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Review article

Cadmium–zinc–telluride SPECT scanners – New perspectives in nuclear cardiology

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ABSTRACT

Nuclear cardiology is one of the most important non-invasive imaging methods in cardiac imaging. It makes possible primarily functional assessment of the heart with quantification of perfusion and systolic function. Development of new types of scanners for nuclear cardiology brings more possibilities in research and clinical practice. This paper describes a brief review of some applications of cadmium-zinc–telluride (CZT) scanners in comparison with conventional cameras.

Contents

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Introduction

Nuclear cardiology is an established and well proved method in non-invasive cardiac imaging. Its sensitivity and specificity for diagnosis of myocardial ischaemia and viability assessment have been reported in many studies [1–4]. For several decades, the single-photon emission tomography (SPECT) scanners used for cardiac imaging were the same as for general nuclear medicine purposes. The conventional type of scanner (Fig. 1) consists of a scintillation detector, using natrium iodide crystal activated by thallium (NaI [Tl]). It works on principle of luminescence, when impact of gamma radiation photon on NaI [Tl] crystal causes a flash of visible light. This flash is detected by photomultiplier tube (PMT), multiplied and transformed to electric signal. The average spatial resolution of scintillation scanners is about 1–2 cm and acquisition time varies between approx. 10and 20 min according to administered activity of radiopharmaceutics. The cadmium–zinc–telluride (CZT) SPECT scanners have been introduced in the first decade of 21st century [5]. The CZT detector works as a semiconductor with direct conversion of gamma radiation to electric signal. This mechanism results in better spatial resolution and sensitivity, what means lower administered dose of radiopharmaceutics and/or shorter acquisition time. One of the most frequently used systems is D-SPECT (Spectrum Dynamics, Haifa, Israel), which uses pixelated CZT detector arrays in 9 vertical columns mounted in a 90° gantry geometry. The parallel hole high sensitivity collimators are made of tungsten. Another commercially available CZT camera is Discovery 530c (SPECT alone – Fig. 2) or 570c (SPECT/CT) manufactured by GE Healthcare (Haifa, Israel). This system is based on multi-pinhole collimator system and an array of nineteen CZT pixelated detectors. Spatial resolution was reported better in GE Discovery (6.7 vs 8.6 mm); count sensitivity is higher in D-SPECT (850 vs 460 counts per second per MBq). Both parameters are better than the mean values for conventional SPECT (15.3 mm of spatial resolution and sensitivity of 130 counts per second per Mbq) [6]. This paper brings a brief review of previously performed studies with CZT SPECT scanners.

Fig. 1 – Conventional two-detector SPECT camera (Discovery NM 630, GE Healthcare).

Radiation dose reduction

Lowering of radiation doses is currently one of the most frequent issues in diagnostic procedures. However, the

Fig. 2 – CZT camera with 90° arch of detectors (Discovery 530c, GE Healthcare).