How can ROTEM® testing help to detect and manage hypercoagulability and/or thrombosis?
Thromboelastogram examples

Normal patient

Hypercoagulable patient

Courtesy of Dr. J. Picard, CHU Grenoble, France
1. Can ROTEM® detect hypercoagulability and/or thrombosis:
   - in cardiac patients?
   - in non-cardiac patients?
   - in cancer patients?
   - in obese patients?
   - in DVT patients?
   - in patients with Behcet's disease?
   - in thalassemic patients?

2. Can ROTEM® detect differences in coagulability during pregnancy?

3. Can ROTEM® predict thrombotic complications?

4. Can ROTEM® prevent thrombotic complications?

5. Does the ROTEM® give faster results than conventional lab tests?
Can ROTEM® detect hypercoagulability and/or thrombosis?

**In cardiac patients:**

“Hypercoagulation is not detected in clinical practice with routinely performed coagulation tests.”

“In the group of patients with thrombosis the ROTEM® parameters CFT, alpha-angle and MCF were significant differences compared with control group.”

“The CFT in EXTEM and INTEM assays was significantly shorter, the MCF and the alpha-angle in EXTEM, INTEM and FIBTEM assays were significantly higher when compared to the control group.”

“The ROTEM® parameters (CFT, MCF) demonstrated excellent value for sensitivity, specificity, PPV and NPV…”

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test</th>
<th>Cut off</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFT</td>
<td>EXTEM</td>
<td>≤ 98 sec</td>
<td>100 (%)</td>
<td>43 (%)</td>
<td>46</td>
<td>100</td>
</tr>
<tr>
<td>MCF</td>
<td>EXTEM</td>
<td>≥ 68 mm</td>
<td>100 (%)</td>
<td>41 (%)</td>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>CFT</td>
<td>INTEM</td>
<td>≤ 93 sec</td>
<td>100 (%)</td>
<td>47 (%)</td>
<td>48</td>
<td>100</td>
</tr>
<tr>
<td>MCF</td>
<td>INTEM</td>
<td>≥ 68 mm</td>
<td>100 (%)</td>
<td>41 (%)</td>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>MCF</td>
<td>FIBTEM</td>
<td>&gt; 12</td>
<td>88.2 (%)</td>
<td>62.9 (%)</td>
<td>69.8</td>
<td>84.6</td>
</tr>
</tbody>
</table>

“Rotation thromboelastography analysis demonstrated to be a reliable method for diagnosis of hypercoagulable state”.

**In non-cardiac patients:**

“Rotational thrombelastography using INTEM and EXTEM prior to non-cardiac surgery is significantly different in patients who develop postoperative thrombembolic complications.”

“Patients with thrombembolic complications specifically had significantly lower clot formation time (CFT), higher alpha angle and larger maximum clot firmness (MCF).”

“INTEM clot firmness at 10 minutes (A10) was the best predictor of thromboembolic complications, with an ROC area under the curve of 0.751.”

“There was no significant difference for any parameter using FIBTEM activator, which excludes platelet interaction.”

“Rotational thrombelastography may be able to detect patients who are susceptible to postoperative thrombembolic complications.”

“…, standard clotting tests such as PTT and INR reflect the time to fibrin formation only, and, like the clotting time, were not different in patients with and without thromboembolic complications.”

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Rotational thromboelastography for assessment of hypercoagulability and thrombosis in patients with cardiovascular diseases.


Rotational thromboelastometry predicts thromboembolic complications after major non-cardiac surgery.

Can ROTEM® detect hypercoagulability and/or thrombosis?


In cancer patients:
“Hypercoagulability is difficult to detect by standard coagulation tests in cancer patients unless the platelet count and fibrinogen concentration is markedly increased. TEG is a sensitive method that is able to identify and measure hypercoagulability, which is not detected by routine laboratory tests.”

“…our data demonstrates thromboelastographic signs of hypercoagulability in patients with solid tumors. ROTEM® is able to identify the contribution of fibrinogen and platelets to clot strength in this patient population.”

“The results of the present study yielded significant hypercoagulability in cancer patients, as detected by ROTEM®.”

“In comparison with the healthy controls, there was a significant decrease in CFT and an increase in MCF by all assays (INTEM, EXTEM, FIBTEM, APTEM) in the study group while a significant decrease in CT was remained for EXTEM, APTEM in patients compared with controls.”


“Preoperative hypercoagulability can be identified with ROTEM® and is associated with lymphovascular/perineural invasion and advanced-staged disease in cancer. Compared with other tumor types, pancreatic adenocarcinomas have the greatest risk for hypercoagulability.”

“The present study showed that 31% of patients with intra-abdominal malignancies were hypercoagulable by ROTEM®.”

“Overall, 86% of hypercoagulable patients had EXTEM abnormalities, whereas 45% and 32% had abnormalities with FIBTEM and INTEM.”

“The most common abnormalities were in clot strength (...) and clot kinetics (...).”
Can ROTEM® detect hypercoagulability and/or thrombosis?

In cancer patients:
“In spite of their recognized risk of thrombosis, patients with myeloproliferative neoplasms (MPN) show little or no abnormalities of traditional coagulation tests.”

“…patients with MPN display a procoagulant imbalance detectable by thrombin generation and thromboelastometry.”

“CFT was shorter and MCF was greater in patients than controls.”

Global coagulation in myeloproliferative neoplasms.

Persistence of hypercoagulable state after resection of intra-abdominal malignancies.

“The data showed that, before surgery, 40% were hypercoagulable. After surgical resection, an even higher proportion became hypercoagulable, reflected by more rapid clot formation time (low CFT, high alpha) and higher MCF. By week 1, 86% (n= 30) had abnormal ROTEM® values, including 17 of 21 (81%) who had normal coagulation profiles preoperatively. Most (n= 30 [86%]) remained hypercoagulable at 3 to 4 weeks. These results support the conclusion that surgical resection does not immediately reverse tumor-induced hypercoagulability and support the use of postdischarge thromboprophylaxis regimens.”

Long-term coagulation changes after resection of thoracoabdominal malignancies.

“The ROTEM® demonstrated increased hypercoagulability postoperatively, which returned to baseline in long-term follow-up.”

“Maximum clot firmness (MCF) in the intrinsic, extrinsic, and fibrinogen pathways increased immediately postoperatively and then decreased by 9.2 ± 4.1 months.”

“Cancer patients at risk for VTE can be identified with a point-of-care ROTEM® test and may benefit from additional anticoagulation.”
Can ROTEM® detect hypercoagulability and/or thrombosis?

Hypercoagulability detected by whole blood thromboelastometry (ROTEM®) and impedance aggregometry (MULTIPLATE®) in obese patients.

In obese patients:
“...in INTEM and EXTEM tests MCF and AUC were significantly increased in III degree obese compared with controls. MCF in FIBTEM was significantly higher in I, II and III degree obesity than controls.”

“A significant difference in platelet aggregation was found between III degree obese subjects and healthy controls in each of the tests considered.”

“Point-of-care tests can be used to assess the degree of hypercoagulability and hyperaggregability in obese patients”

In DVT patients:
“...maximum clot firmness and the area under curve values, which are expected to better correlate with the hypercoagulable state in the acute phase of deep vein thrombosis, were significantly higher in patients than in controls. As expected, fibrinogen was shown to be one of the main determinants of the hypercoagulability in rotation thrombelastogram assays.”

“The new rotation thrombelastogram thromboelastometry is a useful tool to detect acute deep vein thrombosis-related hypercoagulability”

Whole blood coagulation assessment using rotation thrombelastogram thromboelastometry in patients with acute deep vein thrombosis.

Whole blood rotation thromboelastometry (ROTEM®) profiles in subjects with non-neoplastic portal vein thrombosis.

“...Maximum Clot Firmness (MCF) in FIBTEM was significantly higher in non-cirrhotic PVT patients (19 mm) than in healthy volunteers (11 mm). The amplitude of MCF in FIBTEM revealed to be a useful tool to discriminate non-cirrhotic subjects with PVT from those without thrombotic events.”

“There were no significant differences in ROTEM® profile, as for INTEM, EXTEM, and NATEM assays... between PVT patients, both with and without cirrhosis, and control groups”
Can ROTEM® detect hypercoagulability and/or thrombosis?

The role of hemostatic mechanisms in the development of thrombosis in Behcet’s disease: an analysis by modified rotation thromboelastogram (ROTEM®).

In patients with Behcet’s disease (BD):
“In INTEM assay, MCF value was significantly increased, and CFT value was decreased in BD patients compared with the control group. In the EXTEM assay, there was a similar significant increase in MCF value and a decrease in CFT value in BD patients compared with the control group. The results of our study indicated that primary hemostatic mechanisms which can be detected by ROTEM may play a role in the development of thrombosis in patients with BD.”

In thalassemic patients:
“The mechanisms responsible for the increased thrombotic risk associated with thalassemia are still unclear.”

“All the thromboelastometry parameters determined in whole blood (including shortened clotting time and clot formation time, and increased maximum clot firmness), were consistent with hypercoagulability, especially in splenectomized patients. Conversely, thrombin generation as determined in platelet-poor plasma was not.”

Hypercoagulability in splenectomized thalassemic patients detected by whole-blood thromboelastometry, but not by thrombin generation in platelet-poor plasma.

Thromboelastometry profile in children with beta-thalassemia.

“Maximum clot firmness (MCF) was significantly higher in subjects with beta-thalassemia than in controls on EXTEM and INTEM analysis…”

“Of the patients with beta-thalassemia, MCF was higher and clot formation time was shorter in splenectomized subjects than in non-splenectomized subjects on EXTEM and INTEM…”

“TEM profiles in beta-thalassemic children were more hypercoagulable compared with controls.”
Can ROTEM® detect differences in coagulability during pregnancy?

Assessment of coagulation in the obstetric population using ROTEM® thromboelastometry.

During normal pregnancy:
“ROTEM® thromboelastometry clearly demonstrates the hypercoagulability of pregnancy. Formal reference ranges for ROTEM® that may be potentially useful in the haemostatic management of the parturient are presented.”

“...thromboelastometry exhibited significantly lower INTEM CT (7.3%), INTEM CFT (11.1%) and EXTEM CFT (18.0%) in the pregnant group. MCF values were significantly higher (INTEM (10.9%), EXTEM (10.6%) and FIBTEM (47.1%)) in the pregnant group compared to the non-pregnant group.”

“CT and CLI30 were not significantly modified during pregnancy whereas MCF, CA5 and CA15 (INTEM, EXTEM, FIBTEM) increased significantly between the second and third trimesters...”

“ROTEM® analysis showed a marked increase in coagulability during normal pregnancy”.

In case of preeclampsia:
“Preeclamptic women showed a significantly more rapid propagation phase in EXTEM assay than controls (CFT 62 ± 15 vs. 75 ± 15 s and alpha-angle 78 ± 4 vs. 75 ± 4°). Moreover, MCF was significantly higher and ML significantly lower in women with PE than in healthy pregnant women.”

“ROTEM® profiles in women with PE were characterized by an increased tissue factor driven clot propagation capability. In addition, higher clot stability due both to the increase in clot firmness and the decrease in blood fibrinolysis was observed.”

Coagulation assessment by rotation thrombelastometry in normal pregnancy.

Whole blood thromboelastometry profiles in women with preeclampsia.
Can ROTEM® detect differences in coagulability during pregnancy?

In case of preeclampsia:
“Women developing preeclampsia showed significantly higher platelet aggregation response compared to controls in early and late pregnancy.”

Calculation of positive predictive value for ADP- and arachidonic acid-induced whole blood platelet aggregometry at a cutoff value of 9000 Ohm x sec:

<table>
<thead>
<tr>
<th></th>
<th>ADP</th>
<th>Arachidonic acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 25 weeks of gestation</td>
<td>Sensitivity (%)</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Sensitivity (%)</td>
<td>100</td>
</tr>
<tr>
<td>After 25 weeks of gestation</td>
<td>Sensitivity (%)</td>
<td>81.5</td>
</tr>
<tr>
<td></td>
<td>Sensitivity (%)</td>
<td>47.4</td>
</tr>
</tbody>
</table>

After delivery:
“Coagulation screens as well as thromboelastometry suggest a persistent hypercoagulation during the first 3 weeks after delivery.”

“ROTEM® revealed low clotting time (CT) at predelivery and continued to be low till day 7. Clot formation time (CFT) significantly low till day 25. Maximum clot firmness, alpha angle and amplitude at 20 minutes were raised till day 19.”

Early detection of preeclampsia by determination of platelet aggregability.

Haemostatic changes in the puerperium ‘6 weeks postpartum’ (HIP Study) — implication for maternal thromboembolism.
Can ROTEM® predict thrombotic complications?

Rotational thromboelastometry predicts thromboembolic complications after major non-cardiac surgery.

“Rotational thrombelastography using INTEM and EXTEM prior to non-cardiac surgery is significantly different in patients who develop postoperative thromboembolic complications.”

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“Rotational thrombelastography may be able to detect patients who are susceptible to postoperative thromboembolic complications.”

Can rotational thromboelastometry predict thrombotic complications in reconstructive microsurgery?

“In most patients, the anticoagulatory regimen is probably not the most crucial aspect of a successful free tissue transfer. In selected high-risks patients, however, it might have the potential to tip the scale.”

Thirteen out of the 14 thromboembolic flap losses (92%) occurred in the 134 patients with an EXTEM MCF of 66 and higher (9.7% flap loss rate).

For calculating the functional fibrinogen to platelet ratio (FPR) the MCF of FIBTEM x 100 was divided by the MCF of INTEM, resulting in a numeric ratio.

“Based on our findings, patients with a hypercoagulable ROTEM® (EXTEM or INTEM MCF >72 mm or FIBTEM >25 mm) or with a FPR of >43 are at a significantly higher risk for thrombotic flap loss (OR 3.75 and 7.9, respectively).”

“Especially in patients with recurrent thromboembolic events or even thromboembolic flap loss, ROTEM® can verify pathological changes in coagulation, enabling a targeted therapy for those patients.”
Can ROTEM® prevent thrombotic complications?

Point-of-Care testing: A prospective, randomized clinical trial of efficacy in coagulopathic cardiac surgery patients.

“The current investigation aimed to study the efficacy of hemostatic therapy guided either by conventional coagulation analyses or point-of-care (POC) testing in coagulopathic cardiac surgery patients” …”Thromboelastometry and whole blood impedance aggregometry have been performed in the POC group”.

“...the incidence of thrombotic complications was 2 of 50 (4%) in the conventional group versus 0 of 50 in the POC group.”

First-line therapy with coagulation factor concentrates combined with Point-of-Care coagulation testing is associated with decreased allogeneic blood transfusion in cardiovascular surgery: A retrospective, single-center cohort study.

“The data of this retrospective, cohort study including 3,865 cardiovascular patients demonstrate that implementation of a coagulation management algorithm based on first-line therapy with specific coagulation factor concentrates combined with POC testing was associated with significantly and substantially decreased allogeneic blood transfusion incidence (primary endpoints) and requirements, as well as with decreased incidence of thrombotic/thromboembolic adverse events.”

“The incidence of composite thrombotic/thromboembolic adverse events decreased (3.19 vs. 1.77%).”

Alternatives to blood transfusion.

“A retrospective cohort study done at University Hospital Essen, Germany, reviewed 3865 patients undergoing cardiac surgery and the incidence of intraoperative allogeneic blood transfusion before and after implementation of point-of-care testing assays including activated clotting time, thromboelastometry, and whole-blood impedance aggregometry ...”.

“Algorithm implementation after point-of-care testing allowed for the transfusion of plasma, platelets, fibrinogen concentrate, and prothrombin complex concentrate only after abnormal point-of-care testing values were obtained. Findings showed a significant decrease in blood and plasma transfusions, a significant increase in platelet, fibrinogen concentrate, and prothrombin complex concentrate administration, and reduction by 50% of rates of re-operation for bleeding and for thrombotic complications.”

“To avoid thrombotic complications, care should be taken to avoid excessive treatment via accurate monitoring of patients’ coagulation status.”
Does the ROTEM® give quicker results than conventional lab tests?

Fibrinogen function after severe burn injury.

Rapid and correct prediction of thrombocytopenia and hypofibrinogenemia with rotational thromboelastometry in cardiac surgery.

A comparative evaluation of rotation thromboelastometry and standard coagulation tests in hemodilution-induced coagulation changes after cardiac surgery.

Early thromboelastometric variables reliably predict maximum clot firmness in patients undergoing cardiac surgery: a step towards earlier decision making.

Using reagent-supported thromboelastometry (ROTEM®) to monitor haemostatic changes in congenital heart surgery employing deep hypothermic circulatory arrest.

“Turn-around time from blood sampling until data reporting was 1 h for standard coagulation testing and 20 min for ROTEM® on average.”

“Turnaround time for ROTEM® tests, 12 minutes, was comparable with emergency requests for platelet count, 13 minutes, and shorter than emergency requests for fibrinogen levels, 37 minutes.”

“EXTEM A5 and FIBTEM A5 showed an excellent correlation with A10 and MCF.”

“ROTEM® variables demonstrated clinically relevant correlations with PLT counts and fibrinogen levels. Decreasing levels of fibrinogen can be quickly determined (<15-20 min) using FIBTEM.”

“We recommend the use of Clot Firmness after 5 or 10 min to allow earlier assessment and potential therapeutic action.”

“ROTEM® results were available within 15 min and therefore much faster than standard tests.”
For further literature please visit our website:

www.rotem.de

Discover a catalogue of influential literature on bleeding management and thrombosis.

Thromboelastometry.

The proven ROTEM® technology provides an overview about the coagulation status within 10 minutes.