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

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The gold standard technique for preoperative parathyroid localisation is 99mTc-Sestamibi/123I dual-isotope parathyroid imaging. This technique subtracts 123I uptake in normal tissue from 99mTc-Sestamibi imaging to reveal parathyroid glands which would otherwise be obscured by the thyroid. Due to the difficulty of interpreting preoperative images within the surgical environment, the translation of preoperative findings into surgical success is highly demanding on the surgeon. The current generation of intraoperative gamma cameras cannot perform dual-isotope parathyroid scintigraphy due to the high energy resolution requirements of this technique. A new device capable of performing intraoperative dual-isotope parathyroid imaging would allow surgeons to directly visualise tracer uptake precisely when needed to aid their surgical decision making; offering the potential to improve parathyroidectomy outcomes.

Intraoperative 99mTc/123I scintigraphy is a challenging application, requiring excellent energy resolution to distinguish between the 99mTc (140keV) and 123I (159keV) photopeaks without down-scatter compromising image quality. Additionally, the small size of parathyroid glands (˜1 mm) and limited activity of radiopharmaceuticals used during surgery demand good detector spatial resolution and sensitivity. Devices for dual-isotope scintigraphy must therefore be optimised to achieve the correct balance of detector properties required to produce images of diagnostic quality. This requires knowledge of the expected source geometry and the detector system response.

This study examines the suitability of the HEXITEC detector system for 99mTc-Sestamibi/123I dual-isotope parathyroid scintigraphy. This small-pixel geometry system uses compound semiconductor materials, such as CdTe/ CdZnTe, and the HEXITEC ASIC to achieve excellent energy resolution, sensitivity and spatial resolution. The expected imaging performance of this system has been simulated using anthropomorphic phantom volumes derived from CT data and Monte Carlo simulation. This study also explores the broader implications of using clinical-like source geometries to design application-specific detector systems for intraoperative imaging.

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