

Parallax Error in Pinhole Thyroid Scintigraphy: A Critical Consideration in the Evaluation of Substernal Goiters

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Parallax error is found to be another pitfall in pinhole thyroid scintigraphy, i.e., a substernal goiter may appear between the thyroid cartilage marker and the suprasternal notch marker. Unless one is aware of this pitfall, a substernal extension of the thyroid may not be realized or be seriously underestimated in its size and extent. We illustrated the parallax error using a thyroid phantom. An illustrative case is shown.

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We have encountered another pitfall of pinhole thyroid scintigraphy: parallax. This phenomenon occurs when a substernal goiter is imaged using a pinhole collimator positioned at the usual thyroid bed between the thyroid cartilage and the suprasternal notch. The substernal portion of the thyroid may appear as if it is within the normal thyroid bed on the resulting image. Our study is designed to demonstrate this parallax phenomenon of the pinhole collimator.

MATERIALS AND METHODS

A standard thyroid phantom was filled with water containing 1 mCi of $\text{Na}^{99\text{m}}\text{TcO}_4$. It was placed under a gamma camera equipped with a pinhole collimator. A styrofoam cup was attached to the end of the pinhole collimator to maintain a fixed distance of 5.0 cm from the collimator to a line connecting thyroid cartilage and suprasternal notch markers. These markers were made with a double ended Q-tip spotted with $\text{Na}^{99\text{m}}\text{TcO}_4$. The Q-tip was attached parallel to the bottom surface of the cup. Two centimeter-thick Lucite blocks were used as tissue equivalent spacers to vary the depth of the "thyroid." For imaging, the styrofoam cup was brought into contact with the phantom or with the top of the spacers when added. A series of images were taken at varying pinhole collimator-to-thyroid distances.

RESULTS

There is an inverse linear relationship between the image size and the pinhole-to-phantom distance (Fig. 1A). The degree

of parallax was also found to be linear (Fig. 1B). Figure 2 illustrates the degree of parallax and the minification effect of the pinhole imaging. The first image represents the actual location of the phantom between the thyroid cartilage and suprasternal notch. The upper margin of the isthmus of the thyroid phantom is seen, as it is placed, at the suprasternal notch. As the pinhole collimator to phantom distance is increased, the thyroid image moves progressively up to the normal thyroid bed.

ILLUSTRATIVE CASE

A 64-yr-old female with a large upper mediastinal mass which deviated the trachea was referred to the nuclear medicine department for a thyroid scan. The routine pinhole image, (Fig. 3A) showed an asymmetric thyroid gland with an enlarged left lobe. Its lower margin, however, extended only down

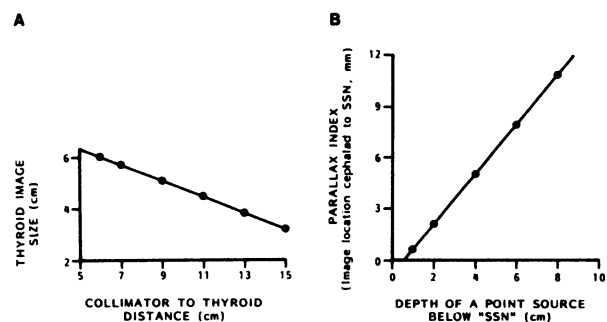


FIGURE 1
A: Linear relationship between collimator to thyroid distance and resulting image size. B: Linear relationship between the depth of object centered off pinhole and resulting parallax

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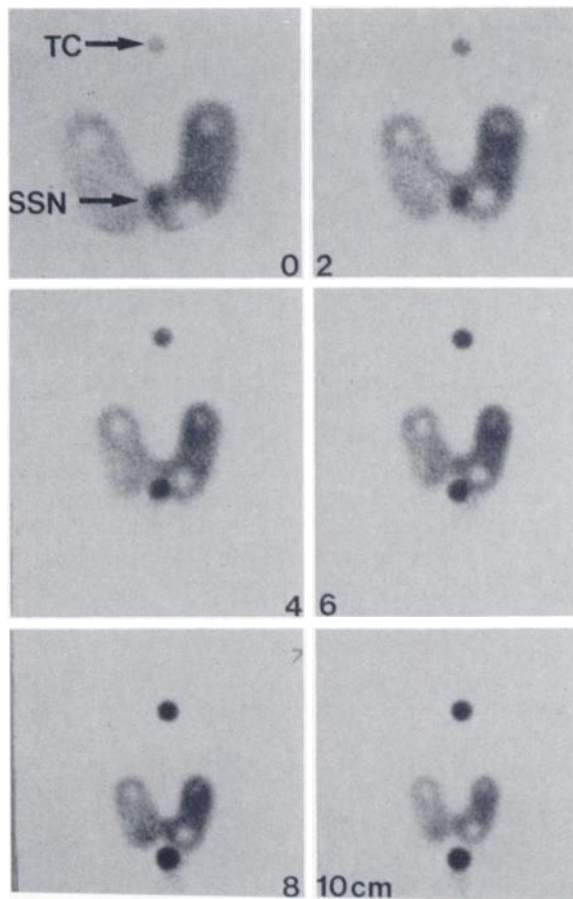


FIGURE 2
Serial images obtained at increasing depths of thyroid phantom intentionally placed off center from pinhole. Notice location of isthmus in relation to SSN marker. As pinhole to phantom distance is increased, thyroid image is "pulled up" to normal thyroid bed. Also note degree of minification becoming more pronounced

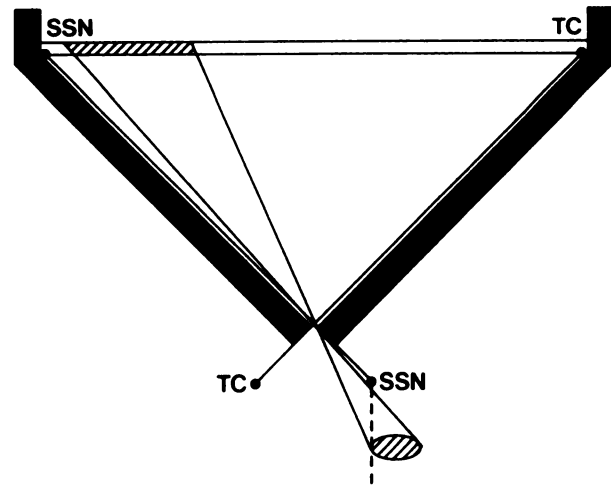


FIGURE 4
Schematic diagram illustrating parallax error. Activity caudal to suprasternal notch may appear cephalad to it on crystal surface and, therefore, also on final image

to the suprasternal notch marker, certainly not low enough to account for the large mediastinal mass. To rule out the possible parallax error in this case, a rectilinear scan was obtained (Fig. 3B). This showed that the bulk of the enlarged left lobe was indeed located substernally. When this scan was superimposed on the chest x-ray, the substernal goiter corresponded to the upper mediastinal mass.

DISCUSSION

Despite the many advantages of pinhole scintigraphy (1-4), some of its pitfalls including anatomical distortion and inaccuracy of sizing have been reported (4-6).

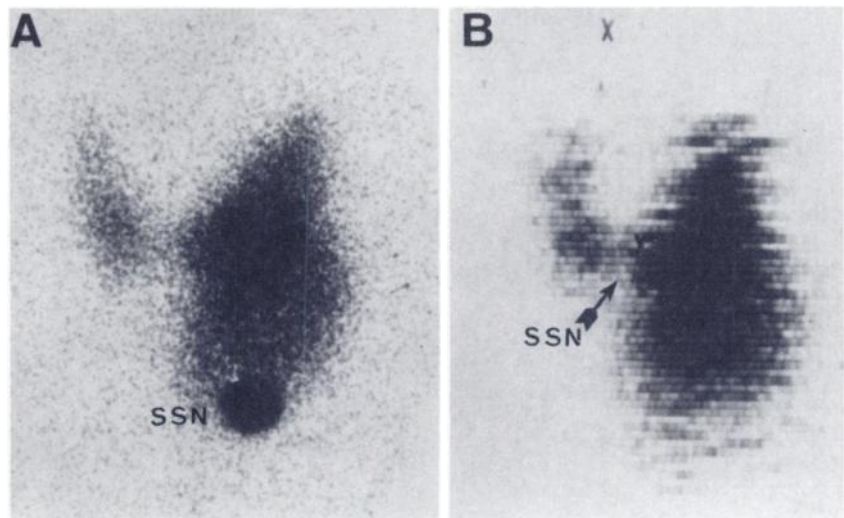


FIGURE 3
A: Routine pinhole thyroid image of 64-yr-old with upper mediastinal mass shows lower margin of enlarged left lobe at suprasternal notch marker. B: Rectilinear image of same patient shows bulk of enlarged left lobe is actually located substernally. Lower X indicates suprasternal notch

Parallax error is another pitfall of pinhole thyroid scintigraphy which is caused by the combination of off-center positioning of the pinhole in relation to the object (substernal goiter) and the inherent minification effect of the pinhole collimator with increasing distance. Figure 4 illustrates the parallax schematically. As the pinhole is moved further up, the object image size will decrease and appear closer to the center of the scintigraph.

This potential error can be avoided by using a rectilinear scanner or a parallel-hole collimator, or by centering the pinhole over the substernal thyroid gland.

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