A method for source-depth estimation using a Hybrid Gamma Camera

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INTRODUCTION

To enhance the location of radiolabelled nodes or tumours prior to or during diagnostic or intraoperative procedures a means of an estimating the depth between the surface and the sites of the accumulated radioactive material would be a useful addition to current clinical practice.

The hybrid gamma camera (HGC) [1] can be adapted to estimate the depth of radiolabelled uptake within a patient. This work describes the estimation of the depth of radioisotope distribution in relation to patient anatomy using a portable hybrid gamma camera which combines optical and gamma imaging. This additional information could be of particular help in optimising surgical procedures for resection of lymph nodes and tumours.

MATERIALS AND METHODS

The hybrid gamma camera was fitted with a 1 mm diameter pinhole collimator (60° acceptance angle) for high efficiency. Two 10mm diameter holes in L-shape phantom were filled with ^{99m}Tc radioactive solution (5.0MBq) to give a simple node (tumour) phantom source. The acquisition time for each image was about four minutes. A single camera was used for imaging the source then it was displaced by 20mm to obtain a second set of images (both optical and gamma). The camera to the source distances were measured from the collimator face. These distances were varied from 120mm to 200mm for the source in the first well and from 115mm to 175mm for the source in the second well in 20mm steps. The first well and the second well are covered, with a 32mm and 8mm Perspex cap respectively, to simulate different depths of lymph nodes. An illustration of the experimental setup and the HGC is displayed in figure 1.

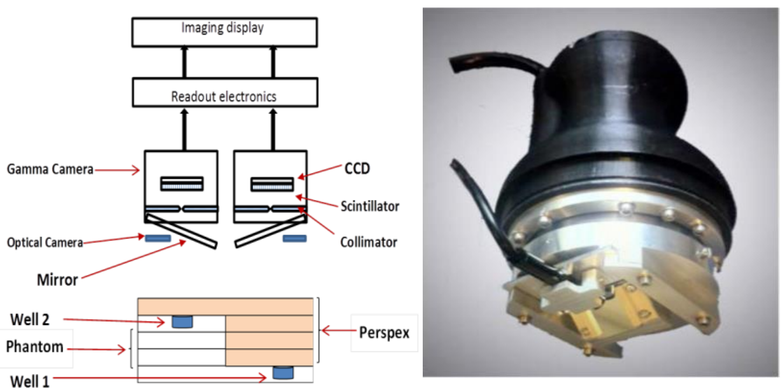

Figure 1. (left) A schematic diagram shows the experimental setup. (right) the Hybrid Gamma Camera (HGC).

RESULTS AND DISCUSSION

(i) Calculated distances

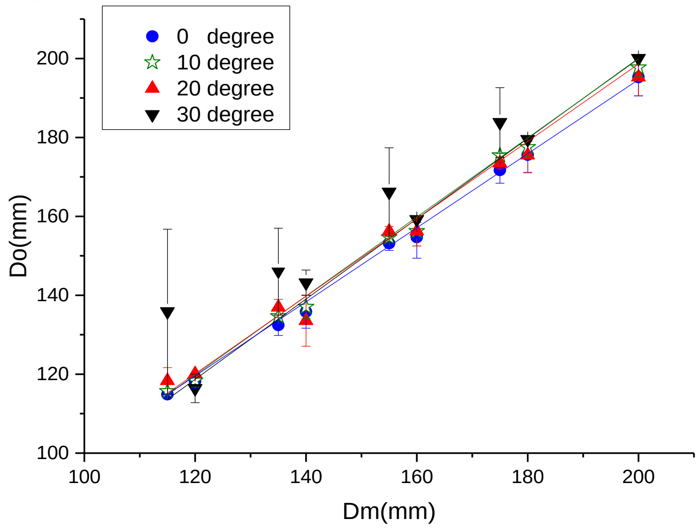

Figure 2. Relationship between calculated distance from collimator to surface of the phantom of optical camera (Do) and measured distance (Dm(mm)) from collimator with the hybrid camera at different viewing angles 0°,10°, 20° and 30°.

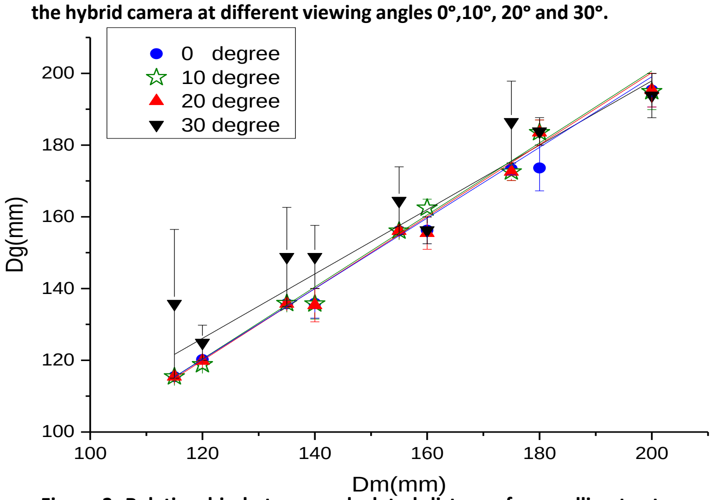

Figure 3. Relationship between calculated distance from collimator to source of gamma camera (Dg) and measured distance (Dm(mm)) from collimator with the hybrid camera at different viewing angles 0°,10°, 20° and 30°.

There is a good agreement between calculated and measured values when the hybrid gamma camera axis was perpendicular (0°) to the source and at 10°, 20° and 30° to the y-axis. Calculated distances were underestimate of true distances by approximately 3.0% for 0°,10°, 20° and by approximately 8% of the measured distance at 30° (figure 2 and 3). This is may be because of the difficulty of determining centre of the images exactly.

(ii)Calculated depths

Θ=0°		Θ=10°		Θ=20°		Θ=30°	
well 1	well 2	well 1	well 2	well 1	well 2	well 1	well 2
32.56	8.87	32.25	7.2	32.21	8.11	25.79	8.97
31.29	8.68	33.82	8.91	34.81	7.31	35.04	5.24
32.24	9.73	31.53	7.71	31.31	7.59	34.36	6.65
32.4	9.86	30.18	7.91	31.58	7.76	36.45	9.35
33.73	9.74	33.12	7.89	35.62	8.92	37.76	16.72

Table 1. Summary of the depths of the first and second wells.

In table 1, there are small differences between calculated and measured depths when the hybrid gamma camera axis was perpendicular to the source (0°) and at different viewing angles: 10°, 20° relative to the Y-axis with the differences approximately 20% when the camera at 30°.

(iii) Stereoscopic imaging

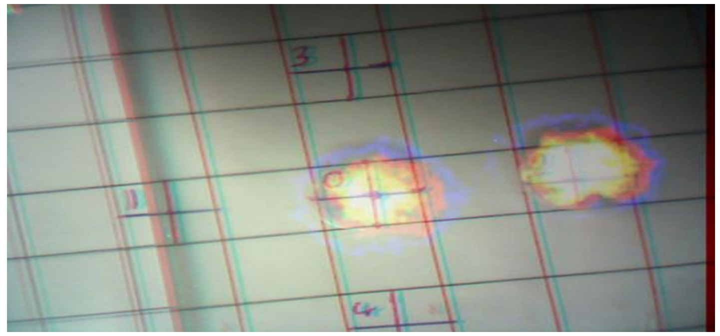

Figure (4). Blue and red combined optical and gamma stereo image of two holes containing coloured solution of ^{99m}Tc as a radioactive source. To realise the stereo effect a pair of blue/red glass is required.

The combination of gamma and optical images (figure 4) can be used to reconfirm the site of the abnormality in the operating room as the sites of the lymph nodes in a patient might be slightly different from the preoperatively specified sites. Clinically, these results indicate that the dual HCGC can provide accurate localization and depth of radiolabelled tissue within the body.

CONCLUSION

A method to calculate the depth from surface to source using the HGC has been described. There is a linear relationship between the calculated and measured distances from the camera to the source and/or the surface. This technique could allow surgeons to determine the depth and location of radiopharmaceutical uptake immediately prior to or during an operation without 3D SPECT imaging.

Reference

1- J E Lees, S L Bugby, A P Bark, DJ Bassford, PE Blackshaw, AC Perkins, A Hybrid Camera for locating gamma sources in the environment, JInst 8 (2013) P.10021

Acknowledgment

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