

A High-Resolution Hand held Hybrid Camera for Gamma and Optical Imaging



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INTRODUCTION

A combination of an optical and a gamma camera, in a co-aligned configuration, offers high spatial resolution multi-modal imaging. The Hybrid Gamma Camera (HGC) gives a superimposed scintigraphic and optical image which offers new possibilities for assisting surgeons and interventionists with intraoperative molecular imaging [1].

MATERIALS AND METHODS

A compact hybrid gamma-optical camera has been developed, which consists of a 1500µm thick CsI(Tl) columnar scintillator coupled to an electron-multiplying CCD. A 0.5mm or 1.0mm diameter pinhole collimator produces a 40x40mm nominal field of view (FOV) with an optical camera aligned to provide the same FOV as the gamma camera for image superimposition.

Images are recorded simultaneously and presented in a fused display. Performance characteristics including sensitivity, spatial resolution and count rate response were measured based on NEMA protocols adapted for use with small FOV systems.

The HGC can either be hand-held or mounted on a articulated arm. Figure 1 shows the system being used in a clinical setting.



Figure 1. Photograph of the Hybrid Gamma Camera being used in a clinical setting.

PHANTOM IMAGING

A number of different phantoms were used to provide a variety of shapes and configurations to explore the imaging response of the HGC system. A standard Picker Nuclear thyroid phantom was used to explore the sensitivity, signal-to-noise ratio and spatial resolution of the HGC [2]. Figure 2 shows the time series with exposure times of up to 15mins. As expected, the clarity of the phantom image improves with exposure time. Ultimately the choice of exposure time will rest with the clinician and will vary depending on the application and activity of the site under investigation.

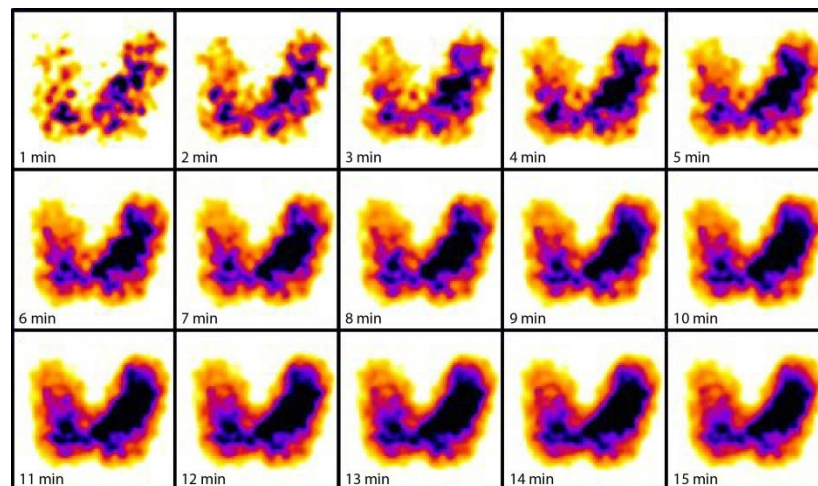


Figure 2. A cumulative time series of thyroid phantom images. Each frame shows an increment in integration time of 1 minute. The phantom contained 15MBq of ^{99m}Tc in 60ml and was imaged from a distance of 10.5cm.

DISCUSSION

The characteristics of the hybrid camera compared favourably with other portable cameras currently available. Spatial resolution ~1.5 mm (at 10mm) was recorded with system sensitivity of up to 214cps/MBq. Initial laboratory phantom simulations and clinical investigations demonstrated a new way of visualising uptake, with good localisation of the site of activity in patients.

CONCLUSION

The anatomical context provided by the optical camera aids the physical localisation of radiopharmaceutical uptake in patients e.g. in sentinel node detection. The compact size and fused display makes the system ideal for surgical use. Recent improvements to the camera system along with results of phantom and clinical imaging have been reported [1,2].

CLINICAL IMAGES

A patient undergoing a thyroid investigation was injected with a standard dose of 20MBq ¹²³I-Nal (159keV) intravenously 90min prior to imaging. Figure 3 shows a set of images from the HGC taken at a distance of 100mm. These images show an active right lobe with no activity present in the left lobe, this result was confirmed with subsequent imaging using a large FOV gamma camera (not shown). In this way the combination of gamma and optical images (Figure 3) could aid surgeons and clinicians localise the radiopharmaceutical uptake and help diagnosis prior to any interventional surgery.

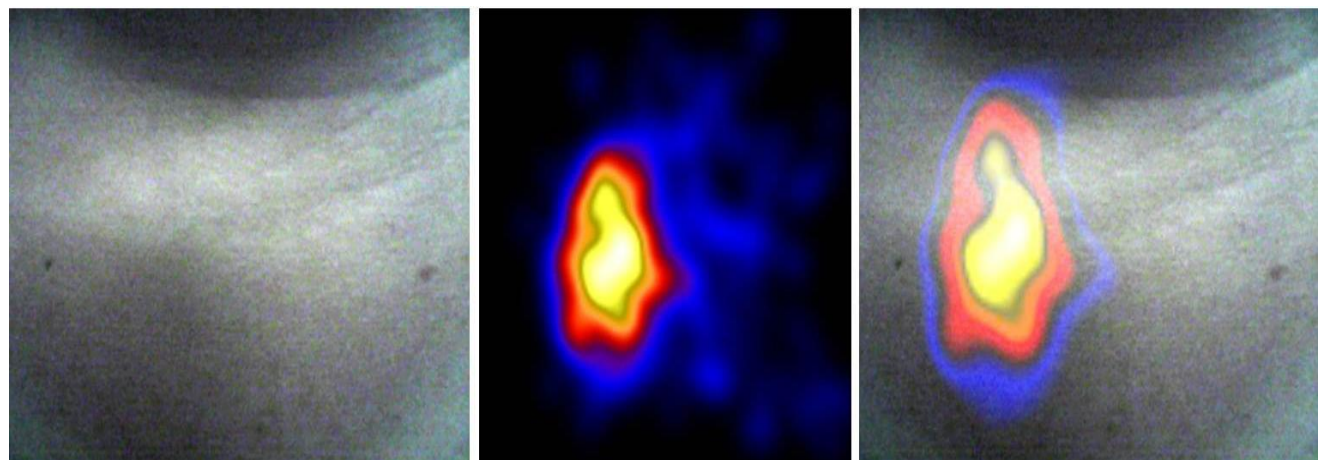


Figure 3. Left: an optical image of the patients neck, centre: gamma image of the thyroid, right: combined optical and gamma images.

Reference

- [1] J E Lees, S L Bugby, B S Bhatia, L K Jambai, M S Alqahtani, W R McKnight, A H Ng and A C Perkins, A small field of view camera for hybrid gamma and optical imaging, Journal of Instrumentation 9 (2014) C12020
- [2] S L Bugby, J E Lees, A C Perkins, A H Ng, Investigation of a SFOV hybrid gamma camera for thyroid imaging, Physica Medica (2015)

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