CONCISE REPORT

Plasma Blood Group Glycosyltransferase Activities After Bone Marrow Transplantation

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Human blood groups (ABO) are known to be determined by the terminal glycosyl residues attached to common carbohydrate chains located on the red cell surface. The A substance is produced from a common substrate, the H substance, by the action of an N-acetylgalactosaminyltransferase (A-enzyme), and the B substance by the activity of galactosyltransferase (B-enzyme). The A-enzyme is found in the plasma of blood group A subjects, B-enzyme in those who have blood group B, and neither enzyme in group O individuals. The origin of the plasma enzyme is not clear, since not only red cell precursors but also other tissues contain the A- and B-enzymes.

The complete replacement of the bone marrow, lymphoid, and monocyte-macrophage systems of patients with acute leukemia or aplastic anemia by transplantation bone marrow from donors with ABO blood group differing from the recipient has provided us with an opportunity to determine the origin of the A- and B-enzymes.

MATERIALS AND METHODS

The transferase activities were assayed by measuring the incorporation of radioactive sugar from nucleotide sugar (i.e., UDP-N-acetylgalactosamine for A-enzyme assay and UDP-galactose for B-enzyme assay) into fucosyllectose, as previously reported. Alternatively, O red cells were incubated with the enzyme and the nucleotide sugar, and the newly produced blood group substance (A or B) was semiquantitatively assayed using anti-A or anti-B agglutinin with serial dilutions. In contrast to usual human plasma, the patients' plasma examined, particularly from patients UPN-35 and UPN-38, exhibited active hydrolysis of the nucleotide sugars, presumably due to an elevated activity of nucleotide pyrophosphatase and/or plasma phosphatase in the subjects' plasma. This high background hydrolysis interfered with the first assay method. Therefore, the second method was used for the assay of blood group transferase activity in UPN-35 and UPN-38. UDP-N-acetylgalactosamine was synthesized as previously described. UDP-galactose was purchased from Sigma Chemical, Co. St. Louis, Mo. UDP-N-acetylgalactosamine (galactosamine-1-H³) was purchased from New England Nuclear, and UDP-galactose (galactose-6-H³) was purchased from Amersham Corp.

The results of our studies are summarized in Table 1 and Fig. 1. After bone marrow transplantation, the patient's blood type gradually changed from the original type to the donor's type, confirming previous observations. The conversion was completed after about 100–120 days. All four patients continue to manifest the blood groups of their bone marrow donors.
In contrast to the erythrocyte antigens, the A- and B-enzyme activities of the patient's plasma changed only slightly after bone marrow transplantation. UPN 29 and UPN 35 were originally blood type O and received bone marrow from a subject with blood type A₁. Weak A-enzyme activity appeared temporarily (in UPN 29) or continuously (in UPN 35) after the treatment. High A-enzyme was continuously observed in plasma from the subject UPN 19, who was originally blood type A₁ and received bone marrow from a subject with blood type O, as a result the subject blood type completely converted from A₁ to O (Fig. 1). No measurable B-enzyme activity was detected in plasma from the subject UPN 38, who was originally blood type A₁ and received B bone marrow, although the subject's blood type completely converted from A₁ to B after the treatment.

Transplantation of the hematopoietic tissues of patients with donors who have different ABO blood groups has given us an opportunity to study the origin of the ABO blood-group-determining glycosyltransferases in the plasma. Although, as expected, the red cells produced by the transplanted marrow were exclusively the donor type, very little of the donor sugar transferase appeared in the plasma. Our findings are consistent with the observations made by Schachter et al., who measured the A-enzyme activity in the plasma of a blood chimeral whose A₁ gene activity appeared to be restricted to bone marrow cells acquired in utero from the subject's A₁ twin. In these studies it was estimated that only about one-fifth of A-enzyme in this serum was derived from the bone marrow. Our studies provide additional evidence that most of the circulating plasma activity is not derived from the bone marrow. Moreover, it apparently does not come from the lymphoid or macrophage-monocyte system, since these are also replaced in marrow transplantation. Other tissues, then, must be the primary source of the serum enzymes characteristic of the ABO blood group system.

REFERENCES

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