Ann Hematol (2004) 83: 716–721
DOI 10.1007/s00277-004-0913-4

CASE REPORT

A. A. N. Giagounidis · M. Heinsch · S. Haase · C. Aul

Early plasmacytoid dendritic cell leukemia/lymphoma coexpressing myeloid antigenes

Received: 28 September 2003 / Accepted: 3 November 2003 / Published online: 5 August 2004

Abstract Early plasmacytoid dendritic cell (pDC) leukemia/lymphoma has recently been described as a $CD4^+CD56^+$ lineage negative malignancy with characteristic clinical, morphologic, immunophenotypic, and biological features. We present a case of a 72-year-old man who was diagnosed with isolated skin involvement 30 months ago and received numerous chemotherapy cycles that did not prevent three relapses of the disease, the last two involving the bone marrow. The bone marrow was nearly completely infiltrated with small- to medium-sized blasts displaying a high nuclear to cytoplasmic ratio, a cytoplasm with faint basophilia lacking granulations or Auer rods. Small vacuoles surrounding the nucleus were frequently observed. Flow cytometry showed $CD4^+$, $CD56^+$, $CD45^+$, $CD38^+$, HLA-DR^+, $CD33^+$, $CD123^+$, $CD2^-$, cyCD3^-, $CD7^-$, $CD10^-$, CD$11b^-$, $CD13^-$, $CD14^-$, $CD16^-$, $CD19^-$, cyCD22^-, $CD24^-$, $CD34^-$, $CD57^-$, $CD61^-$, $CD64^-$, $CD65^-$, cyCD$79a^-$, $CD117^-$, MPO^-, and TdT^- population. At the second bone marrow relapse, CD117 was also positive. Our patient was initially treated with acute myeloid leukemia-type chemotherapy, later he was given acute lymphoblastic leukemia-type treatment, and at the last relapse he received CHOP chemotherapy. Each treatment led to rapid response of tumor manifestations with disease-free intervals of 7 months, 9 months, and 8 months, respectively. Although patients usually have an ominous prognosis, with only 25% living more than 24 months, our patient is alive after 30+ months and has again achieved complete remission after the last chemotherapy.

Keywords Blastic NK cell leukemia/lymphoma · $CD4^+CD56^+$ leukemia · CD33 · Plasmacytoid dendritic cell leukemia/lymphoma

A. A. N. Giagounidis (✉) · M. Heinsch · S. Haase · C. Aul
St Johannes Hospital, Medizinische Klinik II,
An der Abtei 7-11,
47166 Duisburg, Germany
e-mail: gia@krebs-duisburg.de
Tel.: +49-203-5462479
Fax: +49-203-5462249

Introduction

$CD4^+CD56^+$ hematopoietic tumors are rare neoplasms that have recently been classified within the WHO classification of tumors [1] as blastic NK cell lymphoma. These malignancies have a tendency to infiltrate the skin, but lymph node, soft tissue, peripheral blood, and bone marrow involvement have been reported to occur regularly. The disease follows an aggressive course and responds only briefly to aggressive type polychemotherapy [2]. Morphologically, the cells may resemble lymphoblasts or myeloblasts and may display an irregular nuclear outline, inconspicuous nucleoli, and small or large cytoplasmic vacuoles. Immunophenotypic diagnosis is primarily based on the coexpression of CD4 and CD56. To prevent confusion with both myeloblastic and precursor T-lymphoblastic leukemia/lymphoma which may also express CD56, the diagnosis of blastic NK cell lymphoma should be made after exclusion of coexpression of CD3, myeloperoxidase, and CD33. Additionally, T-cell receptor (TCR) gene rearrangement should be absent. Specific chromosomal aberrations have not been observed, but cases with normal as well as complex karyotype have been reported to date [2]. The Groupe d'Etude Immunologique des Leucémies (GEIL) has recently suggested classifying the subgroup of $CD4^+CD56^+$ malignancies with negativity for both myeloid and lymphatic antigenes, as early plasmacytoid dendritic cell (pDC) leukemia/lymphoma [3]. We present a case of $CD4^+CD56^+$ acute leukemia that coexpressed CD33 and CD117, showed the typical clinical course of pDC cell lymphoma/leukemia, and had a normal karyotype.

Case report

The 72-year-old Caucasian male was first admitted in August 2001 with a 4-month history of livid dermal infiltrates that were accentuated on physical exercise. Because of their itchy nature he consulted a dermatologist. There were no fever, weight loss, or night sweats. Skin

biopsy was done and the diagnosis of acute myeloid leukemia (AML) with primary extramedullary involvement (leukemia cutis) made. Apart from mild hypertension, previous medical history was noncontributory. The patient was on metoprolol and lacidipin p.o. On physical examination he displayed livid skin plaques that covered part of his face, trunk, upper arms, and upper legs (Figs. 1 and 2). Maximum diameter was 5 cm. There was no sign of lymph node involvement or hepatosplenomegaly. Peripheral blood values showed leukocytes of 6,500 μl^{-1}, hemoglobin of 14.6 g/dl, and thrombocytes of 275,000 μl^{-1}. The differential count was 3% band forms, 62% polymorphonuclear forms, 25% lymphocytes, 8% monocytes, and 2% eosinophils. Bone marrow involvement was excluded by cytology and histology. Bone marrow cytogenetics showed 46, XY. An additional skin biopsy was performed. This revealed a population of medium-sized blasts with scanty cytoplasm negative for periodic-acid Schiff staining. Immunohistochemistry was positive for CD56, and weakly positive for Ki67 and CD4, while CD5, CD8, MPO, CD20, CD30, and CD34 were negative. Further investigation showed an oligoclonal rearrangement of the T-cell receptor γ and negativity for CD3, CD7, and CD2. This led ultimately to the differential diagnosis of extramedullary, CD56-positive AML and blastic NK cell lymphoma. The patient was treated with AML-like chemotherapy and he went into complete remission (CR). A second course with high-dose cytarabine and mitoxantrone was given. Further chemotherapy was delayed due to pulmonary aspergillosis. First relapse occurred in March 2002, and skin biopsies again showed $CD4^+CD56^+$ tumor cells negative for CD20, CD21, and CD35. Idarubicin and cytarabine chemotherapy was given, and the patient went again into CR for 9 months. A second relapse was noted in December 2002. At this time, bone marrow infiltration was noted. Cytology and histology showed a dense infiltration of the bone marrow by small- to medium-sized tumor cells. Nuclear to cytoplasmic ratio was high and nuclear chromatin was homogeneous, displaying small, inconspicuous nucleoli. Neither Auer rods nor granula were noted (see Fig. 3). Myeloperoxidase and esterase staining were negative, while some cells showed a granular staining pattern of the cytoplasm with periodic acid-Schiff reagent.

Immunophenotyping revealed a $CD4^+CD56^+$ malignant cell population that also stained positive for CD45, CD33, CD36, CD68, HLA-DR, monoclonal antibody 7.1, and CD38 (see Table 1). Those negative were CD2, CD3, cyCD3, CD7, CD8, TCR-α/β, TCR-γ/δ, CD16, CD57, CD10, CD19, cyCD22, CD24, cyCD79a, surface immunoglobulins, CD11b, TdT, CD71, CD34, CD117, CD 13, CD14, CD15, CD64, CD65, CD61, and MPO. Cytogenetics showed a normal karyotype. At fluorescence in situ hybridization, 11q23 rearrangement was not detected. Peripheral blood differential count showed 1% myelocytes, 1% metamyelocytes, 7% band forms, 29% polymorphonuclear cells, 58% lymphocytes, 2% monocytes, and 2% eosinophils. Leukocytes were 2,700 μl^{-1}, hemoglobin 14.3 g/dl, and thrombocytes 53,000 μl^{-1}. Of note, the skin biopsies were positive for CD4, CD56, and CD123, but negative for CD8, CD3, CD20, CD34, CD68, TdT, MPO, and lysozyme.

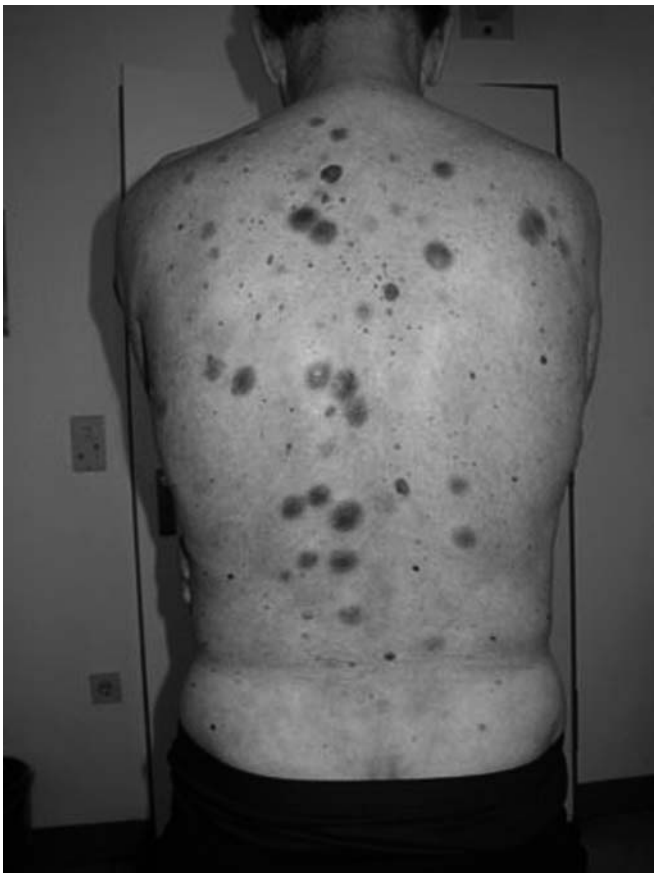

Fig. 1 Dermal infiltrates at first diagnosis

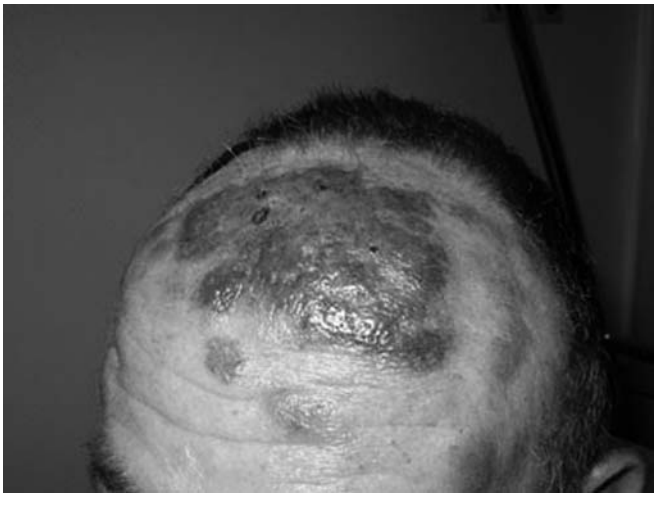

Fig. 2 Skin involvement at second relapse

The patient was treated with three courses of aggressive polychemotherapy according to a Burkitt-lymphoma protocol (methotrexate, cyclophosphamide, vincristine, adriamycin, and dexamethasone alternating with methotrexate, ifosfamide, vincristine, teniposide, dexamethasone, and ara-C) and went into CR again. He relapsed for the third

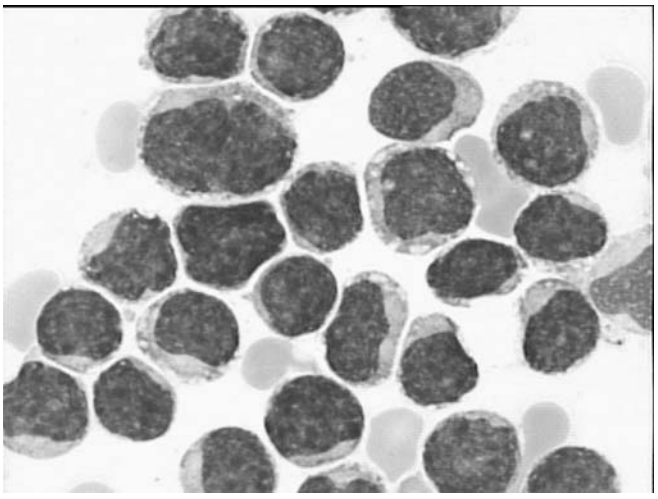

Fig. 3 Bone marrow cytology at time of first bone marrow involvement. Dense infiltrates of small- to medium-sized agranular blasts, sometimes displaying microvacuolation

time in September 2003. There was skin and bone marrow involvement. Peripheral blood values were nearly normal at this time (leukocytes 6,500 μl^{-1}, hemoglobin 14.3 g/dl, thrombocytes 64,000 μl^{-1}). Morphologic and immunophenotypic results were comparable to the time of first bone marrow involvement. The malignant cell phenotype was again $CD4^+CD56^+CD38^+CD33^+HLA\text{-}DR^+$. However, at that time, CD117 was also positive, while other lineage markers were lacking. The patient is currently being treated with CHOP chemotherapy. After the first course, the skin infiltrates have nearly completely disappeared.

Discussion

$CD4^+CD56^+$ hematologic malignancies have been variably classified in the past as histiocytic-associated hematologic malignancy [4], cutaneous agranular $CD4^+CD56^+$ lymphoma [5], agranular $CD4^+CD56^+$ hematodermic malignancy [6], NK lymphoma [7], myelomonocytic precursor cell–related lymphoma [8], myeloid/NK cell precursor acute leukemia [2], and blastic NK cell leukemia/lymphoma [9]. The current WHO classification refers to blastic NK cell lymphomas as malignancies expressing CD4, CD56, CD2, and CD45. Further characteristics are shown in Table 1.

A new entity of $CD4^+CD56^+$ hematologic neoplasms

In a landmark paper, Chaperot et al. were able to show that a subset of $CD4^+CD56^+$ positive cells being negative for CD3, CD13, CD33, and CD19 were derived from early pDCs [3]. In a series of 23 patients with the above-mentioned characteristics, the same group showed recently that this cell subset displayed the characteristic markers of pDC, i.e., $HLA\text{-}DR^+$, $CD123^{high}$, $CD116^{low}$, $CD45RA^+$,

Table 1 Comparison of different NK-cell neoplasms, pDC lymphoma/leukemia, and the current case. *mb* Membrane; *cy* cytoplasm; + or − refers to positive or negative, depending on the context

Specific marker	Blastic NK cell leukemia/ lymphoma [1, 12]	Myeloid/NK cell precursor leukemia/ lymphoma [2]	Early plasmacytoid dendritic cell leukemia/ lymphoma [10, 11]	Current case
T/NK markers				
CD2	+ or −	+ or −	+ or −	−
CD3	−	−	−	−
cyCD3	−	+ or −	−	−
CD5	−	−	−	−
CD7	+ or −	+	+ or −	−
CD4	+	+	+	+
CD8	−	−	−	−
CD56	+	+	+	+
CD16	−	−	−	
CD57	−	−	−	−
CD94				
TIA1			+ or −	−
Myeloid				
CD13	−	+ or −	−	−
CD33	−	+	−	+
CD11c	−	+ or −	−	−
MPO	−	+ or −	−	−
CD14	−	−	−	−
CD64			−	−
CD36			+	+
CD68	−		+	+
B lymphocytes				
CD19	−	−	−	−
CD20	−	−	−	−
CD22	−	−	−	−
CD79a			−	−
mb or cy Ig			−	−
pDC				
HLA−DR	+ or −	+ or −	+	+
CD45			+	+
CD123			+	+
Others				
CD11b				−
CD117	−	+ or −		− (at relapse: +)
CD15	−	−		−
CD64				−
CD61				−
TCR gene rearrangement	−	−	−	−
CD34	−	+	−	−
TDT	−	−	−	−

CD45RO$^-$, BDCA-2$^+$, and BDCA-4$^+$ [10]. Apart from CD36 and CD68, which were frequently expressed, and CD2 and CD7 that were variably expressed, they were negative for all conventional markers of the B or myeloid lineage, i.e., CD20, CD22, CD79a, surface and cytoplasmic immunoglobulins, CD11c, CD65, CD117, MPO, CD14, and CD64. TCR genes were always in germline configuration. The progenitor antigene CD34 was always negative; TdT was negative in all but one patient [11].

CD56 may be expressed on subsets of normal plasmacytoid dendritic cells

Some criticism has arisen about the CD56-positivity in this setting, as CD56 is supposed to be a salient feature of blastic NK-cell lymphomas and was shown to be expressed very early on in committed NK precursor cells [12]. However, after studying seven cases of CD4$^+$CD56$^+$ neoplasms failing to display other T-myelomonocytic, B-myelomonocytic, or NK-cell markers [13], Petrella et al. provided evidence in a consecutive paper that CD56 is actually expressed on a subset of normal pDCs [14]. These results have further been corroborated by immunophenotypic studies of specific pDC markers and in vitro investigations showing interferon α production of these cells as a reaction to influenza virus incubation and their ability to activate naive cord blood lymphocytes after IL-3 and CD40L stimulation [11].

Coexpression of myeloid markers

Our case is unusual because of its expression of two myeloid markers (CD33 and CD117) on the blast cells. A number of reports have emerged in the medical literature where cases with slight differences to the classical immunophenotype of pDC expressions but identical clinical, cytologic, and histologic features have been described. In most cases additional expression of CD33 was noted [15, 16], but TCR rearrangement [17], cyCD3 positivity [18], or TIA-1 positivity [19] have also been noted. As for CD33, this marker does not exclude the diagnosis of pDC malignancy. CD33 may be faintly expressed on normal peripheral blood pDCs, and one case of CD4$^+$CD56$^+$CD33$^+$CD13$^-$ neoplasm could definitely be classified as arising from pDCs [11]. The presence of cyCD3$^+$ is frequently shown when using the anti-CD3-antibodies, while the monoclonal antibody Leu-4 remains mostly negative. CD117 is unusual in pDC lymphoma/leukemia, but recently, Anargyrou et al. presented a case with coexpression of CD33 and CD117 [20]. In our case, the differential diagnosis of acute monoblastic leukemia (FAB M5) arises because of expression of CD68, CD4, CD36, CD123, HLA-DR, and the monoclonal antibody 7.1. Coexpression of CD4 and CD56 has been reported in acute monoblastic leukemia [21]. However, the malignant cells at cytology did not resemble FAB M5 blasts. Also, they were negative in the esterase staining. Moreover, there was negativity for CD11b, CD14, and CD64 in flow cytometry. Finally, the pattern of the blast cluster in the CD45/side scatter did not resemble the typical cluster of monocytic leukemia. Clinical and morphologic characteristics of the present case were similar to those detailed in patients with early pDC malignancies [10] or related immunophenotypes [11]. Most patients reported on were elderly men with a male to female ratio of 3:1. As in most cases, the disease presented with isolated cutaneous lesions and dissemination at a later stage. However, the long delay of 20 months until disease generalization in our case study is uncommon, but may be explained by the early onset of aggressive chemotherapy in this patient. At any time, even at diagnosis of bone marrow involvement, our patient felt well and experienced no major tumor-associated symptoms, especially no fever, night sweats, or weight loss. At the time of first bone marrow involvement, mild leukopenia and moderate thrombocytopenia developed. At the second time, peripheral blood values remained normal. Although the monoclonal antibody 7.1 was highly expressed (83%) at flow cytometry at the time of bone marrow involvement, we were not able to detect 11q23 deletion. A striking characteristic of the disease seems to be the good initial chemosensitivity with repetitive remission induction (sometimes 3 or 4 times) but a tendency to relapse and regular dissemination of the disease [11]. In accordance to the report of Feuillard et al. [10] who reported a median disease-free survival of 9 months (range, 3–18 months), our patient experienced relapse after 7, 9, and 8 months after each therapy. Only three patients in the medical literature have been reported as long-term survivors after conventional chemotherapy [22–24], two of them had isolated cutaneous nodules for 15 and 2 years.

Morphology, flow cytometry, and differential diagnosis

A high-power view of the bone marrow infiltration at the first time of bone marrow involvement is presented in Fig. 3. In accordance to the description of Feuillard et al. [10], the blasts were devoid of granulations but sometimes exhibited a microvacuolation in a “pearl necklace” way at the cytoplasmic outline. This appearance was still present at second bone marrow involvement in September 2003, but the blasts at that time were more homogenous, the nuclear to cytoplasmic ratio was higher, and nuclear chromatin more condensed. Microvacuolation and lack of granulation were still present.

Table 1 compares the immunophenotypic characteristics of the so-called blastic NK cell leukemia/lymphoma, myeloid/NK cell precursor leukemia/lymphoma, early pDC leukemia/lymphoma, and our case. The difference between myeloid/NK cell leukemia and lymphoma and pDC leukemia/lymphoma is that in the former CD7 was always reported and at least the myeloid marker CD33, but in many cases also CD13, MPO, or CD11c were expressed. Also, CD34 was positive. The myeloid markers

in pDC leukemia/lymphoma are usually negative while CD7 positivity may frequently be observed. CD34 is negative. Blastic NK cell lymphoma as defined in the WHO classification never shows myeloid markers and may also have CD2 and CD7 negativity. Table 1 demonstrates that early pDC leukemia/lymphoma is a new entity that will cover many cases that have previously been diagnosed as myeloid/NK cell precursor leukemia/lymphoma or blastic NK cell leukemia/lymphoma, including the case of Anargyrou et al. [20] and ours. The cornerstone of diagnosis will be the identification of typical pDC phenotype, i.e., positivity for CD123, CD45RA, BDCA2, or BDCA4, with negativity for CD45RO.

Diagnostic work-up

The diagnostic work-up of pDC leukemia/lymphoma involves careful appreciation of patient history, physical signs and symptoms, histopathology of the skin as well as peripheral blood and bone marrow cytology, pathology, and flow cytometry. Most patients initially show isolated livid dermal lesions. If these lesions can be attributed to an infiltration by malignant cells, and lineage specificity cannot unequivocally be determined, CD4 expression and CD56 expression must be investigated for. In case of coexpression of these markers, specific markers of pDC leukemia/lymphoma should be examined. In more advanced disease, there will be involvement of blood and bone marrow, and possibly cerebrospinal fluid. Microscopic identification of medium-sized lymphoid cells with scanty, microvacuolated cytoplasm, irregular nuclear outline, and negativity in cytochemical reactions must be followed by flow cytometric analysis of the above-mentioned antigenes. Failure to clearly identify lineage specificity in flow cytometry again should lead to analysis of CD4 and CD56, and possibly more specific markers of pDC.

To conclude, we present a case with the clinical, morphologic, and immunophenotypic characteristics of early pDC leukemia/lymphoma coexpressing CD33 and CD117 with a surprisingly long-term overall survival of 30 + months since first diagnosis. Even after the third relapse, this patient shows good clinical response to chemotherapy.

References

1. Jaffe ES, Harris NL, Stein H, Vardiman JW (2001) Tumours of haematopoietic and lymphoid tissues. IARC, Lyon
2. Suzuki R, Nakamura S (1999) Malignancies of natural killer (NK) cell precursor: myeloid/NK cell precursor acute leukemia and blastic NK cell lymphoma/leukemia. Leuk Res 23:615–624
3. Chaperot L, Bendriss N, Manches O, Gressin R, Maynadie M, Trimoreau F, Orfeuvre H, Corront B, Feuillard J, Sotto J-J, Bensa J-C, Brière F, Plumas J, Jacob M-C (2001) Identification of a leukemic counterpart of the plasmacytoid dendritic cells. Blood 97:3210–3217
4. Gattei V, Carbone A, Zagonel V, Pinto A (1990) Expression of natural killer antigens in a subset of "non-T non-B" lymphoma/leukemia with histiocytic features. Br J Haematol 76:443–446
5. Kameoka J, Ichinohasama R, Tanaka M, Miura I, Tomiya Y, Takahashi S et al (1998) A cutaneous agranular CD2-CD4+CD56+ "lymphoma": report of two cases and review of the literature. Am J Clin Pathol 110:478–488
6. Kato N, Yasukawa K, Kimura K, Sugawara H, Aoyagi S, Mishina T et al (2001) CD2-CD4+CD56+ hematodermic/hematolymphoid malignancy. J Am Acad Dermatol 44:231–238
7. Drénou B, Lamy T, Amiot L, Fardel O, Caulet-Maugendre S, Sassportes M et al (1997) CD3-CD56+ non-Hodgkin's lymphomas with an aggressive behaviour related to multidrug resistance. Blood 89:2966–2974
8. Bagot M, Bouloc A, Charue D, Wechsler J, Bensussan A, Boumsell L (1998) Do primary cutaneous CD4+CD56+ lymphomas belong to the myelo-monocytic lineage? J Invest Dermatol 111:1242–1243
9. DiGiuseppe J, Louie D, Williams J, Miller D, Grifin C, Mann R et al (1997) Blastic natural killer cell leukemia/lymphoma: a clinicopathologic study. Am J Surg Pathol 21:1223–1230
10. Feuillard J, Jacob M-C, Valensi F, Maynadié M, Gressin R, Chaperot L, Arnoulet C, Brignole-Baudouin F, Drénou B, Duchayne E, Falkenrodt A, Garand R, Homolle E, Husson B, Kuhlein E, Le Calvez G, Sainty D, Sotto M-F, Trimoreau F, Béné M-C (2002) Clinical and biologic features of CD4+CD56+ malignancies. Blood 99:1556–1563
11. Jacob M-C, Chaperot L, Mossuz P, Feuillard J, Valensi F, Leroux D, Béné M-C, Bensa JC, Brière F, Plumas J (2003) CD4+CD56+ lineage negative malignancies: a new entity developed from malignant early plasmacytoid dendritic cells. Haematologica 88:941–955
12. Shapiro M, Wasik MA, Junkins-Hopkins JM, Rook AH, Vittorio CC, Itakura H, Frankel MC, Georgala S, Schuster SJ (2003) Complete remission in advanced blastic NK-cell lymphoma/leukemia in elderly patients using the hyper-CVAD regimen. Am J Hematol 74:46–51
13. Petrella T, Dalac S, Maynandié M, Mugneret F, Thomine E, Courville P, Joly P, Lenormand B, Arnould L, Wechsler J, Bagot M, Rieux C, Bosq J, Avril M-F, Bernheim A, Molina T, Devidas A, Delfau-Larue M-H, Gaulard P, Lambert D (1999) CD4+CD56+ cutaneous neoplasms: a distinct hematological entity? Am J Surg Pathol 23:137–146
14. Petrella T, Comeau M, Maynadié M, Couillaut G, De Muret A, Maliszewski C et al (2002) Agranular CD4+CD56+hematodermic neoplasm (blastic NK cell lymphoma) originates from a population of CD56+ precursor cells related to plasmacytoid monocytes. Am J Surg Pathol 26:852–862
15. Touhari T, Belouani H, Mossafa H, Pulik M, Bourguigna L, Ibbora D et al (2002) Agranular CD4+/CD56+ cutaneous neoplasm. Leuk Lymphoma 43:1475–1479
16. Ginarte M, Abalde M, Peteiro C, Fraga M, Alonso N, Toribio J (2000) Blastoid NK cell leukemia/lymphoma with cutaneous involvement. Dermatology 201:268–271
17. Aoyama Y, Yamane T, Hino M, Ohta K, Nakamae H, Yamamura R, Koh K-R, Takubo T, Inoue T, Tatsumi Y, Tatsumi N (2001) Blastic NK-cell lmphoma/leukemia with T-cell receptor γ rearrangement. Ann Hematol 80:752–754
18. Shinoda K, Muraki T, Yano M, Yamada T, Takao A (2000) Infant leukemia suggestive of natural killer cell precursor origin followed an unusual clinical course. Acta Haematologica 104:202–206
19. Kojima H, Mukai H, Shinagawa A, Yoshida C, Kamoshita M, Komeno T et al (2000) Clinicopathological analyses of 5 Japanese patients with CD56+primary cutaneous lymphomas. Int J Hematol 72:477

20. Anargyrou K, Paterakis G, Boutsis D, Politou M, Papadhimitriou SI, Siakandaris M, Vassiliadis J, Androulakis A, Meletis J, Rombos J, Tassiopoulou A, Vaiopoulos G (2003) An unusual case of CD4+CD7+CD56+ acute leukemia with overlapping features of type 2 dendritic cell (DC2) and myeloid/NK cell precursor acute leukemia. Eur J Hematol 71:294–298
21. Tauchi T, Ohyashiki K, Ohyashiki JH, Kawanishi Y, Kimura Y, Saito M, Nakazawa S, Kawai Y, Toyama K (1990) CD4+ and CD56+ acute monoblastic leukemia. Am J Hematol 34:228–229
22 Falcao R, Garcia A, Marques MG, Simoes B, Fonseca B, Rodriques M et al (2002) Blastic NK cell leukemia/lymphoma: a report of seven cases. Am J Clin Pathol 117:41–50
23. Brody JP, Allen S, Schulman P, Sun T, Chan WC, Friedman HD, Teichberg S, Koduru P, Cone RW, Loughran TP (1995) Acute agranular CD4-positive natural killer cell leukemia. Cancer 75:2474–2483
24. Dummer R, Potoczna N, Haffner A, Zimmermann D, Gilardi S, Burg G (1996) A primary cutaneous non-T, non-B CD4+CD56+ lymphoma. Arch Dermatol 132:550–553