



Koagulations- monitorering

Anders Östlund
MD PhD

Funktionsområde Trauma och Akut kirurgi
Perioperativ Medicin och Intensivvård (PMI)
Karolinska Universitetssjukhuset, Solna

Provtagning

- **Blodgaser:** pH/BE/lactat, Hb, S-Ca⁺⁺, S-K⁺
- **TEG** (tromboelastografi)/**ROTEM**
(tromboelastometri)
- (Koag.prover: fibrinogen, TPK, PK/INR, APTT)

Massiv okontrollerad blödning

Transfusionsprotokoll (Blodprod 4:4:1, Tranexamsyra, Fibrinogen)



Målstyrd behandling (Tromboelastometri: TEG/ROTEM)

Viskoelastisk koagulationsanalys

- Utföra analys bedside eller låta blodcentralen/lab. göra detta ?
- TEG eller ROTEM ?

Rotational thromboelastometry-guided trauma resuscitation

Damian D. Keene, Giles R. Nordmann, and Tom Woolley

Purpose of review

Haemorrhage from major trauma is a significant cause of death worldwide. The UK Defence Medical Service (UK-DMS) has had significant experience in managing severely injured and shocked trauma casualties over the last decade. This has led to the integration of rotational thromboelastometry (ROTEM) into damage control resuscitation delivered at Camp Bastion Field Hospital in Afghanistan. This review aims to describe the rationale for its use and how its use has evolved by UK-DMS.

Recent findings

Although there is reasonable evidence showing its benefit in cardiac and liver surgery, evidence for its use in trauma is limited. More recent studies and meta-analyses have demonstrated a reduced rate of transfusion and blood loss, but no benefit on mortality. Despite this, there is a growing body of opinion supporting ROTEM use in trauma with European guidelines supporting its use where available. Recent UK-DMS experience has shown that it is a fast, reliable and robust means of identifying transfusion requirements.

Summary

ROTEM provides a means to rapidly assess coagulation in trauma casualties, allowing targeted use of blood products. It provides information on clot initiation strength and breakdown. However, its use in trauma has still to be fully evaluated.

Keywords

coagulopathy, rotational thromboelastometry, trauma

Table 1 Grading of recommendations after [24] (reprinted with permission)

Grade of Recommendation	Clarity of risk/benefit	Quality of supporting evidence	Implications
1A Strong recommendation, high-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	RCTs without important limitations or overwhelming evidence from observational studies	Strong recommendation, can apply to most patients in most circumstances without reservation
1B Strong recommendation, moderate-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	RCTs with important limitations (inconsistent results, methodological flaws, indirect or imprecise) or exceptionally strong evidence from observational studies	Strong recommendation, can apply to most patients in most circumstances without reservation
1C Strong recommendation, low-quality or very low-quality evidence	Benefits clearly outweigh risk and burdens, or vice versa	Observational studies or case series	Strong recommendation but may change when higher quality evidence becomes available
2A Weak recommendation, high-quality evidence	Benefits closely balanced with risks and burden	RCTs without important limitations or overwhelming evidence from observational studies	Weak recommendation, best action may differ depending on circumstances or patients' or societal values
2B Weak recommendation, moderate-quality evidence	Benefits closely balanced with risks and burden	RCTs with important limitations (inconsistent results, methodological flaws, indirect or imprecise) or exceptionally strong evidence from observational studies	Weak recommendation, best action may differ depending on circumstances or patients' or societal values
2C Weak recommendation, Low-quality or very low-quality evidence	Uncertainty in the estimates of benefits, risks and burden; benefits, risk and burden may be closely balanced	Observational studies or case series	Very weak recommendation; other alternatives may be equally reasonable

ROTEM-analys på traumapatienter

Karolinska, Solna

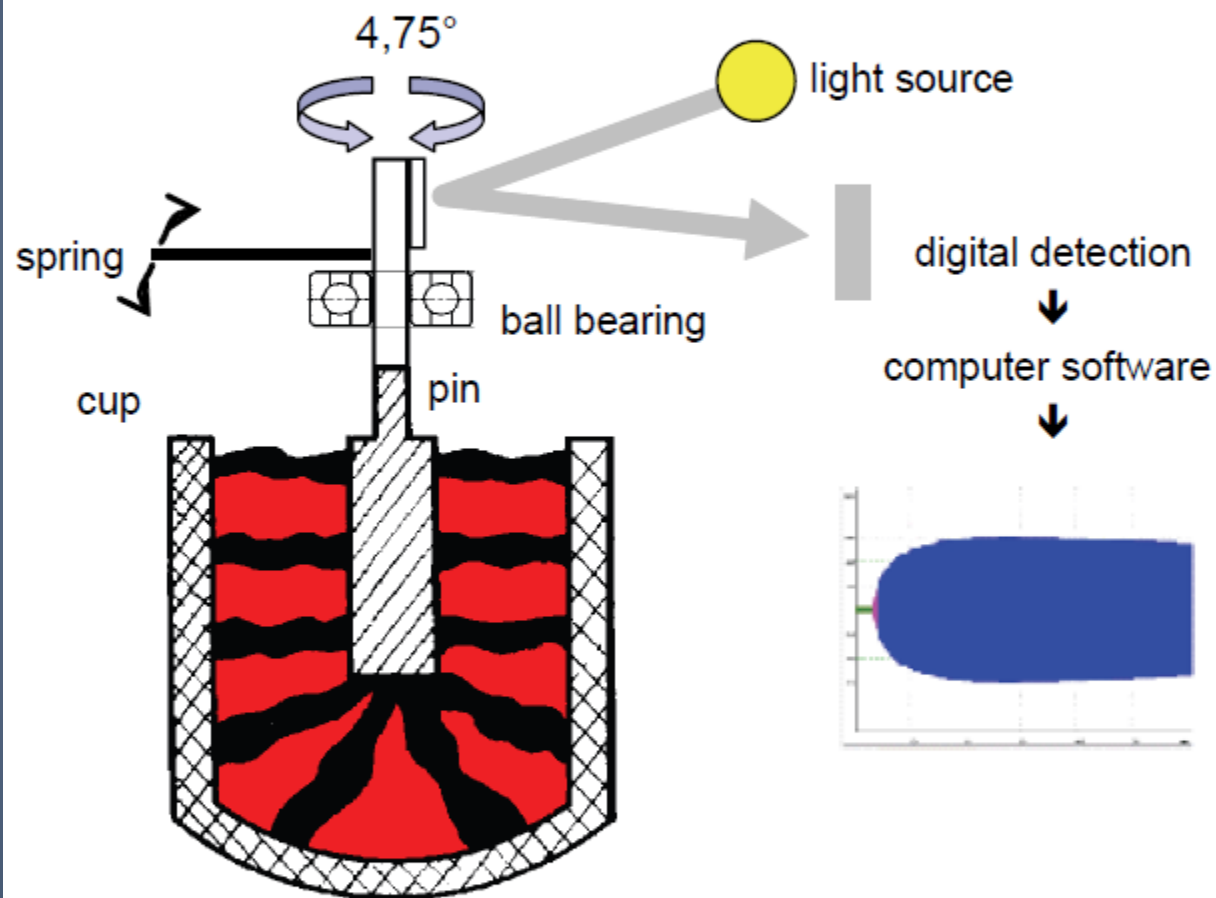
- Citratrör skickas med rörpost till blodcentralen
- Blodcentralen sätter provet/påbörjar analysen
- Resultatet / kurvorna kan ses på traumaenhetens dator bedside
- Inom 10-15 min. kan graden och typen av koagulopati uppskattas



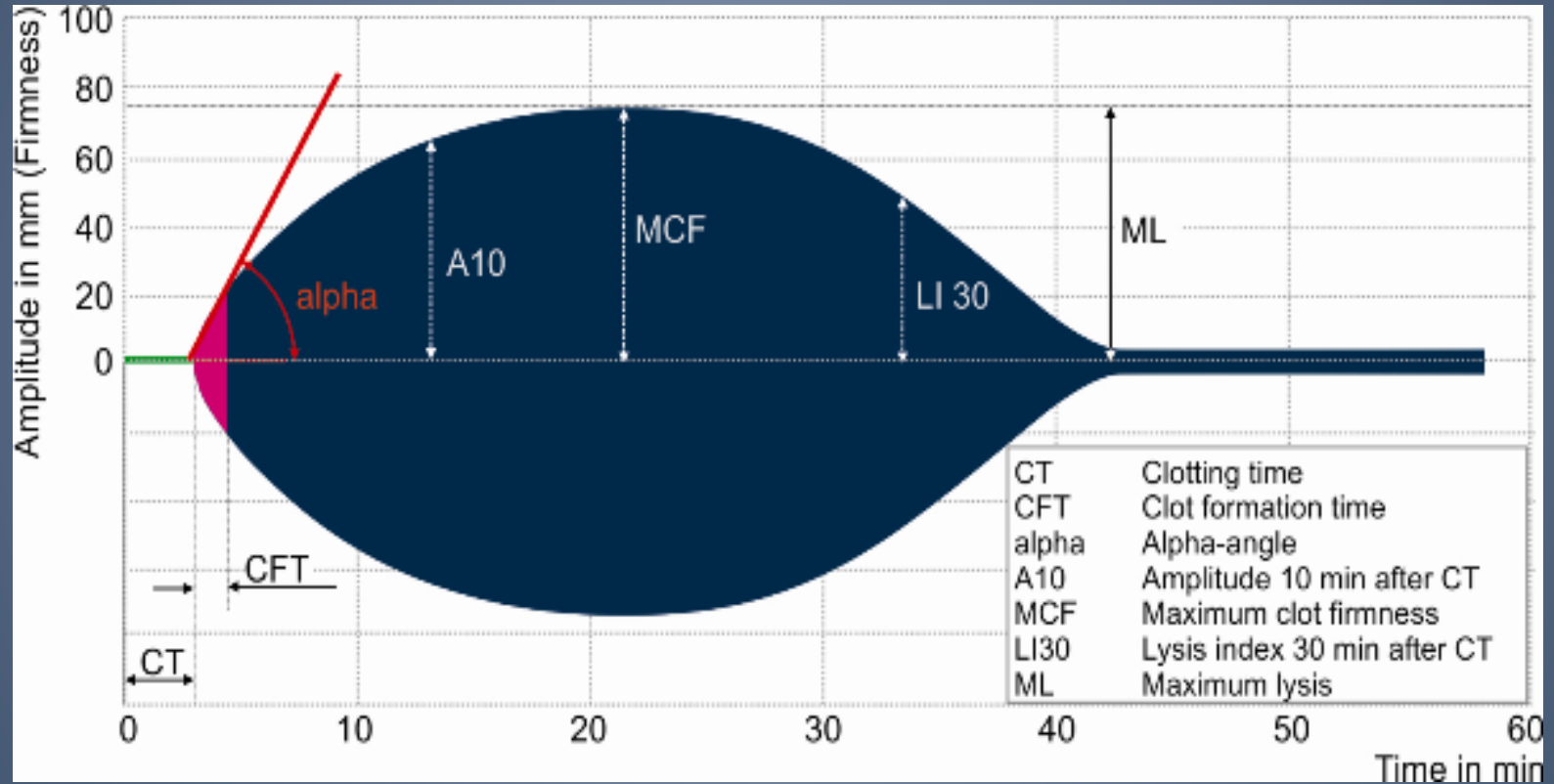
ROTEM® - System

- 4 channels for simultaneous assays
- electronic pipetting facilitates the use outside of established laboratories

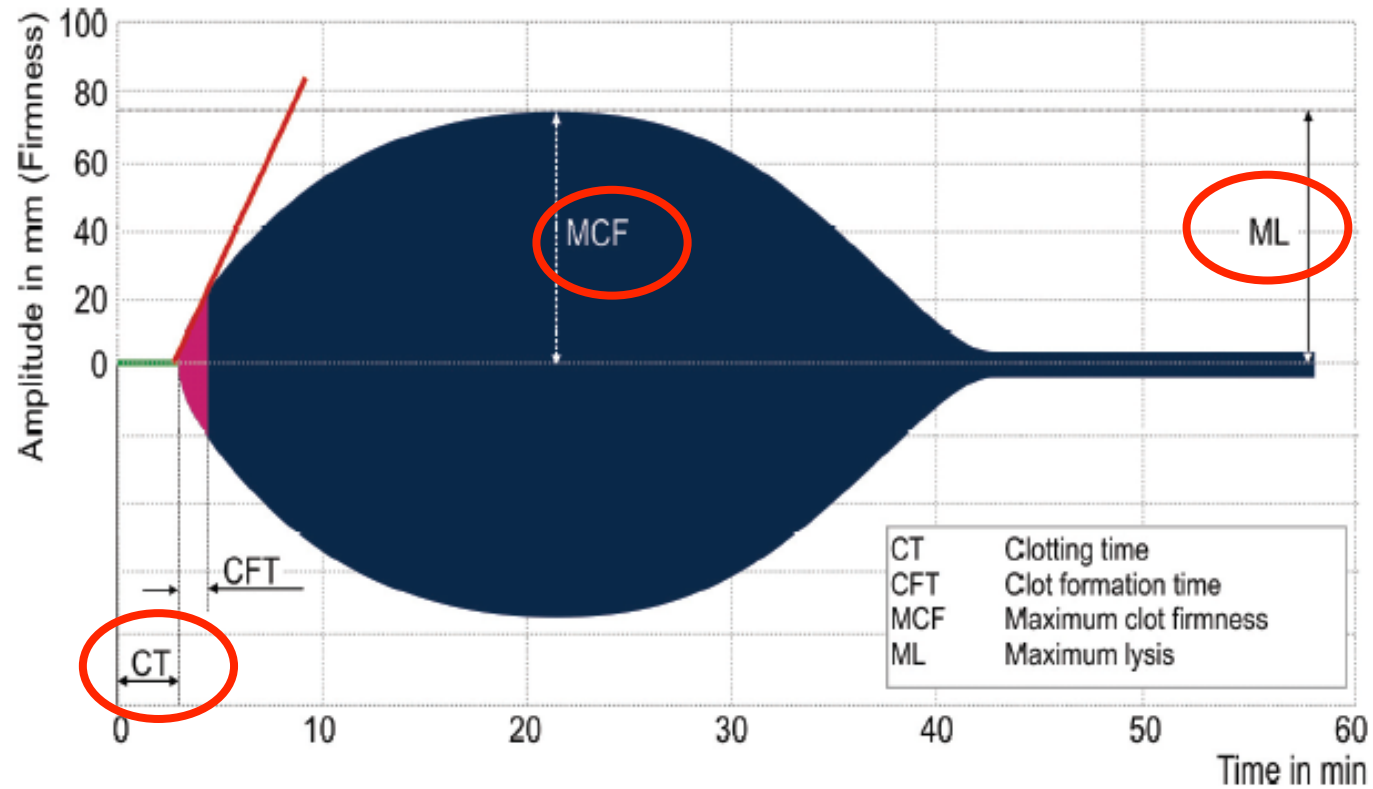
> ROTEM® Detection Method



Viskoelastisk helblodsanalys-ROTEM

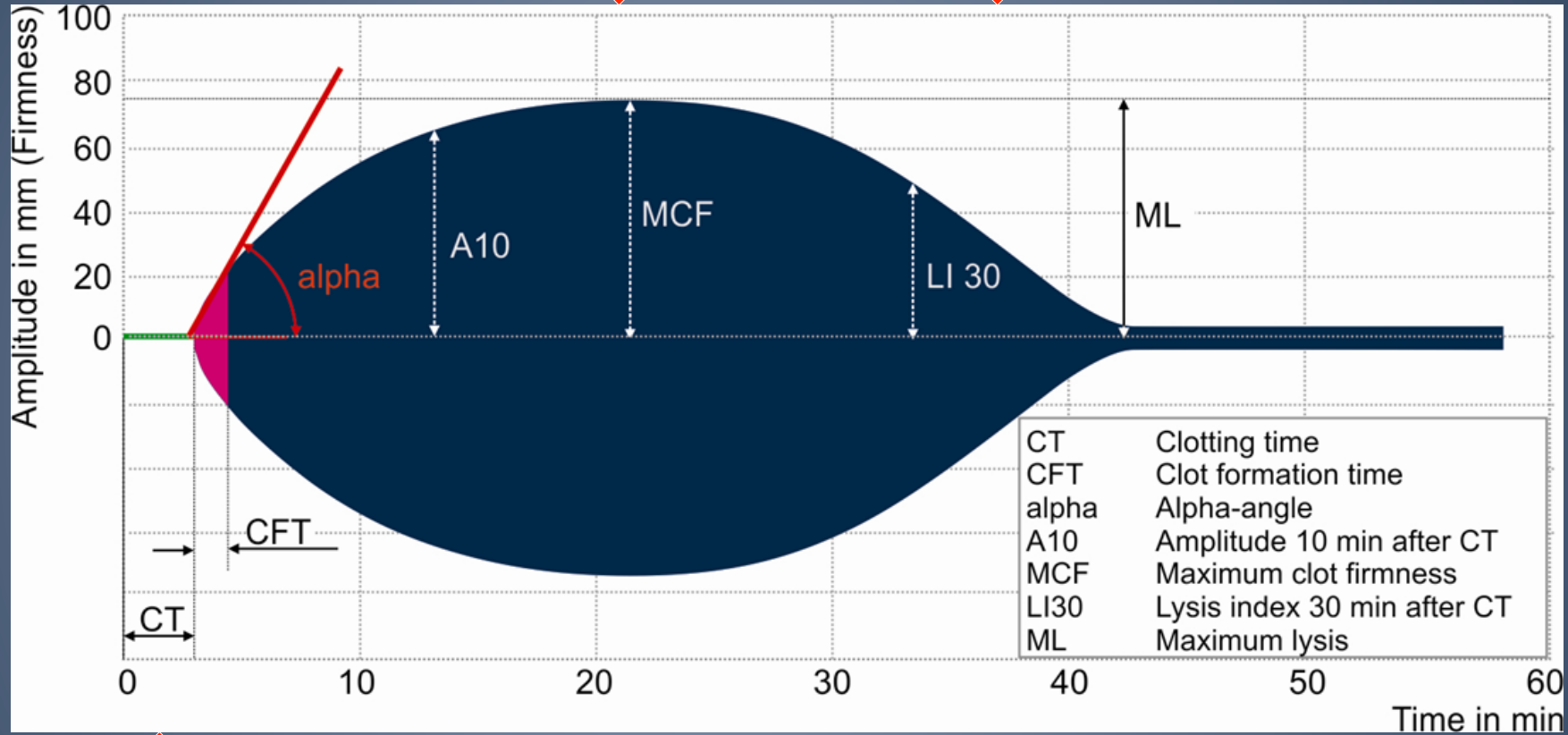


> Parameters and Scaling



Fibrinogen, trombocyter

Fibrinolys



Koagulations
faktor

(Ref. CT**100-240s** MCF**50-72mm**)



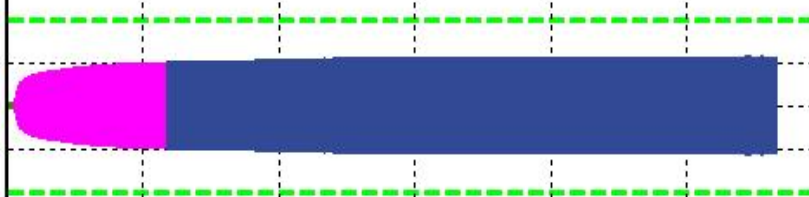
INTEM	2012-08-11 12:36	2: 26587762PQ
CT: 127s	CFT: 100s	α : 78°
A10: 46mm	A20: 53mm	MCF: 56mm

(Ref. CT**38-79s** MCF**50-72mm**)



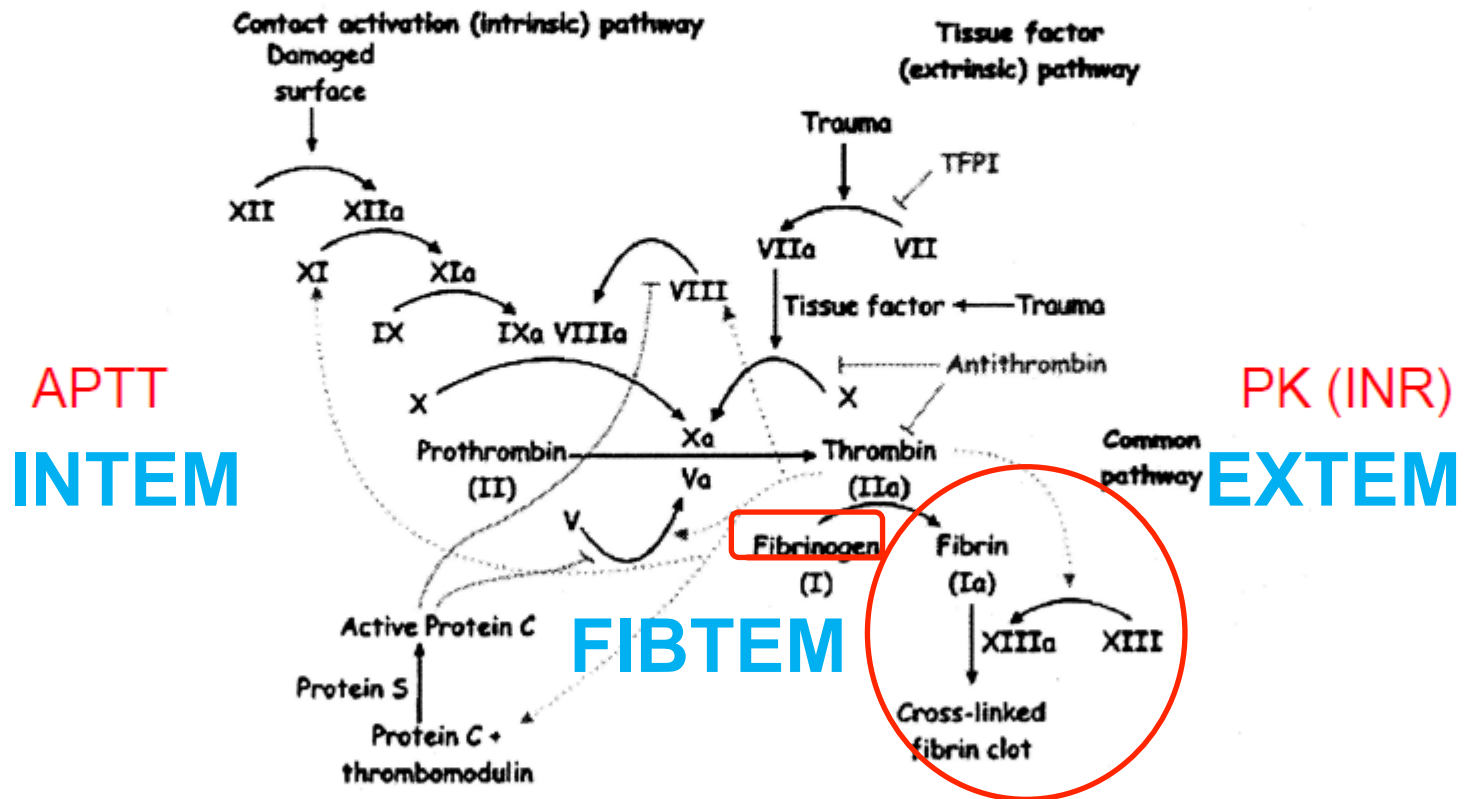
EXTEM	2012-08-11 12:40	2: 26587762PQ
CT: 48s	CFT: 140s	α : 76°
A10: 42mm	A20: 50mm	MCF: 54mm

(Ref. MCF**9-25mm**)



FIBTEM	2012-08-11 12:39	2: 26587762PQ
CT: 38s	CFT: 712s	α : 81°
A10: 20mm	A20: 21mm	MCF: 22mm

KOAGULATIONSKASKADEN



(Ref. CT**100-240s** MCF**50-72mm**)



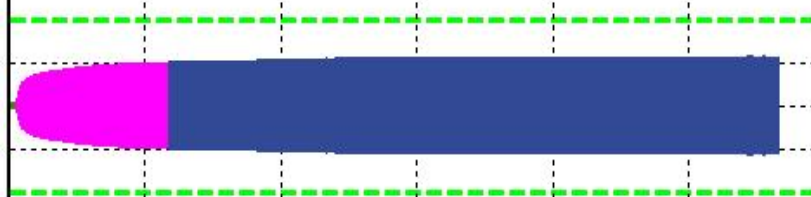
INTEM	2012-08-11 12:36	2: 26587762PQ
CT: 127s	CFT: 100s	α : 78°
A10: 46mm	A20: 53mm	MCF: 56mm

(Ref. CT**38-79s** MCF**50-72mm**)



EXTEM	2012-08-11 12:40	2: 26587762PQ
CT: 48s	CFT: 140s	α : 76°
A10: 42mm	A20: 50mm	MCF: 54mm

(Ref. MCF**9-25mm**)



FIBTEM	2012-08-11 12:39	2: 26587762PQ
CT: 38s	CFT: 712s	α : 81°
A10: 20mm	A20: 21mm	MCF: 22mm

(Ref. CT**100-240s** MCF**50-72mm**)



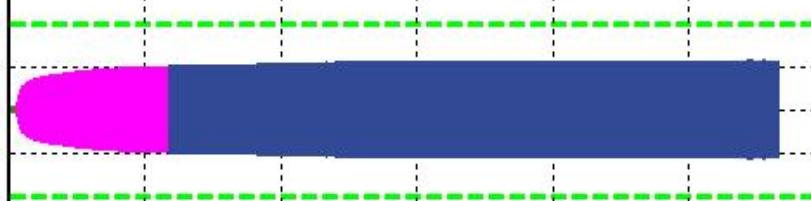
INTEM	2012-08-11 12:36	2: 26587762PQ
CT: 127s	CFT: 100s	α : 78°
A10: 46mm	A20: 53mm	MCF: 56mm

(Ref. CT**38-79s** MCF**50-72mm**)



EXTEM	2012-08-11 12:40	2: 26587762PQ
CT: 48s	CFT: 140s	α : 76°
A10: 42mm	A20: 50mm	MCF: 54mm

(Ref. MCF**9-25mm**)



FIBTEM	2012-08-11 12:39	2: 26587762PQ
CT: 38s	CFT: 712s	α : 81°
A10: 20mm	A20: 21mm	MCF: 22mm

Extem-CT↑ - brist på koag.faktorer/plasma

Extem-MCF↓ - brist på trombocytter eller fibrinogen

Fibtem-MCF↓ - brist på fibrinogen

(Ref. CT**100-240s** MCF**50-72mm**)



INTEM	2012-10-10 12:34	2: 27092644PQ
CT: 137s	CFT: 193s	α : 69°
A10: 36mm	A20: 43mm	MCF: 46mm

(Ref. CT**38-79s** MCF**50-72mm**)



EXTEM	2012-10-10 12:36	2: 27092644PQ
CT: 39s	CFT: 195s	α : 70°
A10: 35mm	A20: 42mm	MCF: 45mm

(Ref. MCF**9-25mm**)



FIBTEM	2012-10-10 12:37	2: 27092644PQ
CT: 48s	CFT: - s	α : 57°
A10: 11mm	A20: 11mm	MCF: 12mm

(Ref. CT**100-240s** MCF**50-72mm**)



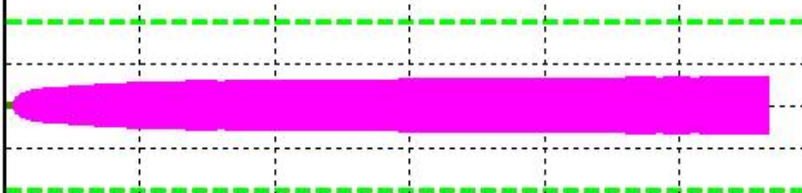
INTEM	2012-10-10 12:34	2: 27092644PQ
CT: 137s	CFT: 193s	α : 69°
A10: 36mm	A20: 43mm	MCF: 46mm

(Ref. CT**38-79s** MCF**50-72mm**)



EXTEM	2012-10-10 12:36	2: 27092644PQ
CT: 39s	CFT: 195s	α : 70°
A10: 35mm	A20: 42mm	MCF: 45mm

(Ref. MCF**9-25mm**)



FIBTEM	2012-10-10 12:37	2: 27092644PQ
CT: 48s	CFT: - s	α : 57°
A10: 11mm	A20: 11mm	MCF: 12mm

(Ref. CT**100-240s** MCF**50-72mm**)



INTEM	2012-10-10 12:34	2: 27092644PQ
CT: 137s	CFT: 193s	α : 69°
A10: 36mm	A20: 43mm	MCF: 46mm

(Ref. CT**38-79s** MCF**50-72mm**)



EXTEM	2012-10-10 12:36	2: 27092644PQ
CT: 39s	CFT: 195s	α : 70°
A10: 35mm	A20: 42mm	MCF: 45mm

(Ref. MCF**9-25mm**)



FIBTEM	2012-10-10 12:37	2: 27092644PQ
CT: 48s	CFT: - s	α : 57°
A10: 11mm	A20: 11mm	MCF: 12mm

trombocytbrist

(100-240s, 50-72mm)



INTEM	2012-08-11 18:31	2: 26588815pq
CT: 249s	CFT: 230s	α : 53°
A10: 34mm	A20: 42mm	MCF: 47mm

(38-79s, 50-72mm)



EXTEM	2012-08-11 18:32	2: 26588815pq
CT: 103s	CFT: 216s	α : 56°
A10: 33mm	A20: 42mm	MCF: 46mm

(9-25mm)



FIBTEM	2012-08-11 18:33	2: 26588815pq
CT: 71s	CFT: - s	α : - °
A10: 6mm	A20: 7mm	MCF: 6mm



HEPTEM	2012-08-11 18:48	2: 26588815pq
CT: 232s	CFT: 228s	α : 53°
A10: 34mm	A20: 42mm	MCF: 46mm

(100-240s, 50-72mm)



INTEM	2012-08-11 18:31	2: 26588815pq
CT: 249s	CFT: 230s	α : 53°
A10: 34mm	A20: 42mm	MCF: 47mm

(38-79s, 50-72mm)



EXTEM	2012-08-11 18:32	2: 26588815pq
CT: 103s	CFT: 216s	α : 56°
A10: 33mm	A20: 42mm	MCF: 46mm

(9-25mm)



FIBTEM	2012-08-11 18:33	2: 26588815pq
CT: 71s	CFT: - s	α : - °
A10: 6mm	A20: 7mm	MCF: 6mm



HEPTTEM	2012-08-11 18:48	2: 26588815pq
CT: 232s	CFT: 228s	α : 53°
A10: 34mm	A20: 42mm	MCF: 46mm

(100-240s, 50-72mm)



INTEM	2012-08-11 18:31	2: 26588815pq
CT: 249s	CFT: 230s	α : 53°
A10: 34mm	A20: 42mm	MCF: 47mm

(38-79s, 50-72mm)



EXTEM	2012-08-11 18:32	2: 26588815pq
CT: 103s	CFT: 216s	α : 56°
A10: 33mm	A20: 42mm	MCF: 46mm

(9-25mm)

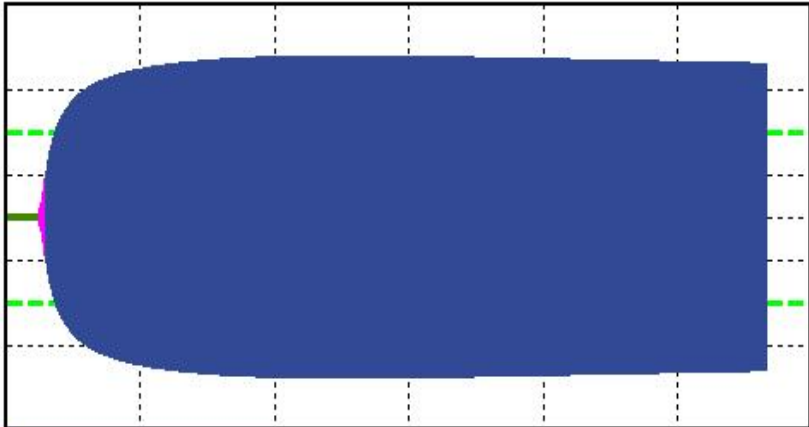


FIBTEM	2012-08-11 18:33	2: 26588815pq
CT: 71s	CFT: - s	α : - °
A10: 6mm	A20: 7mm	MCF: 6mm

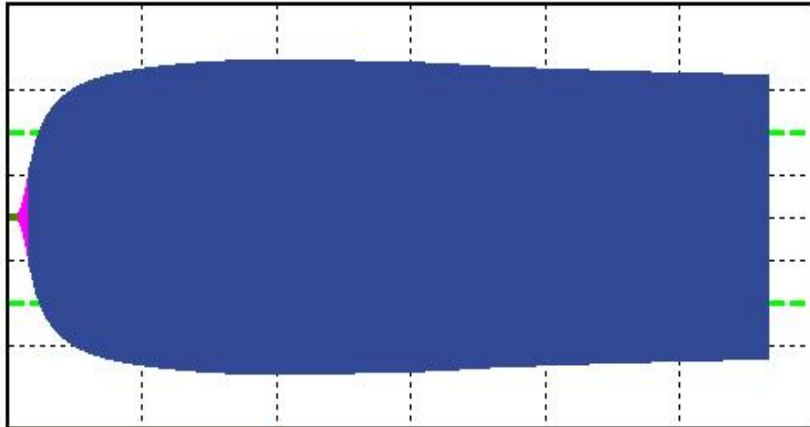
HEPTEM

HEPTEM	2012-08-11 18:48	2: 26588815pq
CT: 232s	CFT: 228s	α : 53°
A10: 34mm	A20: 42mm	MCF: 46mm

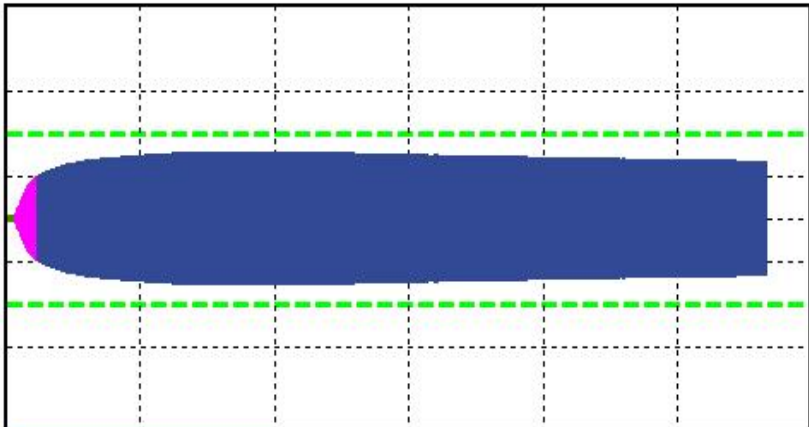
Brist på fibrinogen + övriga koagul.-faktorer, ingen heparineffekt



INTEM	2012-10-16 18:28	2: 27146838PQ
CT: 160s	CFT: 33s	α : 83°
A10: 71mm	A20: 75mm	MCF: 75mm

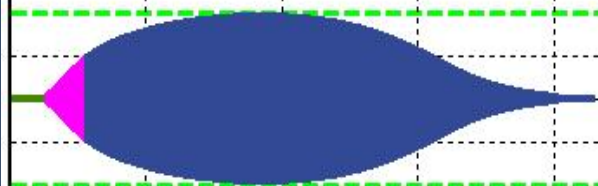


EXTEM	2012-10-16 18:29	2: 27146838PQ
CT: 59s	CFT: 44s	α : 81°
A10: 70mm	A20: 74mm	MCF: 74mm



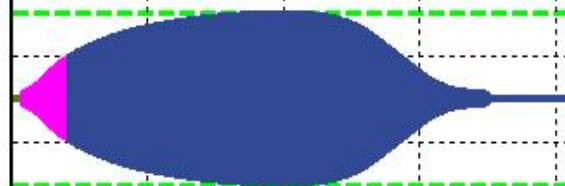
FIBTEM	2012-10-16 18:30	2: 27146838PQ
CT: 48s	CFT: 109s	α : 73°
A10: 30mm	A20: 31mm	MCF: 31mm

(100-240s, 50-72mm)



INTEM	2012-09-25 17:16	2: 26964274PQ
CT: 169s	CFT: 191s	α : 56°
A10: 36mm	A20: 39mm	MCF: 39mm

(38-79s, 50-72mm)



EXTEM	2012-09-25 17:18	2: 26964274PQ
CT: 43s	CFT: 224s	α : 51°
A10: 34mm	A20: 41mm	MCF: 41mm

(9-25mm)



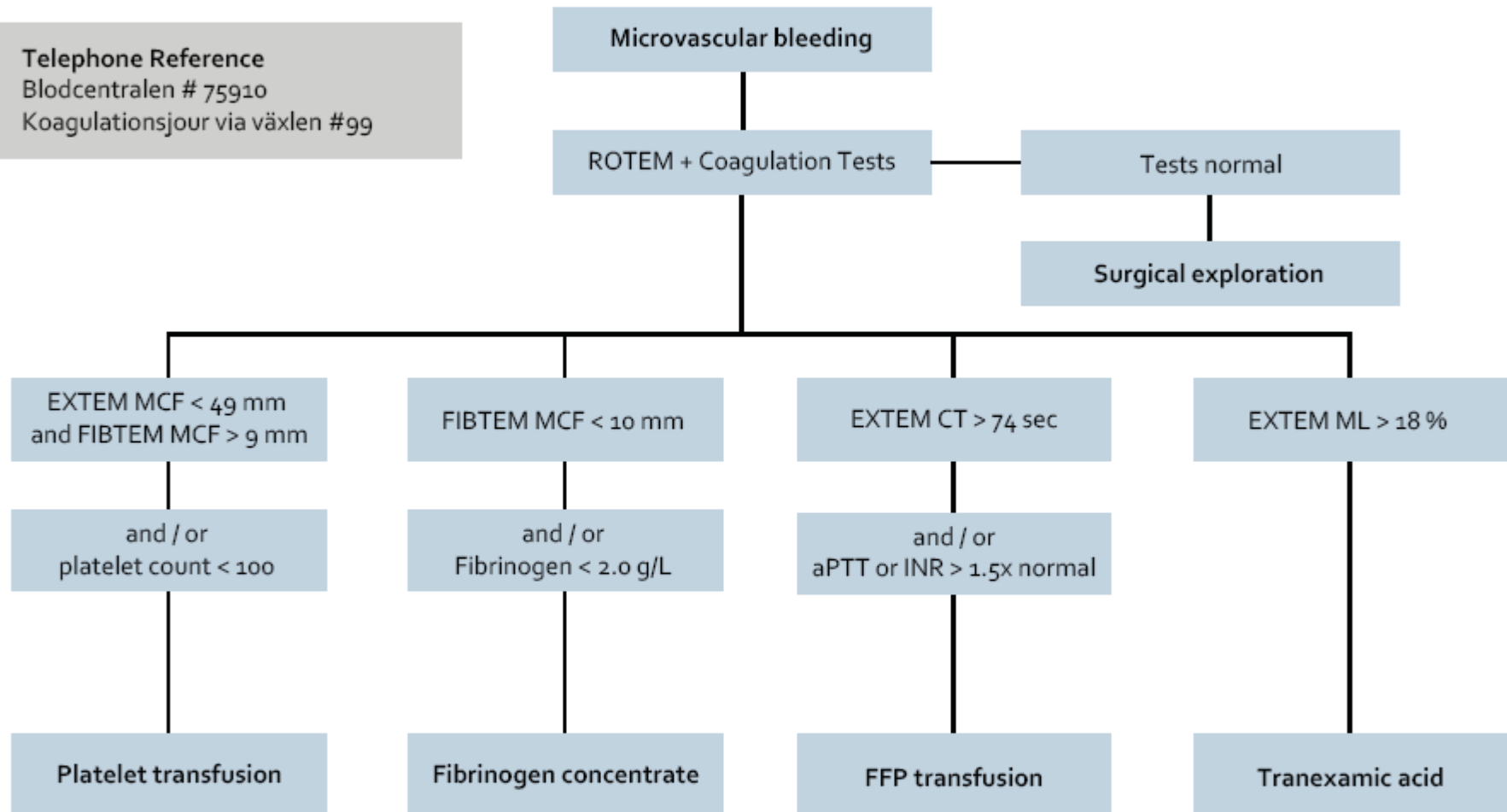
FIBTEM	2012-09-25 17:19	2: 26964274PQ
CT: 60s	CFT: - s	α : - °
A10: 5mm	A20: 5mm	MCF: 5mm

OBS

Missvisande ROTEM-kurva vid:

- Hypokalcemi (Ca tillsätts före analysen)
- Hypotermi (analysen görs vid 37°C)
- Trombocythämmande läkemedel
- Waran-beh
- Hemofili, v. Willebrand

Telephone Reference
Blodcentralen # 75910
Koagulationsjour via växlen #99



References & Literature

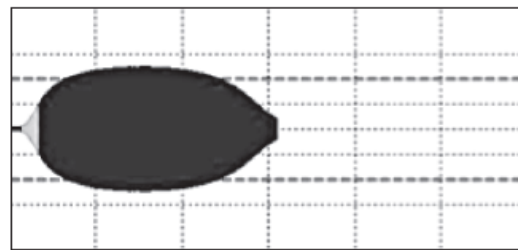
Lang et al. 2006 Multi-centre investigation on reference ranges for ROTEM thromboelastometry. *Blood Coagulation Fibrinolysis*
Bolliger et al. 2013 Principles and Practice of Thromboelastography in Clinical Coagulation Management and Transfusion Practice. *Transfusion Medicine Review*
ROTEM Analysis: Targeted Treatment of Acute Haemostatic Disorders. Calatzis et al. TEM International GmbH. (Booklet)



EXTEM		
CT: 64s	CFT: 178s	α : 57 ⁺
A10: 44mm	A20: 50mm	MCF: 52mm



EXTEM		
CT: 65s	CFT: 625s	α : 64 ⁺
A10: 20mm	A20: 24mm	MCF: 28mm



EXTEM		
CT: 93s	CFT: 131s	α : 65 ⁺
A10: 48mm	A20: 47mm	MCF: 50mm



Red wine glass

Normal trace

- Short CT (stem)
- Wide MCF (body)



Champagne glass

Coagulopathic trace

- Long CT (stem)
- Narrow MCF (body)



Pufferfish

Hyperfibrinolysis trace

- Wide MCF initially with narrowing

Keene et al. 2013

FIGURE 2. Global trace patterns.