Serial Thrombelastography Identifies Distinct Pathophysiologic Responses Based on Fracture Type

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INTRODUCTION: Venous thromboembolism (VTE) risk remains high in patients with major orthopaedic fractures, despite thromboprophylaxis.[1] Thrombelastography (TEG) is a whole-blood assay which provides a comprehensive analysis of hemostasis from clot initiation to fibrinolysis (clot breakdown) and can identify orthopaedic trauma patients at increased risk for VTE[2,3]. Parameters included in TEG analysis include, kinetic time (k-time = rate of clot propagation), alpha-angle (a-angle = speed of clot formation, maximal amplitude (MA; measure of clot strength, where $\geq$ 65mm is an independent predictor of in-hospital VTE in a trauma population[2], and 30-minute lysis (LY30 = measure of clot breakdown). This study aimed to use serial TEG analysis to determine the distinct patterns of coagulopathy that emerge following major orthopaedic fractures.

METHODS: This is a single center prospective cohort study of patients with pelvic, acetabular, hip, or femoral diaphyseal fractures requiring surgical management. Patients underwent serial TEG analysis (TEG6s) at admission, pre-operatively, then on post-operative day one (POD1). Symptomatic and image-confirmed VTE events were captured. The majority were receiving low molecular weight heparin thromboprophylaxis. The Kruskal-Wallis test was conducted to compare TEG parameters between groups, with a post-hoc Dunn's test to adjust the p-values and identify pairwise group differences.

RESULTS: A total of 487 patients were included (86 pelvic or acetabular [PA] fractures, 283 hip fractures, and 118 femur fractures), with a median age of 69 years (IQR= [49.0,81.0]), and 52.2% being female. There were a total of 27 VTE events (5.5%), with 11 VTE in those with PA fractures (12.8%), 11 in those with hip fractures (3.9%), and five in those with femur fractures (4.2%). At admission and pre-op, patients with femur and PA fractures had significantly lengthened k-time compared to patients with hip fractures ($p < 0.05$; Figure 1), and on POD1, patients with femur fractures had increased k-time vs. hip fractures. At admission, pre-op, and POD 1, hip fracture patients had significantly increased alpha-angle vs. femur fractures. At admission and POD1, patients with PA fractures had significantly increased alpha angle, compared with femur fractures (Figure 2). At the pre-operative and POD 1 timepoints, patients with hip fractures had significantly lower LY-30 (worse fibrinolytic shutdown) compared to those with femur fractures.

DISCUSSION: This study demonstrated a high risk for VTE, particularly following pelvic, acetabular, and femur fractures (5.5 to 12.8%). Serial TEG analysis identified distinct pathophysiologic responses to injury type and surgical intervention. This study supports the need for further investigation into personalized thromboprophylaxis based on injury type and individualized response to injury and surgical intervention, and that the highest risk patients may benefit from serial TEG analysis to help inform personalized thromboprophylaxis. Limitations include the single center and observational study design; however, strengths include the large volume of serial TEG analysis across multiple major orthopaedic fracture patterns.

SIGNIFICANCE/CLINICAL RELEVANCE: Despite thromboprophylaxis, VTE was common after pelvic or acetabular fractures (12.8%) and femur fractures (5.5%). Serial TEG analysis identified distinct coagulopathy based on fracture type, suggesting a personalized approach to thromboprophylaxis that includes injury type may be warranted to help reduce the observed high rate of VTE events.

REFERENCES: 1. Falck-Ytter et al, CHEST, 2012. 2. Gary, et al, J Orthop Trauma, 2019. 3. Brown et al., J Orthop Trauma, 2020.
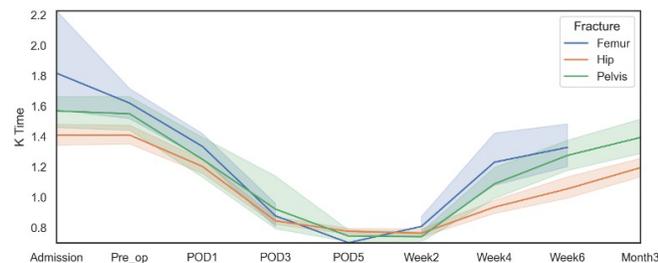
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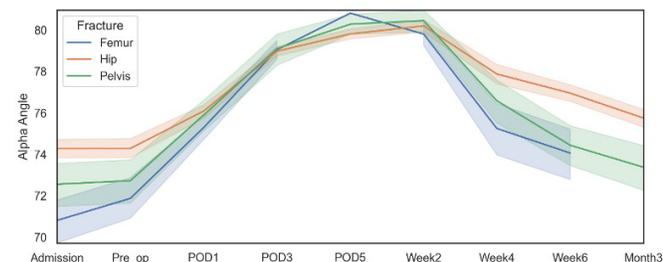

Figure 1: Serial kinetic time (k-time) from TEG analysis.

Figure 2: Serial alpha-angle from TEG analysis.