SUV and signal-to-noise ratios (SNRs) for small lesions [Table 1]. The clinicians in the study preferred the small voxel reconstructions in 76% of the cases.

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The clinicians at Isala also recently published a case study that reported the results of an examination of a 68 year-old woman suspected of lung cancer, who underwent a whole body FDG-PET scan [2]. The results are shown below [Figure 3]. At initial evaluation, using 4 mm voxels, the combination of low FDG uptake and normal size led to a most likely benign diagnosis and combined chemotherapy was initiated. At later assessment, however, using 2 mm reconstructions, the lesion was much more suspicious and was considered metastatic, in keeping with the appearance of bone metastases. If 2 mm voxels had been used at initial evaluation, management would have been different.

CONCLUSION

Koopman et al [1,2] conclude that the detection of small lesions using 18F-FDG PET is improved using small voxel reconstructions on a state-of-the-art TOF PET/CT system. New (probably higher) cutoffs and lesion-to-background values will need to be defined, to distinguish benign from malignant small lesions when using small-voxel reconstructions on state-of-the-art TOF PET/CT devices.

REFERENCES


MORE INFORMATION

The studies described above were carried out on a Philips Ingenuity TF PET/CT scanner. More information on these scanners is available at http://www.healthcare.philips.com/main/products/nuclearmedicine/products/pet/

The statements described herein are based on results with Philips Ingenuity TF PET/CT scanner that were achieved in the hospital’s unique setting. Since there is no “typical” hospital and many variables exist, there can be no guarantee that other hospitals will achieve the same results.