The potential of thromboelastometry for the diagnosis and treatment of coagulopathy in patients undergoing craniotomy due to isolated traumatic brain injury (TBI)

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Background: Craniotomy to treat traumatic brain injury is a major neurosurgical intervention associated with significant bleeding. Adequate assessment of coagulation status is crucial as coagulopathy (CGP) in patients with TBI is prevalent. Rotational thromboelastometry (ROTEM) is a coagulation assay proven to be useful in trauma and major surgery.

Aim of the Study: To compare preoperative standard coagulation test (SCT) and ROTEM results and evaluate their efficacy to predict intraoperative blood loss in neurosurgical isolated TBI patients.

Materials and Methods: We performed a prospective, observational pilot study in a cohort of 32 adult patients requiring urgent craniotomy. Isolated severe TBI was defined as Abbreviated Injury Scale for head (AIS_{head})>3 and AIS_{extracranial}<3. Blood was collected preoperatively and analyzed with SCT (prothrombin time index [PTI], partial thromboplastin time [APTT], platelet count [PLT], fibrinogen concentration [Fib.]), and ROTEM assays (EXTEM, INTEM, FIBTEM). CGP was defined as any abnormality on ROTEM and/or PTI<70%, APTT>38s, Fib.<1.5g/L, PLT<100*10⁹/L. Significant blood loss was considered>300mL. Study patients were allocated into low blood loss (LBL) and significant blood loss (SBL) groups, and comparative analysis was performed.

Results and Discussion: Overall incidence of CGP was 40.6% (N=13), 31.3% (N=10), and 53.1% (N=17) according to SCT; ROTEM; and SCT/ROTEM, respectively. Median blood loss in study cohort was 350 (Q1–Q3, 300–500)mL. Significant ROTEM parameter differences (CT, CFT, alpha angle, A10, MCF) between significant and low blood loss groups were detected, whereas according to SCT, only Fib. differed (table 1). Despite Fib.>1.5g/L in all cases, there were 4 patients (12%) with impaired clot firmness according to ROTEM findings (figure 1). Significant relationship between CGP in ROTEM as well as in ROTEM/SCT, and SBL was detected. Sensitivity and specificity of CGP in ROTEM to predict SBL was 50% and 87.5%. CGP in SCT/ROTEM predicted SBL with 68.8% sensitivity and 75% specificity.

Conclusion: ROTEM may aid in predicting blood loss, and can be superior in characterizing and optimizing coagulation, especially if SCT values are marginal. Lower target for fibrinogen (1.5g/L) in TBI may be too low.

Table 1. Coagulation parameter comparison between low and significant blood loss groups

	LBL group, n = 16	SBL group, n = 16	p-value
	Expressed as median (Q1–Q3)		
Admission GCS	10 (5.5–13.5)	5.5 (4–10)	0.034*
Standard laboratory tests			
Hemoglobin, g/L	127.5 (120.25–142.75)	135.5 (119.5–145.5)	0.692
Platelet count, *10 ⁹ /L	190 (148.25–257)	183 (103–263.75)	0.749
PTI, %	99.5 (83.5–117.75)	92.5 (79–109.25)	0.611
INR	1.01 (0.96–1.08)	1.03 (0.96–1.11)	0.650
APTT, s	31.6 (28.4–34.63)	31.25 (29.2–32.9)	0.763
Fibrinogen, g/L	3.83 (3–4.2)	2.32 (1.92–2.86)	0.006*
Thromboelastometry			
INTEM CT, s	156 (138.75–170.5)	155 (135.25–198.75)	0.763
INTEM CFT, s	78.5 (64.25–99)	96.5 (80–141.75)	0.055
INTEM alpha angle	74.5(73–77.75)	72 (66–74)	0.041*
INTEM A10, mm	55 (47.5–60)	48 (40.5–51.75)	0.010*
INTEM MCF, mm	62.5 (56.5–66.75)	56.5 (50.25–61.5)	0.010*
INTEM ML, %	4 (2.25–7)	3.5 (2–6.75)	0.582
EXTEM CT, s	56 (50.75–59.5)	69.5 (53.25–79)	0.033*
EXTEM CFT, s	79 (59–107.25)	104.5 (78.5–152.25)	0.016*
EXTEM alpha angle	77.5 (72–78)	70.5 (61.25–76)	0.010*
EXTEM A10, mm	55 (49.5–62.5)	47.5 (40.25–52)	0.004*
EXTEM MCF, mm	63 (57.25–67.75)	54.5 (50.5–60.75)	0.004*
EXTEM ML, %	4.5 (3.25–7.75)	5 (2.25–6)	0.676
FIBTEM CT, s	53 (47.25–72)	63 (47.5–83.75)	0.534
FIBTEM A10, mm	20 (15.25–24)	13 (8–19.75)	0.008*
FIBTEM MCF, mm	22.5 (17–29.25)	15.5 (8.25–22)	0.006*
FIBTEM ML, %	0 (0–3)	0.5 (0–3)	0.225
Coagulopathy (%)			
CGP acc. to SCT	5 (31.3%)	8 (50%)	0.28
CGP acc. to ROTEM	2 (12.5%)	8 (50%)	0.022*
CGP acc. to ROTEM and/or SCT	5 (31.3%)	12 (75%)	0.013*

*Significant differences between groups, p<0.05.

GCS – Glasgow coma score, CT – clotting time, CFT – clot formation time, A10 – clot amplitude after 10 minutes, MCF – maximum clot firmness, ML – maximum lysis.

Non-parametric Mann-Whitney U and Pearson Chi-square tests were used as applicable.

Figure 1. ROTEM (EXTEM and FIBTEM) tracings reflecting low clot firmness due to insufficient fibrinogen contribution.