

TITLE: COMPARISON OF VISCOELASTIC MEASURES OF COAGULATION FOLLOWING CARDIOPULMONARY BYPASS

AUTHORS: K. J. Tuman, M.D., R. J. McCarthy, Pharm.D., B. D. Spiess, M.D., A. D. Ivankovich, M.D.

AFFILIATION: Department of Anesthesiology, Rush-Presbyterian-St. Luke's Medical Center, Chicago, Illinois 60612

**Introduction:** Postoperative hemorrhage remains a major cause of morbidity after cardiopulmonary bypass (CPB). Treatment often remains empiric because of the need for immediate correction and the lack of availability of rapid intraoperative coagulation monitoring (except for activated clotting time (ACT)) at most institutions. Thrombelastography (TEG) and Sonoclot analysis (SONO) are measures of viscoelastic properties of blood and allow rapid evaluation of coagulation factor and platelet activity as well as overall clot integrity from a single blood sample.<sup>(1,2)</sup> This study was designed to compare TEG, SONO and routine coagulation tests (RCT) to determine what correlations exist between these various measures of coagulation as well as to assess which best predicted clinical hemostasis after CPB.

**Methods:** After approval by the institutional human investigation committee, 191 consenting adult cardiac surgical patients were studied (Group I). None had preoperative alterations in coagulation or liver function nor were receiving anticoagulant or antiplatelet medication. Before heparinization, samples of whole blood were obtained from all patients for RCT (PT, PTT, platelet count (PLT), fibrinogen (FIB), and ACT), TEG (Logos Scientific) and SONO (Sienco, Inc.). SONO and TEG were diatomaceous-earth activated in 91 (SONact and TEGact) and nonactivated in 100 patients. 42 patients prospectively felt to be at high risk for excessive postCPB bleeding (eg reoperations, valve or LV aneurysm surgery) had all of the above tests repeated after protamine was administered according to the method of Bull, et al.<sup>(3)</sup> The presence of abnormal bleeding (>150cc/hr for at least 2 hrs) in the first 8hr postCPB was noted. The TEG variables R, K,  $\alpha$ , MA and  $A_{60}$  as well as SONO variables  $T_1$ ,  $R_1$ ,  $R_2$ ,  $T_2$ , peak impedance and R3 were measured. Pearson correlation coefficients between TEG, SONO, and RCT variables were determined to measure the degree of association between pairs of variables (significance accepted at  $p \leq 0.001$ ). The % correct prediction of postCPB hemostasis was determined for TEG, SONO and RCT. Abnormality of each parameter was defined as 20% change toward hypocoagulability from the normal preCPB values. The chi-square test was used to compare predictive value of the various coagulation tests.

**Results:** Before CPB there were significant correlations between SONact and TEGact that reflect platelet-fibrin interaction and platelet function (MA,  $A_{60}$ ,  $\alpha$  and  $R_1$ , Peak,  $R_3$ ). When not surface-activated the only significant correlations between TEG and SONO reflect the initial phases of clot formation (R,  $\alpha$  and  $T_1$ ,  $R_1$ ). There were weaker but significant correlations between TEGact parameters (MA and  $A_{60}$ ) with PLT, and ( $\alpha$ ) with FIB. There was a significant correlation between SONOact

$T_1$  and ACT. Nonactivated SONO parameters correlated only weakly with RCT, whereas nonactivated TEG parameters had a greater number of significant correlations with RCT. After CPB, the only significant correlations were between  $T_1$  and ACT as well as between SONOpeak and ( $\alpha$  and MA).

Nine patients in Group 2 had excessive chest tube drainage, but none required reoperation. All had blood component therapy guided by postCPB TEG and SONO analysis in conjunction with RCT. TEG and SONO were both 100% accurate in predicting bleeding in these 9 patients, and overall, both tests were significantly better predictors of postoperative hemorrhage than RCT.

	% OVERALL CORRECT	% FALSE NEGATIVE	% FALSE POSITIVE
TEG*	88	0	15
SONO*	74	0	33
RCT	33	44	73

$p < 0.001$ , \*TEG & SONO significantly better than RCT

**Discussion:** More accurate, rapid prediction of clinical hemostatic function will lessen morbidity associated with bleeding after cardiopulmonary bypass as well as the risks of empiric treatment with protamine, FFP and platelet concentrates. The adverse effects of hemodilution, mechanical trauma, hypothermia and protamine on platelet function are major contributors to abnormal hemostatic function after CPB and may not be detected by RCT which do not measure platelet-fibrin interaction nor platelet function. These viscoelastic determinants of clot strength may be abnormal after cardiopulmonary bypass and this explains the lack of correlation of RCT with TEG or SONO after cardiopulmonary bypass. We conclude that TEG and SONO are superior to RCT in predicting functional defects in coagulation. In addition to providing rapid, easily obtainable information on coagulation factor function, they allow assessment of platelet abnormalities and clot integrity. Further studies are underway to evaluate the effectiveness of viscoelastic measures of coagulation in guiding coagulation therapy after cardiopulmonary bypass.

**References:**

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