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Original Article

Haematological and biochemical characteristics of the splenic effluent blood in schistosomal patients undergoing splenectomy

Características hematológica e bioquímica do sangue efluente esplênico em pacientes esquistossomáticos submetidos à esplenectomia

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A B S T R A C T

Objective: To assess hematological and biochemical features of splenic effluent blood and their influence on the rise of hematological values after splenectomy. **Methods**: we studied 20 patients undergoing surgical treatment for schistosomatic portal hypertension. We collected blood samples for CBC, coagulation, bilirubin and albumin in the splenic vein (perioperative) and peripheral blood (immediately pre and postoperative periods). **Results**: the splenic blood showed higher values of red blood cells, hemoglobin, hematocrit, platelet count, total leukocytes, neutrophils, lymphocytes, monocytes, eosinophils and basophils, as well as reduction of laboratory coagulation parameters in relation to peripheral blood collected preoperatively. In the postoperative peripheral blood there was an increase in the overall leukocytes and in their neutrophil component, and decreased levels of basophils, eosinophils and lymphocytes. The other postoperative variables of complete blood count and coagulation tests were not different compared with the splenic blood. The albumin values were lower postoperatively when compared to preoperative and splenic blood. There were higher values of direct bilirubin in the postoperative period when compared with the preoperative and splenic blood. Postoperative indirect bilirubin was lower compared to its value in the splenic blood. **Conclusion**: hematological and biochemical values of splenic effluent blood are higher than those found in peripheral blood in the presence of schistosomal splenomegaly. However, the splenic blood effluent is not sufficient to raise the blood levels found after splenectomy.

Key words: Blood. Spleen. Blood cells. Portal hypertension. Blood transfusion, autologous. Splenic vein.

INTRODUCTION

The spleen is one of the most vascularized organs of the body, with a blood flow of approximately 350 liters a day. It is part of the mononuclear phagocyte system and it is located between the portal and systemic circulations. Its irrigation comes from the splenic artery and from a rich arterial collateral network, mainly esplenogastric, while its venous drainage flows to the splenic vein and a small part to the esplenogastric veins. The splenic vein joins the superior mesenteric vein to form the portal vein [1-3]. The spleen plays important functions, including hematopoiesis, cell purification and reservoir of blood elements [1,4,5].

During splenectomy, the approach and splenic artery ligation allow blood to exit the spleen through the splenic vein, reducing its size[3,6-9]. It is believed that the inflow of splenic blood into the bloodstream explains the observed increase in hematologic indexes immediately after splenic artery ligation[7,10,11]. However, there is no scientific reasoning to prove this hypothesis.

In schistosomatic portal hypertension (SPH), splenomegaly, anemia, thrombocytopenia and leukopenia associated with bone marrow hyperplasia occur without clinical manifestation [1,3,12-14]. The normalization of this blood and bone marrow condition is obtained after partial or total removal of the spleen and even after splenic vein bypass without splenectomy [15-18]. Despite the extensive literature on this organ, the characteristics of its effluent blood are still unknown. These data are especially important in situations such as portal hypertension, in which there is increase in the organ size, with accumulation of blood inside it.

This study aimed to determine the hematological and biochemical values of effluent splenic blood and evaluate their influence on the rise of hematological values after splenectomy.

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METHODS

This was a cross-sectional descriptive study approved by the Ethics Committee of the Federal University of Minas Gerais under record CAAE-0399.0.203.000 11. We studied 20 consecutive adult patients, of both genders, with a diagnosis of schistosomiasis that were referred to undergo surgical treatment of SPH. All patients were diagnosed with hepatosplenic schistosomiasis confirmed by parasitological examination of stool and rectal biopsy positive for Schistosoma mansoni eggs, abdominal ultrasound and liver biopsy during surgery, which revealed Symmers-Bogliolo fibrosis [1,19].

All procedures were performed electively and the surgical option depended on patients' data and disease stage[3]. The indication for surgical treatment was upper gastrointestinal bleeding [3].

In the immediate preoperative period 5 ml of blood was drawn for blood count (RBC count, hemoglobin, hematocrit, leukocytes and platelets), coagulation (international normalized ratio - INR and prothrombin time), and quantification of bilirubin and albumin. The same tests were performed on blood collected from the splenic vein after splenic artery ligation (FIGURE 1) and from peripheral blood immediately after the operation.

Statistical analysis was performed using the nonparametric Mann Whitney test and the Shapiro Wilks normality test [12,20]. The level of significance was greater than 95% ($p < 0.05$) [21].

RESULTS

The age of patients ranged from 17 to 65 years, mean 44 ± 13; there were 11 men and nine women. Three patients underwent subtotal splenectomy, and the others, total splenectomy. Operative time ranged from 180 to 330 minutes, with a mean of 259 ± 42 minutes. The length of stay ranged from 4 to 10 days, with a mean of 6 ± 2. No patient had postoperative complications.

During preoperative evaluation, thrombocytopenia (<150,000 platelets/mm^3) occurred in 20 (100%) individuals, leukopenia (<4,000 cells/mm^3) was observed in 19 (95%) and anemia (<12 g/dl) was found in 14 (70%). The prothrombin time was less than 70% in 10 patients (50% of cases). Only one patient had a dose of albumin below 3.5 g/dl. Direct bilirubin was below 0.4 g/dl in all patients and only four (20%) had indirect bilirubin greater than 0.9 g/dl, the highest value being 1.8 g/dl (Table 1) .

The values of the number of red blood cells ($p = 0.01$), hemoglobin ($p = 0.04$), hematocrit ($p = 0.03$), platelet count ($p = 0.00$), total leukocyte ($p = 0\ 00$), neutrophils ($p = 0.00$), lymphocytes ($p = 0.00$), monocytes ($p = 0.00$), eosinophils ($p = 0.00$), basophils ($p = 0.00$) and INR ($p = 0.02$) were higher in the splenic effluent compared with the preoperative peripheral blood. The comparison of the splenic blood with the postoperative peripheral blood showed differences only in the global leukocyte count ($p = 0.04$) and its neutrophil component ($p = 0.00$), which were higher in the splenic effluent. Variables of blood count showed no difference.

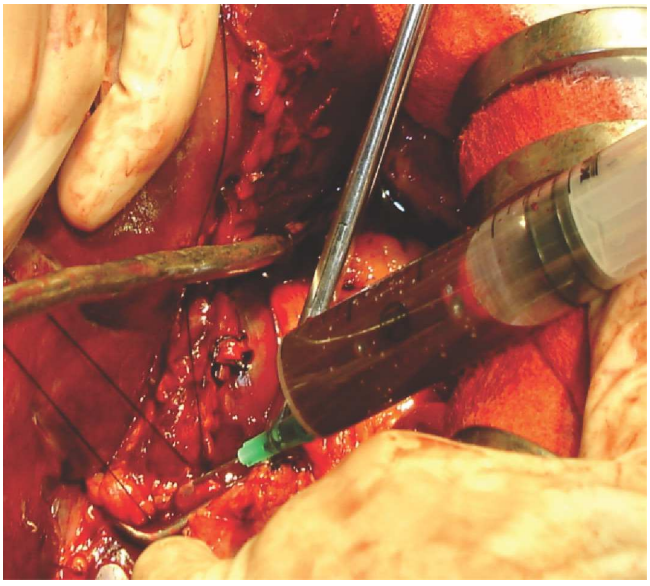

Figure 1 - *Puncture and collection blood from the splenic vein.*

In the comparative analysis of peripheral blood pre and postoperatively, there was an increase in the number of red blood cells ($p = 0.03$), platelet count ($p = 0.00$), total leukocyte ($p = 0.00$), number of neutrophils ($p = 0.00$) and monocytes ($p = 0.00$) at the end of the operation. The other parameters showed no difference.

There was a reduction of albumin in the postoperative peripheral blood relative to its values in the splenic vein and preoperative peripheral blood ($p = 0.04$ and $p = 0.00$, respectively). The analysis of bilirubin showed higher postoperative values of direct bilirubin compared with the preoperative and splenic effluent ($p = 0.03$ and $p = 0.01$, respectively). The indirect bilirubin level was higher in the splenic blood and decreased in the postoperative peripheral blood in relation to the splenic vein blood ($p = 0.01$).

DISCUSSION

The splenic artery ligation in early splenectomy allows the output of blood by the spleen splenic vein and reduces the size of the spleen due to the inflow of splenic blood into the portal circulation [22-25]. According to the literature during the removal of larger spleens there is inflow of more than 500 ml of whole blood [1]. However, the characteristics of the blood exiting the spleen and its effects

Table 1 - Results of hematological and biochemical tests in peripheral blood and in the splenic vein effluent blood of the 20 patients undergoing surgical treatment for schistosomatic hypertension.

Exams	Preoperative		Splenic Vein		Postoperative	
RBCs (10^6/mm^3)	4.48 ±	0.43*	4.74 ±	0.64*	4.75 ±	1.04**
Hemoglobina(g/dl)	11.80 ±	1.76*	12.48 ±	2.49*	12.26 ±	2.58*
Hematocrit (%)	35.83 ±	3.96*	39.50 ±	8.50**	39.35 ±	10.75**
Platelets(cel/mm^3)	50050.00 ±	22530.62*	128052.00 ±	50860.89*	115500.00 ±	107000.00**
Total leukocyte count (cells/mm^3)	1900 ±	1542.50**	10131.05 ±	5310.68*	14133.00 ±	4890.00*
Neutrophils (cells/mm^3)	1320.00 ±	1070.00**	5020.00 ±	7115.00**	12073.11 ±	4258.93*
Lymphocytes (cells/mm^3)	523.79 ±	245.61*	1690.00 ±	2580.00**	510.00 ±	258.50**
Monocytes (cells/mm^3)	140.00 ±	129.00**	310.00 ±	470.00**	570.00 ±	783.00**
Eosinophils (cells/mm^3)	70.00 ±	105.00**	220.00 ±	180.00**	0.00 ±	0.00**
Basophils (cells/mm^3)	0.00 ±	12.50**	30.00 ±	20.00**	5.00 ±	19.25**
INR ***	1.30 ±	0.15*	1.47 ±	0.19*	1.32 ±	0.28**
Prothrombin activity (%)	68.70 ±	14.66*	54.46 ±	12.58*	61.83 ±	17.26*
Albumin (g/dl)	4.30 ±	1.00**	3.58 ±	0.52*	3.30 ±	0.73**
Direct bilirubin (mg/dl)	0.10 ±	0.00**	0.10 ±	0.10**	0.20 ±	0.23**
Indirect bilirubin (mg/dl)	0.69 ±	0.49*	0.72 ±	0.51*	0.51 ±	0.39*

Shapiro Wilks normality test used to characterize the variables.
** - Mean ± standard deviation for parametric variables.*
*** - Median ± interquartile range for nonparametric variables.*
**** - INR: international normalized ratio*

on the peripheral circulation had not been studied. As for the biochemical tests, preservation of liver function is in line with the literature [26,27].

The findings of this study support the hypothesis that correction of cytopenias starts perioperatively and can be observed soon after the operation. The higher values of blood elements in the splenic effluent blood compared with preoperative one suggest that the splenic blood after splenic artery ligation is self-infused. At the same time there is reduction in the size of the spleen, which becomes softened [1].

The increase in total number of leukocytes and their neutrophilic component in the postoperative peripheral blood suggests acute response to surgical trauma. However, even the infusion of 500 ml of splenic blood is not sufficient to raise the values of peripheral blood elements to the levels achieved in the postoperative period, which are close to the values of the effluent. It is worth considering the dilution of elements present in the splenic blood in about five liters of the systemic circulation of the adult [1,28]. Even in the presence of leukopenia, sepsis is not registered in these patients [1,6,7,10].

Therefore, the spleen may have only a partial role in elevating the blood levels observed postoperatively. There is the possibility that the increased spleen possesses a factor that inhibits the release of blood proteins from the bone marrow into the blood stream. This theory being true, partial or total splenectomy would be accompanied by splenic infusion of blood elements from the bone marrow, with increased values in the peripheral blood.

The blood from the spleen does not appear to influence the values of coagulation. Thus, the observed large increase in coagulation parameters cannot be attributed to the splenic blood. Coagulation factors are produced in hepatocytes and bone marrow to be released into the circulation as needed,, even though their pathophysiology is not well understood [1,6,7,10]. Even when these factors are low in the circulation, there is no clinical manifestation of coagulopathy, as observed in all patients of this study.

The reduction of postoperative albumin is in agreement with previous studies, which showed a decrease after medium and large operations, as part of the systemic response to surgical trauma [29].

Given the lack of relationship between the various structures of the mononuclear phagocyte system and its influence on blood elements, more research is needed to understand the mechanism of blood control and the role of the spleen in the process.

In conclusion, haematological and biochemical values of the splenic effluent blood are higher than those found in the peripheral blood. However, the splenic effluent is not sufficient to raise the hematological values found in the peripheral blood after splenectomy.

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R E S U M O

Objetivo: *verificar valores hematológicos e bioquímicos do sangue efluído do baço e avaliar a sua influência na elevação dos valores hematológicos após esplenectomia.* ***Métodos:*** *foram estudados 20 pacientes submetidos ao tratamento cirúrgico para hipertensão porta esquistossomática. Foram coletadas amostras sanguíneas para hemograma, coagulograma, bilirrubinas e albumina na veia esplênica (peroperatório) e no sangue periférico (pré e pós-operatórios imediatos).* ***Resultados:*** *o sangue esplênico apresentou valores maiores de: hemácias, hemoglobina, hematócrito, contagem de plaquetas, global de leucócitos, neutrófilos, linfócitos, monócitos, eosinófilos e basófilos, bem como redução dos parâmetros laboratoriais da coagulação em relação ao sangue periférico colhido no pré-operatório. No sangue periférico pós-operatório, houve aumento do global de leucócitos e de seu componente neutrofílico, além de redução dos valores de basófilos, eosinófilos e linfócitos. As demais variáveis do hemograma e do coagulograma pós-operatórios não foram diferentes na comparação com o sangue esplênico. Os valores da albumina foram menores no pós-operatório em relação ao pré-operatório e sangue esplênico. Houve valores maiores para a bilirrubina direta pós-operatória em relação à pré-operatória e à do sangue esplênico. A bilirrubina indireta pós-operatória foi menor em relação ao seu valor no sangue esplênico.* ***Conclusão:*** *os valores hematológicos e bioquímicos do sangue efluído do baço são superiores aos encontrados no sangue periférico em presença de esplenomegalia esquistossomática. Entretanto, o efluente sanguíneo esplênico não é suficiente para elevar os níveis sanguíneos encontrados após esplenectomia.*

Descritores: *Sangue. Baço. Células sanguíneas. Hipertensão portal. Transfusão de sangue autóloga. Veia esplênica.*

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