A lymphoscintigraphic phantom study using a novel hybrid optical-gamma camera

M.S. Alqahtani[1], J.E. Lees[1], S.L. Bugby[1], B.S. Bhatia[1,2], L.K. Jambi[1], W.R. McKnight[1], A.H. Ng[3] and A.C. Perkins[3]

[1] Space Research Centre, University of Leicester, Leicester, LE1 7RH, UK
[2] Clinical Imaging Group, Sandwell and West Birmingham Hospital NHS Trust, West Bromwich B71 4HJ, UK
[3] Radiological and Imaging Sciences, Medical Physics and Clinical Engineering, Medical School, University of Nottingham and Nottingham University Hospitals NHS Trust, NG7 2UH, UK

M.S. Alqahtani contact:
msma7@le.ac.uk

INTRODUCTION

The lymphatic system is a prime area of research in oncology. It is known to be the main route for dissemination of tumour cells from primary to metastatic sites and is therefore of major clinical interest.

Currently, nuclear medicine techniques are used to assess lymph node drainage. We are investigating the role of a novel Hybrid Compact Gamma Camera (HCGC) developed by the Space Research Centre, University of Leicester for imaging a range of diagnostic and image-guided procedures such as sentinel lymph node biopsy in melanoma and breast cancer. The HCGC is a portable handheld medical device for a small field of view (SFOV) hybrid gamma imaging equipped with 0.5mm diameter pinhole collimator.

This work describes the use of the HCGC in a phantom simulation of lymphatic imaging.

MATERIALS AND METHODS

Lymphatic vessels were simulated with a 0.55mm internal diameter cannula containing ^{99m}Tc with an activity of 2MBq/cm. A micro vial containing 60MBq of ^{99m}Tc (0.4ml) was used to simulate the injection site. Perspex thicknesses (ranging from 5 to 30mm) have been used to imitate lymphatic vessels in different depths inside the human body. An illustration of the experimental setup and the HCGC is displayed in figure 1.

A metallic frame with a clamp held the HCGC perpendicular to the Perspex surface. The distance between the collimator and the Perspex surface was determined to be 10cm. Gamma and optical gamma images were acquired for each Perspex thickness. The experiment was also repeated using a conventional gamma camera (Mediso X-Ring, Hungary) equipped with low-energy high-resolution collimator.

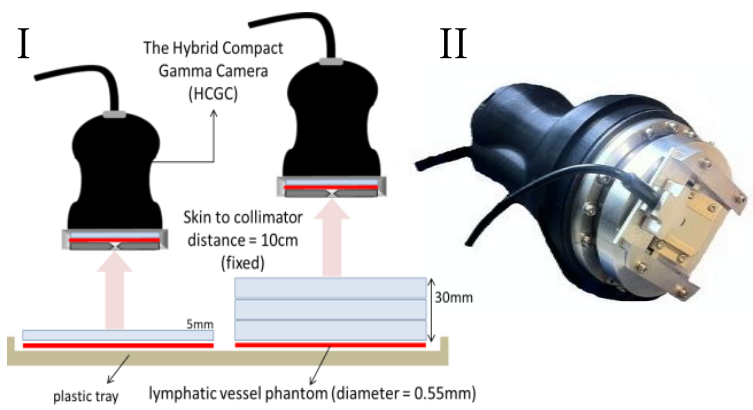

Figure 1. (I) A schematic diagram shows the experimental setup. (II) the Hybrid Compact Gamma Camera (HCGC).

RESULTS AND DISSCUSSION

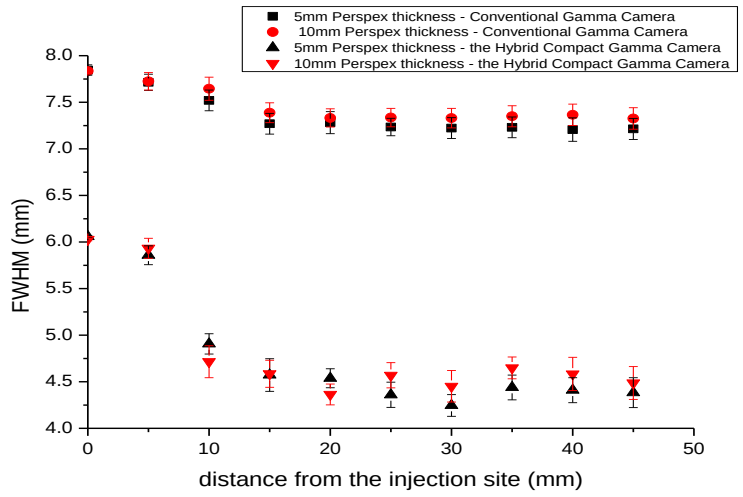

Figure 2. Full Width at Half Maximum (FWHM) of the injection site and lymphatic vessel phantom images during imaging by a conventional gamma camera and the HCGC.

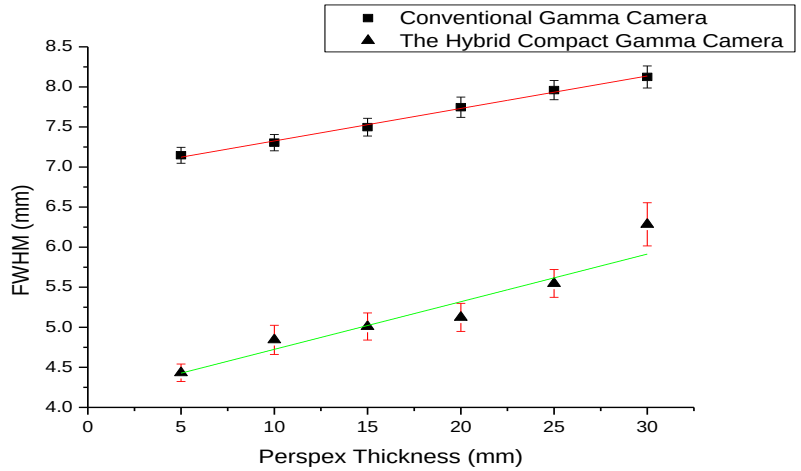

Figure 3. FWHM of the lymphatic vessel phantom images produced by a conventional gamma camera and the HCGC.

At an imaging distance of 10cm, the resolution of the HCGC was not degraded (variation <5%) at separations of more than 1.5cm from the injection site (figure 2).

The steady increase in the full width at half maximum (FWHM) with an increase of Perspex thickness reflects the degradation of the spatial resolution. The poorest spatial resolution recorded is 6mm at 13cm collimator to source distance with the presence of 3cm Perspex thickness (figure 3).

Nevertheless, these results appear better to those produced by the conventional gamma camera.

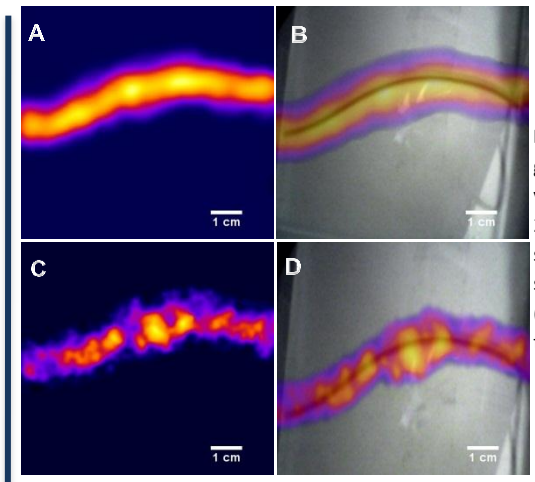

Figure 4. (A,B) gamma and hybrid gamma images for the lymphatic vessel phantom (1000 frames ~ 2mins - 5mm thick Perspex). (C,D) same imaging and experimental setup with longer acquisition time (5000 frames ~ 10mins - 5mm thick Perspex).

In figure 4, two imaging sets are presented as an example of hybrid gamma images. The difference between the two sets shows the effect of the acquisition period on the system detectability. However, informative images can be provided within a couple of minutes (figure 4, A and B). Fused optical and gamma images showed good alignment of the two modalities allowing localisation of activity within the field of view.

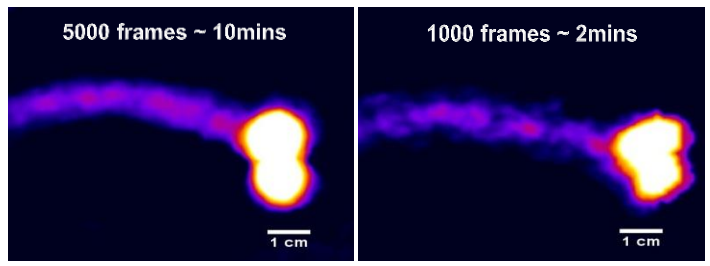

Figure 5. Gamma images show the lymphatic vessel phantom including the dual injection site. The lymphatic vessel was placed underneath 5mm thick Perspex.

The effect of the injection site presence within the field of view (FOV) is shown in figure 5. Even in the presence of the injection site, the targeted lymphatic vessel was detectable with an acquisition time of less than 2 minutes, which reflects its capability to produce an informative image for a complex area within the human body in a short period.

CONCLUSION

The performance of the HCGC in this study shows that it is well suited for lymphatic vessel drainage imaging. The anatomical context provided by the optical camera aids the physical localisation of radiopharmaceutical uptake. Further evaluation will be carried out with the aim of using the camera in a surgical theatre setting.

Reference

Lees, J.E., D.J. Bassford, O.E. Blake, P.E. Blackshaw, and A.C. Perkins, A Hybrid Camera for simultaneous imaging of gamma and optical photons. Journal of Instrumentation, 2012. 7(6).

Acknowledgment

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