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Splenectomy leads to a persistent hypercoagulable state after trauma

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Abstract

BACKGROUND: It was hypothesized that splenectomy following trauma results in hypercoagulability.

METHODS: A prospective, nonrandomized, single-center study was performed to evaluate coagulation parameters in trauma patients with splenic injury.

RESULTS: Patients with splenectomy (n = 30) and nonoperative management (n = 50) were enrolled. Splenectomy patients were older, had higher Injury Severity Scores, and had longer intensive care unit and hospital stays ($P < .05$). Splenectomy patients had significantly increased white blood cell counts and platelet counts at baseline and follow-up ($P < .01$). Fibrinogen was initially elevated in both groups and remained elevated in the splenectomy group ($P < .05$). Tissue plasminogen activator, plasminogen activator inhibitor–1, and activated partial thromboplastin time were higher in splenectomy patients only at baseline ($P < .05$). Baseline thromboelastography showed faster fibrin cross-linking and enhanced fibrinolysis following splenectomy ($P < .05$). Only clot strength was greater at follow-up in the splenectomy group ($P < .01$). Deep venous thrombosis developed in 7% of splenectomy patients and no control patients ($P = .03$).

CONCLUSIONS: A significant difference in deep venous thrombosis formation was noted, and coagulation assays indicated persistent hypercoagulability following splenectomy for trauma.

Trauma remains the leading cause of death in persons between aged 1 to 44 years, and it is among the 10 leading causes of death for persons of all age groups.[1,2] Most deaths that occur during the first 24 hours following a traumatic event are the result of hemorrhage.[3] However, later in the course, the resultant hypercoagulable state contributes to the development of thromboembolic complications as well as to the development of acute respiratory distress syndrome and multiple organ failure. The spleen is the most commonly injured abdominal organ after blunt trauma and is also commonly injured after penetrating trauma.[4,5] In the past century, the management of splenic injury has continued to evolve from a focus almost entirely on splenectomy to one of selective nonoperative management.

Prior studies have documented a significant increase in thromboembolic disease in patients who have undergone

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splenectomy for various reasons. In 1989, Pimpl et al[6] reviewed 37,012 autopsies over 2 decades. Two hundred two of these patients had undergone splenectomy. Pulmonary embolism was the cause of death more frequently in the splenectomy group than in the control group (35.6% vs 9.7%, $P < .001$). Of the 202 patients with splenectomy, 61 had undergone splenectomy for trauma. Compared with 123 trauma patients who did not undergo splenectomy, a significant increase in the incidence of pulmonary embolus was found (31% vs 8%, $P < .001$). The investigators concluded that splenectomy imparts a lifelong risk for thromboembolism.[6]

In 1994, Geerts et al[7] found that 58% of patients had thromboembolic complications after major trauma. On the basis of the results of the retrospective autopsy study by Pimpl et al,[6] it is likely that splenectomy contributes to this hypercoagulable state. However, the existence of a prothrombotic state following splenectomy for trauma has not been evaluated in a prospective fashion. We hypothesized that trauma splenectomy results in a persistent hypercoagulable state which may increase the risk for life-threatening thromboembolic complications. To study our hypothesis, we carried out a prospective study of patients with splenic injury, managed with splenectomy or splenic salvage.

Methods

This was a prospective, nonrandomized, single-center study evaluating coagulation parameters in trauma patients with splenic injury. Trauma patients admitted to Oregon Health & Science University with splenic injury were candidates for the study. Patients were excluded from eligibility for the following reasons: inability to obtain consent from the patient or an appropriate designee, currently undergoing therapeutic anticoagulation, any known preexisting coagulopathy, or pregnancy.

Patients who were managed with splenic preservation, either nonoperative or splenorrhaphy, constituted the control group, and those who required splenectomy constituted the study group. Fifty patients were enrolled in the control group and 30 patients in the splenectomy group. The primary endpoints of the study were differences in coagulability as measured by laboratory studies and the incidence of thromboembolic events. The study was approved by the institutional review board at Oregon Health & Science University, and written consent was obtained from patients or their surrogates.

Laboratory studies collected included complete blood count with differential, partial thromboplastin time, prothrombin time, international normalized ratio, fibrinogen, thrombin-antithrombin complex, tissue plasminogen activator (tPA), plasminogen activator inhibitor–1 (PAI-1), PFA-100 (Siemens Medical Solutions, Erlangen, Germany) including both collagen/epinephrine and collagen/adenosine diphosphate tests, and thromboelastography (TEG). The selected assays were based on a study by Canonico et al[8] with the addition of the TEG and were meant to elucidate comprehensive information concerning coagulation and platelet function, thrombin activation, and fibrinolysis. In addition, patients filled out a simple questionnaire regarding their medical histories. Following discharge, patients returned approximately 6 weeks later for follow-up coagulation parameters and a repeat questionnaire. Participants' medical records were also reviewed for infections occurring during hospitalization and any ultrasound, computed tomographic, or angiographic evidence of thromboembolic disease.

Data analysis

Statistical analyses were performed using SPSS version 17.0 (SPSS, Inc, Chicago, IL). Student's t tests were used to determine differences between groups, and data were analyzed categorically using χ^2 analysis and Fisher's exact test as appropriate. Significance was defined as a P value $< .05$.

Results

Splenectomy patients were older, had higher Injury Severity Scores, and had longer intensive care unit and hospital stays than control patients. All demographics are presented in Table 1. Laboratory studies are presented in Table 2. Splenectomy patients had significant leukocytosis and thrombocytosis at baseline. At follow-up, the splenectomy patients had higher white blood cell counts compared with the control patients, but they were within the normal

Table 1 Demographics

Variable	Splenectomy (n = 30)	Control (n = 50)	P
Age (y)	41.1 ± 2.6	33.7 ± 2.0	.03
Men/women	20/10	39/11	NS
Injury Severity Score	35.3 ± 2.7	21.2 ± 1.5	<.01
Days in intensive care unit	9.2 ± 1.2	3.4 ± .5	<.01
Days in hospital	17.5 ± 2.9	8.3 ± .8	<.01
Apache score (at baseline blood draw)	5.7 ± .8	2.7 ± .3	<.01
Days from injury to enrollment	10.2 ± 1.3	6.3 ± .8	.01
Days from surgery to enrollment	8.1 ± 1.3	NA	NA
Days from injury to follow-up*	97.2 ± 29.4	75.8 ± 17.6	NS

Data are expressed as mean ± SD or as numbers.
NA = not applicable.
*n = 19 splenectomy follow-up (11 men, 8 women), n = 25 control follow-up (20 men, 5 women).