Method for Determining Tomographic Plane Separation and Detector Distances for Use with the Searle Pho/Con Tomographic Multiplane Scanner

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Use of the Anger rectilinear tomographic scanner provides such benefits as better information density, superior resolution away from the geometric focal plane, and opportunities to assess lesion depth and reduce confusion and error by virtue of its ability to separate pathology from surrounding normal variance. To reap these benefits, the technologist must have a thorough working knowledge of the tomoplanes. This allows him to distribute the planes throughout the organ being scanned in a fashion that best utilizes tomographic imaging and optimizes resolution.

In working with the new breed of rectilinear scanner with tomographic multiplane imaging capabilities, the technologist needs to distribute the tomoplanes (focal planes) accurately and evenly throughout the organ being scanned. This paper discusses ways of best utilizing tomographic planes and optimizing resolution between them.

Methods and Materials

The Searle Pho/Con tomographic multiplane scanner produces six images per detector on a transparency film. Each image represents a selected tomoplane. These six tomoplanes are evenly spaced, three above and three below the geometric focal plane (Fig. 1). Gamma emissions occurring in a given tomoplane are recorded as sharply focused dots. Emissions from all other planes are recorded as blurred points of much lower intensity. The space between tomoplanes, the total spread of the six tomoplanes, and their distance from the face of the collimator vary depending on format size, collimator used, and setting of the tomographic selector.

Ideally, the tomographic planes should be evenly spaced throughout the organ being scanned. Tomoplanes should not be uselessly spaced outside the organ or needlessly overlap in the organ, thereby leaving other areas unexamined (Fig. 2). This ideal cannot always be realized when scanning the whole body because of the

irregularity of the longitudinal body contour and the fact that the detector distance is not altered during a scan. Maldistribution of the tomoplanes can be caused by incorrectly setting the tomographic selector, incorrect detector distances, or a combination of both.

It is important to note that tomoplane No. 1 varies in its distance from the face of the collimator depending upon the collimator, format size, and tomoplane setting used. For this reason, the distance of the collimator from the organ surface being scanned varies accordingly. The closer the tomoplanes are spaced, the better the resolution will be between them.

It is recommended that the technologist refer to the operating manual section on collimators and, for each collimator, determine the total tomoplane spread for each format with its ten different tomographic settings (Table 1). This needs to be done only once when the permanent technique charts are being prepared. Using the tomoplane charts, subtract the distance from TP-1 to the face of the collimator from the distance listed for TP-6 to obtain the total TP spread.

Sometimes it is necessary to concentrate the TPs through an area that is not an equal distance from the
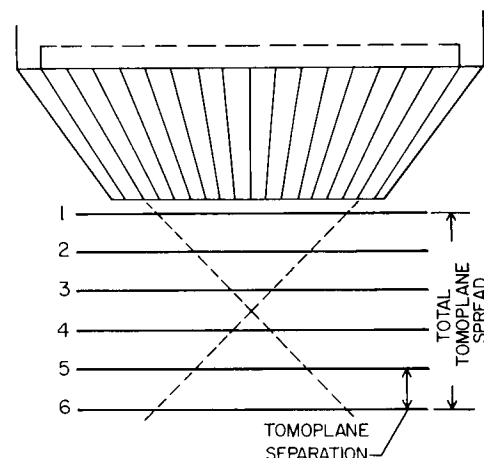

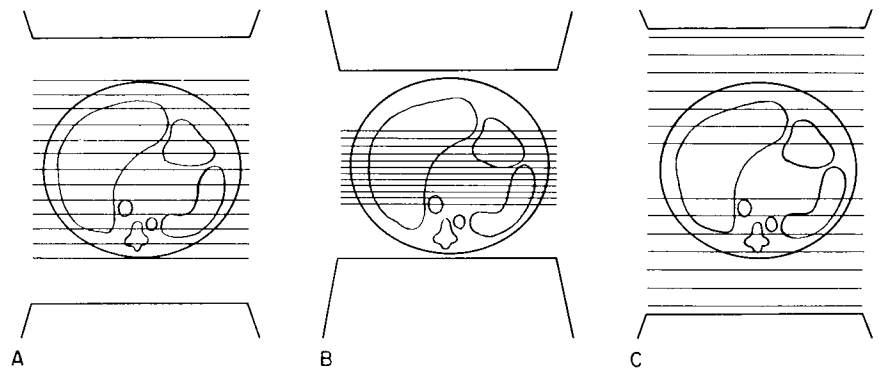**FIG. 1.** Detector with its six tomoplanes.

FIG. 2. Transverse section of abdomen with tomoplanes visualizing all depths of abdomen in (A). (B) and (C) leave areas unscanned.

A   B   C

upper and lower detectors. Such is the case with thyroid and pancreas imaging.

In such cases, alteration and refinement of the basic procedure are possible and sometimes necessary. A thorough working knowledge of the use of tomoplanes will be of greater benefit to the technologist than any specific formula.

A simple guide to establishing upper and lower distances and tomographic plane separation for scanning with the Pho/Con tomographic multiplane scanner can be given in step form:

1. Select the correct format size and collimator for the area to be scanned and radionuclide in use.
2. Measure the thickness of the area.
3. Calculate the half-thickness of the area.
4. Select the tomographic setting that has a total tomoplane spread equal to or just less than the half-thickness.
5. Consult the Pho/Con manual specification sheet for the collimator in use and determine the distance between the face of the collimator and the first tomoplane.
6. Establish the upper probe distance using the formula

   Full thickness + (distance found in Step 5 - 1 cm) = upper probe distance.

7. Establish lower detector distance using the formula

   Distance found in Step 5 - 1 cm = lower probe setting.

Example No. 1:

A bone scan using Tc-99m EHDP would proceed as follows:

1. Whole body format and the 150-keV 10-mm collimator.
2. Patient measures 20 cm.
3. Half-thickness is 10 cm.
4. Tomographic separation—switch settings:

Setting No. 1	TP-6	11.2 cm
	TP-1	-6.6 cm
Total tomoplane spread		4.6 cm

TABLE 1. Total Tomoplane Spreads: Collimator 820-822875; 150 keV; 10 mm.

Tomographic separation settings	Format Size				
	15 × 15 (cm)	25 × 25 (cm)	35 × 35 (cm)	45 × 45 (cm)	65 × 65 and whole body (cm)
1	1	1.7	2.4	3.2	4.6
2	2.2	3.6	5	6.4	9.2
3	3.2	5.4	7.4	9.6	13.7 (5)
4	4.2	7.1	9.9	12.7	14.6 (5)
5	5.4	8.8	12.3	15.9	18.4 (5)
6	6.4	10.6	14.8	15.2 (5)	22.1 (4)
7	7.4	12.3	17.2 (5)	17.8 (4)	19.3 (4)
8	8.5	14.1	15.8 (4)	15.2 (4)	25 (4)
9	9.6	15.9	17.8 (5)	17.2 (4)	24.7 (4)
10	10.6	17.6	19.7	19.1	27.5

( ): No. tomoplanes available at that setting.

TABLE 2. Tomographic Technique Chart: Collimator 820-822875; Whole Body Format 150 keV; 10 mm.

Organ thickness (cm)	Half thickness (cm)	Tomographic setting	Upper detector distance (cm)	Lower detector distance (cm)
14	7	2	17.3	3.3
16	8	2	19.3	3.3
18	9	2	21.3	3.3
20	10	2	23.3	3.3
22	11	2	25.3	3.3
24	12	3	25	1
26	13	3	27	1
28	14	4	30.4	2.4
30	15	4	32.4	2.4
32	16	4	34.4	2.4
34	17	5	35	1
36	18	5	37	1
38	19	7	42.7	4.7
40	20	7	44.7	4.7

Setting No. 2	13.5 cm
	−4.3 cm
Total tomoplane spread	9.2 cm
Setting No. 3	15.7 cm
	−2.0 cm
Total tomoplane spread	13.7 cm
Setting No. 4	18.0 cm
	−3.4 cm
Total tomoplane spread	14.6 cm

Use TP Setting No. 2. It is less than and closest to the half-thickness of 10 cm.

5. Distance between detector and TP-1 is 4.3 cm.
6. 20 cm + (4.3 cm − 1 cm = 23.3 cm. Thus, upper probe setting is 23.3 cm from the table top.
7. 4.3 cm − 1 cm = 3.3 cm. Therefore, set lower detector 3.3 cm from the undersurface of the table. (See Table 2.)

TABLE 3. Tomographic Technique Chart: Collimator 820-822875; 25 × 25 Format: 150 keV; 10 mm.

Organ thickness (cm)	Tomographic setting	Upper detector distance (cm)	Lower detector distance (cm)
14	4	18.3	4.3
16	4	20.3	4.3
18	5	21.5	3.5
20	5	23.5	3.5
22	6	24.6	2.6
24	7	25.7	1.7
26	7	27.7	1.7
28	8	28.8	0.8
30	8	30.8	0.8
32	9	32	0
34	9	34	0
36	10	36	0

Example No. 2:

In a brain scan (lat) using sodium pertechnetate, the procedure gives:
1. Format 25 × 25 and 150-keV 10-mm collimator.
2. Head measures 16 cm.
3. Half-thickness is 8 cm.
4. Tomographic separation—switch settings:

Setting No. 3	TP-6	11.6 cm
	TP-1	−6.2 cm
Total tomoplane spread		5.4 cm
Setting No. 4		12.4 cm
		−5.3 cm
Total tomoplane spread		7.1 cm
Setting No. 5		13.3 cm
		−4.5 cm
Total tomoplane spread		8.8 cm
Setting No. 6		14.2 cm
		−3.6 cm
Total tomoplane spread		10.6 cm

Use Setting No. 4.

5. Detector-to-TP-1 distance is 5.3 cm.
6. 16 cm + (5.3 cm − 1 cm) = 20.3 cm, the upper detector distance.
7. 5.3 cm − 1 cm = 4.3 cm, the lower detector distance. (See Table 3.)

Acknowledgment

Reference

1. Searle Radiographics Inc.: Pho/Con Multi-plane Imager, Operation Manual; first and second preliminary editions.