Paper - Basic Science

Paper Session: Polytrauma

Individual Hypercoagulable and Inflammatory Response Following Surgical Fixation of Femur Fractures

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Purpose: Patients with femur fractures have the highest incidence of deep vein thrombosis (DVT) (14.5%) and pulmonary embolism (PE) (4.4%) among patients with lower extremity fractures. The duration of increased venous thromboembolism (VTE) risk following a femur fracture is unknown and there is no consensus for recommended duration of VTE prophylaxis. Thromboelastography (TEG) is a whole blood test with growing evidence that an elevated maximal amplitude (MA) parameter, a measure of clot strength, is predictive of VTE in trauma patients. The objective of this study was to determine the duration of hypercoagulable state that ensues after treatment with a reamed intramedullary nail (rIMN) and to characterize systemic inflammatory response.

Methods: This is a prospective cohort pilot study of adult patients with femur fractures requiring surgical fixation (AO/OTA 32-A, B, and C). Eligible patients underwent serial blood draws at admission, 1 hour preoperatively (preop), 1 hour postoperatively (postop), every 24 hours postop until day 5, then at 2 and 6 weeks. Serial TEG analysis (TEG 6s; Haemonetics) and serum assays for pro- and anti-inflammatory cytokines were performed using a human cytokine array using a Bio-Plex 200 suspension array system (Bio-Rad). Serial plasminogen activator inhibitor-1 (PAI-1) was measured using an ELISA (enzyme-linked immunosorbent assay), as elevated PAI-1 is a risk factor for thrombosis. All patients received standardized VTE prophylaxis with enoxaparin. Hypercoagulability was defined as MA >65. Measurements at each time point were compared to admission MA using Wilcoxon signed-rank tests. Pearson's correlations were used to compare serial PAI-1 and MA values.

Results: 12 adult patients with femur fractures (6 female) with a median age of 28 years (range, 24-66) were included. Progressive hypercoagulability occurred with a median admission MA = 59.8 (range, 57.3-61.6) versys 71.0 (70.3-74.3) at 2 weeks (P = 0.002). Systemic inflammation was demonstrated by early elevation in interleukin (IL)-6, with a return to below admission levels by 2 weeks (median admission IL-6 = 45.6 (25.4-72.1) versus at 2 weeks 2.8 (1.8-6.8); P = 0.02). Serial C-reactive protein analysis demonstrated a more individualized response, with an increase following surgery and return to admission levels after 6 weeks. The patient who presented with the highest MA on admission experienced a PE and remained hypercoagulable at the 6-week follow-up. PAI-1 had a strong correlation with MA at 2 weeks (r = 0.80).

Conclusion: All patients had MA >65 at the 2-week follow-up, indicating a hypercoagulable state and increased VTE risk that may extend beyond commonly used VTE prophylaxis duration. There was an individualized systemic inflammatory response to treatment of femur fractures with rIMNs, which may affect duration of elevated PAI-1 and hypercoagulability. TEG can be used as a point-of-care tool to quantify duration of hypercoagulable state and the interaction of systemic inflammatory response to trauma and coagulopathy warrants further investigation.

OTA Grant