Quinine- and Quinidine-dependent Antiplatelet Antibodies

REQUIREMENT OF FACTOR VIII-RELATED ANTIGEN FOR PLATELET DAMAGE AND FOR IN VITRO TRANSFORMATION OF LYMPHOCYTES FROM PATIENTS WITH DRUG-INDUCED THROMBOCYTOPENIA

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ABSTRACT The requirement of Factor VIII-related antigen (VIIIIR:Ag) for platelet damage by quinine- and quinidine-dependent antibodies was studied in platelet-rich plasma (PRP) of four patients with severe von Willebrand’s disease (vWd) (Factor VIII deficiency). Platelet factor 3 availability, platelet aggregation, and release of [14C]serotonin from labeled vWd-PRP by drug-dependent antibodies were significantly reduced in comparison with PRP from normal controls. Addition of purified VIIIIR:Ag restored levels of platelet damage to that of normal PRP. In vWd-PRP, platelet damage by two human antiplatelet sera, not dependent on drugs, and by a rabbit antiplatelet serum did not differ from that in normal PRP. PRP from patients deficient in Factor VIII coagulant activity, Factor IX, or Factors II, VII, IX, and X behaved like normal PRP. The role of VIIIIR:Ag in forming antigen able to transform lymphocytes of patients who had recovered from drug-induced thrombocytopenia was investigated by measuring incorporation of [methyl-3H]thymidine into DNA. When lymphocytes were cultured for 7 d, significantly less transformation occurred in response to platelets and the drug in the presence of vWd sera than in normal sera or sera deficient only in Factor VIII coagulant activity or Factor IX. Addition of purified VIIIIR:Ag to vWd sera restored transformation to that obtained in normal sera. Nonspecific lymphocyte transformation by pokeweed mitogen was not affected by VIIIIR:Ag.

Thus VIIIIR:Ag is involved both in platelet damage by drug-dependent antibodies and in the interaction between platelet and drug which produces an antigen able to transform sensitized lymphocytes.

INTRODUCTION

In drug-induced thrombocytopenia occurring as a result of quinine or quinidine ingestion, IgG antibodies are formed, which, in the presence of the drug, cause blood platelet destruction (1, 2). An antigen that causes lymphocytes of these patients to proliferate is formed by interaction of the drug, platelet membranes, and a plasma factor (3). Platelets from patients with Bernard-Soulier syndrome, in which platelet glycoproteins Ib and Ia are deficient (4), do not react with these drug-dependent antibodies (5) and also do not possess the components required for formation of an antigenic stimulus (3). These glycoproteins have also been implicated in the ability of platelets to react with Factor VIII (6). We therefore examined the relationship between Factor VIII and drug-dependent antibodies by studying whether platelet damage by these antibodies occurs normally in platelet-rich plasma (PRP)1 from patients with von Willebrand’s disease (vWd) (Factor VIII deficiency). We have also examined whether Factor VIII participates in formation of the antigenic stimulus that causes lymphocyte proliferation in patients sensitive to the drugs.

1 Abbreviations used in this paper: PF3, platelet factor 3; PRP, platelet-rich plasma; vWd, von Willebrand’s disease; VIII-C, Factor VIII coagulant activity; VIIIIR:Ag, Factor VIII-related antigen.
METHODS

Patient material. Blood was obtained from four patients fulfilling the diagnostic criteria of vWD (7). They all had < 10% of the normal coagulation activity of Factor VIII (VIII:C) (8). Von Willebrand factor detected by ristocetin-induced agglutination of formalin-fixed platelets (9) was 0%. VIIIIR:Ag was undetectable by immunoelectrophoretic assay (10). Platelet-associated VIIIIR:Ag (11) was undetectable when measured on three patients.

Blood was also obtained from a patient with hemophilia A (VIII:C, 105% von Willebrand factor, 141% VIIIIR:Ag), from two patients with hemophilia B (normal VIII levels, but 0 and 10% Factor IX), and from a patient on anticoagulant warfarin therapy whose levels of Factors II, VII, IX, and X were reduced to < 20% normal.

Sera with antiplatelet activity. Quinine- or quinidine-dependent antibody-containing sera were obtained from seven patients fulfilling the diagnostic criteria of drug-induced thrombocytopenic purpura (1). Antibodies not dependent on drugs were obtained from a patient after multiple transfusions and from another with idiopathic thrombocytopenia.

An antplatelet serum was raised in rabbits by immunization with human platelets, which had been washed six times. All sera were heated at 56°C for 30 min.

Methods. Procedures for blood collection and for preparation of platelet-rich plasma (PRP) were as described (3). Antiplatelet antibody was detected by the ability of sera to increase the rate of platelet factor 3 (PF3) availability (12, 13). 0.1 ml serum was incubated at 37°C for 30 min with 0.8 ml PRP (platelet count adjusted to 3 x 10^9/liter) and 0.1 ml either 0.15 M NaCl, 0.01 M Tris-HCl, pH 7.4, or quinine or quinidine hydrochlorides at a final concentration of 50 µM. 0.1 ml kaolin suspension (50 mg/ml) was added, and after 1 min, 0.1 ml was removed and added to a tube containing 0.1 ml 0.02 M CaCl₂ and 0.1 ml Russell’s viper venom (1:10,000 dilution, Wellcome Research Labs, Beckenham, England) and clotting time recorded. Platelet aggregation in an aggregometer (Payton Associates Ltd., Scarborough, Canada) and [14C]serotonin release were measured as described (14). High molecular weight VIIIIR:Ag (270 U/mg protein), containing von Willebrand factor, was purified as described (15). Lymphocyte transformation was measured by incorporation of [methyl-3H]-thymidine into DNA (3). Statistical significance of results was estimated using an unpaired t test on an electronic calculator (CS-365P) (Sharp Corp., Osaka, Japan).

RESULTS

Antibody-induced PF3 availability. When PRP from vWD patients was substituted for normal PRP, significantly less PF3 was made available by seven drug-dependent antibody sera (P < 0.001) (Fig. 1). When purified VIIIIR:Ag was added to PRP from vWD patients at 1 U/ml (the normal concentration of VIIIIR:Ag in plasma), the mean results for PF3 availability in the presence of drug and drug-dependent antibody sera increased significantly (P < 0.001) to levels obtained with normal PRP, while having no effect on clotting times obtained in controls with normal human serum (Fig. 1). Addition of VIIIIR:Ag to normal PRP did not significantly alter the PF3 availability with drug-dependent antibody sera.

The decreased response of PRP from patients with vWD to antibodies was specific for quinine and quinidine-dependent antibody sera. PRP from all vWD patients responded normally to an antiplatelet antisera raised in rabbits and to two human sera containing antiplatelet antibodies unrelated to drugs (Fig. 1). PRP from a patient with hemophilia A, two patients with hemophilia B, and a patient on anticoagulant warfarin therapy responded normally to the drug-dependent antibodies. This suggests that low levels of VIIIIR:Ag, but not of VIII:C or of coagulation Factors II, VII, IX, or X prevent platelet damage by drug-dependent antibodies.

Antibody-induced platelet aggregation and [14C]-serotonin release. Four of the antibodies caused platelet aggregation and [14C]serotonin release in normal PRP in the presence of the appropriate drug. Both of these platelet responses were significantly (P < 0.01) reduced in PRP of patients with vWD (Fig. 2). Addition of purified VIIIIR:Ag to vWD-PRP restored aggregation and [14C]serotonin release when antibody-containing sera and drug were added. Addition of VIIIIR:Ag to normal PRP did not significantly alter
Pooled autologous platelets (3) report and the release of aggregation differ significantly from either normals. Addition of serum deficient in normal platelets (Fig. 2). Therefore, panels (B) and (C) (Fig. 2). The cultures were examined by pokeweed mitogen (PWM) and cultured with normal platelet components, or with platelet membranes and the appropriate drug. The cultures always contained pooled normal human serum.

When patients' lymphocytes were cultured with autologous platelets and quinine in the presence of sera from patients with vWD, transformation was markedly reduced in comparison with that obtained in cultures containing normal sera (Fig. 3) ($P < 0.001$). Sera from patients with either hemophilia A or B supported transformation to levels similar to those of normals. Addition of purified VIIIIR:Ag to cultures containing vWd serum restored their ability to be transformed by platelets and quinine. This effect of VIIIIR:Ag was specific for the platelet-drug stimulus and was not a nonspecific enhancement of lymphocyte transformation because transformation by pokeweed mitogen, or in saline controls, was similar in cultures containing either normal or vWd serum and was not significantly changed by addition of VIIIIR:Ag (Fig. 3).

**DISCUSSION**

These results suggest that VIIIIR:Ag is involved in the interaction of the platelet and drug-dependent antibodies. Shulman (2) suggested in 1958 that drug-dependent antibodies may be directed against a complex of the drug and a factor from plasma with a special affinity for the platelet. Our findings that platelet damage, measured by three criteria, was markedly reduced in the absence of VIIIIR:Ag, and was restored to normal levels by the addition of purified VIIIIR:Ag, but was not affected by the absence of VIIIIR:Ag, or by reduction in levels of coagulation Factors II, VII, IX, or X, suggest that this plasma factor is VIIIIR:Ag. Indeed VIIIIR:Ag has a special affinity for platelet membranes, mediating platelet adhesion to the vessel wall (16). The requirement for VIIIIR:Ag in platelet attack by drug-dependent antibodies has probably remained unobserved until now because of the use in antibody detection tests of platelets and sera containing VIIIIR:Ag.

The platelet components, glycoprotein Ib and Is, required for von Willebrand factor reaction with platelets (6) are also necessary both for interaction of drug-dependent antibodies with platelets (5) and for forma-
tion of an antigen which caused transformation of lymphocytes of patients with drug-induced thrombocytopenia (3). This suggests that these glycoproteins are more than simply a receptor for a drug-antibody complex and actually form part of the antigen. Our demonstration that VIIIIR:Ag is also required for formation of the lymphocyte-transforming complex suggests that reaction of glycoproteins Ib and Is with VIIIIR:Ag is involved in forming the drug-induced antigen. The manner in which these components interact with quinine or quinidine to produce an antigen remains unclear.

ACKNOWLEDGMENT

This study was supported by a grant from the National Health and Medical Research Council of Australia.

REFERENCES