



Utilità del trombo-elastogramma nel paziente critico (inquadramento generale)

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Rianimazione e Terapia Intensiva
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Dichiaro di non avere alcun conflitto di interessi relativo all'argomento in oggetto.

DICHIARAZIONE DI INSUSSISTENZA
DI SITUAZIONI, ANCHE POTENZIALI, DI CONFLITTO DI INTERESSE
(ART. 53 D.LGS. N. 165/2001 COME MODIFICATO DALLA LEGGE 190/2012)

The TEG system is a real-time analyzer of **whole blood** measuring the **visco-elastic properties** of the hemostasis process and allowing for **individualized goal-directed therapy**. It provides rapid, comprehensive and accurate identification of an individual's hemostasis condition, in a laboratory or in the context of near-patient testing, which allows clinicians to drive personalized, clinically and **economically sound treatment and monitoring decisions**.

viscoelasticità

La viscoelasticità è un modello matematico che descrive un **materiale che si comporta in modo intermedio tra un solido elastico e un fluido**. Costituisce un modello ampiamente studiato in reologia.

tromboelastografia



Valutazione **dinamica** di **tutto** il processo emocoagulativo entro 30 minuti circa.

Primi dati diagnostici orientativi già dopo 8 - 10 minuti circa

- **Cardiac surgery:** TEG allows a reduction in blood product usage
- **Patients on antiplatelet medications:** TEG helps to stratify bleeding risk and reduce time to schedule **coronary artery bypass graft**
- **TEG is more predictive than conventional coagulation tests (CCTs) in anticipating massive transfusion in TRAUMA** delivers results faster for trauma physicians and guides **specific blood products** and **'high risk' drugs** to stop bleeding in trauma patients and **predicts those at high risk of pulmonary embolism (PE).**
- **TEG helps to stratify risk of thrombotic events** by helping clinicians determine which patients are at risk of thrombotic events and **to determine the effectiveness of P2Y12 antagonists (es. clopidogrel)**
- **TEG helps to stratify risk of deep vein thrombosis and PE** in ICU patients and improves adequate use of expensive pharmaceuticals (rFVIIa, fibrinogen).

Focus su ...

- 1. Emorragia in atto (in linea generale se il paziente ha un TEG patologico, ma non sanguina, si continua il monitoraggio clinico-strumentale) .**
- 2. Trauma**
- 3. Emorragia post-partum**
4. Gestione trombosi (condizioni di ipercoagulabilità)
5. Coagulopatie ereditarie
6. Malattie onco-ematologiche (leucemia mielo-monocitica)

Di particolare interesse è la gestione del paziente EMORRAGICO (che sanguina attivamente).

ATTENZIONE AL RISCHIO TROMBOTICO SECONDARIO AL TRATTAMENTO FARMACOLOGICO

Emorragia : farmaci

- Plasma fresco congelato
- Emazie concentrate
- Piastrine
- Fibrinogeno
- Fattori della coagulazione (fattori II, VII, IX, X, proteina C e proteina S).
- Acido tranexamico

Effetti collaterali delle emotrasfusioni

- **TRALI** : **T**ransfusion-**R**elated **L**ung **I**njury
- **TACO** : **T**ransfusion-**R**elated **C**irculatory **O**verload

Test tradizionali

- Turn-around time lungo (45-60 min)
- Valutazione limitata alla fase iniziale della coagulazione
- In vitro (plasma)
- Non adeguato a valutare il paziente acuto
- Eseguito da laboratorio

Tromboelastografia

- Turn-around time breve (15-20 min)
- Valutazione globale del processo emostatico
- In vivo (sangue intero)
- Possibilità di terapia mirata
- Richiede personale esperto

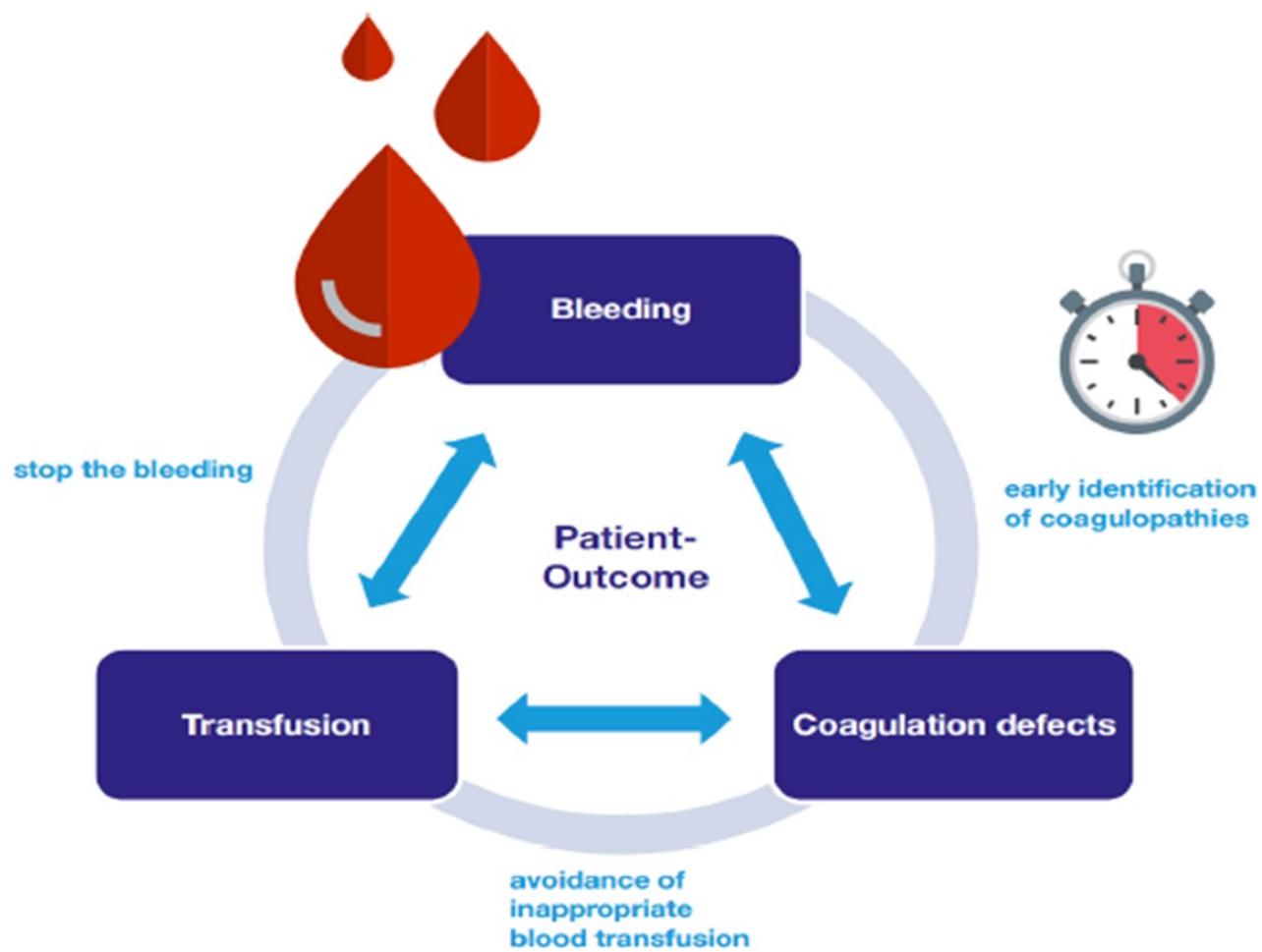


- Tempo di protrombina
- Tempo di tromboplastina
- Fibrinogeno
- D-dimero
- INR

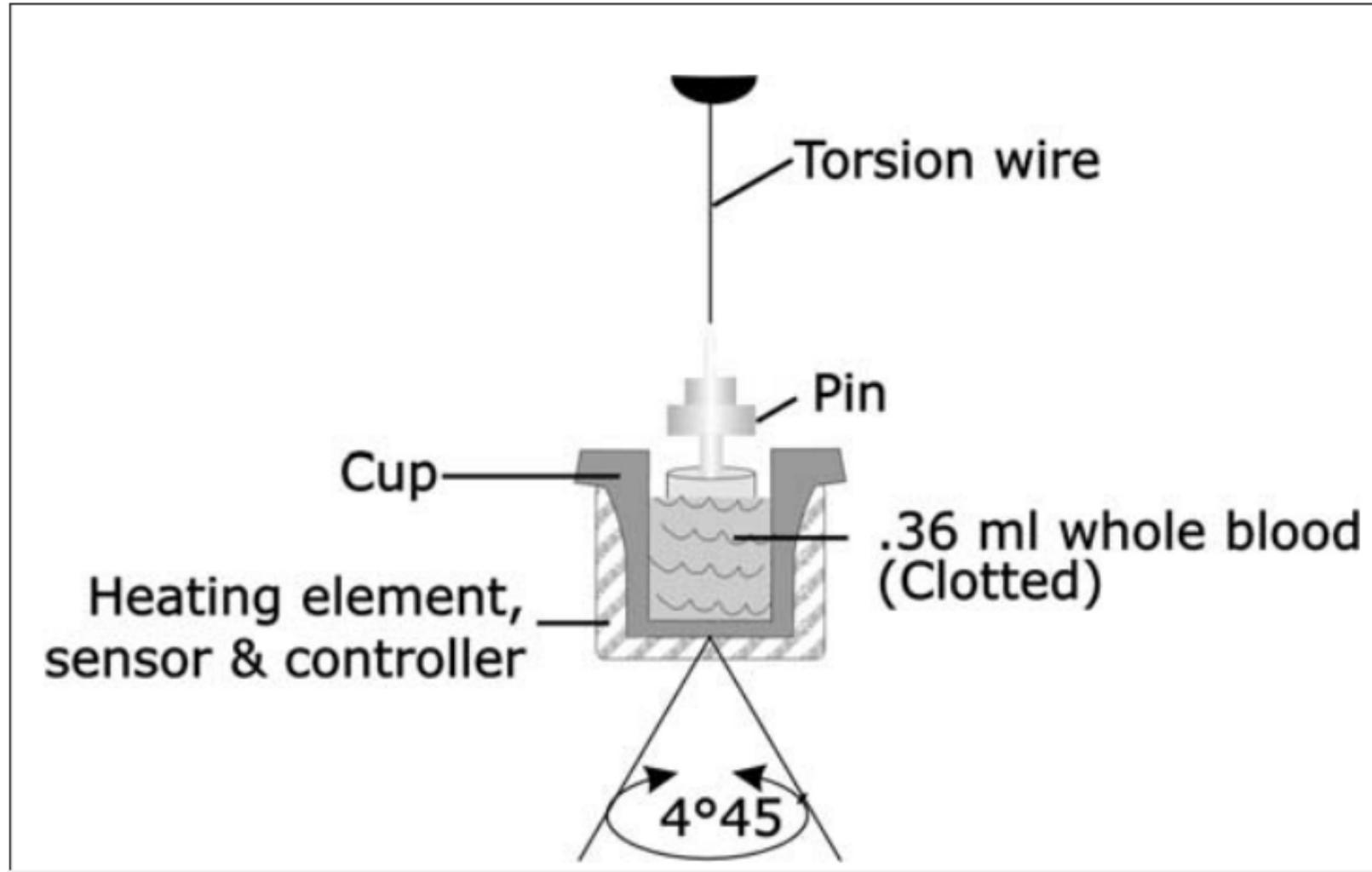
Nessuna informazione relativa alla FORMAZIONE DEL COAGULO , valutazione fondamentale durante una situazione di urgenza (emorragia)

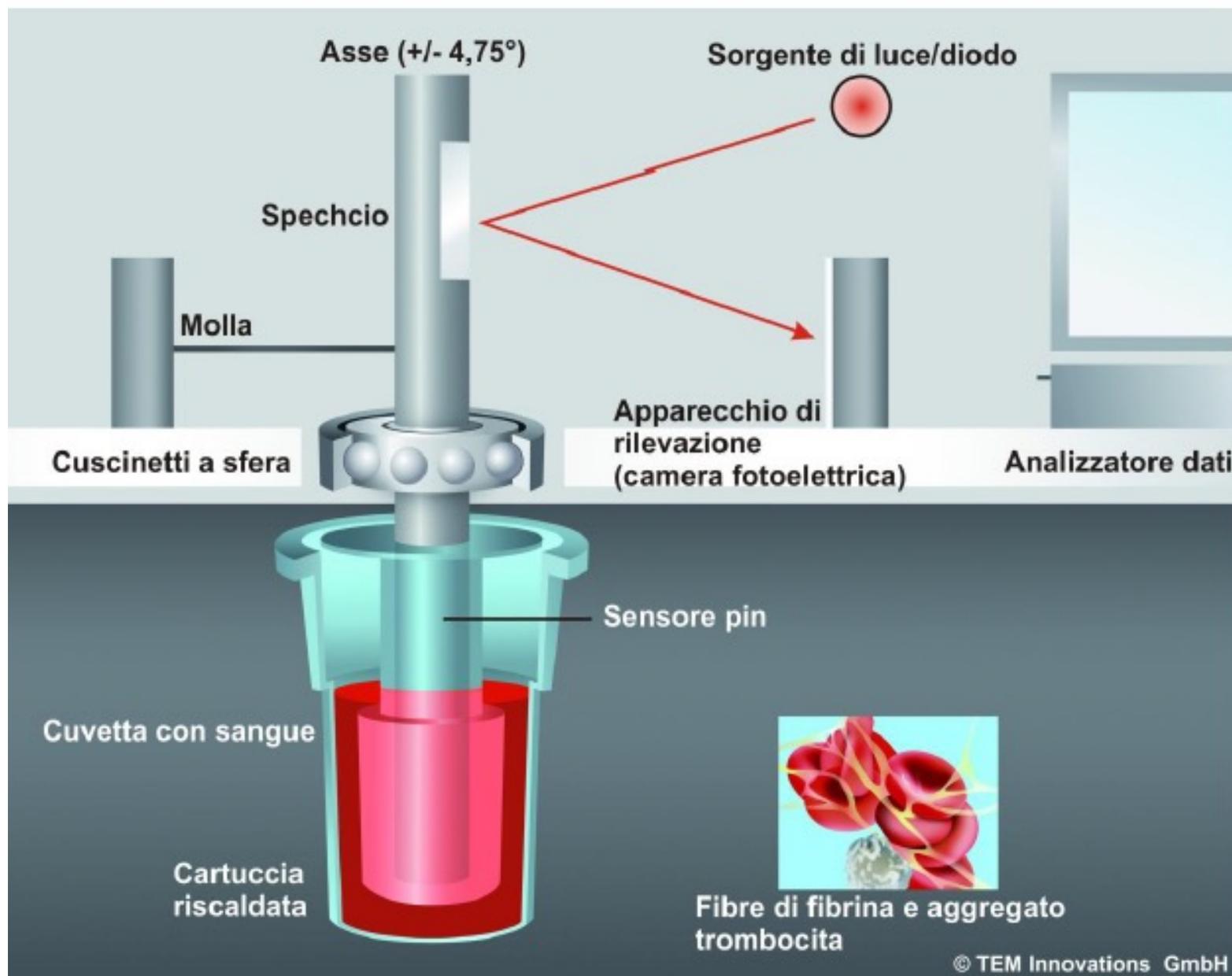
Tromboelastografia : principali evidenze...

- Riduzione utilizzo emoderivati
- Riduzione perdite ematiche
- Terapia mirata
- Valore prognostico
- Miglioramento decorso postoperatorio
- Riduzione mortalità
- Riduzione costi



In principio...





ROTEM Sigma

trombo-elastometria rotazionale



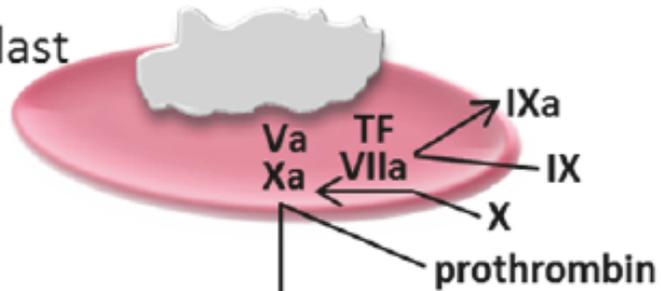
Werfen

TEG6s : tromboelastografo

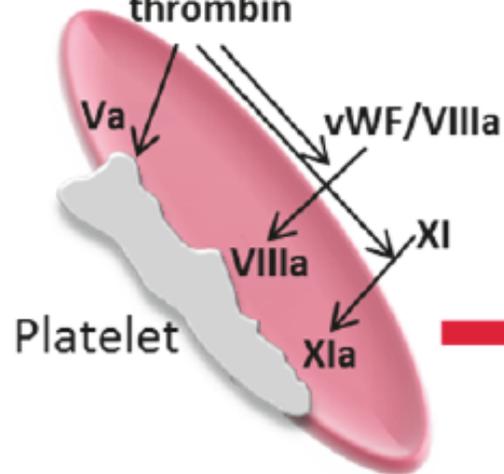


INITIATION

Fibroblast



thrombin

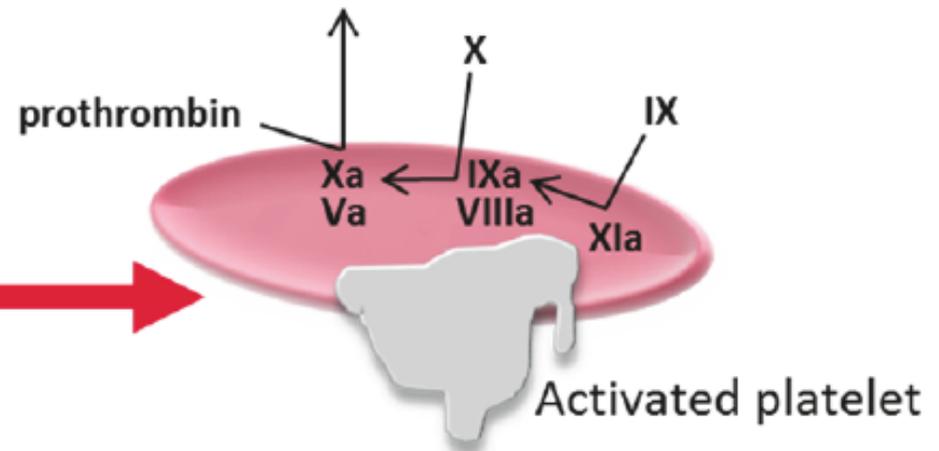


Platelet

AMPLIFICATION

PROPAGATION

thrombin



Activated platelet

Test possibili

EXTEM

INTEM

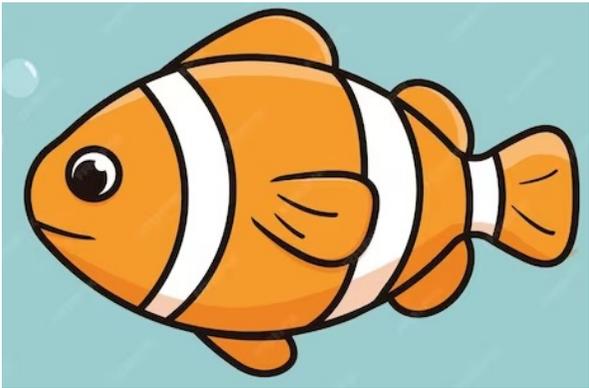
FIBTEM

HEPTEM

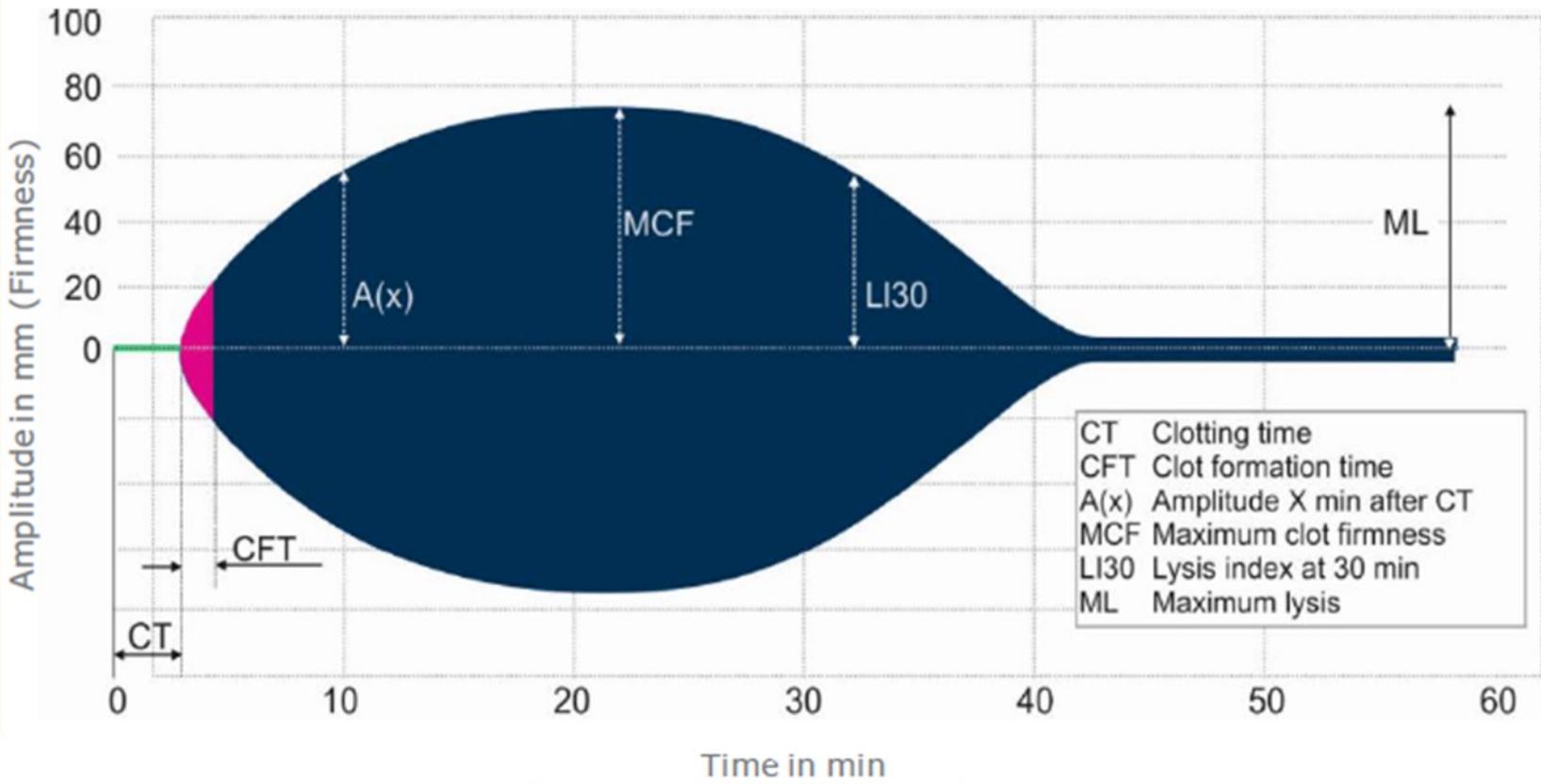
APTEM

Assay	Activators and additives	Clinical comments
ROTEM <i>delta</i> (and <i>sigma</i>) assays		
EXTEM	CaCl ₂ + recombinant tissue factor + polybrene	Deficiency of factors of the extrinsic pathway; VKAs and DOACs; indication for PCC administration; clot firmness based on platelet and fibrin contribution
FIBTEM	CaCl ₂ + recombinant tissue factor + polybrene + cytochalasin D	Fibrin polymerization; dose calculation for fibrinogen concentrate or cryoprecipitate; hyperfibrinolysis; FXIII deficiency
APTEM	CaCl ₂ + recombinant tissue factor + polybrene + aprotinin/tranexamic acid	Verifying the effect of antifibrinolytic drugs; differential diagnosis to clot retraction and FXIII deficiency (in combination with EXTEM)
INTEM	CaCl ₂ + ellagic acid	Deficiency of factors of the intrinsic pathway; unfractionated heparin (UFH) and protamine effects (in combination with HEPTTEM)
HEPTTEM	CaCl ₂ + ellagic acid + heparinase	Testing in patients with very high heparin plasma concentrations; UFH and protamine effects (in combination with INTEM)
NATEM	CaCl ₂	Tissue factor-expression on circulating cells (e.g., monocytes or malignant cells); other anticoagulants (e.g., LMWH)
NA-HEPTTEM	CaCl ₂ + heparinase	Tissue factor-expression on circulating cells (e.g., monocytes or malignant cells) in blood samples with heparin or HLE; other anticoagulants (e.g., LMWH) (in combination with NATEM)

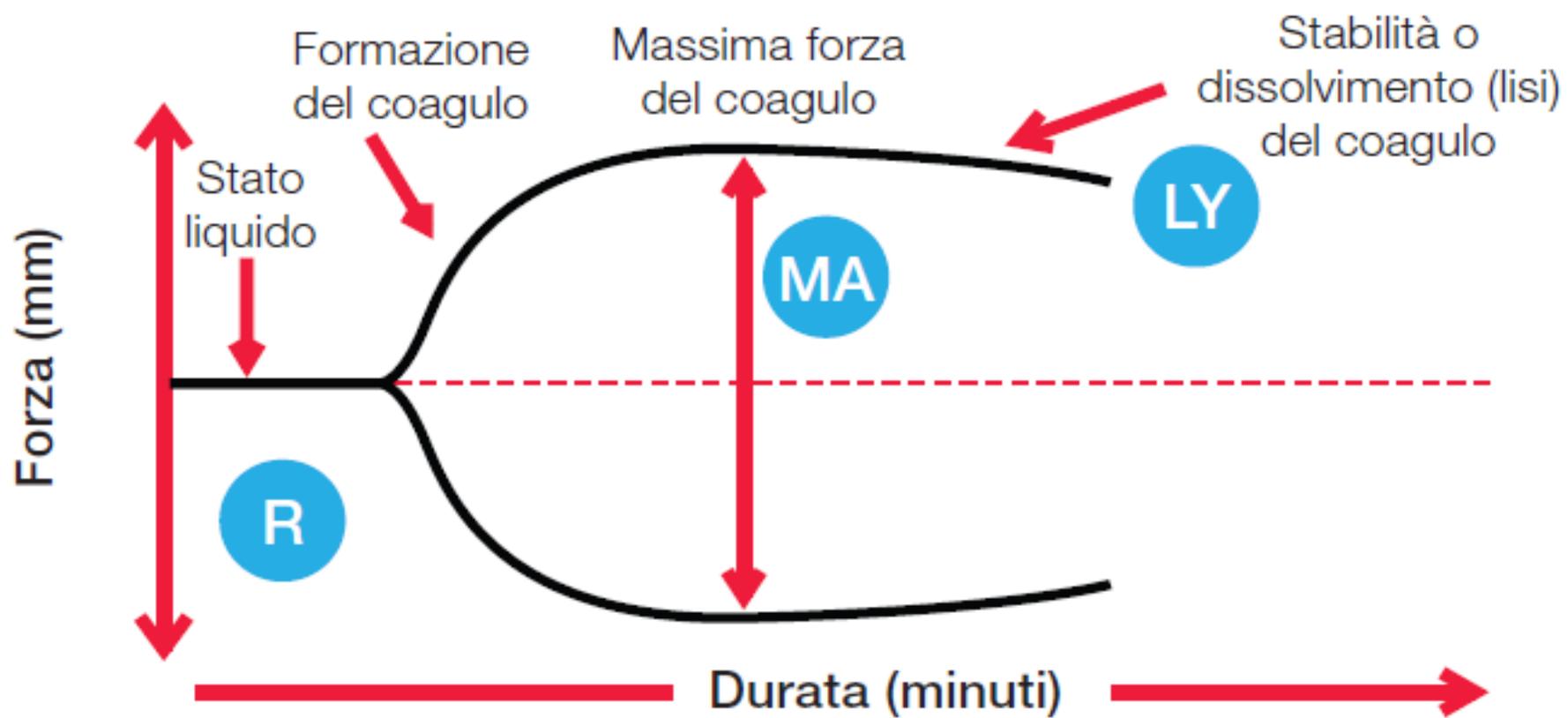
VKAs: vitamin K antagonists, DOACs: direct oral anticoagulants, PCC: protamine complex concentrate, UFH: unfractionated heparin, LMWH: low molecular weight heparin, HLE: Heparin-like effect, COX-1: cyclooxygenase-1, CPB: cardiopulmonary bypass, ADP: adenosine diphosphate, PAR-1: protease-activated receptor-1.



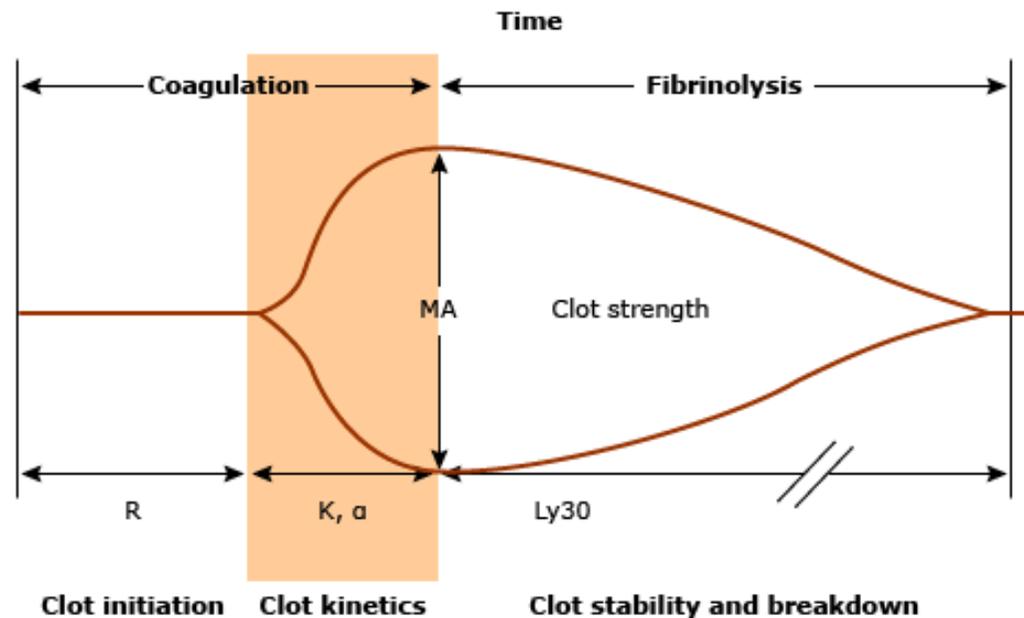
Ampiezza del coagulo in
millimetri



Tempo in minuti

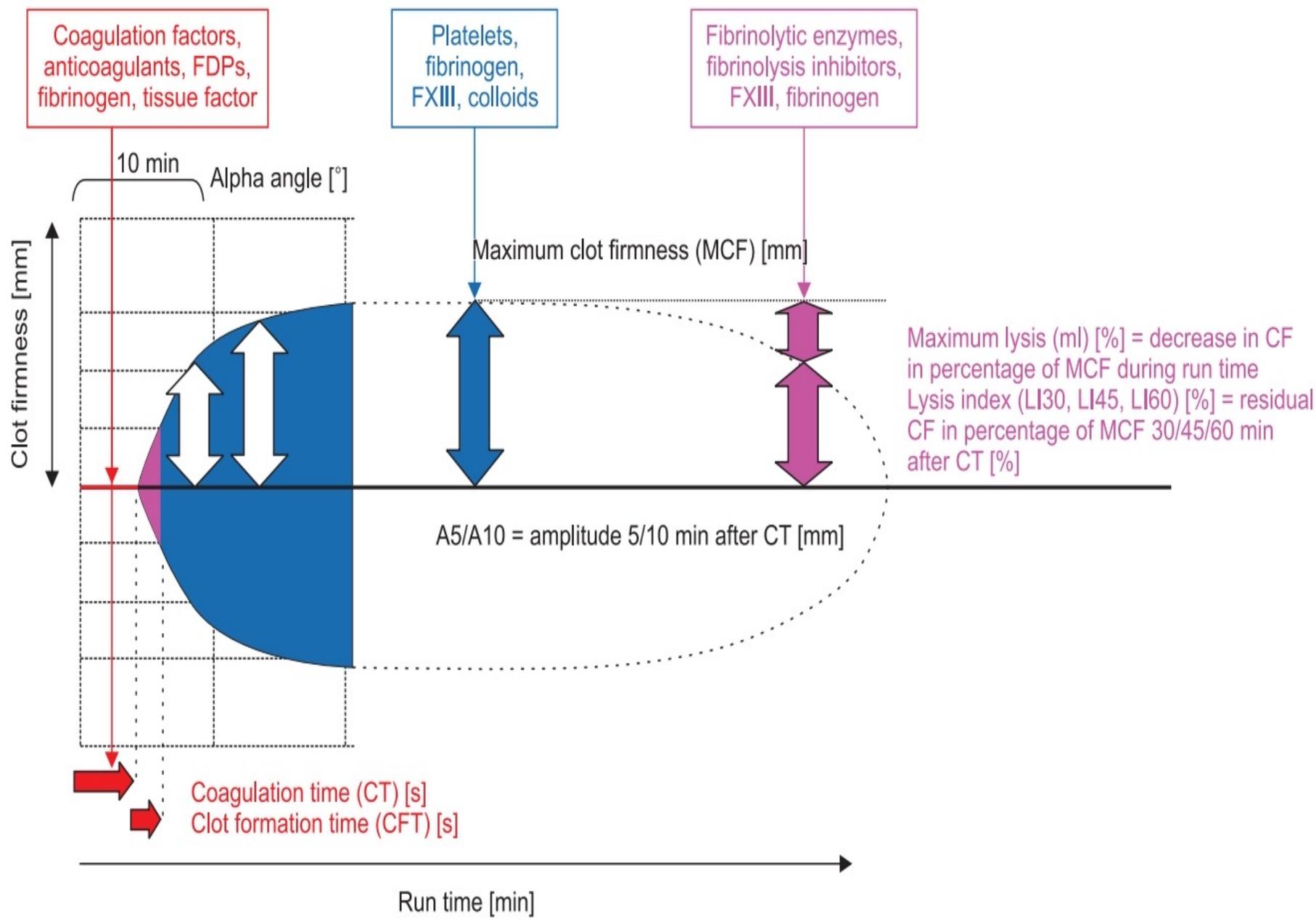


Thromboelastography (TEG) tracing parameters



"R" is the reaction time (the time it takes the coagulation cascade to generate thrombin and fibrin). "K" is the clot firmness. " α " (alpha) is the angle (describes the kinetics of clot formation). MA is the maximum amplitude (describes the maximum clot strength). Ly30 is the percent clot lysis 30 minutes after the MA is reached. Refer to UpToDate topics on platelet function testing and trauma management for details of the use and interpretation of thromboelastography.

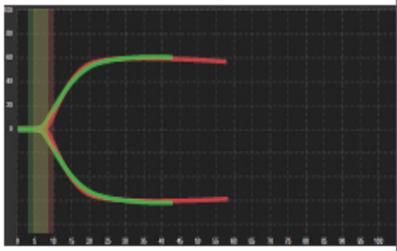
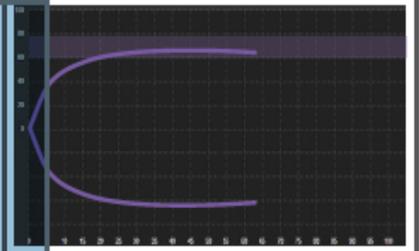
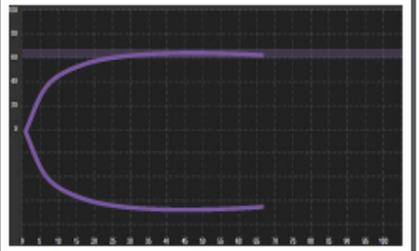
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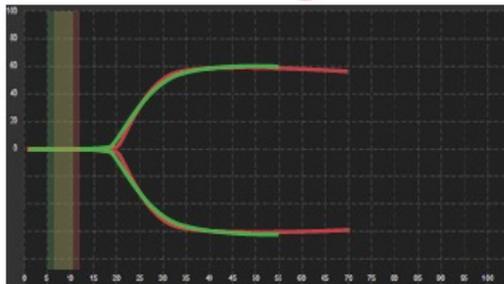
Thromboelastography definitions

Clot phase	Parameter	Measurement	TEG abbreviation	ROTEM abbreviation	Enzymatic stage	Abnormalities
Clot initiation	Clotting time	Time from start of sample to 2 mm clot amplitude	Reaction time (R)	Clot time (CT)	Early activation of clotting cascade resulting in initial thrombin burst	Prolonged by clotting factor deficiencies, anticoagulants, and hypofibrinogenemia. Shortened in hypercoagulable states.
	Clot kinetics	Clot formation time	Time from 2 to 20 mm clot amplitude	Clot formation time (K)	Clot formation time (CFT)	Prolonged by clotting factor deficiencies, hypofibrinogenemia, thrombocytopenia, and platelet dysfunction.
	Angle	Angle of tangent line from 2 to 20 mm clot formation	Alpha angle	Alpha angle	Abnormally low in clotting factor deficiencies, hypofibrinogenemia, thrombocytopenia, and platelet dysfunction.	
Clot strength	Maximal clot strength	Amplitude measured at peak clot strength	Maximal amplitude (MA)	Maximal clot firmness (MCF)	Maximal clot strength achieved via GP IIb/IIIa-mediated platelet-fibrin interactions	Abnormally low in hypofibrinogenemia, thrombocytopenia, or platelet dysfunction.
	Clot viscoelasticity	Calculated from maximal amplitude	G	Maximal clot elasticity (MCE)		Abnormally high in platelet hypercoagulability.
Clot lysis	Clot lysis	Percentage of loss of amplitude at fixed time after maximal amplitude	Lysis at 30 minutes (LY30), estimated percentage of lysis (EPL)	Lysis index at 30 minutes (LI30), maximal lysis (ML)	Activation of fibrinolytic system	Abnormally high in enzymatic or mechanical hyperfibrinolysis.

TEG: thromboelastography; ROTEM: rotational thromboelastometry.

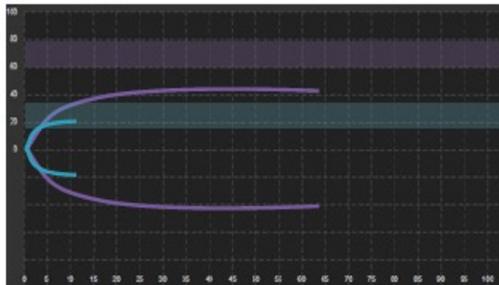
	Velocità di formazione del coagulo	Forza del coagulo	Forza del coagulo	Stabilità del coagulo
Componente emostatica	Fattori di coagulazione e eparina	Coagulo di fibrina	Coagulo di piastrine e fibrina	Fibrinolisi
Test - Parametro	CK / CKH - R	CFF - MA	CRT - MA	CRT - LY30
Tracciati normali <i>Range di riferimento ombreggiati a solo scopo illustrativo</i>				
Range di riferimento	4,6 - 9,1 min	15 - 32 mm	52 - 70 mm	0,0 - 2,2%
Ipocoagulabile	↑ R _{CK} (min)	↓ MA _{CFF} (mm)	↓ MA _{CRT} (mm)	↑ LY30 _{CRT} (%)
Ipercoagulabile	↓ R _{CK} (min)	↑ MA _{CFF} (mm)	↑ MA _{CRT} (mm)	N/A

Velocità di formazione del coagulo



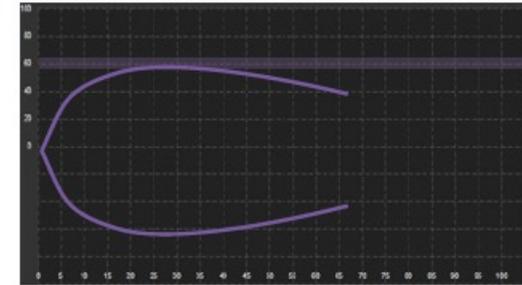
Carenza di fattori

Forza del coagulo

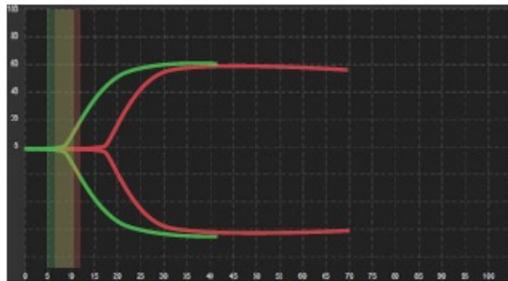


Carenza di piastrine

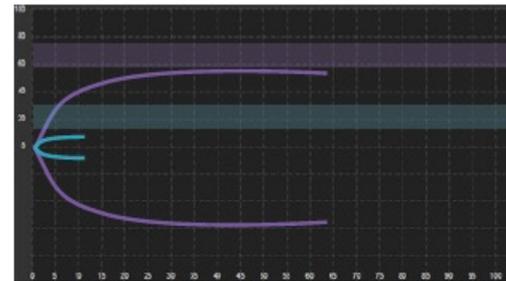
Stabilità del coagulo



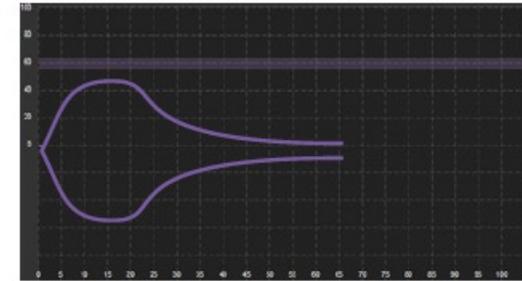
Iperfibrinolisi



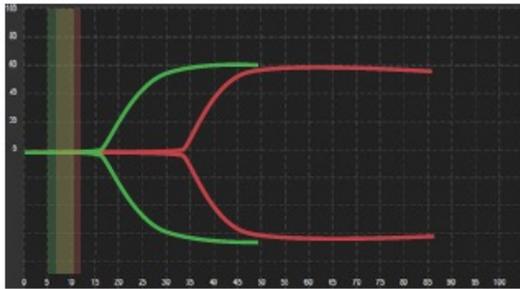
Effetto dell'eparina



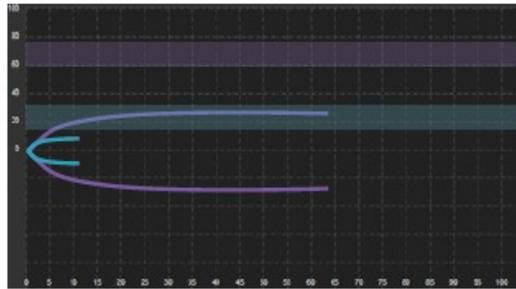
Carenza di fibrinogeno



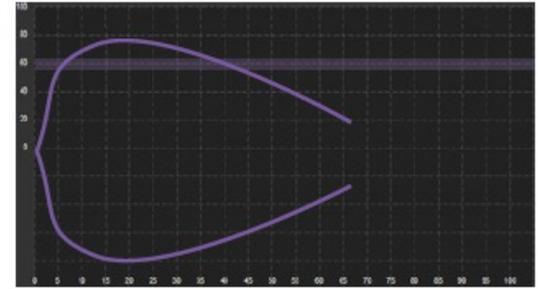
Fibrinolisi primaria



Carenza di fattori ed effetto dell'eparina

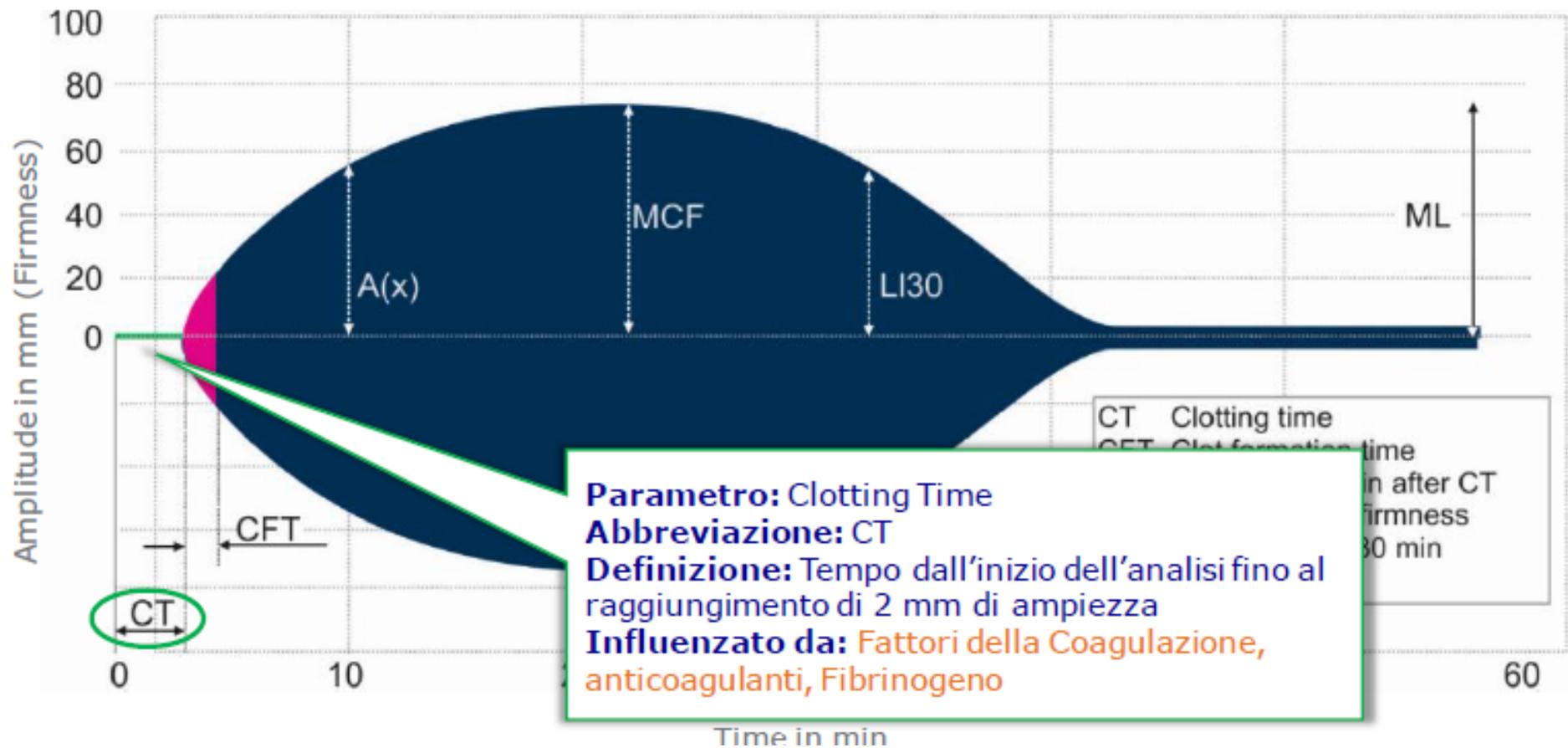


Carenza di piastrine e fibrinogeno

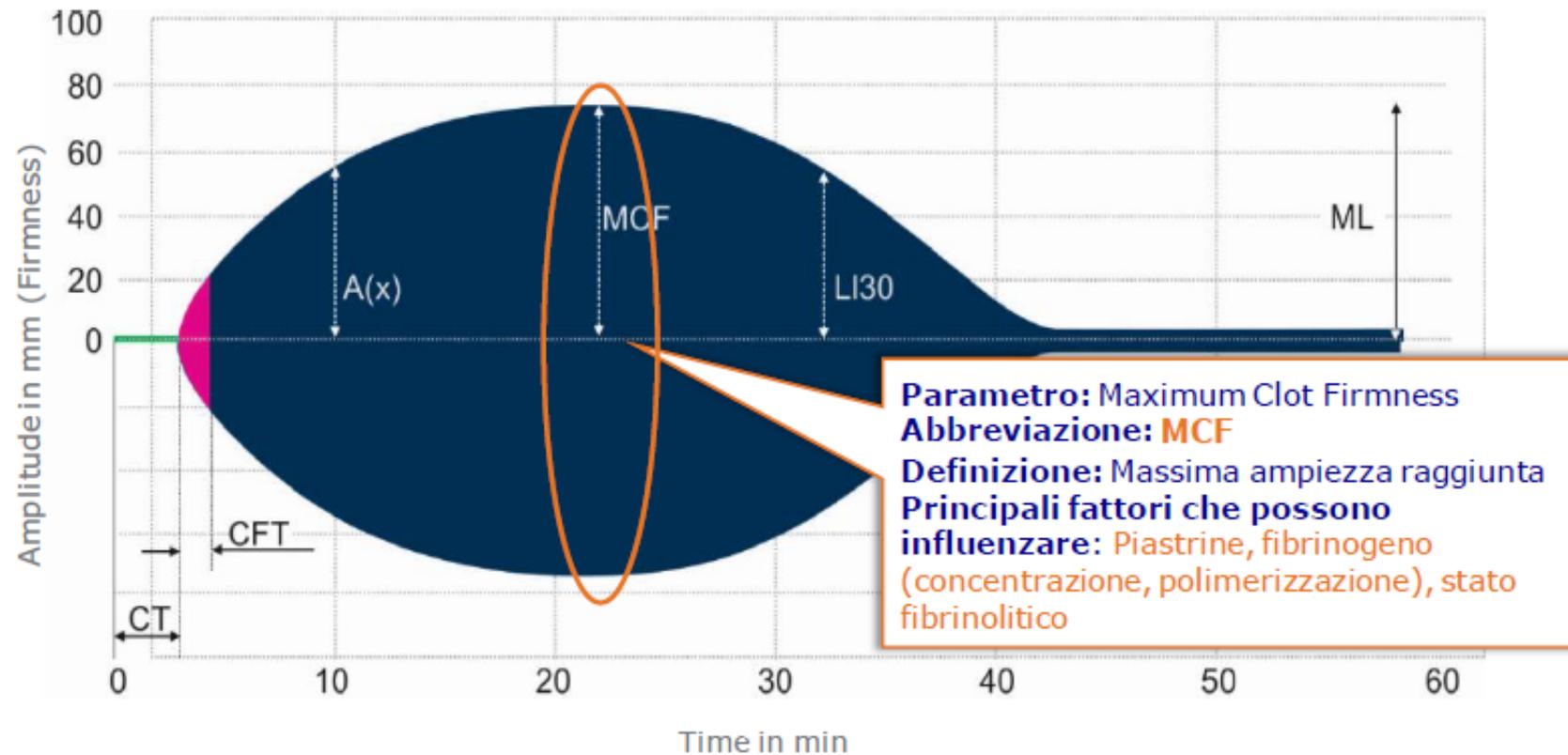


Fibrinolisi secondaria

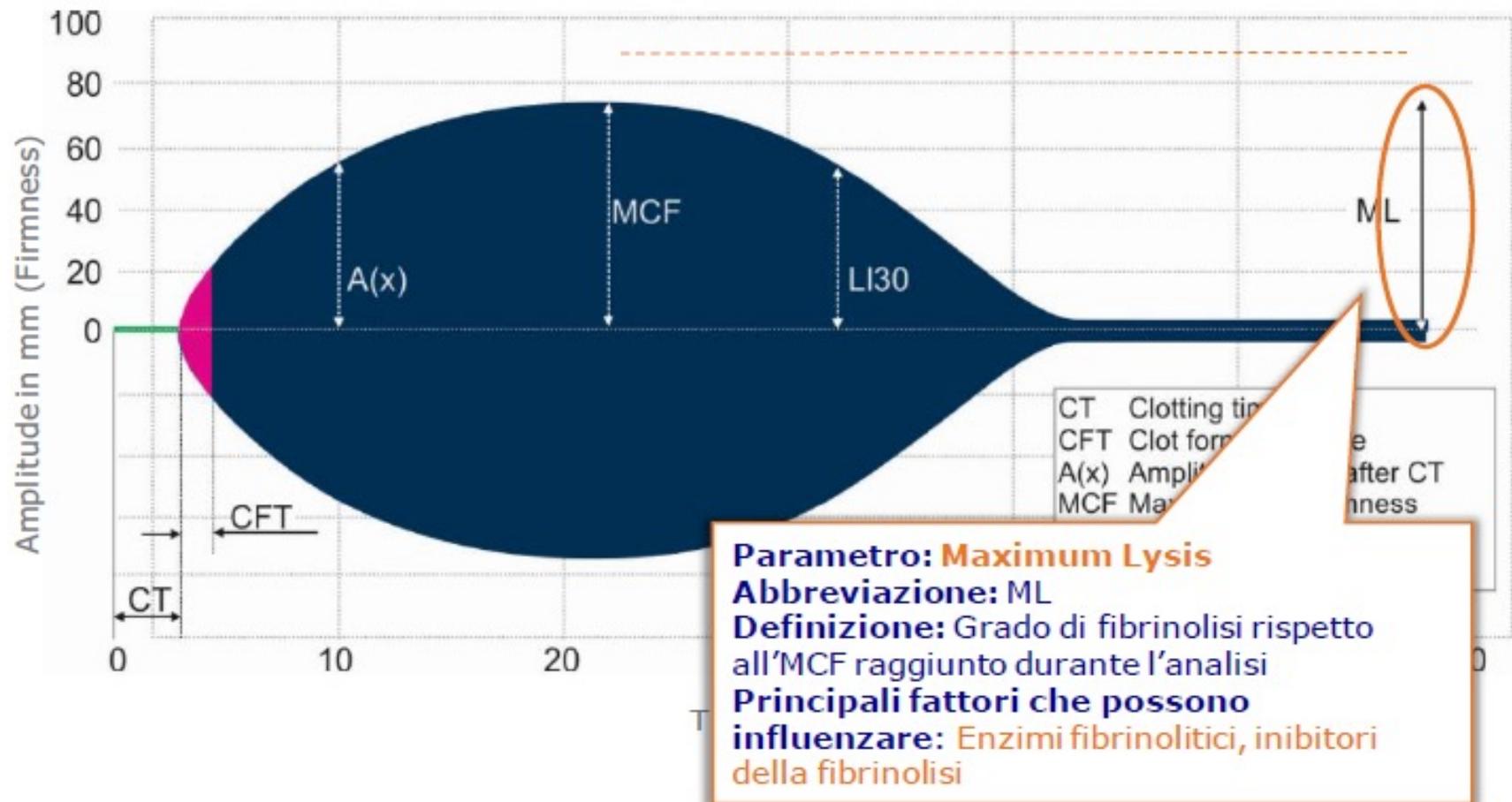
CT: Tempo di coagulazione in secondi



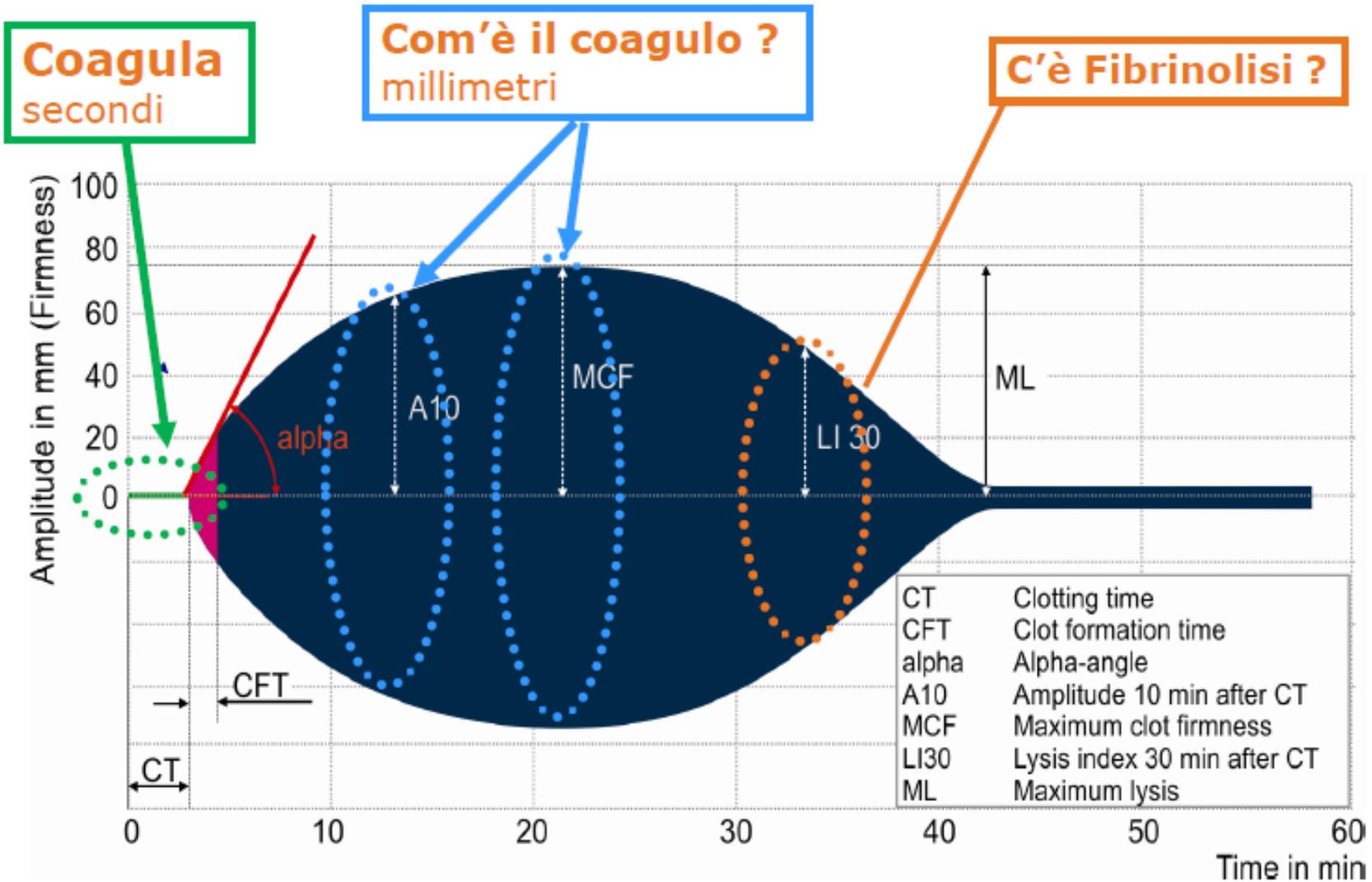
MCF: Maximum Clot Firmness (in mm)



ML: Massima Lisi espressa in %

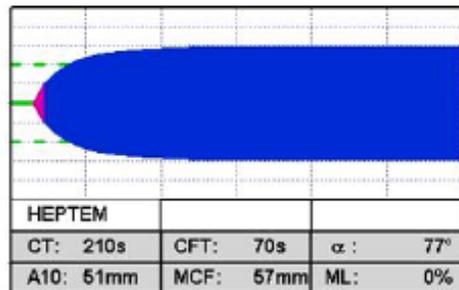
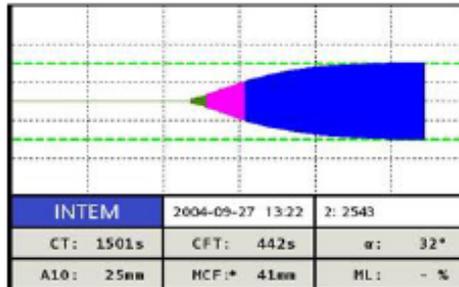


In sintesi...



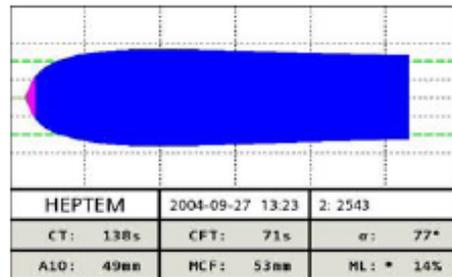
Heptem ed Eparina

Effetto eparina



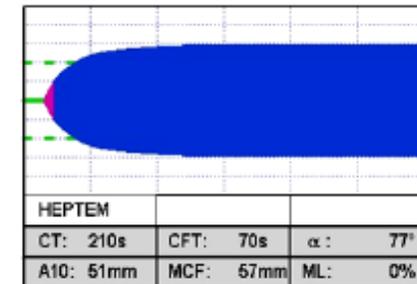
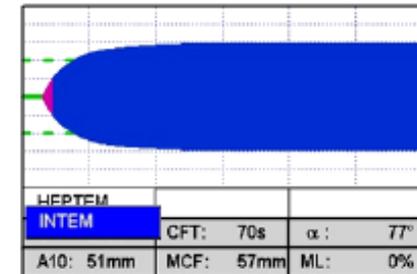
Eparina residua

CEC



Effetto eparina

Post protamina



No eparina

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Epub 2019 May 17.

The role of evidence-based algorithms for rotational thromboelastometry-guided bleeding management

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PMID: 31096732 PMCID: PMC6676023 DOI: 10.4097/kja.19169

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ACTIONS

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In particolare...

Algoritmo PPH A5 (emorragia ostetrica)

Algoritmo Trauma A5



Grazie