Whole-Body Lymphoscintigraphy Using Transmission Scans

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Objective: Our objective was to show the advantages of performing whole-body lymphoscintigraphy using transmission sources. This technique should decrease scanning time, help locate the sentinel lymph node, and decrease radiation exposure to the technologist.

Methods: Twenty patients with proven melanoma received 18.5 MBq (0.5 mCi) filtered (0.22 μm) ^{99m}Tc-sulfur colloid in a 0.2-mL volume, administered as multiple intradermal or subcutaneous injections around the known melanoma lesion or scar. All 20 patients underwent serial static imaging immediately after the injection, along with whole-body scanning after the static imaging. The static emission images were acquired for 5 min and the transmission images for 1 min using a 256 × 256 matrix. The whole-body transmission scans were acquired after the whole-body emission scans. The transmission scans were obtained with the same parameters as the emission scans, with the addition of placement of a ^{57}Co sheet source on one of the detectors of the large-field-of-view dual-head camera. The planar static axial images (transmission, emission) were compared with the whole-body images (transmission, emission) to determine whether the same number of lymph nodes was visualized with each technique. Posterior outlines were obtained through computer manipulation of anterior transmission images.

Results: In all 20 patients, the number of lymph nodes seen on the static images was the same as that seen on the whole-body emission and transmission images. The whole-body emission and transmission scanning time was an average of 30 min less than the time required to acquire the serial static images.

Conclusion: The anatomic location of the sentinel lymph node is seen more easily on whole-body images, both anterior transmission and posterior transmission, than on planar static images. Whole-body emission and transmission imaging decreased scanning time and thus improved patient comfort and throughput. Technologists received less radiation exposure when handling the ^{57}Co source only twice during whole-body imaging, as opposed to several times during static imaging.

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The lymphatic system consists of a network of vessels and lymph nodes that are dispersed throughout the body. The average adult has approximately 500 to 1,000 nodes (*1*). Lymphoscintigraphy is the injection of radioactive particles that are then imaged as they pass through afferent lymphatic vessels to their respective lymph node drainage basins. Lymphoscintigraphy has made it easier to trace the complicated lymphatic drainage to the sentinel lymph node (SLN), which is the draining node nearest the tumor. It has been proposed, and appears to have been proven, that in melanoma the pathologic status of the SLN accurately predicts the status of the entire nodal basin (*2*). Not only nodes of the draining basin but also in-transit lymph nodes, situated between the injection site and the anatomically recognized regional lymph node groups, have been found to be SLNs and to accurately predict the pathologic status of the regional nodal basin as a whole. The SLN hypothesis has been strongly supported by the results of studies on both melanoma and, more recently, breast cancer (*2*,*3*). Preoperative lymphoscintigraphy has become an important step before surgical removal of the SLNs at risk for metastatic disease (*4*). The nuclear physician must track the afferent drainage channels to see whether multiple drainage channels culminate in multiple SLNs or whether the lymphatic channels converge to terminate in a single SLN. Cutaneous lymphatic flow is so rich that afferent lymphatics can be traced in most cases. Therefore, dynamic or sequential imaging is important in SLN identification. The patient is imaged in multiple projections for proper SLN localization. We used whole-body lymphoscintigraphy in conjunction with a whole-body transmission scan to better locate the SLN.

MATERIALS AND METHODS

Twenty patients received 18.5 MBq (0.5 mCi) filtered (0.22 μm) ^{99m}Tc-sulfur colloid as multiple intradermal or subcutaneous injections around a cutaneous melanoma. Im-

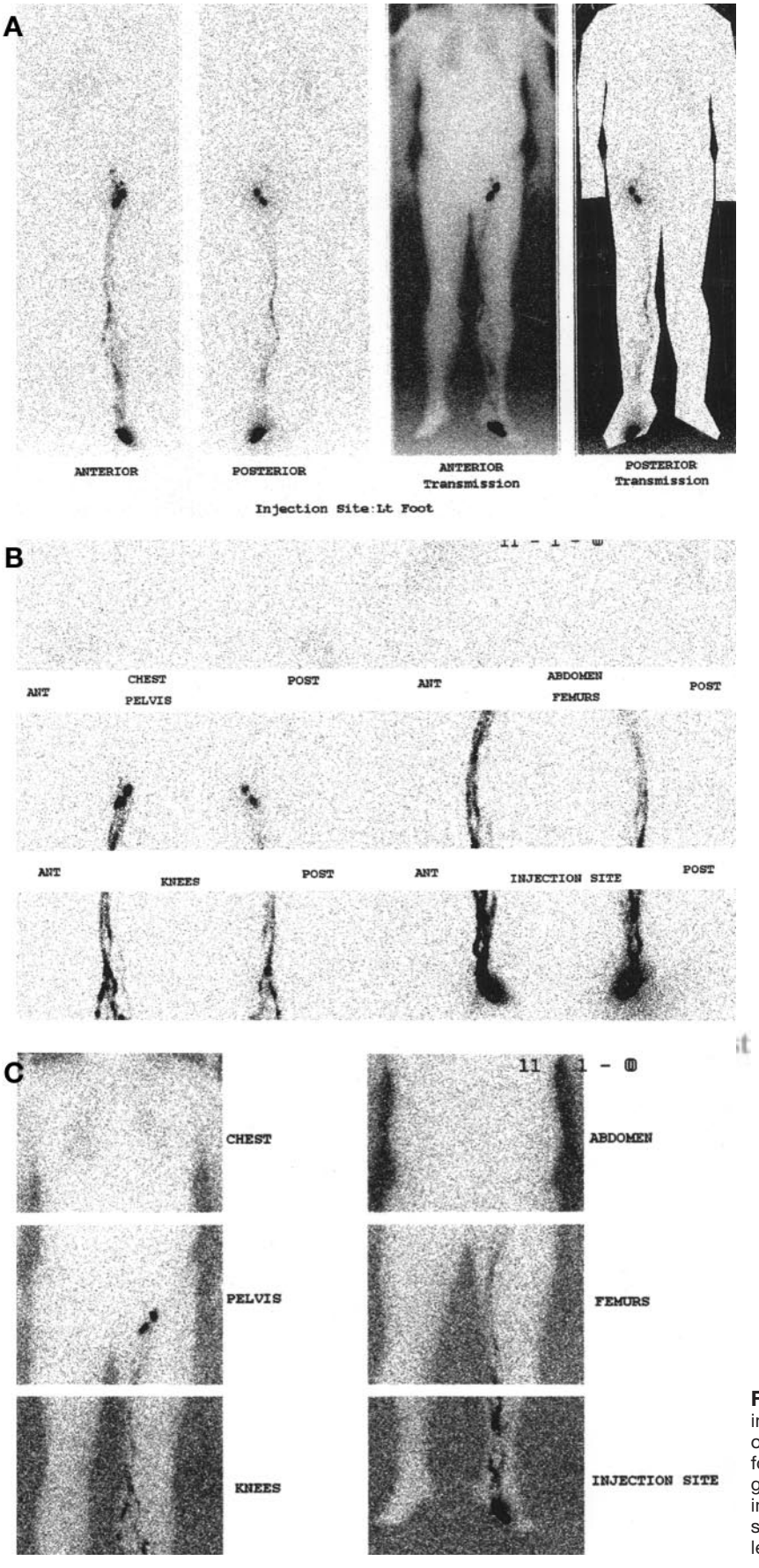

FIGURE 1. (A) From left to right, 3 whole-body images and 1 posterior-outline transmission image of patient with melanoma. Injection site was left foot. Continuous lymphatic vessel and inferior inguinal node are seen. (B) Serial static emission images of same patient. (C) Respective transmission images of same patient. ANT = anterior; Lt = left; POST = posterior.

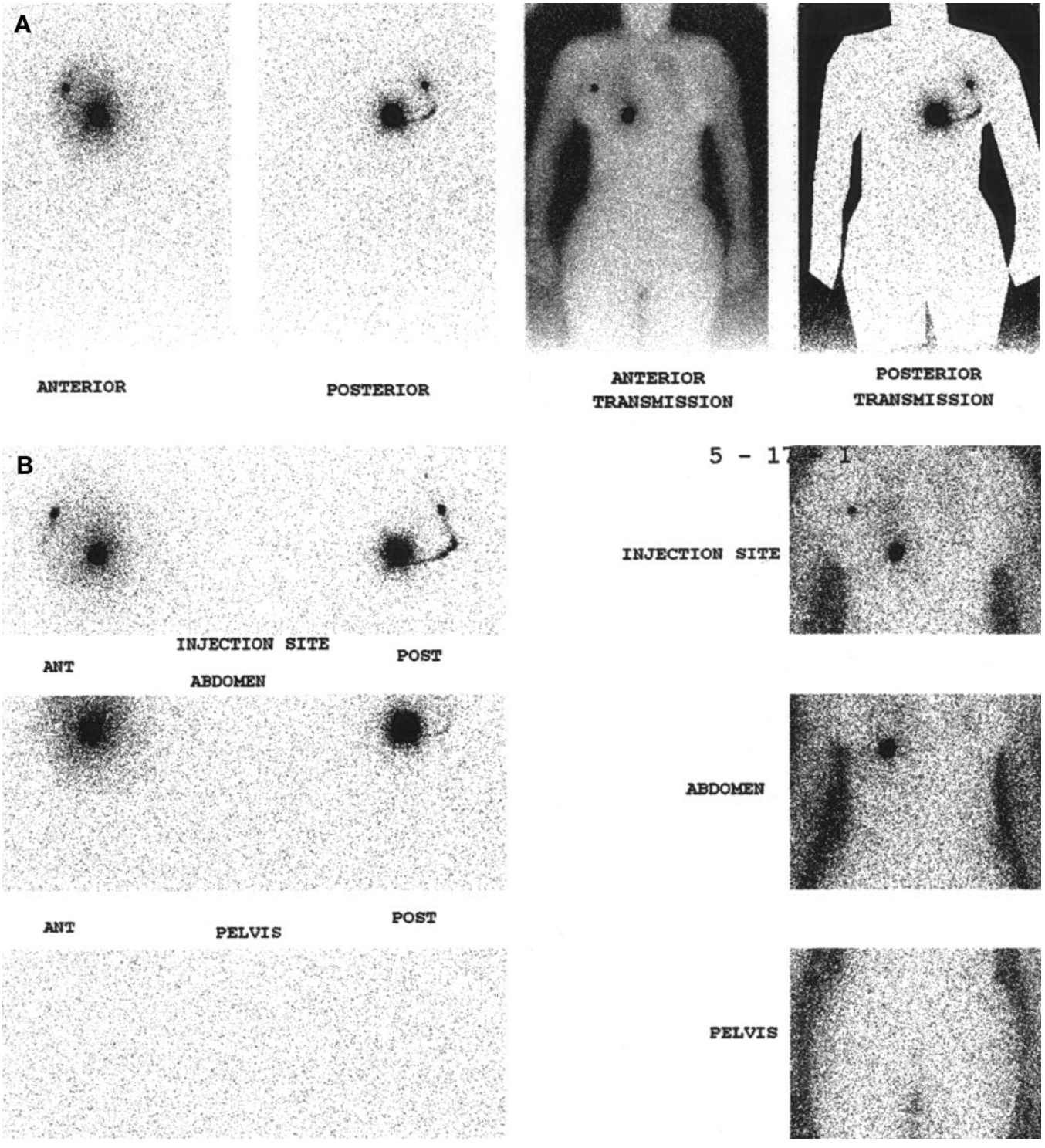

FIGURE 2. (A) Whole-body emission/transmission images of patient with melanoma. (B) Serial static images of same patient. Static imaging does not allow acquisition of both anterior and posterior transmission images unless additional images are acquired by positioning patient prone. ANT = anterior; POST = posterior.

mediately after the injections, serial static images were obtained using a 256 × 256 matrix, acquiring the emission images for 5 min and the transmission images for 1 min. A whole-body emission scan was acquired after the static imaging, using a 1,024 × 256 matrix with a speed of 12 cm/min. A whole-body transmission scan was acquired after the emission scan without moving the patient. The transmission scan was acquired at the same speed as the emission scan, with the addition of a ^{57}Co sheet source placed on the detector that was under the scanning table. The melanoma lesions were on the back of 11 patients, shoulder of 3, forearm of 2, left foot of 1, left mid shin of

TABLE 1
Comparison of Acquisition Time for Emission/Transmission Whole-Body Images and Serial Planar Images

Patient no.	^{57}Co source (MBq)	Injection site	Total time (min)		Time reduced by (min)	No. of nodes in WB vs. planar
			Emission/ transmission WB	Planar		
1	126.17	Upper back	16	58	42	3 WB/3 planar
2	130.61	Mid back	20	58	38	2 WB/2 planar
3	130.61	Lower back	20	53	33	4 WB/4 planar
4	130.61	L foot	36	67	31	2 WB/2 planar
5	175.75	R forearm	18	53	35	1 WB/1 planar
6	175.75	R shoulder	16	59	43	2 WB/2 planar
7	126.17	Mid back	18	50	32	1 WB/1 planar
8	126.17	Upper back	20	55	35	1 WB/1 planar
9	126.17	L mid tibia	30	65	35	1 WB/1 planar
10	121.73	Mid back	18	40	22	2 WB/2 planar
11	127.28	Upper mid back	20	50	30	3 WB/3 planar
12	122.84	L forearm	20	62	42	1 WB/1 planar
13	122.84	Upper back	20	50	30	2 WB/2 planar
14	122.84	Lower back	19	65	46	3 WB/3 planar
15	122.84	L shoulder	20	45	25	4 WB/4 planar
16	122.84	R posterior shoulder	20	40	20	1 WB/1 planar
17	114.33	R anterior chest	21	44	23	1 WB/1 planar
18	114.33	Upper mid back	20	30	50	4 WB/4 planar
19	127.28	L mid back	18	47	29	1 WB/1 planar
20	106.56	L clavicle	20	55	35	3 WB/3 planar

WB = whole body.

1, and anterior chest of 2. The 18 patients with upper-body lesions, such as on the back, chest, and forearm, were scanned from the top of the shoulders to the pelvis. The 2 patients with lower-extremity lesions were scanned from the top of the shoulders to the feet.

Posterior transmission images were obtained through computer manipulation of the anterior transmission images. A copy of the anterior transmission image was placed beside the original anterior transmission image. A matrix utility program was used to flip the anterior image along the long axis of the patient, left to right. A region of interest was drawn around the outline of the body, and the inside was masked to obtain only the body outline, without the activity seen from the anterior transmission image. Lastly, the posterior emission whole-body image was superimposed on this posterior body outline.

RESULTS

Whole-body imaging allowed physicians to better visualize the anatomic location of the sentinel node. Interpreta-

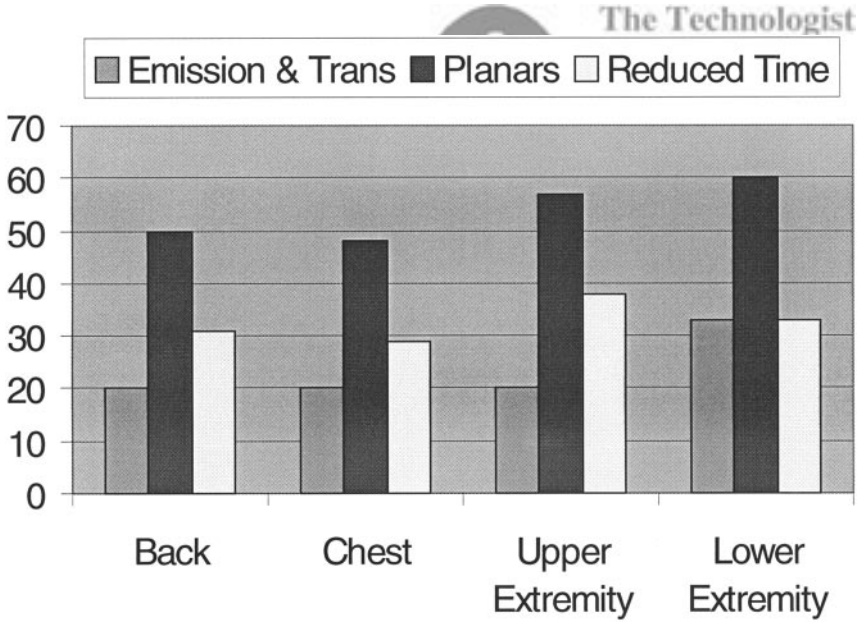

FIGURE 3. Acquisition time, shown on *y*-axis in minutes, for static and whole-body emission and transmission images. Trans = transmission.

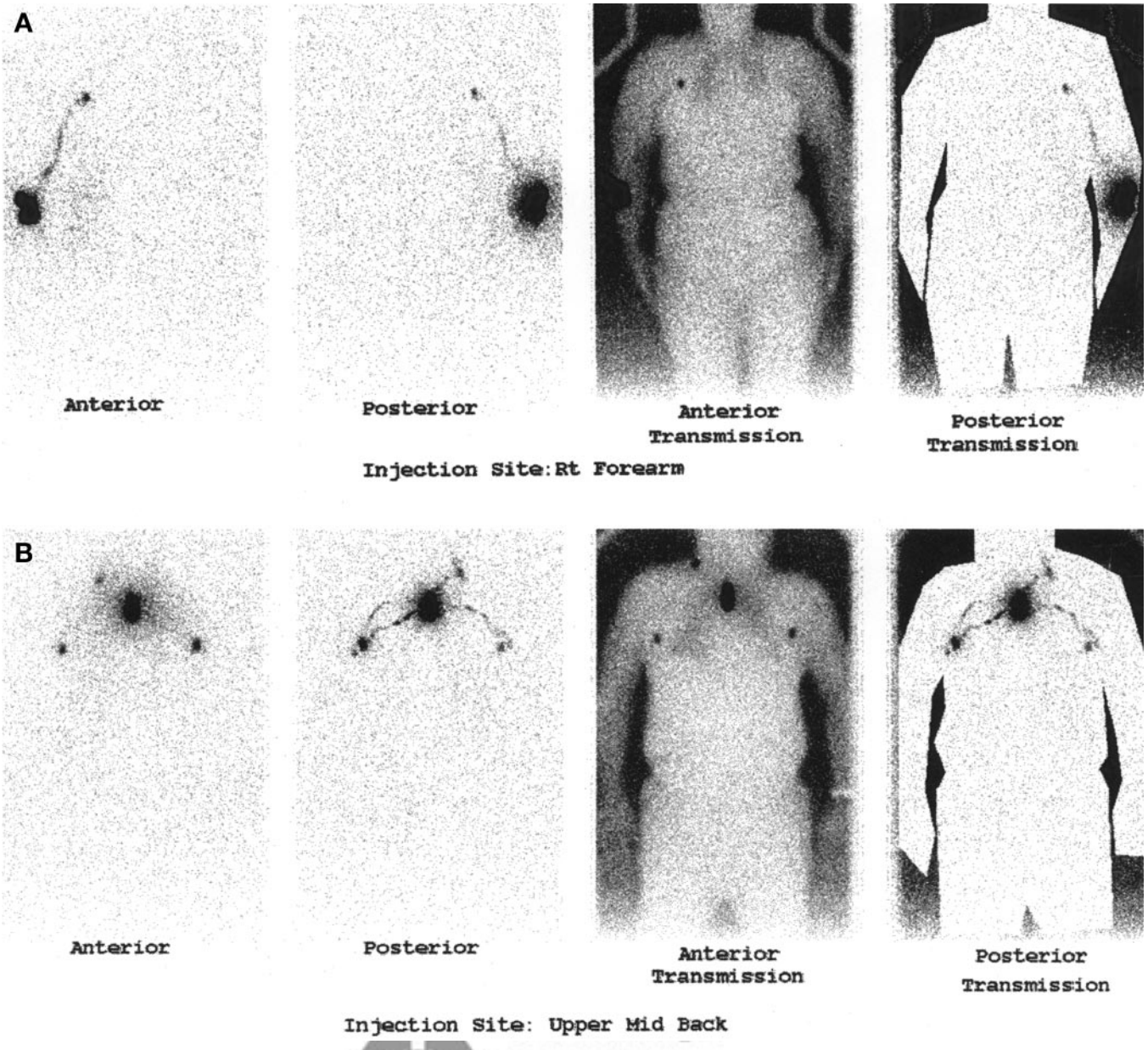

FIGURE 4. (A) Images obtained when injection site was right forearm show continuous lymphatic vessel and inferior axillary node but no olecranon node. (B) Images obtained when injection site was upper mid back show bilateral inferior axillary nodes and right jugular node. Rt = right.

tion of conventional planar static images from lymphoscintigraphy was confusing when several spot images were obtained. Viewing one film from whole-body emission imaging was much easier than viewing several films from static imaging (Figs. 1 and 2). A physician trying to identify the olecranon or popliteal sentinel nodes could continuously follow the lymphatic vessels in the upper or lower extremities. Locating these nodes on static images was difficult because continuous lymphatic channels could not be viewed.

The time to acquire the static images and the whole-body emission and transmission images was recorded. Acquisition of both whole-body emission images and whole-body transmission images required 20 min, whereas serial static images required 55 min (Table 1). The total imaging time was an average of 30 min less for whole-body images than for static images (Fig. 3).

The whole-body method benefited technologists by decreasing the number of times they directly handled the ^{57}Co source. During static imaging, technologists had to handle the ^{57}Co source approximately 7 times, because each static planar view was acquired with and without the transmission source. During whole-body transmission lymphoscintigraphy, technologists handled the ^{57}Co source only twice. This method allowed better adherence to the "as low as reasonably achievable" principle because the source was handled less frequently.

DISCUSSION

Whole-body lymphoscintigraphy was used to better locate the sentinel node and to reduce imaging time. Viewing several static images with and without transmission is confusing when one must match several planar images to the transmission images to locate the sentinel node. Physicians can more easily see the anatomic location of the sentinel node on whole-body lymphoscintigrams by viewing one film containing both emission and transmission images (Fig. 4). Because whole-body lymphoscintigraphy takes 20 min, it cannot replace dynamic or cine imaging. It can only be supplementary. However, immediate whole-body lymphoscintigraphy may obviate dynamic or cine imaging if an afferent lymphatic vessel is shown. Static imaging poses a problem with obtaining both posterior and anterior transmission images. If a lesion is on a patient's back, the posterior transmission image has to be obtained with the patient lying prone on the table, over the transmission source. Most patients are uncomfortable lying prone for 1 h, but if whole-body scanning is performed, the patient can lie supine while both the anterior and the posterior images are acquired. Surgeons have questioned findings of metastases to popliteal nodes in patients with lower-extremity melanomas and metastases to olecranon nodes in patients with upper-extremity melanomas. Patients with upper-extremity melanomas will usually show SLNs in the axilla, but drainage to olecranon nodes may occasionally occur. Patients with lower-extremity melanomas will usually show drainage to the groin, with drainage to popliteal nodes occurring occasionally (*5*). Whole-body lymphoscintigraphy, by showing the continuous lymphatic vessel, allows the physician to detect the popliteal or olecranon nodes. Being able to follow the lymphatic vessels can also aid in detecting 2 adjacent lymph nodes (*6*).

CONCLUSION

Whole-body transmission lymphoscintigraphy benefits patients, physicians, and technologists. Scanning time is 30 min less than for static imaging, and patients can lie comfortably in the supine position during both anterior and posterior transmission imaging. Physicians need view only one film containing all pertinent images for diagnosis, can locate the sentinel node with less confusion, and, because continuous lymphatic vessels are shown, can better detect popliteal sentinel nodes in the lower extremity and olecranon sentinel nodes in the upper extremity. Technologists benefit from decreased exposure to the ^{57}Co source used for transmission images, handling it twice during whole-body lymphoscintigraphy as opposed to 7 times during planar static studies.

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