An Improved Technique for the Study of Lymph Nodes in Surgical Specimens

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The importance of the meticulous study by pathologists of the lymph nodes in surgical specimens is emphasized. Most pathologists identify only a small proportion of the lymph nodes in these specimens and valuable prognostic information is lost. Data illustrating the evolution in the Columbia Laboratory of surgical pathology of methods used to study surgical lymph node specimens over a 44-year period (1935–1979) are reviewed. An improved method of clearing the specimens of axillary dissections in radical mastectomy finds more lymph nodes and more metastases, and greatly shortens the time required for clearing. The importance of identifying metastases in the interpectoral nodes is emphasized. In a special study with our new clearing technique metastases were found in the interpectoral nodes in 19% of the radical mastectomy specimens. These nodes are not removed in the modified operation, which does not include resection of the pectoral muscles. The opportunity to cure a substantial proportion of patients is thus lost.

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IN 1908 LORD MOYNIHAN, one of the wisest surgeons of his day, wrote "The surgery of malignant disease is not the surgery of organs, it is the anatomy of the lymphatic system." We can re-emphasize and refine Moynihan's thought by stating that prognosis in carcinoma depends not only on the complete removal of the regional lymph node filter, but also on the identification and microscopic study of all of the lymph nodes in the surgical specimen.

Most pathologists have relied on the traditional crude method of dissecting out the lymph nodes by hand from fresh or fixed specimens. With this method, even when it is meticulously performed, the number of nodes identified is small as compared with number of nodes found with the modern clearing technique. In this technique the fat is cleared from the specimen by immersion in increasing concentrations of alcohol and finally in cedar wood oil. In the translucent specimen nodes smaller than 1 ml can be identified.

Ackerman,[1] in a careful study of radical mastectomy surgical specimens in 1951, reported finding by hand dissection an average of 19.1 lymph nodes per specimen. Pickren,[11] working in our laboratory of surgical pathology at Columbia reported in 1956 finding an average of 21.5 nodes per specimen by hand dissection in radical mastectomy specimens. Hand dissection continues today to be the almost universal method of identifying lymph nodes in these specimens. In their 1970 study of the relationship of lymph node metastases to prognosis in carcinoma of the breast in the National Adjuvant Breast Project, Fisher and Slack reported the number of lymph nodes found in radical mastectomy specimens.[4] In 42 of the 43 participating institutions the nodes were identified by hand dissection. In ten of the total of 57 case series no nodes at all were identified in one or more specimens, although all of the operations were classified as radical mastectomies. In 20 of the case series the median number of nodes found ranged from eight to 14; in 26 of the case series it ranged from 15 to 19; and in nine case series it ranged from 20 to 25. The mean number of nodes examined was 17.

Monroe[9] was probably the first to use the clearing method for identifying the lymph nodes in radical mastectomy specimens. In the Presbyterian Hospital in Chicago he cleared the axillary specimens in 87 cases and found an average of 30.4 nodes per case.

In 1952, Davis and Neis from the Department of Surgery of the University College of Medicine in Omaha reported clearing 77 such specimens and finding an average of 31 nodes per case.[3]

Columbia-Presbyterian Data

The advantages of the clearing technique for identifying axillary lymph nodes in radical mastectomy specimens are well illustrated by the data concerning the numbers of lymph nodes found by the different methods of searching for them in the senior author's

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(C.D.H.) long series of radical mastectomy specimens studied in our laboratory of surgical pathology at Columbia. This case series is particularly useful in this regard because the clinical stage of advancement of the carcinoma has been defined in all of the patients, thus providing a comparatively uniform series of cases for study. Moreover, the technique of the meticulous axillary dissection which is a feature of this case series has not been changed since 1935.

An essential part of the study of axillary lymph nodes in radical mastectomy specimens in our laboratory has been the determination of the exact anatomic position of the nodes in the axillary lymphatic filter. We have used the grouping and anatomical nomenclature introduced by Poirier and Cunéo and adopted with modifications by Rouvière (Fig. 1).[14] In this plan there are six different lymph node groups. These lymph node groups may be described as follows:

The External Mammary Nodes

This chain of nodes lies beneath the lateral edge of the pectoralis major following the course of the lateral thoracic artery on the chest wall from the sixth to the second rib. Rouvière stated that these nodes lie upon or within the thickness of, or beneath, the fascia covering the digitations of the serratus anterior muscles.[14] However, the usual situation of lymph nodes is along the vessels in the areolar tissue superficial to a fascial plane rather than within or beneath it, and the senior author (C.D.H.) has assumed that this is the case with the external mammary nodes. Therefore he does not attempt to dissect the fascia off of the serratus digitations. But he carefully dissects the areolar tissue containing the vessels and lymph nodes off of this fascia. These structures are very loosely attached to the underlying fascial plane and are dissected laterally away from it. With this technique he has not usually seen any external mammary nodes, and the pathologist in his study of the specimen has identified very few.

The Scapular Nodes

Several lymph nodes lie closely applied to the scapular vessels and their thoracodorsal branches, from the point of origin of the subscapular vein from the axillary trunk to the insertion of these vessels into the latissimus dorsi muscle and the lateral chest wall. As they cross the axilla toward the arm, the intercostobrachial nerves thread their way through the more cephalad of these scapular nodes. The thoracodorsal nerve, as it accompanies the thoracodorsal vessels, also runs through these scapular nodes. It is because these nerves are so intimately associated with the scapular nodes that these nerves should be sacrificed in any thorough dissection of the axilla for carcinoma.

The Central Nodes

These nodes lie embedded in the fat in the center of the axilla. One or more of them may be situated surprisingly superficially beneath the skin and fascia of the center of the axilla, half way between the posterior and anterior axillary folds. They are therefore the nodes most easily palpated in the axilla, and the ones on which our clinical estimate of the state of the axillary nodes is usually based. They are the largest and most numerous of the axillary nodes, and the group of nodes in which metastases are most often found. The central nodes are, therefore, from every point of view, the most important of the axillary nodes.

The Interpectoral Nodes

The interpectoral nodes lie between the pectoralis major and minor muscles, along the pectoral branches of the thoracoacromial vessels. They are small and vary usually from one to four in number. Later on in this presentation we will discuss their special importance in relation to the type of operation performed for carcinoma.

The Axillary Vein Nodes

These nodes lie along the lateral portion of the axillary vein, on its caudal and ventral aspects, from the white tendon of the latissimus where the most lateral of these nodes are found, to a point just medial to the origin of the thoracoacromial vein. If these nodes are not fixed to the axillary vein they are easily dissected away from it after division of the delicate layer of fascia which covers the structures of the axilla. This fascia is divided along the cords of the brachial plexus, and is dissected caudad across the axillary vein, taking with it the fat and areolar tissue and the axillary vein nodes that are embedded in it.

The Subclavicular Nodes

This is the highest, or most medial group of axillary nodes. They are situated along the ventral and caudad aspects of the axillary vein from a point just medial to the origin of the thoracoacromial vein to the very apex of the axilla, where the axillary vein disappears beneath the tendon of the subclavius muscle. There are usually several small nodes belonging to this group lying in the areolar tissue in the crevice between the highest portion of the axillary vein and the chest wall. This area is entirely inaccessible to the surgeon un-

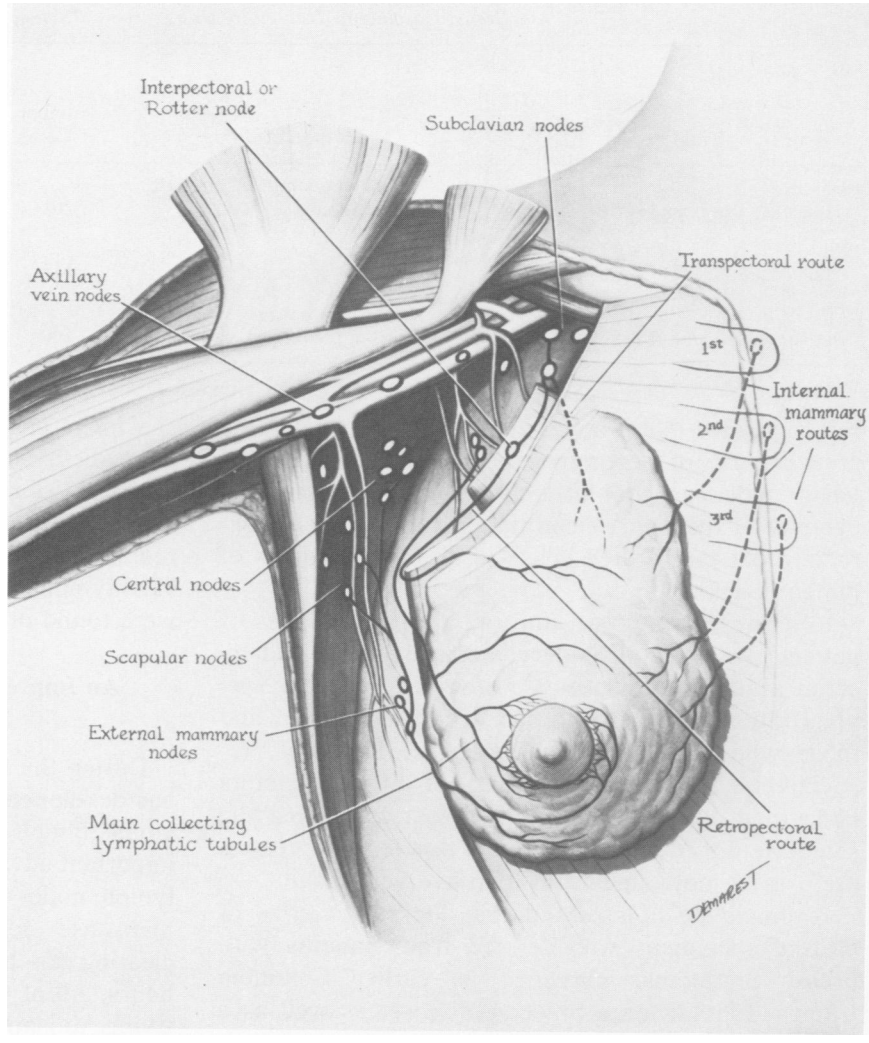

FIG. 1. The lymphatic routes from the breast to the axilla and the axillary lymph nodes.

less the pectoralis minor muscle is divided and dissected downward out of the way.

Since 1935 the method of identifying the lymph nodes in the specimens of axillary dissections has evolved through three phases in our laboratory.

From 1935 to 1950, inclusive, the axillary nodes were dissected out by hand or found by multiple sections through the fixed specimen. The senior author's series of patients with Columbia clinical Stage A carcinoma for whom radical mastectomy was done during this period totaled 201 (Table 1). An average of 19.4 nodes per case were identified. Metastases were found in 34.3% of these patients.

In 1951 John Pickren, who was a member of the staff of our laboratory of surgical pathology at the time, began to clear the axillary portions of the radical mastectomy specimens. He did all of the work personally with meticulous care. Between 1951 and 1953 he cleared a total of 196 specimens. He identified a total of 7,260 lymph nodes—an average of 37.3 nodes per case. Metastases were present in 53% of the cases. The distribution of these nodes in the different node groups is shown in Table 2.

Pickren not only began the clearing of axillary lymph nodes in radical mastectomy specimens in our laboratory, and determining the position of the nodes found in terms of the six anatomic node groups, but he introduced another important technical procedure which improved the detection of metastases in the nodes. Saphir in Chicago had shown that when lymph nodes are serially sectioned minute metastases are often found that are missed when nodes are cut in only one level as has usually been the custom.[15] Pickren studied the axillary lymph nodes found by clearing a series of 51 radical mastectomy specimens. An average of 36 nodes was identified in each specimen.[11] The nodes in which an original single section had failed to reveal metastases were recut in serial sections, which revealed occult metastases in 22%. Routine serial sectioning of nodes is of course not practical, but Pick-

TABLE 1. *A Comparison of Three Methods of Studying Axillary Lymph Node Specimens from Patients with Columbia Clinical Stage A Breast Carcinoma Treated by Haagensen's Radical Mastectomy*

Time Period	Method of Study	Number of Cases	Average Size Primary Carcinoma	Average Number Nodes Per Case	Per Cent of Cases with Axillary Metastases
1935–1950 Haagensen personal series of cases	Hand dissection or multiple sectioning	201	34.8 mm	19.4	34.3
1951–1975 Haagensen personal series of cases	Clearing Pickren technique	317	24.7 mm	32.9	31.8
1977–1979 six surgeons using Haagensen technique	Clearing Durkin technique	100	26.1 mm	50.3	37

ren concluded that if nodes are cut at three levels, the great majority of these minute occult metastases missed when nodes are cut at only one level, would be detected. It has since been the custom in our laboratory to cut these three levels in all of our studies of lymph nodes.

In a subsequent 1961 study of this same series of patients with occult axillary metastases revealed by serial sectioning Pickren reported the five year survival rates for those who had occult metastases and those who did not.[12] They were 91 and 89%, respectively. In studying a variety of different factors concerned with end results in breast carcinoma the senior author (C.D.H.) has found that ten year results are usually more significant than five year results.

It should be pointed out that Pickren's series of cleared specimens was derived from patients with breast carcinomas classified as earlier Columbia Clinical Classification Stage A disease, as well as a considerable proportion of patients with more advanced clinical Stage B disease. In these patients with more advanced carcinoma the proportion with axillary lymph nodes containing metastases is higher than in patients with clinical Stage A disease.

For a fair comparison of the merits of hand dissection versus clearing of axillary radical mastectomy specimens only Columbia Clinical Stage A cases should be studied. The senior author's (C.D.H.) 1951 to 1975 series of Columbia Clinical Stage A cases in which the clearing method introduced in our laboratory by Pickren was used totaled 317 (Table 1). An average of 32.9 lymph nodes per case was found. Metastases were found in 31.8% of the patients.

TABLE 2. *Numbers of Lymph Nodes and Frequency of Metastases in the Six Groups of Axillary Lymph Nodes in 125 Cleared Radical Mastectomy Specimens*

Node Group	Number Nodes Found	Average Number Nodes per Specimen	Per Cent with Metastases
External mammary nodes	169	1.3	2
Scapular nodes	814	6.5	10
Central nodes	1414	11.3	46
Interpectoral nodes	223	1.8	10
Axillary vein nodes	1634	13.1	20
Subclavicular nodes	413	3.3	9
Totals	4667	37.3	53

An Improved Technique for Clearing Lymph Node Dissection Specimens

During the last two years the junior author (K.D.) has developed an improved technique for clearing regional lymph node dissection specimens which has important advantages. It has increased the numbers of lymph nodes identified, as well as the per cent of metastases detected. Moreover, the time required for clearing has been reduced from about a week to 24 hours. All of these features help the physician who is trying to satisfy his worried patient regarding her prognosis.

This improved technique is based on agitation of the specimen in ethanol, which clears the lipids from it. We use for this purpose a mixing apparatus well known to chemists. Figure 2 shows the apparatus with the specimen contained in quart thermos flasks filled with ethanol.

The technique of clearing the axillary portion of a radical mastectomy specimen must begin in the operating room with the surgeon marking the borders of the axillary specimen with black silk ties so that the pathologist can orient it when it reaches the laboratory. The subclavicular nodes at the apex of the axilla are of critical importance in determining the patient's prognosis and the need for postoperative prophylactic irradiation to the axilla and supraclavicular area. If these nodes contain metastases the prognosis is very poor and prophylactic irradiation should certainly be given. Therefore these apical nodes must be accurately identified in the surgical specimen. It is not enough for the pathologist to

report concerning the status of the nodes in the outer, middle and inner thirds of the axilla, as is done in most laboratories. The surgeon begins his axillary dissection at the apex of the axilla and carries it laterally to end at the white tendon of the latissimus muscle. In order to make certain of the pathologist identifying the nodes from the true apex of the axilla, when the surgeon has completed the apical portion of his axillary dissection he should sever the medial 2 or 3 cm of the pyramidal mass of apical tissue from the main mass of axillary tissues which are being dissected. This small specimen, representing the true apex of the axilla, is put in a separate container and marked for the pathologist. The surgeon then places a single black silk tie on the medial border of the remaining main axillary specimen. When his axillary dissection is completed laterally at the white tendon of the latissimus he places two black silk ties on the lateral border of the axillary tissues.

When the radical mastectomy specimen reaches the laboratory the individual responsible for clearing the axillary portion places the entire specimen skin surface down on a cutting board, and identifies the medial and lateral borders of the axillary portion by its black marking ties. The stump of the pectoralis minor muscle severed from the coracoid process is seen protruding from the back of the specimen close to the mass of axillary tissue. In order to find the interpectoral nodes which lie between the pectoralis major and minor along the pectoral branches of the thoracoacromial vessels it is necessary to dissect the pectoralis minor away from the pectoralis major beneath it as the specimen lies on the cutting board. The stump of the pectoralis minor is grasped with toothed forceps, and with a scalpel this muscle is dissected up in a caudad direction away from the underlying pectoralis major, leaving the interpectoral fascial plane, the anterior thoracic nerve, the pectoral vessels, and lymph nodes accompanying them exposed. These interpectoral structures are then dissected up from the pectoralis major from its medial to its lateral edge, and are left attached to the main axillary specimen.

The search for interpectoral nodes having been completed, the mass of axillary tissues can be separated from the pectoralis major and the breast by a transverse incision which includes a narrow rim of breast tissue to make certain that all of the axillary tissue is included in the specimen to be cleared.

The axillary specimen is then thoroughly washed in tapwater to remove the blood from it. Clotted blood, when submerged in cedar oil, turns hard and black, obscuring the lymph nodes. The specimen is then placed in 10% formalin in a quart thermos container that fits on the mixer (Fig. 2), is shaken for one

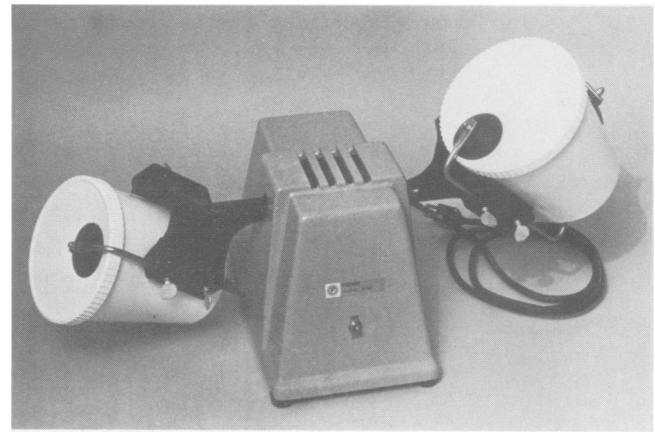

FIG. 2. The mixing apparatus used for clearing regional lymph node dissection specimens.

hour at 60 C, and is left to stand overnight until it is thoroughly fixed. It is not fixed in Bouin's or Kaiserling's solutions which discolor the specimen. Fixing the specimen in 10% formalin for just the right length of time is an important factor in the clearing process. Unfixed tissue will not clear well. After fixation in formalin the specimen should be thoroughly washed in water.

Clearing is begun by filling the thermos container with enough 95% ethanol to cover the specimen. The specimen is then shaken on the mixer for one hour. A second bath of fresh hot 95% ethanol and another hour of shaking follow. Finally, at least two more baths of 100% ethanol are necessary to dehydrate the tissue so that it can absorb the cedar wood oil in place of lipids and water, thus becoming transparent. We use a plastic thermos which can be sealed, and ethanol preheated to 65 C, for safety.

Each individual specimen clears in a different length of time depending on its bulk, and therefore each takes a different number of ethanol baths to reach the cleared state. Due to their greater thickness axillary specimens usually take longer to clear than lymph node dissections from colons and necks.

After each hour on the mixer the specimen is removed from the container, and under a hood it is squeezed with gloved hands between layers of absorbent brown paper towels, blotting up the ethanol and the lipids until the specimen is dry. The first squeezing begins the process of getting rid of the lipids dissolved by the ethanol. The 100% ethanol bath is repeated until this process is completed as evidenced by the fact that only lipid-free ethanol can be squeezed out of the tissue. During this process the specimen is obviously reduced in volume. After the specimen is squeezed dry for the last time, it is placed in the thermos with cedar wood oil at 65 C

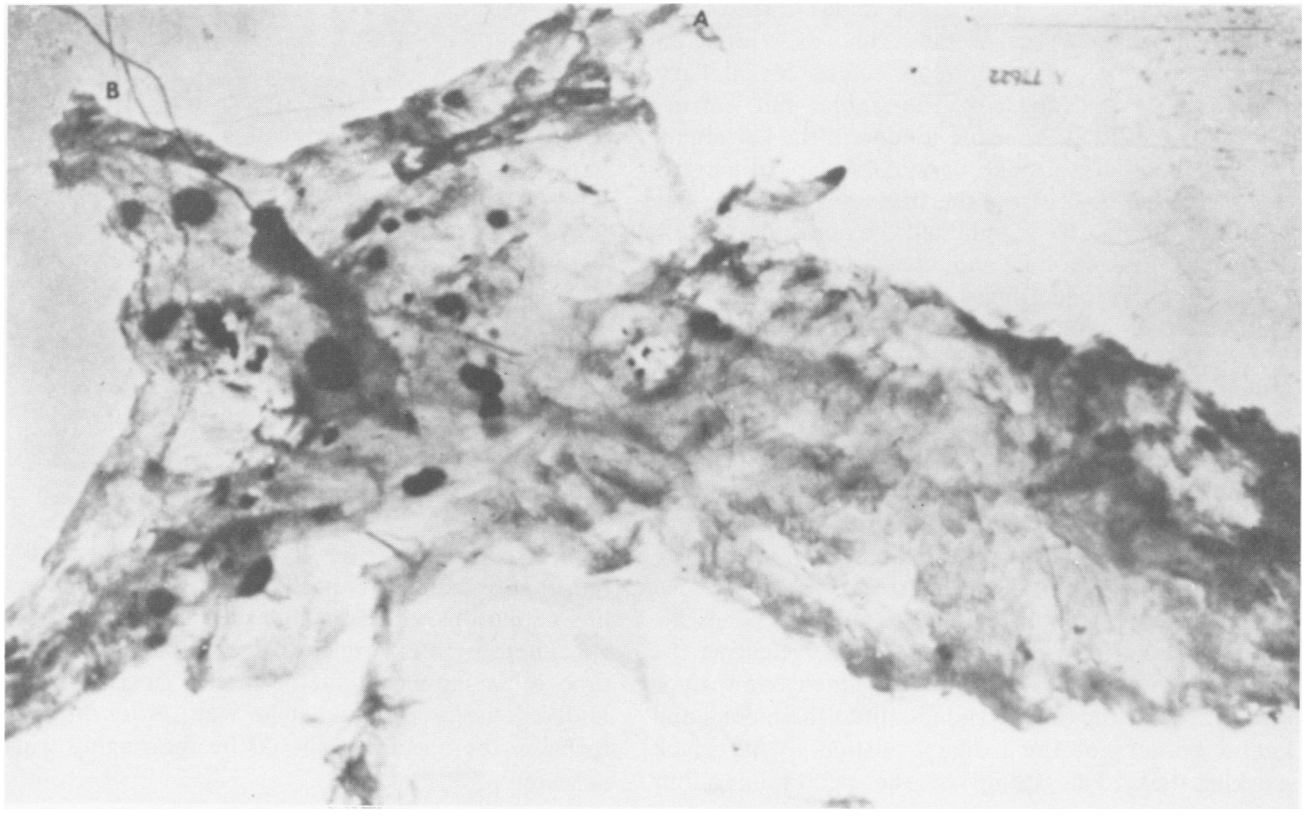

FIG. 3. A radical mastectomy axillary specimen after clearing. A Single black silk thread marks the apical edge of the specimen at A. Two black silk threads mark the lateral edge of the specimen at B.

and agitated for 15 minutes until the oil has sufficiently penetrated the tissues. Finally, the specimen is allowed to stand for 15 minutes to permit the air bubbles to surface.

For dissecting the lymph nodes out of the specimen it is placed in a pyrex tray, covered evenly with cedar wood oil, and transilluminated from below. A cleared axillary specimen is shown in Figure 3. With a fine forceps in one hand and a small scalpel in the other the lymph nodes are identified by cutting and teasing apart the tissue in which they lie. As the nodes are identified their position in the specimen in terms of the six axillary node groups described above is recorded. Their position can be plotted on a standard diagram as shown in Figure 4.

The greatest diameter in centimeters of the largest node in each specimen is recorded. Many nodes only 1 mm or less in diameter will be found by clearing. These very small nodes can easily be overlooked by the technician transferring the nodes to the embedding mold from the cassette in which the individual doing the clearing places them; to avoid this the number of nodes in each cassette is marked on it.

The clearing technique as we have described it is a complex and precise procedure. We believe that it will only be done well when it is entrusted to one individual in a laboratory of surgical pathology.

We are able to report the results of our improved technique of clearing in 100 consecutive axillary specimens from patients with Clinical Stage A breast carcinoma treated by radical mastectomy performed with the senior author's (C.D.H.) technique by six different surgeons (Robert G. Bertsch, Frederic P. Herter, Sven J. Kister, Alfred M. Markowitz, John B. Price, Jr., and Philip Weidel) between July 15, 1977 and July 15, 1979. In Table 1 these data are compared with the results of studies of axillary lymph node specimens by methods formerly used in our laboratory for the senior author's personal series of Clinical Stage A radical mastectomies between 1935 and 1975.

These data show strikingly how the clearing technique increases the number of nodes found in the radical mastectomy specimens. With our new clearing technique we are identifying more than twice the number found in specimens dissected by hand.

One of the most interesting features of these data is that over the time span of some 40 years the average size of the primary tumor in our patients with Columbia Clinical Stage A carcinoma has clearly decreased,

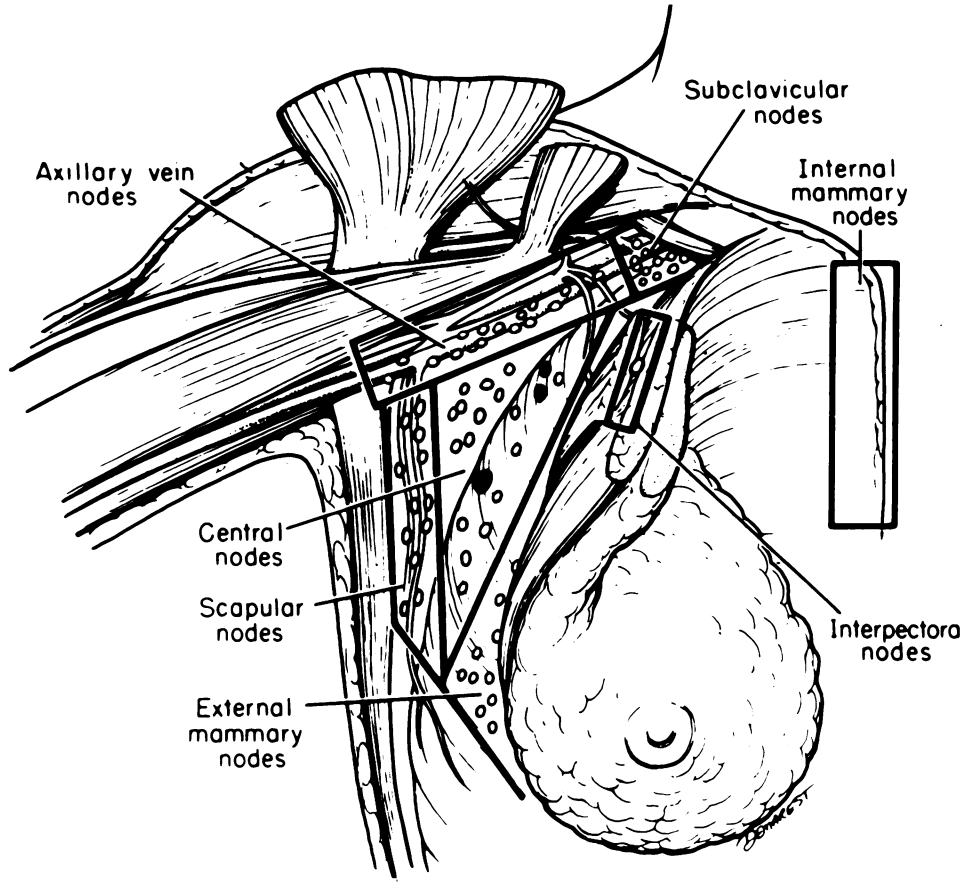

FIG. 4. Diagram of lymph nodes in a cleared radical mastectomy axillary specimen. A total of 70 nodes were found—3 in the central group contained metastases. No adjuvant treatment. Patient well 26 years later.

indicating that they are coming for treatment earlier in the course of their disease. Data from the senior author's (C.D.H.) series of radical mastectomies show that the larger the primary tumor is, the higher the percentage of involved axillary nodes (Table 3). With this relationship in mind a lower percentage of axillary metastases would be expected in the recent 1977–1979 series of 100 specimens cleared with our improved technique in which the average size of the primary tumors was only two-thirds the size of the tumors in our 1935–1950 case series. In fact the percentage of metastases in our recent 1977–1979 case series was somewhat higher. Our improved clearing technique therefore finds more axillary nodes and detects more axillary metastases, and it provides this information in a much shorter time than our earlier clearing method.

The distribution of metastases in the different axillary node groups as found in our new clearing technique is shown in Table 4.

Interpectoral Nodes

The existence of the interpectoral lymphatic route from the breast to the axillary lymph nodes has been known for a long time. Grossman in 1896 reported finding interpectoral nodes in four of 25 cadavers that he dissected. Rotter, for whom these nodes have been named, in 1899 identified two or three of them in 50% of a series of surgical specimens of breast carcinoma operations. But it was not until 1951 when Pickren introduced the clearing technique for radical mastectomy specimens in our laboratory that we began to accumulate data as to the frequency of metastases in interpectoral nodes and its prognostic significance. In the series of 125 specimens that Pickren cleared between 1951 and 1953 he found an average of 1.8 interpectoral nodes per specimen, and he identified interpectoral metastases in 10 per cent of the cases. The senior author (C.D.H.) subsequently reported the 10 year survival data for a series of 17 patients with metastases in the interpectoral nodes revealed with the clearing technique (Table 5).[6,7] It is interesting that three of these patients had metastases only in the interpectoral nodes and they were all cured. The other 14 patients, all of whom also had metastases in several other node groups, eventually succumbed to their disease, although two survived for more than 10 years.

Kay,[8] studying interpectoral nodes found by hand dissection in radical mastectomy specimens, reported

TABLE 3. *Personal Series of Radical Mastectomies—Haagensen (1935–1975) The Relationship of Size of the Primary Tumor to the Frequency of Axillary Metastases*

Columbia Clinical Classification	Greatest Diameter of Primary Tumor in Millimeters	Number of Cases	Per Cent Axillary Metastases
	No palpable tumor	27	22
	Less than 10 mm	25	20
	10–19 mm	123	24.4
	20–29 mm	241	30
Stages A and B	30–39 mm	188	42
	40–49 mm	150	47.3
	50–59 mm	101	60.4
	60–79 mm	78	52.6
	80 mm and more	27	51.9
Stages C and D		93	80
Total		1053	

four patients in whom these nodes were the only ones involved. All four survived for five years.

In the 100 radical mastectomy specimens from Columbia Clinical Stage A patients cleared by the improved method which we have described above, the dissection of the surgical specimens was performed by the trainees in our laboratory of surgical pathology most of whom have had little or no surgical experience and as a result are not familiar with the anatomical features of these specimens. Only the actual clearing was done by the junior author (K.D.) The interpectoral nodes are the most difficult of the six different groups of axillary nodes to identify in these radical mastectomy specimens. They are few and small in number. They lie along the pectoral branches of the thoracoacromial vessels and the anterior thoracic nerve beneath the sheet of costocaracoid fascia between the deep surface of the pectoralis major muscle and the underlying pectoralis minor. These vessels and nerve enter the deep surface of the pectoralis major and constitute its neurovascular supply. Unless the surgical pathologist understands these fundamental anatomical details and knows how to identify this fascial plane and how to dissect it out together with this nerve and these vessels and lymph nodes from between the pectoral muscles he will miss these interpectoral nodes.

TABLE 4. *Numbers of Lymph Nodes and Frequency of Metastases in the Six Groups of Axillary Lymph Nodes in 100 Cleared Radical Mastectomy Specimens—Columbia Clinical Stage A Carcinoma—Durkin and Haagensen, 1977–1979*

Lymph Node Group	Number Nodes Found	Average Number Nodes per Specimen	Per Cent of Nodes with Metastases
External mammary nodes	195	2.0	1
Scapular nodes	820	8.2	11
Central nodes	1865	18.7	33
Interpectoral nodes	147	1.5	9
Axillary vein nodes	1512	15.1	12
Subclavicular nodes	491	4.9	8
Totals	5030	50.3	37

After completing the clearing of the series of 100 radical mastectomy specimens with our improved technique it was apparent to us that interpectoral nodes were being missed in the specimens because the surgical pathology trainees who dissected them did not know how to find them. The junior author (K.D.) therefore studied a further series of 42 radical mastectomy specimens in which he personally dissected the specimens paying special attention to identifying the interpectoral nodes. In addition he of course personally performed the clearing.

In this special series of 42 specimens he found a total of 126 interpectoral nodes in 40 of the specimens. They varied from one to 12 in number in each of the 40 specimens, averaging 3.3 per specimen. Eighty-one per cent of these interpectoral nodes were situated within 5 mm and 44% within 1 cm of the pectoral branches of the thoracoacromial vessels along the costocoracoid fascial plane on the deep surface of the pectoralis major. These interpectoral nodes are not easily seen in the dissection of the surgical specimen but they are obvious in the cleared specimen. Sixty-six per cent of the interpectoral nodes found in this series of 42 specimens were less than 1 mm in diameter. In general nodes of this small size cannot be found by hand dissection of these specimens. Twelve of the 126 interpectoral nodes contained metastases. They were recovered from eight of the 42 specimens. Interpectoral lymph node involvement was therefore demonstrated in 19% of our 42 radical mastectomy specimens. In Table 6 we have compared the interpectoral lymph node findings reported by Pickren[11] in his 1951–1953 series of 125 radical mastectomy specimens cleared in our laboratory, with the special series of 42 specimens dissected and cleared with our improved method by the junior author (K.D.) in 1979. It will be seen that we found interpectoral nodes in a higher percentage of specimens, and also a higher percentage of metastases in them, although all of our cases were from patients with Clinical Stage A carcinoma while Pickren's series included both Clinical Stage A and B cases.

Further evidence of the importance of these interpectoral node metastases in the eight patients in our special series of 42 in whom they were found relates to the extent of involvement of other lymph groups. Two of the eight patients each had two of four interpectoral nodes involved but no metastases in other

TABLE 5. *Ten Years Results in 17 Cases with Interpectoral Node Metastases*

Case	No. of Nodes Involved in Different Node Groups						Total No. Involved Nodes	Total No. Nodes Found	Results of Treatment
	Sub-clavicular	Axillary Vein	Central	Scapular	External Mammary	Inter-pectoral			
1						1	1	61	10 year cure
2						1	1	58	11 year cure
3						1	1	58	12 year cure
4		1	4			2	7	44	10 year cure. then local recurrence
5			1			1	2	34	10 year survival with metastases
6			2			1	3	29	Died in 58 mos.
7			3			1	4	76	Died in 91 mos.
8			3			2	5	59	Died in 45 mos.
9			1			1	2	35	Died in 54 mos.
10		3	3			1	7	32	Died in 17 mos.
11		9	6			2	17	43	Died in 18 mos.
12		2	1	1		4	8	46	Died in 9 mos.
13	12	13	7	3		2	37	69	Died in 48 mos.
14	1	11	7			1	20	39	Died in 112 mos.
15	4		1		5	1	11	82	Died in 59 mos.
16	1		4	3		7	15	19	Died in 15 mos.
17	1			1		4	6	48	Died in 17 mos.

Average number of involved nodes per case—8.6.
10 year survival rate—29.4%.

axillary nodes. In one of these two cases a total of 70 uninvolved axillary nodes was found, and in the other a total of 57. In a third case a single interpectoral node contained metastases although there were no metastases in 39 other axillary nodes. In a fourth case there was also a single involved interpectoral node, and in addition one of a total of 62 other axillary nodes contained metastases. In these four patients the fact that their involved interpectoral nodes were removed in the course of radical mastectomy may be a critical factor in the likelihood of cure.

The considerable frequency of metastases in interpectoral nodes which we have demonstrated should be viewed in the light of the fact that these nodes are not removed in the "modified" mastectomy in which the pectoral muscles are not sacrificed. In this procedure the pectoralis major muscle, which forms a sort of roof over the axilla blocking access to it, is retracted forcibly medially. In 1948 Patey[10] made an important contribution to the technique of this operation. When he was ready to dissect the axilla in his modified operation he raised the patient's arm vertically and had it held in this position. This position greatly relaxes the tension on the pectoralis major as compared with the usual position with the arm abducted on an arm-board, and facilitates retracting the muscle medially thus improving access to the axilla. This maneuver makes it possible to preserve the anterior thoracic nerve and the thoracoacromial vessels which enter the deep surface of the pectoralis major. It does not, however, enable the surgeon to identify and dissect out the small interpectoral nodes which accompany this nerve and these vessels because the broad blade of the retractor which retracts the pectoralis major medially also retracts and hides these structures which enter its deep surface. Sacrificing the nerve and blood supply of the pectoralis in an attempt to remove the interpectoral nodes leaves the muscle atrophied and functionless. This defeats the purpose of the modified operation which is to preserve the pectoralis major intact.

TABLE 6. *Interpectoral Lymph Nodes in Radical Mastectomy Specimens Found with the Clearing Method*

Author	Columbia Clinical Stage	Total Number Cases	Per Cent with Interpectoral Nodes	Total Number Interpectoral Nodes	Average Number Interpectoral Nodes per Case	Per Cent of Total Number Cases with Interpectoral Metastases
Pickren (1951–1953)	A & B	125	65%	223	1.8	10
Durkin (1979)	A	42	95%	126	3.3	19

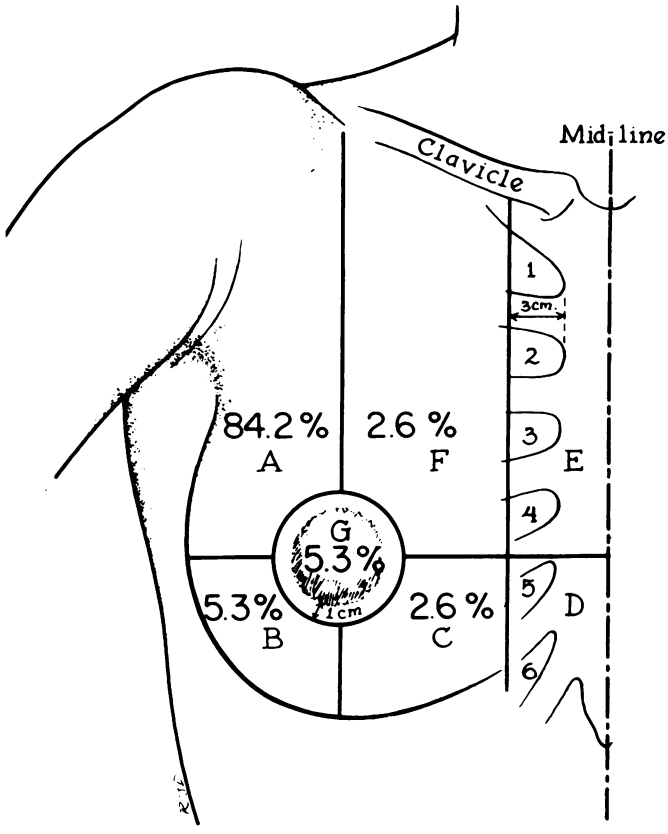

FIG. 5. The site of the primary carcinoma within the breast in 38 patients in whom metastases were found in the interpectoral lymph nodes.

The proof of the fact that interpectoral nodes are not removed in the modified operation is illustrated by the experience of the junior author (K.D.) with specimens of modified operations. He carefully searched for interpectoral nodes in a series of 27 specimens of this operation which he has recently dissected and cleared. No interpectoral nodes were found in any of the specimens, although the surgeons concerned claimed to have made a special effort to excise them without sacrificing the pectoralis major.

Finally, we have been able to correlate the presence of metastases in these interpectoral nodes with the site of the primary carcinoma in the breast. Figure 5 shows the site of the primary carcinoma in a total of 38 of our patients treated by radical mastectomy in whom metastases were found in the interpectoral nodes. In the great majority of these patients (84.2%) the primary carcinoma was in the upper outer sector of the breast (sector A). Figure 6 shows the site of the primary carcinoma in the seven different sectors of the breast in a series of 1007 patients in which the senior author (C.D.H.) performed radical mastectomy. In our 38 patients with interpectoral node metastases the primary carcinoma was situated in the upper outer breast sector, more than twice as often as would be expected in terms of this series of 1007 patients. This suggests that the lymphatic route from primary carcinomas of the breast in its upper outer sector which lies directly over the pectoralis major muscle is a direct one, either penetrating the muscle or more likely turning around its outer edge and going to the interpectoral nodes without first involving the central group of axillary nodes as is usually the case.

We have emphasized the importance of meticulous study by pathologists of the lymph nodes in surgical specimens, and have described an improved method for clearing these specimens which, in radical mastectomy specimens has yielded an average of 50.3 lymph nodes per specimen, and has also identified more metastases.

In a special study of the interpectoral lymph nodes the improved method of clearing has revealed metastases in 19% of our Columbia Clinical Stage A patients treated by radical mastectomy. These interpectoral nodes are not removed in the modified mastectomy. Surgeons who perform this limited operation in which the pectoral muscles and the interpectoral nodes are not included in the excision

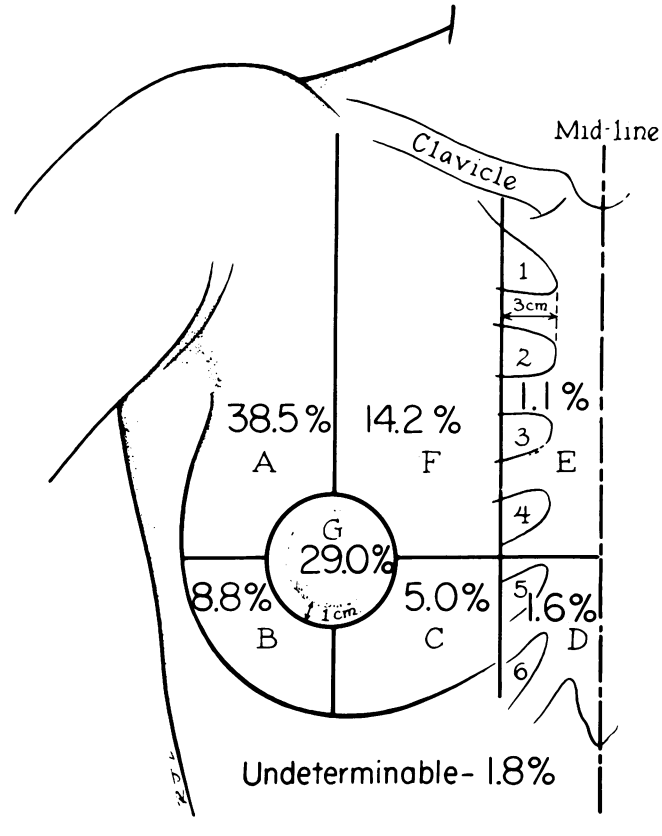

FIG. 6. The site of the primary carcinoma within the breast in a personal (C.D.H.) series of 1007 patients.

therefore forego the opportunity of curing these patients with interpectoral node metastases.

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