The Accuracy of Combined Cytopathologic and Flow Cytometric Analysis of Fine-Needle Aspirates of Lymph Nodes

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**Key Words:** Cytopathology; Lymph node; Fine-needle aspiration; Flow cytometry; Lymphoma

**Abstract**

We studied flow cytometry in 156 fine-needle aspirations (FNAs) of lymph nodes performed between June 1993 and September 1998. Information from flow cytometry was combined with cytomorphologic evaluation, and the diagnosis determined by using combined modalities was compared with tissue biopsy results or clinical follow-up. In 74 cases, a combined cytopathologic-flow cytometric diagnosis of lymphoma was made; histologic material was available for 52 patients; in no case was a benign process found. The lymphoma grade assigned agreed with histopathologic findings in 45 of 48 cases with a specific cytologic diagnosis. Treatment was initiated on the basis of the FNA alone for 17 of 52 patients with a history of lymphoma and in 22 additional patients with no follow-up biopsy. Among 71 cases in which the diagnosis using both modalities was benign, the only false-negative was 1 case of Hodgkin disease. Of the 156 cases, 11 were considered atypical or suggestive of lymphoma; biopsies from 8 of 10 patients revealed lymphoma. A combination of flow cytometry and cytomorphology of cells obtained by FNA of lymph nodes can distinguish between benign and malignant lymphoid infiltrates and support a diagnosis of lymphoma that permits definitive therapy in most cases.

The fine-needle aspiration (FNA) technique has been used in the diagnosis of lymph node disease since the early 20th century. The method was used originally for the identification of infections and in the diagnosis of metastatic cancers.1-3 Application to lymphoma diagnosis was viewed historically as problematic because of the central importance given to the evaluation of lymph node architecture. Some cytologic criteria, such as cellular monomorphism, have been considered useful for helping to distinguish malignant lymphoid infiltrates from benign infiltrates,4,5 but widespread use of FNA as a primary diagnostic modality in lymphoma has been limited.

Ancillary studies have been applied widely to the classification of lymphomas in cytopathology and in histopathology. Many early cytologic studies used standard immunocytochemical methods6-10 because the perceived need for high cellularity in multiparameter flow cytometry limited its application in cytopathology.11,12 However, modern flow cytometry seems ideally suited to the study of FNA specimens because this technique gives rise to single-cell suspensions of well-preserved cells, and with care, adequate numbers of cells can be harvested and studied by multiparameter analysis to accurately diagnose lymphoma.13,14 Several studies have documented the value of flow cytometry in lymphoma diagnosis,9,14 although many have been descriptive or focused specifically on comparison of immunocytochemistry and flow cytometry.10,13,15

We describe our experience with the use of flow cytometric testing and routine cytomorphologic examination during a 5-year period. We deliberately did not design the study to compare the accuracy of one modality with another, because we believe that they are complementary techniques that provide information that is best used...
together. We thus tried to formulate the most clinically useful diagnosis we could by combining information from both techniques and studied how this correlated with available histopathologic diagnoses or with clinical follow-up.

Materials and Methods

Flow cytometry was performed on 156 FNA specimens that were clinically or morphologically suggestive of lymphoma between June 1993 and September 1998. Cases were largely unselected, although those in which cellularity or cell preservation was insufficient for flow cytometric analysis and cases of nonhematolymphoid processes were excluded. Specimen collection was performed in the clinic or at the patient’s bedside. After the patient was examined, the procedure and risks were discussed, informed consent was obtained, and the area was cleaned and draped. Aspirations were performed using a 23- or 25-gauge needle, a 10-mL syringe, and a syringe holder ( Cameco, London, England). Paired slides were prepared, with 1 slide air dried and stained with a modified Wright-Giemsa stain ( Diff-Quik stain set, Dade Behring, Newark, DE), and the other alcohol-fixed for Papanicolaou staining. Material was sent for flow cytometric analysis based on clinical suspicion or from on-site evaluation of smears stained with a modified Wright-Giemsa. An average of 3 passes was made to provide a sufficient number of cells. Material from these passes was placed in Hank balanced salt solution and transported immediately to the flow cytometry laboratory. Of the total 450 lymph node aspirations performed during this time, 156 were sent for flow cytometric evaluation.

Flow cytometric evaluation was performed on aliquots of aspirate material by 3-color immunofluorescence using the combinations kappa-fluorescein isothiocyanate (FITC)/lambda-phycoerythrin (PE)/CD19-PE-cyanine 5 (cyochrome), CD5-FITC/CD22-PE/CD3-perdinin chlorophyll protein (PerCP), and CD71-FITC/CD33-PE/CD45-PerCP as a screening panel. When sufficient cells were available and in cases in which an abnormal population was identified, additional antibodies, including CD10, CD20, CD23, FMC7, CD11c, CD7, CD4, CD8, CD2, and, occasionally, others also were used for improved subclassification. All antibodies were from Becton Dickinson, San Jose, CA, except CD19-cyochrome (Pharmingen, La Jolla, CA) and FMC7 (Immunotech, Westbrook, ME). Flow cytometric analysis was performed on a flow cytometer (FACScan, or, in later cases, FACSCalibur flow cytometer, Becton Dickinson).

Data analysis was performed using PAINT-A-GATE PRO software (Becton Dickinson). Populations were identified by “painting” (arbitrarily assigning color, for analysis) the constituent populations, and the phenotype of normal and abnormal cell components was inferred from the distribution of the painted populations in multiparameter space. To determine the presence of B-cell clonality, all B cells in the sample were assigned 1 color, and the relative distribution of kappa and lambda was visualized in displays of kappa vs lambda and in displays of forward-angle light scatter (a measure of cell size) vs light chains. In this manner, visual determination of clonal populations was readily made even in the presence of normal polyclonal B cells in the background.

Flow cytometric data were reviewed in conjunction with the morphologic features to determine a diagnosis, and both pieces of information were incorporated into the final pathologic report. However, no specific mandate was given to the pathologist signing out the case about how the information should be used. In the first portion of the study, cytopathologic reports were reviewed retrospectively for all cases and initially categorized as positive for lymphoma, negative for lymphoma, or atypical or suggestive of lymphoma. The latter category included cases in which the report contained the terms “atypical” or “suspicious for lymphoma,” without giving a definitive diagnosis. Although no single explanation could be identified for this diagnosis, most of these cases had insufficient cell number, poor cellular preservation, or indefinite flow cytometric findings, and patients given this diagnosis generally underwent further more definitive examination.

As the retrospective review proceeded, however, it became clear that among cases diagnosed as lymphoma, some of the reports gave more precise diagnoses than did others. For example, some specified the grade of lymphoma and some the histologic subtype, while others simply diagnosed lymphoma without further elaboration. Because it was unclear how much of this variability could be due to lack of standardized reporting, all cases diagnosed as lymphoma without mention of specific grade were re-reviewed blindly in an attempt to assign a definitive grade. We chose to focus on grade because we believed that attempting to reproduce histopathologically defined classification systems, such as the Revised European-American classification of lymphoid neoplasms (REAL), was likely to be difficult or impossible, while lymphoma grade provides clinically useful information.

Once cases were classified, additional pathology records were reviewed to identify evidence of definitive tissue biopsy for correlation. In cases in which there was no additional pathology material, medical records were reviewed when available to determine clinical outcome. Pathologic or clinical follow-up was available for 132 (84.6%) of 156 patients.
Results

Correlation Between Cytopathologic and Flow Cytometric Diagnoses and Histopathologic Diagnosis

Table 1 shows the correlation between the combined cytopathologic and flow cytometric diagnosis and histopathologic diagnosis. A total of 74 specimens were considered positive for lymphoma; 52 of these cases also had histologic diagnoses of lymphoma. One patient had a follow-up biopsy that was of poor quality and nondiagnostic, and treatment was instituted without additional procedures. No case diagnosed as lymphoma had a benign disease or nonhematolymphoid malignant neoplasm revealed by tissue biopsy. Seventy-one specimens were considered negative for lymphoma; for 12 of these, results of follow-up biopsies were negative, while 58 patients did not undergo biopsy, although no other clinical or pathologic evidence of lymphoma was ever obtained. For 1 patient who underwent biopsy, Hodgkin disease was found (see “Cases Diagnosed as Benign”). Of the 11 specimens considered atypical or suggestive of lymphoma, 10 patients had undergone biopsy and 8 were found to have lymphoma.

Cases Diagnosed as Lymphoma

As noted, histologic material was available for comparison in 52 cases in which a definitive diagnosis of lymphoma was made by the combination of cytopathologic examination and flow cytometry. Treatment decisions were made for 21 patients diagnosed as having lymphoma without tissue biopsy ever having been obtained. In 17 cases, a previous diagnosis of lymphoma had been given, and the combined cytopathologic and flow cytometric diagnosis was considered evidence of recurrence; treatment was initiated without additional biopsy. In 31 of the remaining 35 cases, the combined cytopathologic and flow cytometric diagnosis also provided grade or precise classification of lymphoma, and in 28 of these 31 cases, this information proved correct by the subsequent biopsy

Table 2.

Image 1 and Figure 1 show an example of the cytopathologic and flow cytometric findings, respectively, in a case of a small lymphocytic lymphoma that was confirmed by tissue biopsy. Cytologically, the cells are small and uniform, and the flow cytometric findings show a dimly kappa-positive clonal B-cell population with the characteristic CD5+, CD23+ B-cell phenotype expected for chronic lymphocytic leukemia/small lymphocytic lymphoma. By contrast, Image 2 and Figure 2 show the cytopathologic and flow cytometric findings, respectively, of a large B-cell lymphoma, again confirmed by tissue biopsy. In this case, the cells are large cytologically and by forward-angle light scatter, and these large cells show clonal kappa light chain expression. This population showed moderate density expression of CD71, the transferrin receptor, a finding that supports a conclusion of an aggressive malignant neoplasm (data not shown).

In 3 cases, subsequent biopsy revealed that the grade of lymphoma on the tissue biopsy specimen was substantially different from that suggested by the combined cytopathologic and flow cytometric diagnosis. In 2 cases, the combined cytopathologic and flow cytometric diagnosis was low-grade lymphoma, while subsequent biopsies revealed large cell lymphomas arising from underlying low-grade lymphomas. One of these is illustrated in Image 3 and Figure 3. The majority of cells are small, and flow cytometry studies showed a typical kappa-positive CD10+ B-cell phenotype characteristic of follicle center cell lymphoma, with only a few large cells by light

<table>
<thead>
<tr>
<th>Cytopathologic/Flow Cytometric Diagnosis</th>
<th>Biopsy or Other Follow-Up</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive for lymphoma (n = 74)</td>
<td>Grade agreed with subsequent biopsy findings</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>No follow-up biopsy result available</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Grade agreed with previous diagnosis</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>No grade given in cytology; follow-up biopsy findings diagnostic</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Grade different in follow-up biopsy findings</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Follow-up biopsy nondiagnostic</td>
<td>1</td>
</tr>
<tr>
<td>Negative for lymphoma (n = 71)</td>
<td>No follow-up biopsy</td>
<td>58*</td>
</tr>
<tr>
<td></td>
<td>Follow-up biopsy result negative</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Follow-up biopsy result positive (Hodgkin disease)</td>
<td>1</td>
</tr>
<tr>
<td>Atypical or suggestive of lymphoma (n = 11)</td>
<td>Follow-up biopsy result positive</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Follow-up biopsy result negative</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No follow-up</td>
<td>1</td>
</tr>
</tbody>
</table>

* Review of available clinical records for 48 patients revealed no evidence of development of lymphoma.
scatter; by contrast, focal sheets of large cells were seen on the histologic section. In these cases, it is likely that tissue sampling limited the accuracy of the combined cytopathologic and flow cytometric diagnosis. In the remaining case, a diagnosis of a high-grade lymphoma was given, but subsequent tissue biopsy revealed a follicular mixed lymphoma with insufficient large cells to warrant classification as a large cell lymphoma.

In 4 cases, the combination of cytomorphologic examination and flow cytometry was sufficient to arrive at a diagnosis of lymphoma, but no further subclassification or grading was attempted. Histologic findings in these cases included 1 case of follicular lymphoma, mixed cell type, 2 cases of large cell lymphoma (1 partially involving a lymph node), and 1 case of a marginal zone lymphoma in which an unusually high number of large cells and focally high (Ki67) proliferative index was noted.

### Cases Diagnosed as Benign

In 58 of 71 cases diagnosed as benign, no corresponding tissue biopsy was obtained. Review of available clinical information in these cases showed no meaningful clinical suspicion of lymphoma and no evidence of development of lymphoma in any patient. For 12 patients, results of follow-up biopsies were negative. Diagnoses in these cases included the following: reactive follicular hyperplasia, 5 cases; atypical hyperplasia, 3 cases; granulomatous inflammation, 2 cases; acute necrotizing lymphadenitis, 1 case; and incidental benign intraparotid lymph node, 1. One patient given a definitive diagnosis of

### Table 2

<table>
<thead>
<tr>
<th>Cytopathologic/Flow Cytometric Diagnosis</th>
<th>Histologic Diagnosis</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggressive B-cell lymphoma</td>
<td>Large B-cell lymphoma</td>
<td>16</td>
</tr>
<tr>
<td>Low-grade B-cell lymphoma (n = 7)</td>
<td>Small lymphocytic lymphoma</td>
<td>2</td>
</tr>
<tr>
<td>Follicle center cell lymphoma</td>
<td>Follicular small cleaved lymphoma</td>
<td>3</td>
</tr>
<tr>
<td>Low-grade B cell, not otherwise specified (n = 2)</td>
<td>Follicular small cleaved lymphoma</td>
<td>1</td>
</tr>
<tr>
<td>Peripheral T-cell lymphoma</td>
<td>Peripheral T-cell lymphoma</td>
<td>2</td>
</tr>
<tr>
<td>Anaplastic large cell lymphoma</td>
<td>Anaplastic large cell lymphoma</td>
<td>1</td>
</tr>
<tr>
<td>Low-grade B-cell lymphoma (n = 2)</td>
<td>Follicular small cleaved lymphoma transforming to large cell lymphoma</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Marginal zone lymphoma transforming to large cell lymphoma</td>
<td>1</td>
</tr>
<tr>
<td>Aggressive B-cell lymphoma</td>
<td>Malignant lymphoma, follicular mixed small cleaved and large cell</td>
<td>1</td>
</tr>
</tbody>
</table>

### Image 1

Small lymphocytic lymphoma. A, Monotonous population of small round lymphocytes in fine-needle aspirate of lymph node (Papanicolaou, ×250). B, Corresponding histologic section of chronic lymphocytic leukemia in bone marrow found on subsequent biopsy (H&E, ×100).
benign subsequently was found to have Hodgkin disease; this patient continued to have clinically suspicious nodal enlargement that was biopsied despite the benign diagnosis.

**Cases Labeled Atypical and Suggestive of Lymphoma**

For 11 patients, the diagnosis was atypical or suggestive of lymphoma. The reasons for failing to determine a definitive diagnosis often were scant or insufficient material (5 cases) or extensive necrosis (2 cases). In 1 case, in retrospect, better communication between cytopathology and the flow cytometry laboratory personnel might have resulted in a definitive diagnosis. In 8 of the 11 cases, subsequent diagnoses of lymphoma were established by tissue biopsy, while 2 cases (1 showing reactive hyperplasia and the other granulomatous lymphadenitis) were benign. One patient did not undergo biopsy.

**Discussion**

We demonstrated that the combination of multiparameter flow cytometry and cytomorphologic diagnosis can be used to distinguish reactive lymphoid proliferations from malignant proliferations and, in addition, can provide more clinically useful information in cases of lymphoma to permit treatment of the disease without subsequent...
**Image 2** Large cell lymphoma, cells from fine-needle aspirate. A, Monotonous population of large cells with immature and often irregular nuclear contours (modified Wright-Giemsa, ×400). B, Histologic section of follow-up biopsy specimen showing similar large irregular cells with numerous mitoses and apoptotic bodies (modified Wright-Giemsa, ×250).

**Figure 2** Flow cytometric analysis of the same case as illustrated in Image 2. A, Clonal population of B cells showing kappa light chain restriction. B, Display of forward-angle scatter (FSC) vs kappa light chain showing that the kappa-positive cells are large (arrow). C, Display of forward-angle scatter vs CD5 showing that the CD5+, presumably normal T cells are small, while the large cells fail to express CD5. FITC, fluorescein isothiocyanate; PE, phycoerythrin.
We found that a definitive diagnosis of benign or malignant was given in 145 (92.9%) of 156 cases, and in only 1 case, Hodgkin disease called benign, was this diagnosis proved to be incorrect. In 58 (82%) of 71 cases, the combination of the negative study result and low clinical suspicion obviated the need for more invasive—and more expensive—tissue biopsy. In 48 of these 58 cases, detailed clinical review showed no evidence of development of lymphoma, while for the other 10 patients, no follow-up information was available.

In cases of lymphoma, the accuracy of the combination of cytopathologic and flow cytometric analysis was high. In 38 (51%) of 74 cases in which a diagnosis of lymphoma was given, definitive treatment was instituted solely on the basis of the cytopathologic analysis combined with flow cytometry results. In 17 of these cases, this analysis confirmed recurrence of lymphoma, while in an additional 21, the findings agreed sufficiently with the clinical impression that the treating physician elected to forego open biopsy. (In 1 additional case, a biopsy was attempted.)
but was inadequate and treatment was initiated anyway). In 28 of 31 cases in which cytologic analysis preceded open biopsy, the histologic findings were equivalent to those predicted by the combination of cytologic and flow cytometric examination (Table 2). Of these cases, 16 were large B-cell lymphomas, 2 were peripheral T-cell lymphomas, 1 was an anaplastic large cell lymphoma, and 2 were Hodgkin disease.

Among the low-grade lymphomas, 2 of 2 small lymphocytic lymphomas and 3 of 5 low-grade follicle center cell lymphomas were diagnosed accurately by cytologic analysis. Of the 2 follicle center cell lymphomas in which this specific diagnosis was not given, 1 was simply called low-grade B-cell lymphoma. The other was considered high grade based on the presence of significant numbers of large cells by flow cytometry, while the histologic findings were those of a follicular mixed small cleaved and large cell lymphoma (follicle center cell lymphoma, grade 2). Although this diagnosis in a sense must be considered a false-positive result because of the incorrect grade, the distinction between follicular large cell lymphoma and follicular mixed lymphoma is known to be arbitrary, and while histopathologic criteria for this discrimination have been well described, there are not well-defined rules for this distinction in cytopathology or flow cytometry. The 2 other cases in which the incorrect grade was given both involved lymphomas diagnosed as low-grade in which tissue biopsy revealed both low- and high-grade areas, suggesting that tissue sampling at the time of FNA had a role in the failure to achieve an accurate classification.

The only false-negative diagnosis in the entire study was a case of Hodgkin disease diagnosed as benign. The inability of flow cytometry to definitively diagnose...
Hodgkin disease is well known, and the presence of a reactive pattern shown by flow cytometry cannot exclude this possibility. It should be noted, however, that in 3 cases, 2 of which were biopsy proven, we were able to give a specific diagnosis of Hodgkin disease based on the finding of cells with characteristic morphologic features, the immunophenotype on tissue from a cell block, and the presence of a polyclonal reactive pattern by flow cytometry.

The combination of cytomorphologic and flow cytometric examination was more valuable than either technique alone. In addition to its ability to recognize Reed-Sternberg cells in cases of Hodgkin disease, cytomorphologic examination was particularly useful in high-grade lymphomas because it could readily identify populations of large atypical cells. While light-scatter characteristics or expression of the activation marker CD71 often permitted recognition of aggressive lymphomas, light-scatter patterns in large cell lymphoma are highly variable. We found that flow cytometry in large cell lymphomas was most useful for lineage assignment and, in the case of B-cell lymphomas, demonstration of clonality. By contrast, in small lymphocytic proliferations, cytomorphologic examination alone often was inadequate, while flow cytometry clearly was useful not only for demonstrating clonality, but also for subclassifying these cases.

Combining CD19 with other antibodies in cases of low-grade B-cell lymphoma allowed phenotypic definition of the neoplastic population with respect to antigens such as CD5, CD10, CD23, and FMC7, which are known to be useful for distinguishing among different types of low-grade lymphomas.

Although our study was limited in the variety of low-grade lymphomas studied, we believe that accurate diagnoses of small lymphocytic lymphoma, low-grade follicle center cell lymphoma, mantle cell lymphoma, and large B-cell lymphoma can be made readily in the majority of cases. Although there are no absolutely diagnostic features for marginal zone lymphomas, these often can be suggested in the appropriate clinical situation by small lymphocytes with a distinct rim of cytoplasm and a clonal B-cell population lacking CD5 and CD10 as identified by flow cytometry. Our study also lacked any cases of Burkitt lymphoma; although the cytomorphologic features of this tumor are characteristic, there may be morphologic overlap with some cases of large cell lymphoma, and there are not well-defined immunophenotypic criteria to distinguish these. S phase fraction has been shown to be valuable in this differential diagnosis.

Many studies of the contribution of immunophenotyping to the diagnosis of lymphoma in cytopathology initially used immunocytochemistry rather than flow cytometry. With the exception of a few studies, ploidy analysis was the major contribution of the flow cytometric technology in early studies. The application of flow cytometry for phenotyping lymphoid populations was recognized in the early 1980s. The acceptance of this technique was slow, however, and through the early 1990s only a few centers routinely incorporated the technology in the evaluation of lymphadenopathy.

More recently, there have been several studies on the use of flow cytometry in the evaluation of FNA specimens.

The approach we took, namely the combination of flow cytometry and cytomorphologic evaluation to determine the most specific diagnosis possible, is not one that has generally been reported in the literature. Nevertheless, our findings support and extend the results of previous series showing the usefulness of flow cytometry as an adjunct to FNA biopsy.

In 1992, Chernoff et al reported that flow cytometry and immunohistochemistry, when combined with morphologic examination, could accurately classify FNA specimens of head and neck nodes as benign or malignant and, in cases of lymphoma, provide information about tumor grade. More recently, MacCallum et al, Layfield, and Tarantino et al showed that flow cytometry was particularly useful for characterizing lymphoid proliferations of the salivary gland.

Robins et al compared immunohistochemistry on cytocentrifuged material with flow cytometry on 71 histologically confirmed cases of lymphoma. They found 97% concordance between phenotyping methods but expressed a preference for immunohistochemistry, although it should be noted that their group had accumulated much more extensive experience with immunostaining.

In a study of flow cytometry applied to FNA specimens, Zander et al were able to recognize 17 (81%) of 21 cases of lymphoma that subsequently underwent biopsy. False-negative diagnoses were attributed to inadequate cell yield, low viability, or technical limitations in the diagnosis of Hodgkin disease.

Dunphy and Ramos described a series of FNAs of 73 patients with suspected nodal or extranodal lymphomas in which flow cytometry was combined with conventional cytomorphologic examination. Their results were generally similar to ours, although a greater proportion of patients (45/73) had a previous diagnoses of lymphoma. A primary lymphoma diagnosis was given for 14 of the 73 cases, and 10 of the patients were treated without subsequent biopsy. As in our series, the most accurate diagnoses were chronic lymphocytic leukemia/small lymphocytic lymphoma, low-grade follicular lymphomas, and high-grade B-cell lymphomas. They saw no false-negative diagnoses among cases diagnosed as reactive.

Finally, Young et al recently published a study similar to ours in which they combined information from...
flow cytometry and cytomorphologic examination to give a definitive diagnosis of lymphoma. In 59 (82%) of 72 cases of non-Hodgkin lymphoma, no subsequent histologic biopsy was deemed necessary, and treatment was instituted on the basis of the combined cytologic and flow cytometric diagnoses.

Concerns raised in the literature about cell preservation and availability of suitable material for flow cytometric study have rarely been a problem in our laboratory. The ability to perform 3- and, more recently, 4-color analysis makes it possible to assess a sample for total B- and T-cell content and for clonality with as few as 100,000 cells. With the usual yield of FNAs in our laboratory averaging 5 × 10⁶ cells, insufficient cellularity is rarely an issue.

We have shown that flow cytometry, when combined with cytopathologic examination of lymph node FNA specimens is a highly sensitive and specific technique for the diagnosis and classification of lymphomas. Although there are certain limitations, such as the potential difficulty in diagnosing Hodgkin disease or the occasional inaccurate assessment of the large cell component of a heterogeneous tumor, overall this technique can be used to provide information for the clinical management of patients in the great majority of cases.

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References


