The Comparison of the Coagulation Factors in Arterial and Venous Blood

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ABSTRACT

Comparative studies of coagulation factors in arterial and venous blood were made in 14 normal subjects and in 4 patients with arterial or ventricular septal defect. No difference was found at the level of prothrombin, factor V, factor VII/X, retraction, factor XIII, and platelet count. Fibrinogen and factor VIII were significantly low in the venous blood. The platelet count was higher in the capillaries than in the arterial and venous blood.

Key Words: Coagulation factors, arterial and venous blood

INTRODUCTION

The coagulation mechanism has been considered in a state of dynamic equilibrium, with a limited amount of clotting occurring continually and an excessive accumulation of fibrin being prevented by fibrinolysis (1). If this were so, because of sluggish circulation and liability to stagnation, it might be expected that blood coagulation would proceed more rapidly to the venous system than to the arterial side. It would be logical to expect that some clotting factors, such as factors II, V, VIII, and fibrinogen, which are used during coagulation would be less in the peripheral venous blood than in the arterial blood. In addition to this, higher activities of these factors should be found in the arterial blood because most of the coagulation factors are synthesized in the liver.

This study was conducted to test the above-mentioned hypothesis by comparing the coagulation factors in the arterial and venous blood because this sort of investigation has rarely been performed (2,3).

MATERIALS AND METHODS

The coagulation factors were assayed simultaneously in the arterial and venous blood of 18 persons, 14 males and 4 females, aged 12–23 years. Fourteen of these were either laboratory personnel or medical students. Their blood samples were obtained from the antecubital vein of one arm and the brachial artery of the other arm with a 2–3 min interval. In four patients, blood samples were obtaiend at the beginning of cardiac catheterization, prior to heparinization. None of these four patients were cyanotic or in distress (one patient had an atrial septal defect and the other three had ventricular septal defects). Blood samples were also obtained from the antecubital vein and brachial artery in the catheterized patients. In all cases, the venous blood was obtained first. If any difficulty was encountered in either arterial or venous puncture, the blood samples were discarded. With the exception of catheterized patients, a venous tourniquet was applied for only a short period of time to allow the insertion of the needle.

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Table 1: Coagulation factors in arterial and venous blood.

Tests	Arterial blood				Venous blood			
	n*	Range	Mean	SD	n	Range	Mean	SD
Quick time, sec	6	11.3–19	14.2 ± 1	2.5	6	11.2–17.00	14.7 ± 0.8	2
Partial thromboplastin time, sec	6	51–106	82.1 ± 8.2	20	6	48–122	83 ± 9.1	22.4
Prothrombin, %	17	50–127	86.5 ± 5.1	21.3	18	46–162	91.8 ± 8	34.4
Factor V, %	17	55–138	96.2 ± 7.1	29.7	17	56–196	103.5 ± 8.5	35.2
Factor VII/X, %	16	63–197	129.2 ± 10.4	41.9	16	71–285	143.6 ± 13.8	55.3
Factor VIII, %	11	53–228	112.3 ± 14.9	49.6	11	44–196	98.6 ± 13.3	44.3
Fibrinogen, mg %	12	257–423	338.7 ± 13.4	46.5	12	226–400	311.2 ± 16.7	58
Hematocrit, %	12	35–46	39.5 ± 1	3.6	10	33.5–45	38.9 ± 0.8	2.8
Platelets, 103/mm^3	18	84–248	165 ± 8.2	35.2	16	76–214	153.4 ± 8.9	35.9

*n: Number of samples on which determinations were performed.

In the present investigation, the following coagulation tests were used: prothrombin time (4); partial thromboplastin time (PTT) (5); assays of prothrombin, factor V, and factors VII/X combined activity (6); fibrin-stabilizing factor (7); assay of factor VII (8); fibrinogen (9); platelet count (10); and hematocrit determined by the microhematocrit method.

RESULTS

Most of the results are summarized in Table 1. In 12 cases, the fibrin-stabilizing factor and in 8 cases the clot retraction were the same in the arterial and venous blood. In 16 cases, the platelet count was slightly higher in the capillary blood than in the arterial and venous blood; however, the difference was not statistically significant.

In all of these determinations, only factor VIII and fibrinogen were significantly lower in the venous blood than in the arterial blood ($P < 0.05$ for both) (Table 2).

DISCUSSION

In most of the previous studies, the arterial and venous blood were compared for the fibrinolytic activity. Although there is some conroversy, in general this activity was found higher in the venous blood than in the arterial blood (2, 11, 12).

In normal pigs, prothrombin time, platelet count, platelet adhesiveness index, clotting time, and thromboplastin generation time were determined in the arterial and venous blood. Only the clotting time was found significantly shorter in the venous than in the arterial blood (3).

In normal human subjects, the arteriovenous differences of blood coagulation factors were examined by Naimi et al. (2). They showed a trend toward the lower coagulation activity in the arterial blood as indicated by Quick prothrombin time. They also determined Stypven time, prothrombin, factor V, factor VII/X, heparin tolerance, and thromboplastin generation with inosithin. The arteriovenous differences, however, were not all in the same direction; some indicated an increased coagulation activity of the arterial blood, while others indicated a decreased coagulation activity.

In the present study, Quick prothrombin time and PTT were not statistically different in the arterial and venous blood; however, these were determined in only six cases. As most of the clotting factors were assayed one by one, no changes were expected in these relatively crude determinations. In this study, prothrombin, factor V, and factor VII/X assays revealed slightly higher yields in the arterial blood in contrast to the findings of Naimi et al. (2). However, these changes were not statistically significant in either study.

We also compared fibrinogen and factor VIII levels in the arterial and venous blood in 11 and 12 paired samples (Table 2). Statistically significant decreases were found for both in the venous blood when the means of the individual differences found between the values observed in each pair of samples were examined ($P < 0.05$). This result can be explained on the basis of the study by Gardiakis et al. (13) who found that the factor VIII concentration was higher in the hepatic venous blood than in the peripheral venous blood. They found that the concentration of factor VIII in the plasma of the blood of the hepatic vein was consistently and significantly higher

Table 2: The factor VIII and fibrinogen levels of the arterial and venous blood in paired samples.

	Antihemophilic globulin % (11 subjects)			Fibrinogen mg % (12 subjects)		
	Arterial		Venous	Arterial		Venous
	70		60	354		354
	146		95	283		270
	116		118	257		257
	114		98	301		308
	115		133	296		226
	72		48	322		296
	150		140	322		314
	228		196	377		400
	53		48	380		277
	117		105	350		255
	55		44	423		378
	-	-		400		400
				-		-
Mean	112.3		98.6	Mean 338.7		311.2
	±14.9		±13.3		±13.4	±16.7
SD	49.6		44.3	SD 46.5		58.0
t		2.54		t	2.229	
P		< 0.05		P	< 0.05	

than that of the venous blood (+150%). The magnitude of the difference between the hepatic and the peripheral venous blood might not be reflected between the arterial and venous blood because of the dilution of the hepatic blood in the arterial system. Although the liver may not be the only organ involved, it is the most important site for fibrinogen and factor VIII synthesis. This is the reason why an increased fibrinogen level in the arterial blood, like factor VIII, would not be a surprising finding.

The lower levels of factor VIII fibrinogen in the venous blood might suggest a continuous clotting process in the periphery. With this supposition, the low level of factor V, and to some degree of prothrombin, would be expected. But this was not the case. Although it is still a possibility that continuous blood clotting takes place in the capillaries, our findings do not fully support this.

Our platelet counts in the arterial and venous blood were generally much lower than would be expected by the Rees-Ecker technique. This was most likely due to the handling of the specimen in the nonsiliconized glass tubes, but our capillary platelet count values were also much lower than for this method. As the samples from both sites were obtained under the same conditions, the arterial and venous platelet counts can be compared. This kind of difference between the arterial and venous blood has also been published previously for animals (3) and human beings (14). However, the difference is not statistically significant.

In this study an insignificant difference between the arterial and venous blood was also observed in the hematocrit values. As hematocrit values in the venous blood are silghtly lower, the differences in the platelet counts might be due to the dilution effect.

From this study it might be concluded that there is no satistically significant difference of coagulation factors between the arterial and venous blood to support continuous blood clotting in the capillaries.

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