Monoclonal Antibodies with Specificity for Hairy Cell Leukemia Cells

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ABSTRACT Hairy cell leukemia is a well described clinical entity, but the cell of origin for this leukemic cell and its function are still unknown. There are no totally specific markers for this cell, although tartrate-resistant acid phosphatase staining has been used extensively as a diagnostic test. This study describes three monoclonal murine antibodies with variable specificity for hairy cells. Antibody 1 was highly specific for hairy cells and was not found to react with normal or leukemic cells in this limited study. It did not react with the cells of all patients. It also did not react with all of the hairy cells of some of the positive cases. Antibodies 2 and 3 reacted with virtually all hairy cells but not with normal peripheral blood cells. However, reactions were obtained with certain leukemic myelomonoblasts and some activated B cells. The most obvious use for these three antibodies is for diagnostic purposes. They should also be helpful reagents to investigate the origin of the leukemic hairy cell. The possibility that antibody 1 detects a tumor-specific antigen is discussed.

INTRODUCTION

Hairy cell leukemia (HCL, leukemic reticuloendotheliosis) is a clinically well defined entity (1). However, the origin of the hairy cell itself is still controversial, and no normal equivalent of this leukemic cell has been found. The cell is clearly related to the B cell because it possesses the highly specific property of having membrane immunoglobulin M (IgM) and IgD (2–6); it occasionally, however, shows properties of the T cell (7). Apparently T and B cell phenotypes may coexist or alternate on hairy cells (8–12). The T cell phenotype may appear after mitogen stimulation (12). These observations suggest the presence of subgroups of HCL or the capacity of hairy cells to differentiate into cells as widely divergent as B and T cells. Such studies, however, suffer from the absence of a specific diagnostic test for hairy cells. So far these cells have been identified by morphology and cytochemical characteristics (1). Demonstration of tartrate-resistant acid phosphatase (TRAP) has been used extensively as a marker for hairy cells in both clinical (13) and experimental situations (7, 14). This test, however, has been shown not to be totally specific for hairy cells (15), especially when results show intermediate positivity. HCL with a negative TRAP test has also been described (15).

The diagnostic usefulness of a hairy cell marker is apparent. Such a marker might also help uncover the true identity and origin of the hairy cell. We have, therefore, used the hybridoma technique to make monoclonal murine antibodies to hairy cell leukemia cells. Three such antibodies with varying degrees of specificity are described in this paper.

METHODS

Patients

Cells from 15 consecutive patients with HCL were studied. Control patients had various leukemias or lymphomas. Patient material was obtained from several medical centers. In each case the diagnosis was made according to standard clinical criteria. HCL was diagnosed on the basis of the morphology of the cells found in peripheral blood, bone marrow or spleen, the presence of TRAP in hairy cells, and a compatible clinical picture. Certain patients (Ya, Ne) had electron microscopic studies confirming the presence of hairy cells. Patient Ne has been reported (16).

Techniques

Cell separation. The cells used for immunization were obtained from patient Ya, who underwent leukapheresis in July 1980. The cells obtained from this procedure were aliquoted and frozen in a medium of RPMI 1640, 10% dimethylsulfoxide, 20% fetal calf serum. A programmable freezer (Cryo Med., Mt. Clemens, MI) with liquid nitrogen was used to freeze cells at a rate of 1°C/min. When thawed
for immunizations or immunofluorescence, the cells remained viable (usually >95% viability by trypan blue exclusion) and contained 80% typical hairy cells by phase microscopy. Other patients’ cells were obtained from heparinized blood, bone marrow aspirates, or from teased organs. Mononuclear cell preparations containing the hairy cells were obtained using a standard separation method with Ficoll-Hypaque (d = 1.077). After washing three times, the cells were used for immunofluorescent staining and frozen in liquid nitrogen for future use.

E rosettes. Spontaneous rosette formation between lymphocytes and neuraminidase-treated sheep erythrocytes was performed as described elsewhere (17).

Reagents

Monoclonal antihairy cell antibodies. The hybridoma technique used is described elsewhere (18). Briefly, BALB/c mice were immunized with 20 x 10⁶ hairy cells on three occasions over a 7-mo period. 3 d after the last immunization, the spleens of these mice were harvested and the splenocytes were fused to the murine lymphoma cell line SP 2/0-Ag 14 (19) using polyethylene glycol 1000. Hybrid cells were selected in a hypoxanthine, aminopterin, and thymidine (HAT) medium and supernatants from growing clones were screened 12-18 d after fusion. 200 supernatants were screened by indirect immunofluorescence for the presence of antibodies reacting with peripheral blood mononuclear cells (PBMC) from a normal donor and with cells used as the immunogen (Ya). A tetramethylrhodamine isothiocyanate (TRITC)-conjugated, affinity absorbed, F(ab)₂, rabbit anti-mouse immunoglobulin antibody was used as the second antibody for indirect immunofluorescence. Only supernatants staining the hairy cells but not the normal PBMC were selected. The corresponding hybridoma cell lines were expanded and cloned on soft agar. Three supernatants from cloned hybridomas were used extensively.

Other antibodies. Murine anti-kappa monoclonal antibody was obtained from an immunization with a purified human monoclonal IgM kappa. Murine anti-lambda monoclonal antibody was obtained commercially from Bethesda Research Laboratories (Bethesda, MD). The antimonocytic monoclonal antibodies (61D3, 63D3) were a gracious gift from Dr. D. Capra (20).

RESULTS

Three monoclonal antibodies, aHC1, aHC2, and aHC3, reacted with the immunizing cells, the hairy cells from patient Ya, but not with normal PBMC. These were selected for further study. Antibodies aHC2 and aHC3 gave weak granular staining with some variation of intensity when used for indirect immunofluorescence on hairy cells. Antibody aHC1 gave brighter and more speckled staining also with variation of intensity (Fig. 1). Whereas the former two antibodies appeared to stain all hairy cells in the specimen from patient Ya, the latter antibody was clearly negative with some hairy cells (Fig. 1).

The reactivity of these antibodies was also tested on hairy cells from patient Ya with a cytofluorograf (Fig. 2). The tracings show positive fluorescence with hairy cells but not with normal PBMC. The fluorescence intensity observed with aHC2 and aHC3 was less than the intensity with aHC1. All three antibodies showed somewhat less fluorescence intensity than that observed with monoclonal anti-kappa light chain antibody. The fluorescence curves of aHC2 and aHC3 follow a Gaussian distribution and suggest that all cells are positive with these antibodies. On the contrary, the curve observed with aHC1 indicates the presence of both a negative and a positive cell population. These findings confirm the above visual description of the staining characteristics of these antibodies.

To define the specificity of these anti-hairy cell antibodies, various normal and pathological cell types were used for immunofluorescent staining. As can be seen in Table I, normal lymphocytes and monocytes contained within the PBMC and normal granulocytes contained within the buffy coat cell preparation did not react with the aHC antibodies. Likewise cells from teased tonsils, mesenteric lymph nodes, spleen, and thymus were mostly negative when stained with the aHC reagents. However, a few cells in normal uninvolved spleen, thymus, and bone marrow did stain with aHC2 and aHC3. aHC1, the most specific of the three antibodies, did not react with any cells from these organs. aHC1 did not react with any of the cell lines tested, including a promyelocytic cell line, HL 60 (22), a histiocytic lymphoma cell line, U 937 (23), and a leukemic cell line from a patient with chronic granulocytic leukemia in blastic crisis, K562 (24). aHC2 and aHC3 did not react with T cell lines or the nonlymphoid cell lines. Some B cell lines were entirely negative as in the case of RPMI 8866 P (Table I). Others were positive and the percentage of cells staining with aHC2 and aHC3 ranged widely (from 5 to 68% of the cells) from cell line to cell line. Further studies of several B cell lines indicated that the percentage of positive cells changed with the phase of cell growth. In addition, although purified preparations of normal resting B cells were usually negative with all three antibodies, positive cells were obtained after pokeweed mitogen stimulation with aHC2 and aHC3. These positive cells appeared before the development of maximal numbers of plasma cells and disappeared at the plasma cell stage. These findings are currently the topic of a separate study.

In Table II individual data on 15 different HCL patients are summarized. The percentage of cells staining with the aHC antibodies showed a general correlation with the percentage of hairy cells seen by phase microscopy on the same sample. aHC1 stained less cells than the two other aHC antibodies in most cases and probably identifies a fraction of the hairy cells in these patients. Supporting this contention was the finding of some morphologically typical hairy cells that did not stain with aHC1 (Fig. 1). Patients in a leukemic phase of their illness, such as patients Ya and Art.
St had many cells staining with αHCl. Others such as Pe had no cells staining with this antibody in spite of the presence of many hairy cells in the sample. This difference in positivity with the αHCl antibody was also seen in two spleen samples (Ho and So). There seemed to be no common feature among the patients with hairy cells lacking reactivity with αHCl (patients Pe, So, Co, and possibly Ne). In several patients only few hairy cells were found in the peripheral blood and percentages of cells staining with the αHC reagents were small, although each cell that stained positively also had the morphology of a hairy cell. In such a patient a sample from a different source, such as spleen (patient By), can be helpful to confirm the staining results.

In two cases follow-up samples of blood obtained at a later date were tested (Table II). In patient Ne clinical deterioration had occurred, manifested by an increasing degree of pancytopenia and an enlarging spleen. This correlated with the presence of more hairy cells in the peripheral blood, both by phase microscopy and by immunofluorescence using the αHC reagents. Staining results and the percentage of hairy cells showed little change in patient St over a 3-mo period during which the patient seemed to be deteriorating.

In Table III cells from nine patients with typical B cell chronic lymphocytic leukemia were totally non-reactive with all three αHC antibodies. Two lymphocytic lymphomas and three patients with acute lymphoblastic leukemia had no reactive cells except for patient Cn, where a few cells reactive with αHC2 were found; their significance remains unclear. Similarly only a few cells from a patient with plasma cell leukemia (60% plasma cells in the specimen) stained with αHC2 and αHC3.

αHCl did not react with any cells from 12 different
of cells

used
hybridoma

supernatant and indicates

immunofluorescence.

FIGURE 2

stained

rescence

negative

positively

with

mouse

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patients

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cell

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bodies

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did

not

aHC3.

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of

Hairy

cells

are

known

both IgG1 kappa immunoglobulins. Mouse hybridoma

antibodies of the same subclasses, but with different

specificities did not stain hairy cells. The α-lambda

light chain reagent used is an IgG1 kappa mouse im-
munoglobulin and constitutes an additional control for

nonspecific Fc binding.

In most of the HCL cases, staining with anti-kappa

and anti-lambda light chain antibodies demonstrates

a monoclonal cell membrane immunoglobulin (Table

II) as described previously from this laboratory (2) and

others (4, 5). This was less readily apparent when only

a few hairy cells were found (for example in patient

Na). In some other cases where lambda light chain was

found on the hairy cells (Co and Gi), another popu-

lation of smaller lymphocytes staining with anti-kappa

was seen, demonstrating the coexistence of the leu-

kemic hairy cells and the nonleukemic B cells.

Because hairy cells do have phagocytic capacity and

and have been thought to be related to monocytes, it is of

interest to note the negative results of staining with

in this study.

patients with various myelomonocytic disorders (Table

IV). However, αHC2 and αHC3 stained cells, espe-

cially in samples containing early myeloid precursors.

The highest counts of staining cells occurred in samples

from acute myeloid or monoblastic leukemias contain-

mainly blasts. These results indicate the presence of

cell surface antigens shared by leukemic myelo-

monoblasts and hairy cells and recognized by αHC2

and αHC3.

Hairy cells are known to possess avid Fc-receptors.

The αHC antibodies we describe do not react with

other cells known to have strong Fc-receptors such as

monocytes and granulocytes. Aggregated human IgG

did not inhibit the staining by the three αHC anti-

bodies (data not shown). Therefore, nonspecific at-

tachment of these antibodies via an Fc-receptor can

be excluded.

By Ouchterlony precipitation αHC1 is an IgG2a

kappa mouse immunoglobulin. αHC2 and αHC3 are


<table>
<thead>
<tr>
<th>Cell source</th>
<th>No. of specimens</th>
<th>αHC1</th>
<th>αHC2</th>
<th>αHC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (NI) PBMCN</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>NI buffy coat</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NI tonsil</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NI mesenteric lymph node</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NI spleen†</td>
<td>6</td>
<td>1.4</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>NI thymus</td>
<td>2</td>
<td>0</td>
<td>0.4‡</td>
<td>1.6‡</td>
</tr>
<tr>
<td>NI bone marrow‡</td>
<td>3</td>
<td>0.1</td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>T cell lines§</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>U 266 (IgG plasma cell line)‡‡</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2132 (IgG plasma cell line)††</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3658 (B-cell line derived from ALL)††</td>
<td>0</td>
<td>52</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>RPMI-8866 P (B-cell line)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Nonlymphoid cell lines*§*</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* A few individuals did show low percentages of positive cells with αHC2 and αHC3 but not with αHC1.
† Uninvolved spleens from patients with hemolytic anemia and Hodgkin’s disease.
‡ Uninvolved bone marrow from patients with systemic lupus erythematosus and hemolytic anemia.
§ The cells staining positive were large.
† Cell lines 1301, Ke 37, Molt 4, Cem-T.
‡‡ Cell lines HL 60, U 937, K 562, fibroblast cell lines.
†† Cell lines obtained from the Human Genetic Mutant Cell Repository.
§§ See reference 21.

** Monoclonal Hairy Cell Antibodies **
**DISCUSSION**

We have described three unique anti-hairy cell monoclonal antibodies, one of which (aHCl) demonstrates specificity for hairy cells and does not react with any other cells tested. Thus aHCl reacted only with hairy cells, but not all hairy cells in a given patient reacted with this antibody. Also, several HCL patients showed only few or no cells reacting with aHCl, even when the percentage of morphologically identifiable hairy cells was quite high. Therefore, this antibody may identify a subset of hairy cells or only react with hairy cells at a specific stage of differentiation. Subsets of HCL have previously been suggested on the basis of (a) the clinical picture, i.e., pancytopenic vs. leukemic form of the disease, remission vs. progression after splenectomy, (b) the varied results of cell marker and cell functional studies from patient to patient (5), and (c) differences in the occurrence of two hairy cell specific membrane proteins from patient to patient (26). Some evidence was obtained indicating that aHCl may identify hairy cells found more frequently during clinically progressive disease such as the leukemic phase of HCL.

Both aHCl2 and aHCl3 reacted with the great majority of hairy cells in all patients, but they also reacted with certain other cell types. This was most apparent for the myeloblasts or myelomonoblasts from patients

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**TABLE II**

**HCL Patients—Cell Surface Characteristics**

<table>
<thead>
<tr>
<th>Patients</th>
<th>WBC 10^6 cells/l</th>
<th>Splenectomy</th>
<th>Hairy Cells</th>
<th>N-SRBC Resettes</th>
<th>Cells staining with</th>
<th>αKappa</th>
<th>αLambda</th>
<th>61 D3</th>
<th>63 D3</th>
<th>αHCl</th>
<th>αHCl2</th>
<th>αHCl3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ya—lph</td>
<td>50.0</td>
<td>+</td>
<td>80</td>
<td>6</td>
<td>85</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>53</td>
<td>73</td>
<td>85</td>
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<tr>
<td>Ho—spl</td>
<td>34.0</td>
<td></td>
<td>83</td>
<td>8</td>
<td>73</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>27</td>
<td>83</td>
<td>77</td>
</tr>
<tr>
<td>St 6-18-81</td>
<td>9-23-81</td>
<td></td>
<td>79</td>
<td>11</td>
<td>1</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>38</td>
<td>40</td>
<td>38</td>
</tr>
<tr>
<td>Pe</td>
<td>9.1</td>
<td></td>
<td>79</td>
<td>11</td>
<td>43</td>
<td>0</td>
<td>44</td>
<td>68</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ma</td>
<td>6.0</td>
<td></td>
<td>30</td>
<td>0</td>
<td>3</td>
<td>75</td>
<td>1</td>
<td>85</td>
<td>86</td>
<td></td>
<td></td>
<td></td>
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<td>Co</td>
<td>7.2</td>
<td></td>
<td>27</td>
<td>27</td>
<td>1</td>
<td>78</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>28</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Hu</td>
<td>7.1</td>
<td></td>
<td>13</td>
<td>50</td>
<td>13</td>
<td>1411</td>
<td>0</td>
<td>18</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>An</td>
<td>3.3</td>
<td></td>
<td>6</td>
<td>76</td>
<td>13</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>7**</td>
<td>7**</td>
<td>7**</td>
<td></td>
</tr>
<tr>
<td>Ne 11-27-80</td>
<td>2.5</td>
<td></td>
<td>6</td>
<td>50</td>
<td>27</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2**</td>
<td>7**</td>
<td>8**</td>
<td></td>
</tr>
<tr>
<td>By</td>
<td>2.0</td>
<td></td>
<td>33</td>
<td>51</td>
<td>57</td>
<td>1</td>
<td>0</td>
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<td>45</td>
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<td>0</td>
<td>1</td>
<td>17</td>
<td>35</td>
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<tr>
<td>Kl</td>
<td>4.5</td>
<td></td>
<td>5</td>
<td>68</td>
<td>10</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>4**</td>
<td>4**</td>
<td>3**</td>
<td></td>
</tr>
<tr>
<td>Gi</td>
<td>3.6</td>
<td></td>
<td>4</td>
<td>93</td>
<td>20</td>
<td>1311</td>
<td>0</td>
<td>2</td>
<td>2**</td>
<td>0</td>
<td>1**</td>
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</tr>
<tr>
<td>Na</td>
<td>2.1</td>
<td></td>
<td>3</td>
<td>68</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2**</td>
<td>0</td>
<td>1**</td>
<td></td>
</tr>
</tbody>
</table>

* PBMNC were used in each case, except where indicated by: lph = leukapheresis, spl = spleen. In patient By both samples were obtained simultaneously.

† The leukocyte count was routine clinical data.

‡ Assessed by phase microscopy at ×1,000 magnification.

§ Neuraminidase-treated sheep erythrocytes.

¶ Usually the aHC antibodies stained cells that were hairy cells by morphology; however occasionally they stained additional cells that had a less typical hairy appearance, as in patients He, Ma, and So.

** Each cell that stained positively also had the morphology of hairy cells.

†† All hairy cells seen stained with this reagent and the kappa-bearing cells were not hairy cells by morphology.
### TABLE III

**Lymphoid Leukemias and Lymphomas: Reactivity with αHC Antibodies**

<table>
<thead>
<tr>
<th>Patient</th>
<th>WBC $10^6$ cells/l$^*$</th>
<th>Lymphocytosis*</th>
<th>α-kappa</th>
<th>α-lambda &amp; α-lambda</th>
<th>αHC1</th>
<th>αHC2</th>
<th>αHC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>OL, CCL</td>
<td>220.0</td>
<td>94</td>
<td>79</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bi, CLL</td>
<td></td>
<td></td>
<td>97</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gr, CLL</td>
<td>73.0</td>
<td>92</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>To, CLL</td>
<td>26.0</td>
<td>69</td>
<td>1</td>
<td>94</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Se, CLL</td>
<td>207.0</td>
<td>94</td>
<td>93</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Me, CLL</td>
<td>43.5</td>
<td>97</td>
<td>30</td>
<td>51</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Si, CLL</td>
<td>39.0</td>
<td>89</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ro, CLL</td>
<td>64.0</td>
<td>87</td>
<td>86</td>
<td>0</td>
<td>0</td>
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</tr>
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<td>Cp, CLL</td>
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<td>95</td>
<td>68</td>
<td>0</td>
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<tr>
<td>Mi, B-Cell ALL</td>
<td>45.4</td>
<td>51§</td>
<td>79</td>
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<tr>
<td>Ri, Null-cell ALL</td>
<td>5.0</td>
<td>68§</td>
<td>3</td>
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<td>Cn, T cell ALL</td>
<td>45.2</td>
<td>97§</td>
<td>3</td>
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<tr>
<td>Ma, WDLL</td>
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<tr>
<td>Go, PDLL</td>
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<tr>
<td>Sv, PCL</td>
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<td>36</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

* Leukocyte count and percentage of lymphocytosis by peripheral smear were routine clinical data.

† All specimens were PBMNC. Abbreviations are: CLL, chronic lymphocytic leukemia; ALL, acute lymphoblastic leukemia; WDLL, well differentiated lymphocytic lymphoma; PDLL, poorly differentiated lymphocytic lymphoma; PCL, plasma cell leukemia.

§ Percentage of lymphoblasts.

### TABLE IV

**Myeloid Leukemias: Reactivity with αHC Antibodies**

<table>
<thead>
<tr>
<th>Patient</th>
<th>WBC $10^6$ cells/l$^*$</th>
<th>Myeloblasts*</th>
<th>Cells staining with</th>
<th>αHC1</th>
<th>αHC2</th>
<th>αHC3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Da, CGL</td>
<td>69.2</td>
<td>0</td>
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<td>0</td>
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<tr>
<td>Li, CGL</td>
<td>88.7</td>
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<tr>
<td>Mo, CGL</td>
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<td>0</td>
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<td>0</td>
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<tr>
<td>Gb, CGL</td>
<td>19.0</td>
<td>0</td>
<td></td>
<td>0</td>
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<td>4</td>
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<tr>
<td>Ch, CMOL</td>
<td>60.7</td>
<td>14</td>
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<td>0</td>
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<tr>
<td>Mk, CGLBC1, lph</td>
<td>90</td>
<td>0</td>
<td>50</td>
<td>67</td>
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<td>Vi, CGLBC</td>
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<td>99</td>
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<td>0</td>
<td>94</td>
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<td>Do, AML</td>
<td>9.8</td>
<td>60</td>
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<td>6</td>
<td>68</td>
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<td>Ke, AMML</td>
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<td>Se, AMML, bm</td>
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<td>Wi, AMML, lph</td>
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<td>As, monocytosis§</td>
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<td>0</td>
<td>14</td>
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</table>

* Lymphocyte count and percentage of myeloblasts on peripheral smear were routine clinical data.

† All specimens were PBMNC except for lph = leukapheresis and bm = bone marrow aspirate. Abbreviations are: CGL, chronic granulocytic leukemia; CMOL, chronic monocytic leukemia with 26% early monocytes; CGLBC, chronic granulocytic leukemia in blastic crisis; AML, acute myelogenous leukemia; AMML, acute myelomonoblastic leukemia.

§ Monocytosis of unclear etiology, 35% monocytes on a peripheral smear.

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**Monoclonal Hairy Cell Antibodies**

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with acute nonlymphocytic leukemia. In addition some positive cells were found in some lymphoblastoid B cell lines and among mitogen-activated B cells. The latter finding, which is the subject of a separate study, suggests that these antibodies detect B cell differentiation antigens that appear transitorily during B cell maturation between the lymphocyte and plasma cell stages. This also probably explains the positive cells observed in some normal peripheral blood specimens. Despite these findings these two monoclonal antibodies proved of value in the study of hairy cell leukemia. For example they clearly differentiated hairy cells from those of chronic lymphocytic leukemia.

The two antibodies αHC2 and αHC3 gave very similar results, but clear differences were noted in a few patients, especially those with myeloid precursor cells (for example patients Do and Wi, Table IV). The studies on the cells of patient Wi were repeated four times and in each experiment only αHC3 gave positive results.

Others have described antibodies reacting with hairy cells. Espinouse et al. (27) describe a rabbit antiserum retaining specificity for hairy cells after absorptions with erythrocytes, T cells, monoblastic leukaemic cells, and CLL B cells. Brooks et al. (28, 29) describe a monoclonal murine antibody (FMC-7) made by immunization with a common B cell lymphoblastoid line that reacts with a subset of normal B cells, with B cells from ~16% of various chronic lymphocytic leukemia patients, and B cells from most prolymphocytic and hairy cell leukemias tested. Neither of these antibodies appear to be identical to the three monoclonal antibodies described in this paper.

The most specific monoclonal antibody of the three described in this paper, αHC1, could not be shown to definitely react with any cells in the normal tissues examined. Thus by this criterion no normal cell equivalent of the hairy cell could be detected, which was one of the objectives of this investigation. However, it may be that the αHC1 antibodies are directed against a specific tumor antigen common to different hairy cell leukemias and would not react with the analogous hypothetical normal cell. If this is indeed the case, this monoclonal antibody is of added interest because of the rarity of human tumor specific antigens. The potential use of this antibody in the therapy of hairy cell leukemia, possibly covalently linked to cytotoxic compounds, deserves consideration. At the moment the most obvious use of these monoclonal antibodies is for diagnostic purposes.

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REFERENCES


