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Upon admission coagulation and platelet function in patients with thermal and electrical injuries

Charles E. Wade *, *Lisa A. Baer*, *Jessica C. Cardenas*, *Lindley E. Folkerson*, *Kisha Nutall-Aurora*, *Bryan A. Cotton*, *Nena Matijevic*, *John B. Holcomb*, *James M. Cross*, *Todd Huzar*

Center for Translational Injury Research and Department of Surgery, University of Texas Health Science Center at Houston, United States

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ABSTRACT

Rational: There has been increased focus on hemostatic potential and function in the initial assessment of the patient with traumatic injuries, that not been extensively studied in patients with burns. We proposed to determine the hemostatic potential of patients with burns upon admission to the emergency department and contrasted their condition with that of healthy controls and patients with other traumatic injuries. In addition we assessed differences due to thermal versus electrical injury and evaluated the effect of burn size.

Methods: This is a patient based prospective observational study conducted with delayed consented. Subjects at the highest level of trauma activation upon admission to the ED had a blood sample collected for research purposes and were subsequently consented. Hemostatic potential was measured by rapid thromelastography (r-TEG®), thrombin generation by calibrated automated thrombogram (CAT) and platelet function by Multiplate® using five activators. Burn subjects were compared to subjects with other traumatic injuries and controls. Within the burn subjects additional analysis compared mechanism (thermal vs. electrical) and burn size. Values are medians (IQR).

Results: Two hundred and eighty two trauma patients (with burns $n = 40$, 14%) and 27 controls were enrolled. Upon admission, compared to controls, subjects with burns or trauma were hyper-coagulable based on r-TEG and CAT, with increased rates of clot formation and thrombin generation. There were no differences in burns compared to other traumatic injuries. The presence of hyper-coagulation did not appear to be related to the type of burn or the percentage of total body surface area involved. Employing previous defined cut points for R-TEG driven therapeutic interventions burn patients had similar rates of hyper- and hypo-coagulation noted in patients with traumatic injuries.

Conclusion: Upon admission patients with burns are in a hyper-coagulable state similar to that of other trauma patients. Employing demonstrated cut points of hemostatic potential in trauma patients associated with increased risk of poor outcomes demonstrated the incidence in burn patients to be similar, suggesting that these values could be used in the early assessment of the patient with burns to guide treatment interventions.

* *Corresponding author at*: University of Texas Health Science Center at Houston, 6431 Fannin St., MSB 5.204, Houston, TX, United States. Tel.: +1 77030 713 500 6818; fax: +1 713 500 0685.
E-mail address: Charles.E.Wade@uth.tmc.edu (C.E. Wade).

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There has been increased focus on the hemostatic potential and function in the initial assessment of the patient with traumatic injuries [1–4]. While measures of hemostatic potential evaluated by viscoelastometry presently aid in guiding care in other trauma populations they have not been extensively assessed in patients with burns [5,6].

Within the spectrum of traumatic injuries those patients admitted to a burn unit represent a unique population. Previous studies of patient with burns have demonstrated a hypercoagulable state that is suggested to contribute to the occurrence of thromboembolic events [7–9]. In addition concern has been raised as to the presence of the acute trauma induced coagulopathy (TIC) resulting in increased bleeding with the performance of early excisions [10–12]. Schaden et al. recently suggested that perioperative correction of coagulation significantly reduces the use of allogenic blood products in patients undergoing excision of burns [10,13]. The predominance of previous studies of coagulation in patients with burns has been conducted in the first 24 h after hospital admission or upon admission to the ICU [7,14–16]. Thus these assessments have been made after initial clinical interventions, such as resuscitation and in some cases surgical procedures, that could alter the coagulation profile of the patient [11,17,18]. The timing of sample collection could contribute to the disparity in the literature concerning the coagulation status of the patient with burns [13,17,19].

Hypercoagulability has consistently been identified in patients with burns and associated with the occurrence of thromboembolic events, organ failure and mortality, but does not necessarily predispose the patient to these outcomes [8,9,14,20,21]. The hypercoagulability is a product of both markedly elevated coagulation factor activity and a reduced fibrinolytic activity [7,8,15,22].

In the general trauma patient population early trauma-induced coagulopathy (TIC) has been well described occurring in about twenty five percent of the most seriously injured patients [3,4]. Reports as to the occurrence of TIC in patients with burns have been highly variable with a reported incidence from 0% to 39% [17,23,24]. This variance has been suggested to be a function of the magnitude of total body surface area (TBSA) burned. However the association of TIC with burn surface area is questionable [23].

Also of interest is the possibility of differences between cutaneous burns compared to electrical injuries. Electrical injuries have been demonstrated to result in a greater overall tissue and solid organ injury and incidence of organ injury [25–27]. The increased tissue injury with electrical burns has been recognized as a risk factor for deep venous thrombosis resulting in a rate 1.8 times higher than thermally injured patients [25–27]. This difference in the rate of thrombotic events suggests differences in the hemostatic potential of these populations.

We proposed a patient based prospective observational study to determine the hemostatic potential of patients with burns (thermal and electrical) upon admission to the emergency department and contrast their condition with that of healthy controls and patients with other traumatic injuries. In addition we proposed to assess differences due to thermal versus electrical injury and to evaluate the effect of burn size on hemostasis.

1. Methods

1.1. Human subjects

This prospective observational study was conducted at Memorial Hermann Hospital Texas Medical Center, a Level 1 trauma center, and The University of Texas Health Science Center at Houston. Prior approval was obtained from The University of Texas Health Science Center at Houston Institutional Review Board (HSC-GEN-12-0059). Adult patients admitted between March 2012 and April 2015 who met the hospital criteria for the highest level of trauma team activation and research laboratory staff were available were eligible for inclusion in this study. Patients were excluded if they were younger than 16 years, pregnant, prisoners, enrolled in other studies, or declined to give consent. Patients from whom we could not obtain an initial blood draw were excluded from analysis. Consent was obtained from the patient or a legally authorized representative within 72 h of admission. A waiver of consent was obtained for those patients discharged or who died within 24 h. In the remaining cases in which consent could not be obtained, the patient was excluded from the study, and their blood samples were destroyed. Plasma was also collected from consented healthy donors to serve as controls under separate protocols (HSC-MS-09-0314; HSC-GEN-13-0059).

Upon hospital admission, 20 mL of blood was obtained. Blood was transferred into vacutainer tubes containing 3.2% citrate and inverted to ensure proper anticoagulation. Patient demographics, vital signs, standard laboratory values, mechanisms and severity of injuries were collected at the time of admission, while outcomes were collected from patient records.

1.2. Rapid THROMBELASTOGRAPHY (rTEG) assay

All rTEG specimens were run on a Thrombelastograph 5000 (Hemoscope Corporation, Niles, IL). Blood specimens for rTEG are routinely obtained as part of standard-of-care during the initial evaluation of all major trauma activations in the emergency department. Specimens were collected in citrated tubes, transported to the Emergency Department stat laboratory along with other trauma blood specimens. There, the citrate was immediately reversed with the addition of calcium chloride according to the recommendations of the manufacturer within the rTEG package insert. After this, standard rTEG was performed using tissue factor (TF) and kaolin as activators. The rTEG, similar to standard TEG, generates several values that describe the clotting cascade. The first value is the activated clotting time (ACT), the time in seconds between initiation of the test and the initial fibrin formation. Increases in ACT would indicate a factor deficiency or severe hemodilution. The split point (SP) represents the time to the initial fibrin formation. Similar to the ACT, the *r-value* (also known as the reaction time) expresses the time between the start of the assay and the beginning of clot formation. The *k-time* is the time needed to reach 20-mm clot strength; this is generally increased in states of hypofibrinogenemia. The *alpha (α) angle* is the slope of the tracing that represents the rate of