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# An application-specific small field of view gamma camera for intraoperative dual-isotope parathyroid scintigraphy

99mTc-Sestamibi/123I dual-isotope scintigraphy is the gold standard for preoperative parathyroid gland localisation but is not currently possible intraoperatively. As parathyroid 99mTc-Sestamibi uptake is non-specific, physiological uptake, such as within thyroid tissue, often confounds parathyroid tissue identification. Simultaneous 99mTc-Sestamibi/123I imaging allows tissue differentiation by the thyroid-specific uptake of 123I. As parathyroidectomy success is strongly predicted by knowledge of parathyroid gland location, and preoperative imaging may not be sensitive enough or insufficient to enable localisation during surgery, there is potential to improve parathyroidectomy success rates by developing detector systems capable of intraoperative dual-isotope scintigraphy.

Dual-isotope parathyroid scintigraphy is a particularly challenging application. Excellent detector energy resolution is essential to resolve 140keV 99mTc and 159keV 123I energy peaks and achieve suitable image quality. Parathyroid tissue tracer uptake is discerned from the 140keV energy window image, which has increased background due to scattered 159keV photons. Poor detector energy resolutions reduce the proportion of 99mTc-decay photons collected, potentially compromising parathyroid gland conspicuity. Detector systems also require sufficient sensitivity to image without disrupting surgery, spatial resolution able to resolve ˜1mm parathyroid glands, and material properties suitable for surgical environments.

Compound semiconductor materials are promising for dual-isotope scintigraphy. Low charge-carrier creation energies allow excellent energy resolution, high atomic number and densities provide good sensitivity for small footprints, and wide band-gaps allow room temperature detector operation. CdZnTe bonded to the HEXITEC ASIC forms a pixelated, spectroscopic detector system with suitable footprint for intraoperative applications. Each pixel can record energy deposition per imaging frame, allowing excellent energy resolution to be achieved using charge-sharing correction algorithms.

This study investigates compound semiconductor detector suitability for dual-isotope parathyroid scintigraphy by simulating performance of a CdZnTe-HEXITEC detector system, using anthropomorphic phantom volumes and Monte Carlo simulation. The trade-offs between energy resolution and photon statistics are investigated, considering implications for application-specific detector system design.

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