Prolonged Platelet Mediated Hypercoagulability Exists Following Primary Total Hip and Knee Arthroplasty

Daniyya Chaudhry[1,2], Paul Duffy MD FRCSC[2,3], Robert Korley MD FRCSC[2,3], Kelly Zarnke MD MSc FRCSC[2], Ahmed Negm MD PhD[2], Prism S. Schneider MD PhD FRCSC[2,3]
[1]Department of Graduate Studies, University of Calgary, Calgary, AB [2]Department of Medicine, University of Calgary, Calgary, AB
[3]Section of Orthopaedic Surgery, Department of Surgery, University of Calgary, Calgary, AB
Email: daniyya.chaudhry@ucalgary.ca

AUTHOR DISCLOSURES: Daniyya Chaudhry (N), Paul Duffy (N), Robert Korley (N), Kelly Zarnke (N), Ahmed Negm (N), Prism S. Schneider (5-Johnson & Johnson, Smith & Nephew; 8-Canadian Journal of Surgery, Osteoporosis Canada)

INTRODUCTION: Total hip and knee arthroplasty (THA, TKA) are effective surgical treatments for managing osteoarthritic pain and disability. However, these major orthopaedic surgeries result in increased risk for developing venous thromboembolism (VTE). Despite guidelines recommending thromboprophylaxis for 10 to 35 days, the rate of VTE, including deep vein thrombosis (DVT) and pulmonary embolism (PE), remains unchanged.

Platelets play a crucial role in clot formation through various pathways. As an antiplatelet agent, aspirin (acetylsalicylic acid [ASA]) targets the arachidonic acid (AA) pathway and is known for its cost-effectiveness and wide safety profile. While ASA has shown promise in preventing VTE events following THA and TKA, its superiority is still under investigation. Notably, ASA resistance is reported in 27% of the general population.

Thrombelastography (TEG) is a point-of-care tool that provides an assessment of individual coagulation profiles, where the maximal amplitude parameter (MA, a measure of clot strength) has been used to define hypercoagulability and to identify patients at risk for VTE. TEG-based Platelet Mapping (PLM) analysis can be used to assess platelet function and antiplatelet use, as the arachidonic acid maximal amplitude parameter (AA-MA) evaluates platelet inhibition. The study aimed to quantify the platelet contribution to hypercoagulability following THA and TKA and to examine platelet inhibition in ASA-treated patients. We hypothesized that some patients would demonstrate prolonged platelet mediated hypercoagulability and platelet hyperactivity, beyond thromboprophylaxis completion. Additionally, we hypothesized that TEG-PLM would effectively identify platelet inhibition resulting from ASA use.

METHODS: Following local Research Ethics Board approval, this prospective cohort study enrolled patients aged 50 or older who underwent a primary THA or TKA, excluding those with a history of VTE, therapeutic anticoagulant use, bleeding disorders, active malignancies, or rheumatoid arthritis. Whole blood samples were collected pre-operatively and at post-operative timepoints selected *a priori* (1-, 24-, 48- , and 72-hours, while in-hospital, and at 2-, 4-, 6-, and 12-week follow-ups) and analyzed using a TEG6s hemostasis analyzer (Haemonetics Corporation). Hypercoagulability was defined as an MA value of 65mm or greater, and platelet hyperactivity was defined as an AA-MA of 55mm or greater. Thromboprophylaxis was standardized to ASA 81mg daily for 28 days following THA and for 14 days following TKA. One-sample t-tests were used to compare mean MA and AA-MA values at each timepoint to the respective threshold. All statistical tests were two-sided, and a p-value < 0.05 indicated statistical significance.

RESULTS: Sixty patients (30 THA, 30 TKA; 34 (57%) female), with a mean age of 68 (± 8.4) years were included in this analysis. At the time of ASA thromboprophylaxis completion, 73% of THA patients remained hypercoagulable (MA=66.1 ± 3.3, $p = 0.12$) and 100% of TKA patients remained hypercoagulable (MA=69.7 ± 4.4, $p < 0.001$). By the 12-week follow-up, 33% of all patients remained hypercoagulable (MA=63.2 ± 5.6). With the initiation of ASA post-operatively, both THA and TKA showed a significant increase in platelet inhibition at 24-hours post-operatively (65.0%, $p < 0.001$; 74.7%, $p < 0.001$, respectively) compared to baseline (6.8%; 6.5%, respectively), which persisted for two weeks, while ASA was used daily (28.9%, $p < 0.001$; 33.6%, $p < 0.001$, respectively). At the time of ASA thromboprophylaxis completion, platelet hyperactivity was demonstrated in 64% (MA-AA=55.2 ± 11.7) and 50% (MA-AA=53.2 ± 12.9) of patients in the THA and TKA groups, respectively. We observed two VTE events in this cohort, with both patients having a PE after undergoing a THA. Both patients were significantly hypercoagulable at 24-hours (MA=64.1 and 64.4, $p < 0.05$) and at 48-hours (70.2 and 68.4, $p < 0.05$) post-operatively, and the MA values for these patients were significantly higher than those who did not have VTE events (61.3 ± 3.7 and 65.8 ± 1.7).

DISCUSSION: This study demonstrated persistent platelet-mediated hypercoagulability and platelet hyperactivity in the majority of patients following THA and TKA, beyond typical duration of thromboprophylaxis. Using serial TEG analysis in this population beyond thromboprophylaxis prescription for the first time, we also demonstrated that those who suffer VTE events following THA displayed significantly elevated MA values compared to those who do not experience a VTE complications. This suggests that elevated post-operative TEG-based MA values may be able to identify the highest risk patients, emphasizing the need for further research. Lastly, TEG-PLM analysis was able to q
uantify platelet inhibition over time, which may be important for evaluating the efficacy of ASA use as a thromboprophylaxis agent and for identifying those with ASA-resistance.

SIGNIFICANCE/CLINICAL RELEVANCE: To date, changes in baseline TEG parameters have not been measured serially following THA and TKA beyond nine days post-operatively, nor has platelet inhibition with ASA thromboprophylaxis use. This study offers novel insights into the safety and efficacy of ASA thromboprophylaxis in preventing VTE events in this population. This information can be used to inform the optimal duration of thromboprophylaxis following THA and TKA, based on TEG-based hypercoagulability, and may help identify the patients at highest risk for VTE.

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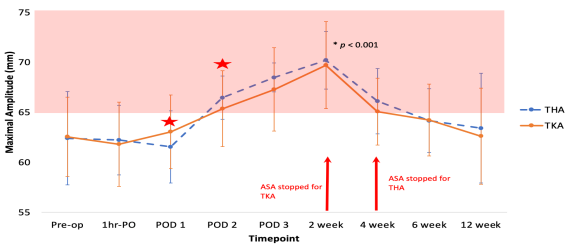

Figure 1. Mean maximal amplitude (MA) in patients undergoing primary total hip arthroplasty (THA) and total knee arthroplasty (TKA). The star indicates the mean MA of the patients with VTE events. *p< 0.001 indicates a significant difference between the threshold of 65 and the mean MA value.

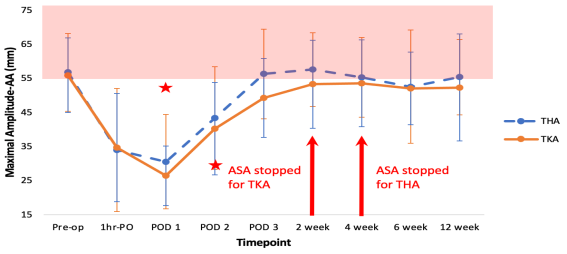

Figure 2. Mean arachidonic acid maximal amplitude (AA-MA) in patients undergoing primary total hip arthroplasty (THA) and total knee arthroplasty (TKA).