FROM THE DEPARTMENTS OF SURGERY II (DIRECTOR: PROF. R. ROMANUS), PATHOLOGY II (DIRECTOR: PROF. S. RANSTRÖM), RADIOTHERAPY (DIRECTOR: PROF. M. STRANDQVIST), ROENTGENDIAGNOSTIC DEPARTMENT II (DIRECTOR: PROF. I. WICKBOM), AND DEPARTMENT OF RADIOPHYSICS (DIRECTOR: ASSOC. PROF. H. SKÖLDBORN), GOTHENBURG, SWEDEN.

TOPOGRAPHY OF LYMPH DRAINAGE FROM MAMMARY GLAND AND HAND TO AXILLARY LYMPH NODES

by

A. HULTBORN, L. HULTÉN, B. ROOS, M. ROSENCRANTZ, B. ROSENGREN and CH. ÅHRÉN

Two main techniques have been adopted in recent years in studying the lymph drainage of the breast in vivo. The use of radioactive tracers in assessing the lymph drainage from the breast to the axillary, internal mammary and supraclavicular nodes has been described by HULTBORN & JONSON (1955), HULTBORN et coll. (1955) and TURNER-WARWICK (1959). Lymphography, i.e. injection of oily contrast media into lymph vessels on the dorsum of the hand, has made it possible to demonstrate the axillary lymph nodes. The same method has also been applied in the preoperative assessment of axillary lymph node metastases from carcinoma of the breast (KENDALL et coll. 1963, and HULTÉN et coll. 1966). The distribution of a radioactive tracer injected locally into the breast parenchyma is supposed to reflect the natural lymph flow.

Lymphography from the hand has been criticized on the grounds that lymph

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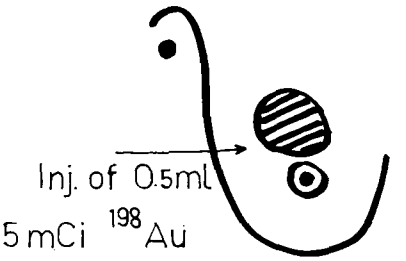

Fig. 1. Sites of tumour and of ^{198}Au injection.

nodes revealed by this route of injection are probably not wholly identical with the nodes that drain the breast.

It has also been proposed from a clinical point of view that selective removal of axillary lymph nodes, i.e. those draining the breast, and sparing the others, would be of great advantage in operations for mammary carcinoma, since post-operative sequelae such as lymphoedema, erysipelas and disturbances of the function of the arm might be reduced. Since this question is of considerable importance, we have studied the lymph drainage from the hand and from the breast by combining the injection of a radioactive tracer into the breast and lymphography from the hand. This method has been described in a previous paper (HULTBORN et coll. 1970) and has been applied in patients awaiting radical mastectomy for carcinoma of the breast.

The purpose of the present investigation was to find out whether a radioactive tracer injected locally into the breast parenchyma would be distributed to regional lymph nodes in the axilla other than those revealed by lymphography from the dorsum of the hand, or whether the tracer and the contrast medium might be similarly distributed to the axillary nodes.

Eight patients with clinical, roentgenologic and cytologic signs of mammary carcinoma but no clinical evidence of metastases in the axilla were investigated. The procedure was as follows: injection of a tracer substance (^{198}Au) into the parenchyma of the breast, followed the next day by lymphography with Lipiodol (the reason for this sequence was that this medium may impede the introduction of the ^{198}Au), radical mastectomy and postoperative investigation of the specimen including roentgen examination directed to the contrast medium, measurement of the radioactivity, autoradiography and finally histologic examination.

Tracer investigation. A colloidal suspension of metallic ^{198}Au was injected with a fine needle into the breast parenchyma (Fig. 1), in amounts of 0.5 to 1.5 ml and 1.5 to 5.0 mCi (HULTBORN et coll. 1970).

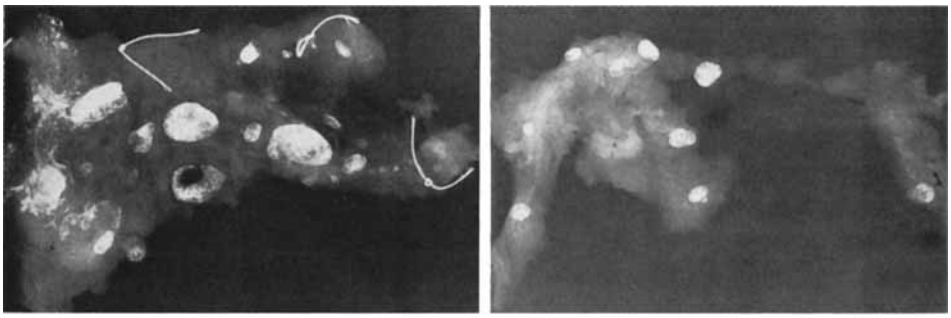

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Fig. 2. a) Ventral layer of specimen lymphadenogram. b) Dorsal layer.

Lymphography was performed by the intralymphatic injection of 6 to 8 ml Lipiodol 38 % into the dorsum of the hand. The axillary and supraclavicular regions were examined roentgenographically, immediately after the injection and 24 hours later. A full description of the procedure has been given in a previous paper (HULTBORN et coll. 1970).

Operation. The patients were subjected to radical mastectomy and axillary dissection according to Halsted, and subsequently Meyer, although the operation was especially modified for the investigation. The breast and both pectoral muscles were removed en bloc, and the axillary lymph node dissection was postponed to a later phase of the operation. The major vessels and nerve trunks were stripped free from surrounding tissue at the axillary dissection. The tissues in the infraclavicular region and those in the angle between the axillary vessels and first rib were meticulously dissected out. The fascia and fatty tissue were removed from the anterior surface of the anterior serratus, subscapular and teres major muscles. The subscapular vessels and the cranial part of the anterior sheath of the rectal muscle were taken away.

In two of the patients the axillary tissue was removed without further attempts to identify the contained lymph nodes anatomically.

In order to facilitate the later topographic orientation of each individual node in the specimen more exactly, silver clips or steel wire sutures were in six patients affixed at certain positions corresponding to the axillary vein, the thoracic wall and the subscapular vessels. In four of these patients, the axillary lymph nodes were dissected by a two-phase procedure, the first including the nodes at the superficial or ventral level, the second the deep or dorsal groups of lymph nodes (Fig. 2).

When lymph node dissection according to either procedure was concluded,

Table

Distribution of injected ^{198}Au and Lipiodol (and metastases) in axillary lymph nodes (lnn) from eight patients operated on for carcinoma of the breast

Case No.	Number of lymph nodes removed	Lnn containing ^{198}Au and Lipiodol	Lnn with only ^{198}Au	Lnn with only Lipiodol	Lnn without ^{198}Au and Lipiodol	Lnn with metastases
1	38	29	2	2	5	0
2	65	59	5	0	1	3
3	46	37	8	1	0	0
4	35	31	3	0	1	0
5	62	55	5	0	2	4
6	58	53	1	4	0	0
7	40	35	1	3	1	0
8	31	23	0	7	1	0
Total	375	322	25	17	11	7

the axillary region was examined roentgenographically and any lymph nodes that had been overlooked were identified and removed separately.

Lymph node dissection. The axillary fat with its lymph nodes was now placed, corresponding to its situation in the axilla, on a film and examined roentgenographically under more favourable conditions. This detailed roentgenogram (specimen lymphadenogram) enabled the lymph nodes finally to be dissected out from the axillary fat, numbered and mapped in series for an individual still more detailed roentgen examination to evaluate the presence of Lipiodol.

The remaining fat was always roentgenologically re-examined to make sure that no lymph nodes had been missed. The dissection was thus sometimes repeated up to three times. The breast and pectoral muscles were investigated similarly, and great care was taken in searching for lymph nodes on the dorsal aspect of the pectoralis major muscle, thus including interpectoral nodes. After this phase was completed, all lymph nodes and axillary fat were kept for further quantitative measurements of radioactivity. High activity in the remaining axillary tissue probably indicated the presence of overlooked lymph nodes, and the specimen was redissected. The next step was to prepare histologic sections for direct examination and for autoradiography.

A detailed orientation during the different steps of the operative procedure in six patients (see page 67) allowed an almost exact anatomic localization of most of the lymph nodes in the axillary fat as well as of those removed separately.

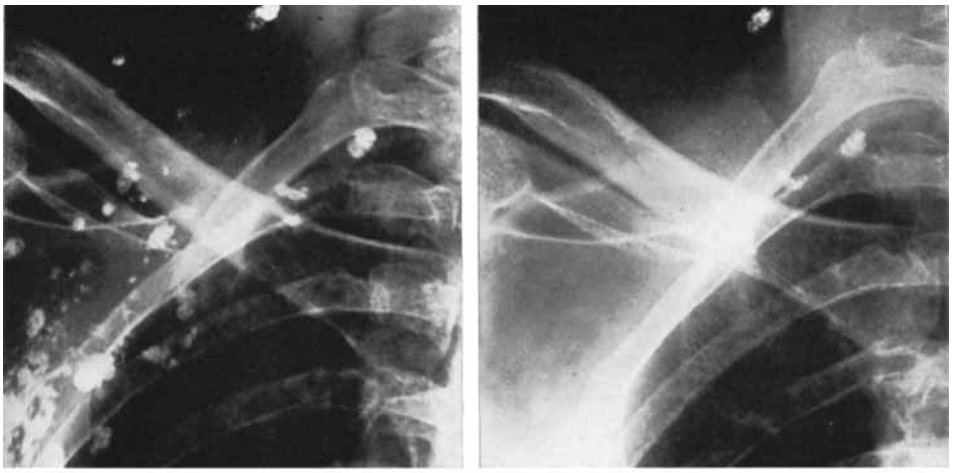

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Fig. 3. a) Lymphadenogram before radical mastectomy. Axillary and supraclavicular lymph nodes containing Lipiodol, a few lymph vessels and extravasated contrast medium lie in the axilla. b) Examination after radical mastectomy with all axillary nodes containing Lipiodol removed but with nodes in the supraclavicular region beyond the operation field remaining.

Individual nodes thus identified in the postoperative specimen lymphadenogram could be transferred to a diagram and for practical purposes arranged in conventional groups. Furthermore in four of these cases lymph nodes located in a ventral layer of the axillary fat could be separated from those in a dorsal (scapular) layer. However, lymph nodes overlooked during the primary dissection from the axillary specimen but subsequently discovered by control roentgen examinations and dissected at the second or third trial, could not as a rule be properly located in their original anatomic positions.

In summary, the postoperative investigations of the specimen included roentgen examination, quantitative measurements of radioactivity, autoradiography, and histologic examination. The technique and procedures involved in these investigations have been described by HULTBORN et coll. (1970).

Results

A total of 375 axillary lymph nodes from the eight patients were found and examined for Lipiodol and ^{198}Au. As many as 322 (85.9 %) of the nodes contained radioactive tracer as well as Lipiodol. The radioactive tracer alone was demonstrated in 25 lymph nodes, Lipiodol alone in 17, and 11 nodes

contained neither ^{198}Au nor Lipiodol. Thus, 28 lymph nodes had no radioactivity and 36 lymph nodes contained no contrast medium (see Table).

Among the twenty-five lymph nodes containing only the radioactive marker, four were located infraclavicularly, six in the axillary vein group and five in the central group of the axilla. Ten nodes could not be topographically identified for technical reasons.

Of the seventeen lymph nodes containing only Lipiodol, eight were located in the axillary vein group and seven in the central group. Two could not be located topographically.

Of the eleven lymph nodes containing neither radioactive substance nor Lipiodol, two were located infraclavicularly, two in the central region and one in the axillary vein group. Six nodes belonging to this category were lost for proper identification.

Two of the patients had axillary metastases; in one patient three lymph node metastases were found, in the other four. In all the lymph nodes with metastases, except one, Lipiodol as well as the tracer were present.

Discussion

The present results indicate that both Lipiodol introduced by direct lymphography of the dorsum of the hand and ^{198}Au injected into the mammary gland are distributed widely to the axillary lymph nodes; their concomitant occurrence could be demonstrated in 86 % of the nodes. The two substances occurred separately only in a small proportion of nodes and in a still smaller proportion of nodes that contained neither substance were demonstrated.

In evaluating these results, attention must be paid to whether the majority of the axillary lymph nodes were removed at operation. However, our operative procedures have always been thorough and carefully checked by repeated roentgen examinations (see Fig. 3). Furthermore, a magnifying glass was used in the dissection of lymph nodes from the specimen. The tissue lymphadenogram always served as the guide for the identification of individual nodes. Overlooked lymph nodes were detected either by repeated roentgen examination or by the occurrence of radioactivity in the remaining axillary fat specimen.

The Spalteholz clearing method for identifying minute lymph nodes (cf. HULTBORN 1952) seems to be less appropriate for axillary lymph nodes, since a high proportion of these exhibit fat involvement and would be made invisible by this technique.

Following mastectomy, the excised axillary lymph nodes in the operation specimen have been studied by several previous investigators by the Spalteholz method. Thus, PICKREN (1956) compared two series of specimens after radical

mastectomy with meticulous lymph node dissection of the axilla. There were 21.5 lymph nodes per specimen in a very thoroughly dissected group. In a 'cleared' group (Spalteholz method) there were 37.3 lymph nodes per specimen. The average number in the present series was 47 axillary lymph nodes, despite the fact that the age of the patients was fairly high (54 to 77, mean 62 years). It is well known that a progressive decrease in the number of lymph nodes occurs with age. It therefore seems reasonable to conclude that the vast majority of the axillary lymph nodes in this series of patients were in fact removed.

A detailed investigation was performed to find out why some nodes lacked either or both substances (Lipiodol and ^{198}Au). No single cause could be established. It is however known that inflammatory reactions, acute or chronic, fat involvement and fibrosis can interfere with the function of lymph nodes, resulting in poor or absent filling with injected substances (HULTBORN et coll. 1955, and HULTÉN et coll. 1966). Furthermore, the radioactive marker retained within a node could probably cause a radiation reaction if the dose is high. This might deviate the lymph flow and obstruct the entry of particles arriving subsequently, particularly particles of larger dimensions, e.g. Lipiodol. This hypothetical explanation is probably of minor importance, as most lymph nodes with large amounts of tracer were also heavily loaded with Lipiodol. However, a radiation effect has in fact been noted in the form of slight oedema and cell depopulation around clusters of tracer substance in the nodes, and this might indicate a deviation of lymph flow.

The occurrence of either substance alone in occasional nodes is probably due to individual variations in lymph flow, which means that there is no complete overlapping in the axilla of the flow from the arm and the breast respectively, as could also be expected on biologic grounds.

The distribution of the injected radioactive substance might also have been affected by the neoplasm itself. Thus, twenty-three of twenty-eight lymph nodes, in which no radioactivity was demonstrated, belonged to a group of four patients in whom the growth was located between the site of the injected ^{198}Au and the axilla. In other words, a tumour block may have existed in these cases.

The present results indicate clearly that most axillary lymph nodes serve two areas of lymphatic drainage: the arm and the breast. It cannot be assumed that the lymph from these areas drains to different groups of nodes within the axilla, though it must be admitted that different groups of nodes may be affected primarily in the course of inflammatory or neoplastic disease.

From the surgical point of view, it must therefore be stressed that all nodes must be excised when the lymph nodes in the axilla are to be removed radically for carcinoma of the breast. Separate regional groups of nodes draining the arm and the breast do not exist and selective removal is therefore impossible.

SUMMARY

Eight patients with mammary carcinoma were examined by preoperative injection of ^{198}Au into the breast parenchyma and by lymphography via the lymph vessels of the hand to elucidate the topography of the lymph drainage of the breast and arm to the axillary nodes. The investigation has clearly indicated that all axillary lymph nodes must be removed when axillary lymphadenectomy is included in the treatment.

ZUSAMMENFASSUNG

Acht Patienten mit Brustdrüsenkarzinom wurden preoperativ mittels ^{198}Au-Injektion in das Brustparenchym und mit Lymphographie der Gefässe der Hand untersucht, um die Topographie des Lymphabflusses von Brust und Arm zu den axillaren Lymphknoten zu erleuchten. Die Untersuchung hat deutlich gezeigt, dass alle axillaren Lymphknoten entfernt werden müssen wenn die Behandlung eine Lymphadenektomie einschliesst.

RÉSUMÉ

Huit malades atteintes de cancer du sein ont été examinées par injection pré-opératoire de ^{198}Au dans le parenchyme du sein et par lymphographie des vaisseaux de la main pour déterminer la topographie du drainage lymphatique du sein et du bras dans les ganglions axillaires. Cette recherche a montré clairement qu'il faut enlever tous les ganglions lymphatiques axillaires quand le traitement comporte une lymphadénectomie axillaire.

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