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# Improving assessment of thrombotic and bleeding risk in chronic kidney disease: Evaluation of thromboelastometry (TEM) profiles

Dr. Alyaa Abdelmaguid[1,2], Dr. Lara N. Roberts[3], Ms. Erika Manolo[1], Prof. Beverley Hunt[4], Dr. Kate Bramham[1,5]
*[1]King's Kidney Care, King's College Hospital NHS Foundation Trust, London, United Kingdom, [2]Medical Research Institute, Alexandria University, Alexandria, Egypt, [3]King's Thrombosis Centre, Department of Haematological Medicine, King's College Hospital NHS Foundation Trust, London, United Kingdom, [4]Thombosis and Haemostasis Centre, Guy's and St Thomas' NHS Foundation Trust, London, United Kingdom, [5]Department of Women and Children's Health, King's College London, London, United Kingdom*

Introduction:
Patients with chronic kidney disease (CKD) are at risk of both bleeding and thrombotic complications due to complex abnormalities in cellular, coagulation and endothelial components of the haemostatic pathway. Standard coagulation assays are unable to predict bleeding or thrombotic risk in patients with CKD. Comprehensive global assessment of haemostasis with thromboelastometry (TEM) are used in routine care in other clinical areas but their role in assessing the multifactorial defects in patients with CKD has not been explored.
Aims:
To assess the relationship between CKD severity and coagulation profile measured by TEM.
Methods:
Patients with CKD and healthy controls (HC) were invited to participate in a prospective observational study. Demographics, cause of renal disease and drug history were reported. Routine laboratory assays including renal function, full blood count and coagulation screen (International Normalised Ratio (INR) and Activated Partial Thromboplastin Time (APTT) were recorded. Citrated whole blood was evaluated by thromboelastometry using ROTEM® delta according to manufacturer's instructions. TEM included INTEM (IN), EXTEM (EX) and FIBTEM (FIB) test which reflect the activation of intrinsic and extrinsic pathway of coagulation and assesses fibrin contribution to clot formation, respectively. Parameters assessed were clotting time (CT), clot formation time (CFT), amplitude of the clot at 5 minutes after CT (A5) and maximum clot firmness (MCF).
Results:
120 CKD patients (10 Stage 2, 20 Stage 3, 20 Stage 4, 20 Stage 5, 20 established haemodialysis (HD), 10 new HD starters and 20 renal transplants) and 30 HC were recruited. Mean ages for the CKD and HC groups were 48 years (± 13) and 55 years (± 14) respectively (p=0.010).
There were no differences in INR and APTT between CKD patients and HC and no relationship with TEM parameters. There was no association between age and any of the TEM parameters. Results are presented in Table 1.
Overall, there was evidence of hypercoagulability in CKD patients compared to HC in TEM parameters where CFTIN,EX, A5IN,EX and MCFIN,FIB were significantly higher in CKD patients compared to HC ($p<0.01$). Haemoglobin, packed cell volume (PCV) and platelets were significantly lower in CKD patients than HC ($p<0.05$). Haemoglobin and PCV were negatively correlated with A5IN,EX (r=-0.50, -0.54 and r=-0.52, -0.57, respectively) and MCFIN,FIB (r=-0.49, -0.61 and r=-0.50, -0.62, respectively), and positively correlated with CFTIN,EX (r=0.47, 0.57 and r=0.49, 0.59, respectively) ($p<0.01$). However, platelets were positively correlated with A5IN,EX (r=0.44 and 0.40) and MCFIN (r=0.36) and negatively correlated with CFTIN,EX (r=-0.45 and -0.30) ($p<0.01$).
TEM profiles also suggested increasing hypercoagulability with worsening renal function demonstrated by negative correlations with eGFR and A5IN,EX (r= -0.33 and -0.36), MCFIN,FIB (r= -0.34 and -0.45) and a positive correlation between eGFR and CFTEX (r=0.41) ($p<0.01$).

Conclusion:
TEM suggests hypercoagulability in patients with CKD compared to controls despite the presence of anaemia and lower platelets, with more marked changes in patients on established HD. TEM is unlikely to be a useful tool for assessing bleeding risk but may have a role for predicting vascular access thrombosis or future cardiovascular risk, which cannot be assessed using standard coagulation tests.