Malignant Lymphomas
Their Classification and Relation to Leukemia

By Lawrence Berman, M.D.

VARIATIONS of practice among pathologists and hematologists with regard to the diagnosis of malignant lymphomas (lymphoblastomas) have made the subject unnecessarily confusing. Some differences in diagnosis, interpretation and classification originate from the habit of many pathologists of relying on tissue sections in contrast with the hematologist’s greater reliance on and experience with dry films of cells. An attempt will be made here to demonstrate the advantages of examining both sections and dry films from lesions of lymph nodes so that the experience of both the pathologist and hematologist can be utilized. For example, re-emphasis of the value of imprint material in Hodgkin’s disease has recently stimulated great interest among dermatologists. The nomenclature generally used in this country, to a great extent influenced by Warren and Picena, and Gall and Mallory has been useful and practical provided two important reservations are made: (1) the various subgroups of tumors belong to a single family of mesenchymal growths varying both in degree and type of differentiation; and (2) the classification is purely descriptive, being based on the morphologic aspects of the various lesions. The transition of one type of lymph node tumor into another indicates the histologic relationships between members of the group. This concept has been documented by Custer and Bernhard. On the one hand, the clinician is confronted with the view of the non-utility of subdivision of lymphoblastomas into various types, and on the other hand, with the continuing practice of many experienced pathologists who classify such tumors on a cytological basis. The oncologist who grades neoplasms according to the degree of differentiation may see no reason to do otherwise in the case of lymphoblastomas. With some tumors, such as squamous carcinoma of the skin, the degree of undifferentiation of cells usually parallels rate of growth, radiosensitivity, or tendency to metastasize, and may be used as a rough index of prognosis, but this does not always apply to tumors composed of reticulum cells, lymphoblasts and lymphocytes. In this case, differentiation of cells also implies the possibility of functional differences, since these cells react differently to various kinds of stimuli or injuries. For example, some therapeutic agents (radio-isotopes, external radiation, urethane, nitrogen mustard, ACTH and cortisone, and aminopterin) are destructive primarily of small lymphocytes but not of reticulum cells; although the latter are morphologically

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the less differentiated.* A functional difference between reticulum cells and lymphocytes is shown in experiments on survival of mice to total body x-radiation during which exteriorized lead-shielded spleens of the animals also received varying amounts of x-radiation. The results indicate that the factors responsible for the greater incidences of recovery in the spleen-shielded animals are derived from the more primitive but more radioresistant cells, such as reticulum cells, rather than the free cells such as lymphocytes.25 Within the Hodgkin’s group of lymphoblastomas, the subcategories, paragranuloma and granuloma differ in

prognosis from the sarcoma type, according to Jackson and Parker;24 and Block and Jacobson.6

The hematopoietic tissue of normal lymph nodes is composed of a framework of reticulum cells and fibers, in the meshes of which are found lymphocytic cells of various types and stages of development. This is shown diagrammatically and in abbreviated fashion in Plate I. The gray stippled areas represent the lymphocytic parenchyma, where the accumulations of lymphocytic cells of various sizes is so dense that it obscures the underlying reticulum cell network. The

* Occasional unusual exceptions are illustrated by the recent account of a thirteen year survival of a patient following a large dose of x-radiation to a reticulum cell tumor, without recurrence.24

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Plate I—Diagram showing hematopoietic tissue of normal lymph node.
lightest regions, corresponding to the sinuses which are prominent at the hilum and periphery, show the reticular character of the underlying tissue which is extended throughout the lymph node. The round nodules of pale cells, the cross sections of follicles, are composed of reticulum cells and varying proportions of their derivatives, namely meso- and macrolymphocytes, reticular lymphocytes ("lymphoblasts"),* macrophages, and a relatively small number of microlymphocytes. Shown at the peripheries of the nodules are coronas of densely packed small lymphocytes with dark nuclei.

Cytologic details can be seen distinctly only in very well fixed and prepared sections which are not always available in the pathologist's routine material, but they are easily revealed in imprints from the sectioned surfaces of lymph node tissue. These are made by touching a glass slide to the surface of freshly cut unfixed tissue. A single layer of cells adheres to the glass. The preparation is air-dried and treated as an ordinary film with the May-Grunwald-Giemsa stain. The appearances of cells in imprints are different from those which are revealed in sections. The cells, being flattened out in toto and not shrunken by fixation and embedding, are larger; the nuclear and cytoplasmic details are different with respect to the patterns which have significance (Plate III, figs. 1 and 2). A great advantage of imprints is the comparability of the cells with those seen in smears of blood and bone marrow, or aspiration biopsy films of lymph nodes and spleen. The special advantage of sectioned material is that it provides the opportunity for studying the topography of the lesion, a feature of prime importance in histologic diagnosis of malignant neoplasms. The lymphoblastomas are difficult to differentiate without biopsy. In doing so, we must deal with growths of reticulum cells, lymphoblasts and lymphocytes. The simple classification shown here (table 1), which does not differ much from those used by Warren and Picena, and Gall and Mallory rests on the predominance of these three main types of cells in the neoplastic tissue. Some authors have subdivided the reticulum cell type to include a form called "clasmatocytic type," characterized by the appearance of discrete, more or less rounded cells with primitive or indented or elongated nuclei. I have not retained this subgroup because the "clasmatocytes" have the same basic morphologic features seen in reticulum cells, except for the histologic appearance of free cells. However, it

* Although the term "lymphoblast" is to be used in this discussion, it is done with reluctance, in deference to common usage of American pathologists. Actually the group of relatively undifferentiated cells so designated has no morphologic similarity to the lymphoblasts of acute leukemia. The cells in question are developed, in part, heteroplastically from reticulum cells. They include types previously referred to as intermediate forms by Downey and reticular lymphocytes by Sundberg.**
is admitted that the cells of the clasmatocytic tumor show a propensity for phagocytosis of debris, so that the subdivision may be justified on the basis of a special functional activity of the cells, not usually present in the form having a syncytial or more solid aspect. In malignant growths, such as the lymphoblastomas generally are considered, we may expect to find examples of abnormal cells of various kinds which may be difficult to classify in sectioned material.

The pathologist’s predicament is that in any lymphoblastoma, each or all of the different elements may participate in the growth of the tumor. Therefore, although it is usually possible to determine the predominating cell, there are many borderline cases in which a decision is not easy. Fortunately, this is not often of great clinical importance. Another source of trouble is that classification implies a “primary” nature of the tumor observed in the lymph node. In many cases the superficial lymph node tumor which is presented for diagnosis is but a part of a more extensive generalized reaction involving other tissues containing reticulum cells and lymphocytic elements. Thus, the reticulum cell type of lymphoblastoma, which is composed mainly of cells common to various organs (lymph nodes, spleen, bone marrow, liver, etc.) may well be a different disease than tumors of lymph nodes composed of cells peculiar to lymphoid tissue. The morphologic classification is a convenience; it does not indicate that the lesions of the group are necessarily related etiologically, since morphologic changes are more limited than the etiologic factors which may provoke them. The various categories of lymph node tumors represent lesions of lymph nodes and, with our present knowledge, are not necessarily specific diseases of patients. However, the resort to a histologic classification is forced by our ignorance of causative factors and justified by the fact that, in a crude manner, the histologic types correspond to clinical behavior.

The diagram (Plate II) is reprinted from a composite drawing published by Warren and Picena to show histologic relationships within the lymphoblastoma group. Although meso- and macrolymphocytes are not clearly represented, the drawing illustrates the differences between the least and most differentiated tumors. If the growth is predominantly of reticulum cells, as on the extreme left, the tumor is a reticulum cell sarcoma, or reticulum cell type of lymphoblastoma, when it occurs in a lymph node. On the other hand, tumors made up chiefly of differentiated lymphocytes, as on the extreme right, are lymphocytic lymphoblastomas. The relative frequencies of the different kinds of tumors are very difficult to estimate, even when the diagnoses are based solely on biopsy. This is due to differences in interpretation, nomenclature, and probably to a greater extent to differences in types of institutions from which the hospital and outpatient material is obtained, since there are certain age, sex and geographic predilections for the various types of lesions.

Figure 3 (Plate III) shows a field from an imprint of a lymphoblastoma, reticulum cell type. The predominating cells are large forms containing typical oval nuclei of reticulum cells, with large pathologic nucleoli. If the pathologist confines his attention to sectioned material the tumor has the appearance shown in figure 4 (Plate III). Another imprint field from the same tumor (fig. 5, Plate III) contains a giant pathologic reticulum cell with a lobulated nucleus and large nucleoli. Such a cell, viewed in sections, cannot be distinguished from the
Diagram showing histologic relationships among lesions of the lymphohistostroma group. (Re-drawn from a plate published by Warren and Rhoda: Am. J. Path., 17: 382-384, 1941, with the kind permission of the authors and publisher.)
Sternberg-Reed cell which is common in Hodgkin's lesions. The presence of usually smaller, but otherwise similar cells in the reticulum cell type of lymphoblastoma indicates the similarity between it and one form of Hodgkin's tumor which will be referred to later. Moeschlin emphasized the neoplastic nature of the Hodgkin cell (Sternberg-Reed cell), but mainly on the basis of nucleolar size and morphology of chromosomes of these abnormal cells he stated that they were dissimilar to reticulum cells of normal lymph nodes, and denied their origin from reticulum cells. This does not conform with the consensus of students of this problem, as will be pointed out.

If the hyperplasia primarily involves cells which are intermediate between reticulum cells and ordinary differentiated lymphocytes, that is, the cells already referred to as lymphoblasts, the neoplasm which results is the lymphoblastic type of lymphoblastoma, a lesion often designated in the older textbooks of pathology as lymphosarcoma (fig. 6, Plate III and fig. 7, Plate IV).

The third type of lymphoblastoma, the lymphocytic form, is composed chiefly of differentiated and usually small lymphocytes. It is characteristic that the tumor is composed almost entirely of a single morphologic type. It is an example of a one-sided and extreme hyperplasia of cells which look quite normal (figs. 8 and 9, Plate IV). There is an important connection between the lymphocytic type and chronic lymphocytic leukemia. The peripheral blood picture, in our experience, is very often that of chronic lymphocytic leukemia, or the other organs are diffusely infiltrated with lymphocytes, as in leukemia. If one does not use an arbitrary definition of leukemia requiring a peripheral leukocyte count of 25,000 or over, as was done by Callender, the lymphocytic lymphoblastoma can be considered a leukemic form of lymphoblastoma, and the diagnosis depends on what part or how much of the patient is examined. If the pathologist sees only a lymph node, his diagnosis is lymphoblastoma, lymphocytic type, but if the entire patient is studied, especially if the blood and bone marrow are examined, the same patient may receive a diagnosis of chronic lymphocytic leukemia.*

Plate III

Fig. 1.—Imprint, normal lymph node. The large cell (r) with a pale oval nucleus is a reticulum cell. Nearby is a lymphoblast (ly) with a large pale nucleus and delicate chromatin pattern. The cells (l) with dark nuclei are differentiated small lymphocytes. 1050 X.

Fig. 2.—Section from the lymph node shown in figure 1, at the same magnification. The cell (r) in the center of the field is a reticulum cell; (ly) is a lymphoblast, and the cells marked (l) are small differentiated lymphocytes. 1050 X.

Fig. 3.—Imprint, lymph node, lymphoblastoma, reticulum type. The huge pathologic reticulum cells (r) have large nucleoli. 1050 X.

Fig. 4.—Section from the lymph node shown in figure 3, at the same magnification, showing reticulum cells (r) with nuclei of various sizes. 1050 X.

Fig. 5.—A giant polyploid reticulum cell in an imprint of a reticulum cell tumor. 1050 X.

Fig. 6.—Imprint, lymph node, lymphoblastoma, lymphoblastic type. The field includes lymphoblasts (ly) with nucleoli, and differentiated lymphocytes (l). 1050 X.

* In the series reported by Gall and Mallory only 48 per cent of the lymphocytic lymphoblastomas were accompanied by a leukemic blood picture. However, it was stated that lymphocytosis was present in 62 to 70 per cent of cases with lymphocytic and lymphoblastic lymphomas.
PLATE III

(See legend, facing page.)
Figure 10 (Plate IV) shows sectioned material from a patient who had a diagnosis of lymphocytic lymphoblastoma as a result of lymph node biopsy. The marrow contained lymphocytic nodules like the one shown, and the blood picture was that of chronic lymphocytic leukemia.

The lymphoblastic type of lymphoblastoma is accompanied by a leukemic blood picture fairly commonly, depending on the frequency of blood examinations. In a series of cases collected by Gall and Mallory, the incidence was 38 per cent. In my own material of patients from whom we were able to get blood studies frequently, a leukemic picture was seen in 50 per cent of cases during the course of the disease. Many of these cases correspond to the old concept of leukosarcoma.

The reticulum cell type, on the other hand, is almost always an aleukemic form, probably because the growth of the large reticulum cells usually assumes a syncytial character, so that free cells are not numerous, but there are rare cases in which the peripheral blood contains primitive undifferentiated reticulum cells and their smaller derivatives (figs. 11 and 12, Plate IV). These primitive cells, which only occasionally have giant nucleoli, and which may remain undifferentiated or more often acquire a lymphocytoid or monocytoid form, are present in the blood in an unusual form of leukemia, well documented in the literature and known as leukemic reticulo-endotheliosis. As a rule, only the smaller hematopoietic reticulum cells are seen in the blood. The larger cells with similar morphology except for size ("voluminose cellule di tipo tumorale" of Ferrata), appear to be trapped in the tissues. They are revealed in smears, imprints and sections of various organs (figs. 13, 14 and 15, Plate V). As it occurs in lymphoid tissue in lymph nodes or elsewhere, in the blood there is sometimes evidence of differentiation of such cells toward atypical lymphocytoid or monocytoid forms. The majority of examples of leukemic reticulo-endotheliosis I have seen are instances of lymphocytic leukemic reticulo-endotheliosis or mixed leukemia with both lymphocytoid and monocytoid cells, but the greatest emphasis in the literature pertains to the monocytoid type (monocytic leukemia of the Schilling type) in which the cells have a monocytoid form because of the indented shapes of their nuclei. This form of leukemia in which the "blast" cells are hematopoietic reticulum cells and their derivatives are incompletely differentiated monocytoid or lymphocytoid cells is accompanied

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**PLATE IV**

**FIG. 7.**—Section from the lymph node shown in figure 6 (Plate III). The large nucleus near the center of the field, with a prominent nucleolus, belongs to a reticulum cell. The other cells are lymphoblasts. 1050 X.

**FIG. 8.**—Imprint, lymph node, lymphocytic type. 1050 X.

**FIG. 9.**—Section from the lymph node shown in figure 8. Occasional lymphoblasts (ly) are present. 1050 X.

**FIG. 10.**—Section of bone marrow. The myeloid tissue is infiltrated by differentiated lymphocytes. 1050 X.

**FIG. 11.**—Undifferentiated hematopoietic reticulum cell in a blood smear from a patient with leukemic reticulo-endotheliosis. 1050 X.

**FIG. 12.**—Undifferentiated reticulum cell in a blood smear from a patient with leukemic reticulo-endotheliosis. The dark angular objects in the cytoplasm are azurophilic granules 1053 X.
Plate IV
(See legend, facing page.)
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by lesions which, if studied only in the form of sections of lymph nodes, may be difficult to distinguish from what would be labeled lymphoblastoma by the pathologist. It seems likely that the morphologic equivalent of this form of reticulo-endotheliosis, as it appears in sections of fixed tissues may, at times, resemble the clasmatic lymphoblastoma of Gall and Mallory, or what others have called monocytoma or reticulocyctoma. In the rare cases in which the primitive cells remain undifferentiated, the lymph node sections appear as reticulum cell lymphoblastoma, or Hodgkin's sarcoma. If we consider these observations, the connection between leukemic and aleukemic forms of reticulo-endotheliosis is easily understood. We agree with others that the two fundamentally identical conditions differ only with respect to the presence of the neoplastic cells in the blood.

Hodgkin's disease falls into the mixed category because the tissue is composed of reticulum cells and various kinds of lymphocytes. In addition, some lesions contain eosinophil and neutrophil leukocytes, plasma cells, proliferating fibroblasts, fibrocytes and collagen and foci of necrosis. According to American writers, the basic defect is a pathologic proliferation of reticulum cells. The other features and local inflammatory signs are considered to be, in part, a reaction to abnormal protein substances resulting from degeneration of the tumor tissue, or to the activity of myeloid stimulator substances which can be extracted from Hodgkin's tissue. Moeschlin's objections to the reticulum cell origin of Hodgkin's tumor cells have been mentioned previously. The concept of their reticulum cell origin is stated well in a recent study by Hoffman and Rottino. The pleomorphic nature of Hodgkin's tissue, reported to occur in

PLATE V

Fig. 13.—Huge undifferentiated cell in a bone marrow smear from a patient with leukemic reticulo-endotheliosis. The large nucleolar masses are obscured by the overlying chromatin network. The cell should be compared for size with the two small lymphocytes in the field. 1050 X.

Fig. 14.—Pathologic reticulum cells (r) in a tumor of the liver from the patient whose bone marrow is shown in figure 13. (Sectioned material.) 1050 X.

Fig. 15.—Section of lymph node from a patient with leukemic reticulo-endotheliosis. The large plurinuclear pathologic reticulum cell cannot be distinguished from a Sternberg-Reed cell. Other cells (u) are abnormal undifferentiated cells whose nuclei in imprint preparations have the characteristics of reticulum cells shown in figures 13 and 16, although they may resemble lymphoblasts in sections. 1050 X.

Fig. 16.—Pathologic reticulum cells in a bone marrow smear from a patient with myeloid reticulosis. 1050 X.

Fig. 17.—Section, lymph node, Hodgkin paragranuloma. The magnification is approximately half that of the preceding photomicrographs. 585 X.

Fig. 18.—Section, lymph node, Hodgkin granuloma. The magnification is the same as in figures 17 (Plate V) and 19 (plate VI). 585 X.

* When the diagnosis was made during life by bone marrow aspiration biopsy on the basis of replacement of the myeloid tissue by large pathologic reticulum cells, the condition has been called myeloid reticulosis, and lymph node involvement may be present as a part of a generalized development of leukemia or a leukemia-like disease, this being similar to the condition described as histiocytic medullary reticulosis. Such cases present lymph node tumors which can be considered as aleukemic or leukemic reticulo-endotheliosis (fig. 16, plate V).
PLATE V
(See legend, facing page.)
60 per cent\(^\text{16}\) to 82 per cent\(^\text{21}\) of lesions, gives it a granulomatosus appearance. Because the lesion resembles that of other conditions known to be of infectious etiology, the search for a pathogen has been diligently pursued by many competent investigators (see the comprehensive review by Hoster et al.\(^\text{22}\)). The question of an infectious agent remains undecided and the proponents of the neoplastic theory of Hodgkin’s disease have not yielded. The search for causes is very important but, as we know so little of the real causes of neoplasia, the arguments about an infectious versus neoplastic nature seem somewhat superfluous, since the theories are not mutually exclusive.

The simplest form of Hodgkin’s lesions is shown in figure 17 (Plate V). The tissue is composed of reticulum cells with oval, pale nuclei, including giant or plurinuclear cells with prominent nucleoli. There are very few eosinophils, plasma cells or fibroblasts. The other cells are mostly lymphocytes and lymphoblasts. This has been called the paragranuloma form of Hodgkin’s disease. The predominating abnormal cell of the neoplastic process is the reticulum cell. The classical granulomatous form is shown in figures 18 and 19 (Plates V and VI). In a small number of cases, the proliferation is characterized by an overgrowth of reticulum cells, usually of bizarre pathologic form, including many polypoid cells. Obviously, the resemblance to the reticulum cell type of lymphoblastoma is very great (fig. 20, Plate VI). Examples of the atypical giant cells seen in both Hodgkin’s disease and reticulum cell tumors are shown in figures 5, (Plate III), 21, and 22 (Plate VI). Excellent illustrations of such cells are available in Rebuck's study.\(^\text{22}\) The particular form of Hodgkin’s disease in which the lesions are composed mainly of pathologic reticulum cells and giant forms of the Sternberg-Reed type is often designated as Hodgkin’s sarcoma.\(^\text{21, 31}\) The distinction between Hodgkin’s sarcoma and reticulum cell sarcoma or lymphoblastoma seems purely arbitrary since they are fundamentally similar, both histologically and clinically.\(^\text{5-8, 10, 20}\) Furthermore, cytochemical studies have shown that the modified reticulum cells of Hodgkin’s disease cannot be distinguished from the reticulum cell sarcoma cell.\(^\text{3}\) Although certain typical blood findings (neutrophilia, monocytosis, eosinophilia) have been described in Hodgkin’s disease,\(^\text{7, 43}\) they do not include those of leukemia.

Follicular lymphoblastoma is considered a mixed type because the hyperplasia mainly involves two types of cells: (1) the small differentiated lymphocytes, like those of the lymphocytic lymphoblastoma; and (2) the larger, less differ-

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**PLATE VI**

**FIG. 19.**—Section, lymph node, Hodgkin granuloma. 585 X.

**FIG. 20.**—Section, lymph node, Hodgkin sarcoma. The lesion is practically identical with the reticulum cell type of tumor shown in figure 4 (plate III) which is from a field containing scattered lymphocytes. 1050 X.

**FIG. 21.**—Sternberg-Reed cell in an imprint of a lymph node (Hodgkin granuloma). 1050 X.

**FIG. 22.**—Section of the lymph node shown in figure 21. A Sternberg-Reed cell is in the center of the field. 1050 X.

**FIG. 23.**—Section of lymph node, lymphoblastoma, follicular type. This lesion contains discrete nodules. 105 X.

**FIG. 24.**—Section of lymph node, lymphoblastoma, follicular type, showing coalescence of nodules of relatively primitive cells. 105 X.
PLATE VI

(See legend, facing page.)
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entiated cells, like those of the lymphoblastic form. The lesions contain multiple nodules resembling follicles. In most instances, the central parts of the nodules are composed mostly of lymphoblasts and some reticulum cells; these are surrounded by proliferating small differentiated lymphocytes. The central collections of the more primitive cells may increase in size and ultimately coalesce, so that the entire lesion becomes lymphoblastic. Hence, the progression of follicular lymphoblastoma to the lymphoblastic type is a common occurrence. Less commonly there is progression to Hodgkin’s disease or other forms of lympho-

**Table 2—Morphologic Relationships of Tumors of the Lymphoblastoma Group, and Their Relationship to Leukemia**

<table>
<thead>
<tr>
<th>Neoplastic lesions of lymph nodes</th>
<th>of RETICULUM TISSUE</th>
<th>of LYMPHOID TISSUE</th>
</tr>
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<tbody>
<tr>
<td>(Malignant lymphomas)</td>
<td>I. Reticulum cell type</td>
<td>II. Lymphoblastic type</td>
</tr>
<tr>
<td>(Lymphoblastomas)</td>
<td>(rarely, leukemic)</td>
<td>(often leukemic)</td>
</tr>
<tr>
<td>morphologically indistinguishable</td>
<td>III. Lymphocytic type</td>
<td></td>
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<tr>
<td></td>
<td>(usually leukemic)</td>
<td></td>
</tr>
<tr>
<td>IV. Mixed type</td>
<td>A. Hodgkin type</td>
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<tr>
<td></td>
<td>1. Paragranuloma</td>
<td></td>
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<tr>
<td></td>
<td>2. Granuloma</td>
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<tr>
<td></td>
<td>3. Sarcoma</td>
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<tr>
<td></td>
<td>B. Follicular type</td>
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</tr>
<tr>
<td></td>
<td>1. “Pre-blastomoid”</td>
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<tr>
<td></td>
<td>2. Progression to diffuse form of lymphoblastoma</td>
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blastoma and, more rarely, lymphatic leukemia. One of these events is illustrated in figures 23 and 24 (Plate VI). The importance of separating follicular lymphoblastoma from the others is in its clinical behavior which is characterized by a relatively benign and slow course. It has been considered to be a “pre-blastomoid” stage, or even a benign hyperplasia and, although progression to a diffuse form of lymphoblastoma is observed often, in some cases the follicular phase persists for many years.

If we now examine an expanded working classification of the lymphoblastomas (table 2), it will indicate a division into four main categories according to the predominating proliferating cells of the abnormal tissue, showing their morphologic relationships to each other and to leukemia and, finally, noting the varied patterns which may be encountered in Hodgkin's disease, and the typical progression of the follicular type into other forms of lymphoblastoma. It may be
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concluded that some of the differences in terminology are the result of exclusive observation of sections or films, and that a diagnosis of lymphoblastoma, at least in all forms except Hodgkin’s disease, represents a partial or temporary diagnosis requiring further investigation of the blood and bone marrow.

SUMMARY

The value of complete hematologic study, including examination of the blood and bone marrow and imprints as well as sections of lymph nodes, for the diagnosis of lymphoblastomas has been indicated. The various forms of these tumors have been described and defined, and their relationships to each other and to leukemia have been discussed and illustrated. A simple working classification has been presented.

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