A Simple Low Cost Phantom for SPECT Orientation Quality Control

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The design of a very simple phantom is presented for SPECT camera orientation quality assurance. The phantom is useful for quickly determining orientation and deriving slice order of SPECT transverse, sagittal, and coronal images.

As a computer-reconstructed imaging technique, the presentation of SPECT slices is usually left to the whims of the software manufacturer and the way in which his routines interpret input from various rotating scintillation camera manufacturers and models. Reconstructed transverse slices may be derived with various orientations (for example, with anterior up or down, viewed from patient's head or feet, or slices ordered top to bottom or bottom to top). Similar problems may exist with the orientation and order numbering of the coronal and sagittal slices that are subsequently created. Compounding this are the orientation changes that can occur for different camera types, camera rotation direction, camera start position, patient positioning (supine or prone, head or feet into gantry) and new versions of reconstruction software. The simple numbering and orientation of SPECT reconstructed slices can become terribly confusing.

Whereas phantoms are available for measuring image quality, none are designed to quickly answer orientation questions. As a quick and easy method of confirming slice orientation and numbering, we present the Traverse-Coronal-Sagittal (TCS) phantom. A scan of this very simple phantom provides rapid (less than 5 min) confirmation of reconstructed slice orientation and numbering.

MATERIALS AND METHODS

The prototype TCS phantom is made of a cubic cardboard box, 15 cm per side. A discarded commercial radiopharmaceutical shipping container suffices nicely. The phantom utilizes plastic tubing attached to the cardboard box for the outline of 8-cm-tall stylized letters T, C, and S, as in figure 1. Ten-inch flexible connecting tubing of 0.105-inch internal diameter is found to be quite acceptable, providing easy loading of 5 mCi ^{99m}Tc with a decreased contamination risk. The heavy mark in the upper right hand corner of each letter removes any confusion in viewing the nearly symmetric T, C, and S from various orientations.

As with any liquid radionuclide, radiation safety procedures must be followed during the use of this phantom. The phantom should be labeled as radioactive, naming the source, the activity, and the date. The phantom could then be placed in a clear plastic bag to minimize the risk of contamination. The external radiation exposure rate 30 cm from this phantom loaded with 5 mCi ^{99m}Tc is less than 5.0 mR/hr.

RESULTS

The phantom is placed in the field of view of the SPECT camera, mimicking the usual patient set-up (T in the transverse plane, C in the coronal plane, and S in the sagittal plane). A rapid (1 sec per 3° step) SPECT scan is acquired and reconstruction undertaken. The 5 mCi phantom loading provides sufficient count density to allow fast, high contrast scans without exceeding camera count rate capabilities.

Figure 2 illustrates the results from imaging the prototype TCS phantom on a SPECT camera* and reconstructing on a computer system†. Comparing the phantom set-up to the images immediately identifies the slice orientation. For example, transverse slices here are presented anterior on top and patient right on image left. Viewing successive slices reveals the slice ordering to run inferior to superior for transverse,

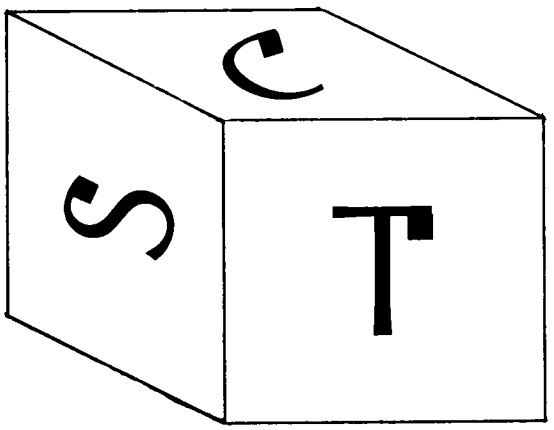

Fig. 1. TCS SPECT phantom. Box dimensions are 15 cm × 15 cm × 15 cm. Letter sizes are 8 cm × 8 cm.

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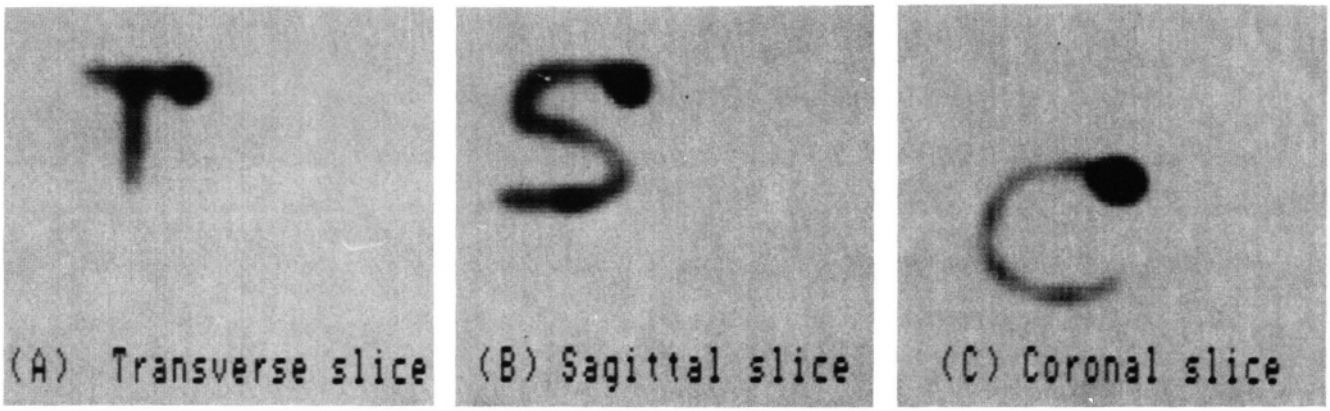

Fig. 2. Images of TCS phantom: (A) transverse, (B) sagittal, and (C) coronal planes.

posterior to anterior for coronal, and right to left for sagittal slice reconstruction.

In conclusion, the phantom has allowed us to accurately define the planes presented by oblique slice reconstruction. It has also identified errors in acquisition and reconstruction software protocols.

FOOTNOTES

* 400 AC/T General Electric Medical Systems, Milwaukee, WI.

† Computer Design and Applications (CDA), Inc., Waltham, MA.