Hemostatic Studies of \textit{ex situ} Hepatic Surgery

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ABSTRACT: \textit{Ex situ} hepatic surgery, in which a diseased liver is resected from outside the body, was first reported in 1988. This study investigates the hemostatic changes occurring during such surgery in two cases. During the anhepatic period of more than 5 hours, veno-venous bypass without heparin was performed. The tests included platelet count, prothrombin activity (PT), partial thromboplastin time (PTT), fibrinogen (Fbg), factor II (F.II), factor V (F.V), and thromboelastography (TEG). Three to 4 hours after entering the anhepatic phase, marked fibrinolysis and a fall in the values of PT, Fbg and F.V were observed. Every parameter temporarily deteriorated immediately after revascularization of the graft, however, all returned to almost normal values within 1–2 hours after hepatic reperfusion except for F.V and platelets. In conclusion, the coagulopathy during \textit{ex situ} hepatic surgery is caused by the marked fibrinolysis and depletion of hemostatic factors which develop 3–4 hours after the onset of the anhepatic phase.

KEY WORDS: hepatic resection, coagulopathy, fibrinolysis, anhepatic state

INTRODUCTION

Since 1988, \textit{ex situ} hepatic surgery, a new technique for bench surgery of the liver, has been performed in Hannover.$^1$ This operation is a kind of liver autotransplantation, however, the anhepatic period is much longer in this operation than in liver transplantation. Development of coagulopathy is frequently associated with liver transplantation$^{2-5}$ and is therefore also to be expected with this operation. Nevertheless, there have been no previous reports concerning coagulopathy during \textit{ex situ} hepatic surgery. Thus, we report herein the hemostatic changes which occurred in two patients during this operation.

PATIENTS AND METHODS

Since the details of this surgical procedure have been reported previously,$^1$ only a brief description is outlined here. The liver is flushed with cooled preservative fluid \textit{via} the portal vein, then totally removed. During the anhepatic phase veno-venous bypass is performed without heparin, as in liver transplantation.$^6$ The shunt system consists of Gott shunt tubing (Argyle, St. Louis), Flow guard venous catheters (Polystan, Denmark) and a Biopump (Biomedicus, Minnesota). Of
these components, only the surface of the Gott tube is coated with heparin and hemodynamic stability is maintained well throughout the anhepatic period. After the diseased liver has been resected outside the body, the remaining liver is reimplanted into the body.

The anhepatic period in two cases studied exceeded 5 hours. Red blood cell concentrate (RBC), fresh-frozen plasma (FFP), platelet concentrate and prothrombin concentrate were given to the subjects, but no antifibrinolytic drugs were used. Blood samples were collected and the following coagulation tests were measured during the operation: platelet count (PLT), quick prothrombin activity (PT), partial thromboplastin time (PTT), and the levels of fibrinogen (Fbg), factor II (F.II) and factor V (F.V). The normal values for these tests are as follows: PLT, 12–34 × 10^3/mm³; PT, 70–120 per cent; PTT, 33–40 sec.; Fbg, 2.0–3.5 g/l; F.II, 70–100 per cent and F.V, 65–120 per cent. Thromboelastography (TEG) was monitored with a Thromboelastograph (Hellige, West Germany) and the variables measured by TEG, as described in other reports were: the maximum amplitude (MA), the amplitude 30 minutes after MA (A30) and the whole blood clot lysis index (CLI) (A30/MA ×100 per cent). The normal ranges of these variables are as follows: MA, 47–67 mm and CLI, more than 85 per cent.

Case 1: A 58 year old male had hepatic tumor metastases. His preoperative liver function tests were within the normal ranges and ex situ hepatic resection was undertaken on Sept 7, 1988, because the tumors were located at the origin of the hepatic vein. The anhepatic period lasted 6 hours and 5 minutes and segments VI, VII and IVa of the liver were preserved and reimplanted. Generalized oozing in the operative field was observed from the fifth hour after entering the anhepatic state. After revascularization of the liver, the patient received 16 packs of RBC and 25 packs of FFP, due to bleeding from the cut surface of the graft and operative fields.

Case 2: A 44 year old female had biliary tract cancer. Her preoperative liver function tests revealed slight abnormality with a SGOT of 60 IU/L and a SGPT of 98 IU/L, but jaundice was not present. Ex situ hepatic resection was performed together with a total pancreatectomy, total gastrectomy and pancreatic autotransplantation on Sept 25, 1988. The entire left lobe and the proximal portion of the right lobe were resected, with the anhepatic period lasting 5 hours and 37 minutes. A total 16 packs of RBC were transfused during the operation, most of which were used after revascularization of the graft. In this case, the coagulation system had been supported since the initiation of the anhepatic state to correct the coagulopathy which was observed on TEG during surgery.

Fig. 1. Changes in the platelet count and plasma fibrinogen levels in the two patients. The platelet count declined in both patients during the course of surgery, while the fibrinogen level dropped only in case 1. PLT, platelet count; Fbg, fibrinogen; Op., operation; Hx., hepatectomy; Rep., reperfusion