Localization of the G-CSF Gene on Chromosome 17 Proximal to the Breakpoint in the t(15;17) in Acute Promyelocytic Leukemia

By Ruth N. Simmers, Lorna M. Webber, M. Frances Shannon, O. Margaret Garson, Gordon Wong, Mathew A. Vadas, and Grant R. Sutherland

The human granulocyte-colony stimulating factor gene (G-CSF) is localized at 17q11.2-21, the region of one of the breakpoints in the 15:17 chromosome translocation specific for acute promyelocytic leukemia (APL). As G-CSF induces differentiation and loss of tumorigenicity in myeloid leukemic cells or cell lines, it was possible that the translocation in APL involved the DNA of the G-CSF coding region or its regulatory region. In situ hybridization to myeloid leukemic cells or cell lines showed that the gene that encodes for G-CSF maps and whether the translocation alters of these regions G-CSF maps and whether the translocation

As the specific chromosome rearrangement in APL divides 17q into two regions, it is of interest to know to which of these regions G-CSF maps and whether the translocation alters the in situ hybridization patterns. We have studied the t(15;17) in two patients with APL using in situ hybridization with the G-CSF probe and in four patients using Southern analysis.

MATERIALS AND METHODS

DNA studies. Bone marrow cells from patients with APL were cultured for 24 hours before being synchronized with 0.1 μmol/L fluorodeoxyuridine. The block was released by the addition of 20 μmol/L bromodeoxyuridine and the chromosomes harvested 8½ hours later after 30 minutes’ exposure to colcemid. These chromosomes were banded and photographed prior to in situ hybridization. This was carried out using a cDNA clone consisting of the entire coding region of the G-CSF gene in the plasmid pXMT2, to these bone marrow and to normal male lymphocyte chromosomes as described by Simmers et al. Kodak NTB-2 (Rochester, NY) and Ilford L4 (Essex, UK) nuclear research emulsions were used for autoradiography.

Southern analysis was performed, using the G-CSF probe, to DNA from normal and leukemic cells of four patients with APL and the t(15;17). (DNA was kindly supplied by Professor A. Morley and Dr L. Ashman.) The DNA was cut by four restriction enzymes: Eco RI, Bam HI, Bgl II, and Hind III.

Patients. Two patients with APL were studied using in situ hybridization. Patient ML was a 72-year-old woman who presented with APL (M3) in June 1986. She died from uncontrollable bleeding shortly after admission. The leukemic cell karyotype showed the typical 46,XX,t(15;17)(q22;q21) in 95% of metaphases examined. Patient SD was a 15-year-old boy who presented with APL in November 1984. The leukemic karyotype was 46,XY,t(15;17)(q22;q21);(17q-); an isochromosome of the partial deletion 1q7 is a recognized variant of the t(15;17). The patient achieved remission, but subsequently relapsed on several occasions and although additional chromosome abnormalities were found at relapse, the t(15;17) was always present, with approximately 20% of metaphases having a partially deleted 1q7. The patient died 21 months after diagnosis.

RESULTS

Examination of 25 normal metaphases probed for G-CSF revealed significant label on the long arm of chromosome 17: 22 out of 108 silver grains (20%) were seen over this region (P < 10^-5 using cumulative Poisson probabilities), indicating that the probe had hybridized to G-CSF on 17q. Chromosomes from 121 metaphases of patient ML had 16 silver grains (6.4% of a total of 249 silver grains over all chromosomes; P < 10^-5) over the region 17cen to 17qter on the normal chromosome 17; 22 (8.8% of 249; P < 10^-5) over 17cen to 15qter on the derived chromosome 17; and four (1.6% of 249;NS) over both 15q15 to 15qter and 15q15 to 17qter on the normal and derived chromosomes 15, respectively. Chromosomes from 130 metaphases of patient SD had 14 silver grains (4.9% of a total of 287 silver grains over all chromosomes; P < 10^-5) over 17cen to 17qter on the normal chromosome 17; 22 (8.8% of 249; P < 10^-5) over 17cen to 15qter on the derived chromosome 17; and four (1.6% of 249;NS) over both 15q15 to 15qter and 15q15 to 17qter on the normal and derived chromosomes 15, respectively. In sum-

From www.bloodjournal.org by guest on September 23, 2017. For personal use only.
Discussing the chromosome 17 breakpoint of the translocation in APL cells has been located variously from 17q11.2 to 17q22. This region overlaps with G-CSF at 17q11.2-21 recently described by Strim et al. Thus, while the location of the G-CSF gene has not been defined more precisely by the present results, the position of the coding region with respect to the breakpoint and its probable noninvolvement in the translocation have been revealed.

The oncogene c-erbA has also been mapped proximal to the chromosome 17 breakpoint in APL14 and no rearrangement of the c-erbA gene resulting from this translocation has been detected. In a case of undifferentiated acute leukemia found to have a t(17;21)(q21-q22;q22), the c-erbA gene was localized proximal to this breakpoint at 17q21-22.14 In addition, the nerve growth factor receptor gene (NGFR) has been mapped distal to this breakpoint at 17q12-22.15 Although cytogenetically similar, the point of translocation in this undifferentiated leukemia is not necessarily the same at the DNA level as in the t(15;17) in APL, so it cannot be assumed that NGFR is actually distal to the breakpoint in APL. No rearrangement of the NGFR gene was detected in chromosomes with the t(17;21) or the APL translocation.14 As the G-CSF probe used for in situ hybridization in our studies contains the entire coding region of the G-CSF gene, the results indicate that these coding regions are proximal to the site of rearrangement in APL. However, this information does not exclude the possibility of the rearrangement occurring through a region of DNA flanking the coding sequence, affecting the regulation of G-CSF production.

Acknowledgment

We thank Dr Steven Clark for preparation of the probe.

References

15. Sheer D, Hiorns LR, Stanley KF, Goodfellow PN, Swallow DM, Povey S, Heisterkamp N, Groffen J, Stephenson JR, Solomon...
E: Genetic analysis of the 15;17 chromosome translocation associated with acute promyelocytic leukemia. Proc Natl Acad Sci USA 80:5007, 1983


Localization of the G-CSF gene on chromosome 17 proximal to the breakpoint in the t(15;17) in acute promyelocytic leukemia

RN Simmers, LM Webber, MF Shannon, OM Garson, G Wong, MA Vadas and GR Sutherland