Noncircular Orbits in SPECT

I read the article by Gottschalk et al. (*1*) with great interest. They have shown advantages of an elliptical orbit over the circular orbit in single photon emission computerized tomography (SPECT), the advantages being better uniformity and resolution in the slice images. A noncircular orbit was obtained by a combination of rotational and translational motion. But one thing was not clear to me. Was the orbit obtained by moving the detector by fixed translational increments in addition to rotation—i.e.,

$$x(\Theta) = A \cdot \Theta \quad (0 < \Theta < \pi/2) \tag{1}$$

—or were the translational shifts given by

$$x(\Theta) = B\sin(\Theta), \tag{2}$$

thus giving a pure elliptical orbit (Fig. 1.). In the case of a 30- by 40-cm ellipse, the difference between a pseudo-elliptical orbit obtained by constant translational shifts and a pure elliptical orbit is negligible in practice. But in reconstructing the data, each row of the sinogram must be shifted by an appropriate displacement $D(\Theta)$, which is the displacement of the observed center of rotation with respect to that obtained for a circular orbit (*2*). $D(\Theta)$ is given by

$$D(\Theta) = \pm \cos(\Theta)x(\Theta) \tag{3}$$

(positive for $0 < \Theta < \pi/2$ and negative for $\pi/2 < \Theta < \pi$, and symmetrically for other values of (Θ). Thus, for a pure elliptical orbit:

$$D(\Theta) = \pm B/2 \sin(2\Theta); \tag{4}$$

and for the pseudo-elliptical orbit

$$D(\Theta) = \pm A\Theta \cos(\Theta) \tag{5}$$

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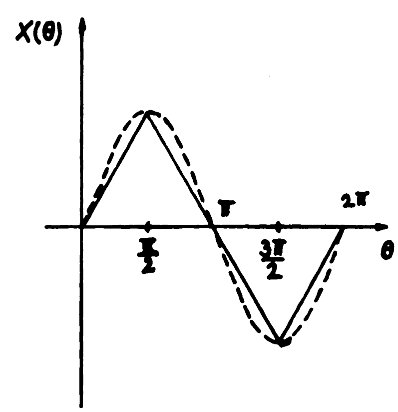

FIG. 1. Translational shifts as functions of Θ, giving pure elliptical (dashed lines) and pseudoelliptical orbit.

REFERENCES

1. GOTTSCHALK SC, SALEM D, LIM CB, et al: SPECT resolution and uniformity improvements by noncircular orbit. *J Nucl Med* 24:822–828, 1983
2. TODD-POKROPEK: Non-circular orbits for the reduction of uniformity artifacts in SPECT. *Phys Med Biol* 28:309–313, 1983

Reply

We would like to stress that our procedure is applicable for arbitrary noncircular orbits. If the translation is $d(\theta)$, then the shift of the projection's central ray is given by:

$$\delta S = -d(\theta) \cos\theta \tag{1}$$

Our specific implementation shifts the projection by δS before back projection. The shift uses linear interpolation, with an accuracy of one AreaScan encoder tick or 0.07 mm (see Erratum, 25:634, 1984).

The particular case of pure elliptical motion of the detector center uses $d(\theta) = (A\text{-}B) \sin\theta$ where A, B are the major and minor axes of the ellipse.

In general the translation $d(\theta)$ is used to control the AreaScan motion and the same $d(\theta)$ is used in Eq. (1) to shift the projections. No approximations are used.

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The Effect of Collimators on the Center of Rotation in SPECT

The introduction of single photon emission computerized tomography (SPECT) has caused considerable interest in the various quality-control protocols that are necessary to ensure optimum performance. Several articles have addressed this issue (*1–4*) and sessions have been devoted to the topic at various meetings, including those of the Society of Nuclear Medicine.

One performance parameter that needs to be checked is the center of revolution. A center that becomes offset by as little as one pixel over 180° can cause a loss of resolution (*2–4*). Quality-control procedures are usually aimed at reducing this offset to a minimum: to at most a quarter of a pixel, in most systems, or less than 1.5 mm.

It may, perhaps, be assumed that a change of collimator will not cause any shift in the center of rotation, but we have recently experienced a situation that proved the contrary. A low-energy, all-purpose collimator was exchanged because there was some evidence of radiation leakage around the periphery. The replacement collimator had similar specifications, but a check of the new center of revolution revealed a shift of three pixels, or almost 19 mm, which was, of course, unacceptable.