BCA-1, a B-cell chemoattractant signal, is constantly expressed in cutaneous lymphoproliferative B-cell disorders

M. Mori\textsuperscript{a}, C. Manuelli\textsuperscript{a}, N. Pimpinelli\textsuperscript{a,*, B. Bianchi\textsuperscript{a}}, C. Orlando\textsuperscript{b}, C. Mavilia\textsuperscript{c}, P. Cappugi\textsuperscript{a}, E. Maggi\textsuperscript{c}, B. Giannotti\textsuperscript{a}, M. Santucci\textsuperscript{d}

\textsuperscript{a}Departments of Dermatological Sciences, University of Florence Medical School, Via degli Alfani, 37, 50121 Firenze, Italy
\textsuperscript{b}Clinical Pathophysiology—Clinical Biochemistry Unit, University of Florence Medical School, Via degli Alfani, 37, 50121 Firenze, Italy
\textsuperscript{c}Internal Medicine—Section Immunodermatology, University of Florence Medical School, Via degli Alfani, 37, 50121 Firenze, Italy
\textsuperscript{d}Human Pathology and Oncology, University of Florence Medical School, Via degli Alfani, 37, 50121 Firenze, Italy

Received 13 August 2002; received in revised form 11 February 2003; accepted 11 April 2003

Abstract

We analysed the immunophenotypic and molecular expression of BCA-1 (B-cell-specific chemokine) and CXCR5 (BCA-1 receptor) in normal skin and different cutaneous lymphoproliferative disorders (cutaneous T-cell lymphoma (CTCL); cutaneous B-cell lymphoma (CBCL); cutaneous B-cell pseudolymphoma (PCBCL)), with the aim of investigating their possible involvement in the pathogenesis of cutaneous B-cell disorders. BCA-1 and CXCR5 were constantly expressed in CBCL and PCBCL, but not in normal skin and CTCL. BCA-1 and CXCR5 were constantly coexpressed by CD22\textsuperscript{+} B-cells, while CD35\textsuperscript{+} follicular dendritic cells coexpressed BCA-1 in PCBCL cells only. In low grade CBCL, as compared with high grade CBCL, the intensity of CXCR5 expression on neoplastic CD22\textsuperscript{+} cells was lower than that of BCA-1. The image analysis of reverse transcriptase-polymerase chain reaction (RT-PCR) products showed a significant quantitative difference between PCBCL/low grade CBCL and high grade CBCL. The above findings, although only observed in a small series of patients, are in keeping with findings in MALT gastric and gastric MALT lymphomas, adding further evidence of the close similarities between CBCL and MALT lymphomas.

Key words: Skin, Lymphoma, Pseudolymphoma, B-cell, Chemokine

1. Introduction

Recent progress in chemokine (chemoattractant cytokine) research has greatly advanced the understanding of the migration properties of lymphoid cells. Two functionally distinct subfamilies of chemokines, referred as “inflammatory” and “housekeeping” chemokines, have recently been recognised [1–4]. While the former are produced by activated tissue cells and leucocytes at sites of inflammation, the latter regulate the localisation of lymphoid cells during lymphopoiesis, antigen-priming and immune surveillance [1–4]. B-cells show a high capacity to recirculate between blood, lymphoid and extralymphoid compartments [5–7]. By contrast to T-cells, migration responses of B-cells to chemokines are not well characterised, although data from the current literature indicate that both housekeeping and inflammatory chemokines act on B-cells [8–10]. The recently discovered chemokine, BCA-1 (also regarded as CXCL13), is the most effective B-cell chemoattractant [11–12]. It selectively binds to CXCR5, a chemokine receptor with predominant expression on blood and tonsillar B-cells, as well as on a subset of memory CD4\textsuperscript{+} T-cells [13].

It has recently been demonstrated that both BCA-1 and CXCR5 are highly expressed in Helicobacter pylori (Hp)-induced Mucosa-Associated Lymphoid Tissue (MALT) lymphoma, showing a distinctive pattern of expression [14]. This findings suggest a possible pathogenic role for BCA-1 in the natural history of MALT lymphoma. No information is currently available concerning the expression of BCA-1 and CXCR5 in cutaneous lymphoproliferative disorders. The clinico-pathological features of primary cutaneous B-cell lymphomas (CBCL) are extensively dealt with elsewhere in Refs. [15–18]. In short, CBCL are mostly characterised by a
homogeneous clinical presentation and behaviour, with a good response to local radiotherapy, low tendency to extracutaneous spread and excellent prognosis. According to the European Organization for Research and Treatment of Cancer (EORTC) classification of primary cutaneous lymphomas [19], CBCL are divided into three subgroups. So-called follicular centre cell (FCC) lymphoma and immunocytoma (IC)/marginal zone lymphoma (MZL), due to putative histological similarities with their purported nodal counterparts, and they have an indolent clinical behaviour. These entities, FCC and IC/MZL, are regarded as follicular lymphoma and extranodal MZL (MALT-type lymphoma), respectively, in the World Health Organization (WHO) classification of lymphoid neoplasms [20]. The different morphologies are often found in different lesions of the same patient or even in different areas of the same lesion and this hampers their strict categorisation into specific subgroups, such as FCC lymphoma and IC/MZL. An alternative possibility of a unitary interpretation of low grade CBCL has been suggested. In fact, we have documented that the histological pattern in CBCL is largely related to the age and growth rates of the skin lesions [15–18], with a characteristic multiphasic progression of the histological/immunohistological pattern from “early” (patchy/nodular infiltrate, with distinct compartmentalisation of neoplastic, small-medium centrocyte-like B-cells and reactive T-cells, that are often prominent) to “late” phases (diffuse infiltrate of neoplastic, large transformed centrocyte-like B-cells, with few admixed reactive T-cells). These multiphasic histological features have no correlation with either the clinical course or the prognosis of the disease. Moreover, most CBCL—despite variable morphological features—show a rather uniform immunophenotype (CD5-, CD10-) and genotype (lack of bcl-1/bcl-2 and c-myc gene rearrangements) of the neoplastic cells. The close similarities between primary CBCL and MALT lymphomas and the evidence for an acquired B-cell arm of Skin-Associated Lymphoid Tissue (SALT) [21] led us to tentatively designate these CBCL as SALT-related B-cell lymphomas [16,18]. Recently, however, more refined definitions of FCC lymphoma [22] and MZL [23] have been suggested, as the prerequisite for a better clinicopathological differential diagnosis. Subtle classification problems apart, in this paper we will refer to CBCL with de novo large round cell histology as “high grade CBCL”.

By the combined use of different methods, including immunohistochemistry, 2-colour immunofluorescence, and molecular analysis (reverse transcriptase-polymerase chain reaction (RT-PCR) and in situ hybridisation), we have analysed the phenotypic and genotypic expression of BCA-1 and CXCR5 in normal skin and different cutaneous lymphoproliferative disorders—CBCL, cutaneous B-cell pseudolymphoma (PCBCL, defined as reactive, polyclonal lymphoid hyperplasia with a prominent B-cell component), and cutaneous T-cell lymphoma (CTCL), in order to investigate the possible involvement of these molecules in the pathogenesis of B-cell disorders of the skin. In addition, we examined the relevance of their possible differential expression in the different subcategories (PCBCL versus low grade CBCL versus high grade CBCL).

2. Materials and methods

2.1. Patients and skin samples

The 17 lesional skin samples, consisting of 6-mm punch biopsies, were obtained under local anaesthesia from: 3 patients with PCBCL (insect bite-related); 10 patients with CBCL (7 low grade, classified as MZL according to the EORTC and extranodal MZL according to the WHO classification; 3 high grade, DLCL, two of which were located on the legs and one on the back), and 4 patients with CTCL (Mycosis Fungoides). Control, healthy skin samples were also obtained from 5 patients who underwent cosmetic surgery.

Each tissue specimen was in part formalin-fixed and paraplast-embedded for routine histological examination; in part embedded in O.T.C. (“Tissue Tek”, Miles Scientific, Naperville, IL), snap frozen and stored at −80 °C until sectioning for use in immunohistochemistry (IHC); 2-colour immunofluorescence; (2c-IF), and in situ hybridisation (ISH); and in part prepared for molecular analysis (Reverse Transcriptase-Polymerase Chain Reaction, RT-PCR). The specimens were put in a
2.1. RNA extraction and RT-PCR

Total RNA was extracted from the skin biopsies. Frozen tissues were ground to a powder with a pestle and mortar in liquid nitrogen before being added to a RNAwiz (Ambion, Austin, TX) for homogenisation. All samples used in these experiments clearly showed 18S and 28S bands in a 0.8% agarose gel, indicating the integrity of RNA. Following extraction, 1 μg of total RNA was reverse-transcribed using M-MLV reverse transcriptase (GIBCO-BRL, Gaithersberg, MD) according to the manufacturer’s instructions. All cDNAs were amplified with primers for β-actin [27]: sense 5'-CCT CGC TTG TGC CGA TCC; antisense 3'-GGG TCT TCA TGA GGT AGT CAG TC to test the quality of cDNAs. PCR products were electrophoresed in an agarose gel and measured by image analysis. Different amounts of cDNA for each sample (corresponding to the same amount of β-actin) were co-amplified with primers for β-actin (626 bp) and for BCA-1 (368 bp) and CXCR5 (318 bp) in the same reaction and distinguished using gel electrophoresis by the differences in the product length. PCR amplification were performed using the primers for BCA-1: sense 5'-GGG CTG CTT TGA TCC; antisense 3'-GGG CTG GAG TAC TCC; primers for CXCR5: sense 5'-ACG CTG GAA ATG GAC CTC GAG AAC CTG GAG; antisense 3'-AGA AGT AGA ACG GGA AAC ACC GG. Primers for CXCR5 were selected using the Oligo Primer Analysis Software Version 5.0 (National Bioscience, Inc. Plymouth, MN, USA). All other primers were purchased from MWG Biotech AG (Ebersberg, Germany). In all PCR reactions, a positive control and 2 negative controls (one omitting the reverse transcription without the RT enzyme, another without cDNA as a template to exclude contamination) were included. We used human genomic DNA as a template in the PCR amplification to confirm that the product was not due to pseudogene sequences. Each sample was subjected to 25 cycles of amplification using 10 pM of each primer with 0.25 units of Taq enzyme. The cycling conditions were 94 °C for 30 s (denaturation), 64 °C for 30 s (annealing) and 72 °C for 40 s (elongation). Before the first cycle, samples were denatured at 94 °C for 2 min and, after the last cycle, samples were subjected to a final elongation step of 72 °C for 2 min. PCR products were electrophoresed on a 2% agarose gel and visualised by ethidium bromide staining. The size of the amplified products was evaluated by comparison with molecular weight markers run in parallel lanes.

2.5. Image analysis of PCR products

The intensity of the bands obtained by PCR amplification were measured by a CCD video camera C3077/01 Hamamatsu Photonics (Japan) connected with the video frame grabber M4476 (Hamamatsu Photonics Japan), in a computer Macintosh IIsi (Apple, USA). Acquisition of the image was obtained with Imagequest software.
IQBase software by Hamamatsu Photonics (Japan). Image processing and analysis was performed with the free software IMAGE by Wayne Rasband, National Institutes of Health Research Services Branch NIMH, version 1.28.

2.6. In situ hybridisation (ISH)

Probes for BCA-1 (368bp) and CXCR5 (312bp) were obtained by PCR amplification, and sequenced. DNA fragments were subcloned using the pGEM-T Vector system (Promega Co. Madison, WI) according to the manufacturer’s instruction. Sequences of the subcloned products were obtained using the Cy5™ Auto-read™ Sequencing kit (Pharmacia Biotech, Uppsala, Sweden) and automatically sequenced (Pharmacia Biotech, Uppsala, Sweden). Probes were labelled using the BrightStar Psoralen-Biotin labelling kit (Ambion, Austin, TX) and ISH were performed using DAKO GenPoint (Dako A/S Glostrup, Denmark) according to

![Fig. 1. Two-colour immunofluorescence detection of BCA-1, CXCR5, CD22 and CD35 expression in PCBCL, low grade CBCL and high grade CBCL. PCBCL (original magnification ×100): heavy CD35+ staining of dendritic cells and, to a lesser extent, lymphoid cells within follicles (1a, top left); dendritic cells coexpress BCA-1 (1b, top right). Low grade CBCL (original magnification ×100): BCA-1 expression (1c, middle left) is restricted to clustered CD22+ B-cells (1d, middle right). High grade CBCL (original magnification ×400): large neoplastic cells show substantial expression of BCA-1 (1e, bottom left) and CXCR5 (1f, bottom right).]
the manufacturer’s instructions. Negative control stains were performed by replacing the labelled probe with hybridisation buffer.

3. Results

3.1. IHC and 2c-IF

BCA-1 and CXCR5 expression was not detected in either clinically healthy skin or CTCL. In contrast, BCA-1 and CXCR5 expression was found in all of the biopsies from PCBCL (3/3) and CBCL (10/10).

By both IHC (according to the step-section analysis) and 2c-IF, a different pattern and intensity of expression was observed among the PCBCL, low grade CBCL and high grade CBCL samples. In PCBCL, that were constantly characterised by a polyclonal B-cell infiltrate that was often arranged in well structured lymphoid follicles, BCA-1 and CXCR5 expression was clear cut and restricted to CD22+ B-cells; BCA-1 was also expressed by CD35+ dendritic cells within follicles (Fig. 1a and b). In low grade CBCL, BCA-1 expression was also clear cut and restricted to CD22+ B-cells, either clustered (Fig. 1c and d) or sparsely distributed within the often strongly T-cell reactive infiltrate. No dendritic staining pattern of BCA-1 was observed in neoplastic, follicle-like B-cell clusters. In these latter cells, CXCR5 expression was less than in the reactive follicles found in PCBCL. In all high grade CBCL, that were virtually composed of monoclonal large cells only, BCA-1 and CXCR5 were highly expressed (Fig. 1e and f).

3.2. RT-PCR and quantitative analysis

BCA-1 and/or CXCR5 were never detected by RT-PCR in either clinically healthy skin or CTCL samples. On the contrary, BCA-1 and CXCR5 signals were detected in all of the CBCL and PCBCL samples. The image analysis of the intensity of bands of β-actin, BCA-1 and CXCR5 obtained with RT-PCR showed a different level of expression for BCA-1 and CXCR5: the intensity of bands from high grade CBCL was clearly higher than that from low grade CBCL and PCBCL samples (Figs. 2 and 3).

3.3. In situ hybridisation

No in situ hybridisation of BCA-1 and CXCR5 was found in either the clinically healthy skin or CTCL samples. On the contrary, BCA-1 and CXCR5 staining was observed in pseudoCBCL and CBCL (Fig. 4). In particular, the expression was more evident in the high grade CBCL.

4. Discussion

In this study, we have analysed the phenotypic and genotypic expression of BCA-1 and CXCR5 in CBCL and PCBCL, in order to investigate the possible involvement of these molecules in the pathogenesis of these
characteristic disorders. We also wanted to examine the relevance of their possible differential expression in the different subcategories (PCBCL versus low grade CBCL versus high grade CBCL).

No expression of BCA-1 and CXCR5 was found at the immunohistochemical and molecular level in biopsies from either clinically healthy skin or CTCL, thus confirming the B-cell restricted specificity of these chemokines.

Interestingly, significant differences were found among the PCBCL, low grade CBCL and high grade CBCL. In fact, although the expression of CXCR5 and BCA-1 was restricted to CD22+ B-cells in all of the examined specimens, CD35+/BCA-1+ dendritic cells were found by 2e-IF in lymphoid follicles of PCBCL only. In low grade CBCL, conversely, virtually no CD35+ dendritic cells coexpressed BCA-1, and the intensity of CXCR5 expression on CD22+ cells was lower than that of BCA-1. In high grade CBCL, both BCA-1 and CXCR5 were strongly expressed by neoplastic CD22+ B-cells. In particular, the intensity of CXCR5 was much higher than that observed in low grade CBCL.

The above findings, although only in a small series of patients, are in keeping with those evidenced in Helicobacter pylori (HP)-induced MALT (gastritis) and gastric lymphoma, MALT type (14). In fact, the distribution and intensity of BCA-1 and CXCR5 in (secondary) lymphoid follicles of PCBCL parallel those found in HP-induced MALT (gastritis) [14]. On the other hand, the expression of BCA-1 and CXCR5 was virtually restricted to neoplastic B-cells in CBCL, as well as in gastric lymphomas [14]. In addition, in both high grade CBCL and high grade gastric lymphomas, BCA-1 and—even more so—CXCR5 expression by large blasts was very pronounced [14]. An interesting issue for debate is the absence of dendritic staining for BCA-1 in both low grade CBCL and low grade gastric lymphomas [14]. In this latter group, we have interpreted this finding as reflecting the absence of follicular dendritic cells from the neoplastic infiltrate (CD21- and CD23-negative staining on paraffin sections). In low grade CBCL, conversely, we usually found CD35+ follicular dendritic cells, with a stronger staining in cryostat sections, while the expression of CD21 is ± in cryostat sections and often lacking in paraffin sections. Indeed, we have previously stressed this “aberrancy” of dendritic cells in neoplastic follicle-like clusters of classic CBCL [15–18,29,30]. Therefore, it is not unlikely that immunologically aberrant follicular dendritic cells have a substantially downregulated expression of BCA-1 in both low grade CBCL and low grade gastric lymphoma of the MALT type.

Taken altogether, the findings described in this paper add to the evidence of close similarities between CBCL (primary cutaneous B-cell lymphoma) and MALT lymphomas, with chronic antigen stimulation as a possible common pathogenic denominator [14,21].

Acknowledgements

This study has been supported by grants from the Italian Ministry of Education, University and Research (MIUR, Ministro dell’Istruzione, Università e Ricerca) the Cassa di Risparmio di Firenze SpA, and the Associazione Italiana per la Ricerca sul Cancro (AIRC).

References


