



Is there a need to measure ROTEM/TEG?

Moniek de Maat
Hematologie

Behandelschema Massaal Bloedverlies

(Bij aankondiging tel: 33204 ter voorbereiding ROTEM)

Mogelijkheid tot compensatie
(systolische RR > puls / klinische beoordeling)

Dreigende verbloeding
(systolische RR < puls / klinische beoordeling)

Bestel Massaal Transfusie Pack (tel: 34590)
- 3x Erytrocytenconcentraat
- 3x Omniplasma
- 1x Trombocytenconcentraat
- Fibrinogeen 2000mg
- Calciumgluconaat 2000mg
Ophalen op Nc407

- Zo snel mogelijk chirurgische / radiologische hemostase!
- Bloedafname:
 - ROTEM (=extra citraatbuis, zet op formulier: ROTEM Massaal bloedverlies!)
 - Hb, Ht, Trombo's, PT, APTT, INR, Fibrinogeen, D-dimeer
 - 2x kruisbloed uit 2 afzonderlijke anamnesen
- Gecontroleerde hypotensie: Streef-systole 85 mmHg (cave hersenletsel)
- Verwarmede infusie Sterofundin / Ringers Lactaat
- Direct Tranexaminezuur: <70kg: 1000mg IV / >70kg: 1500mg IV
- Streef-temperatuur >35°C
- Streef-calcium >1,10 mmol/L: z.n. CaGluc 2000mg IV
- Streef-pH >7,30: z.n. NaBic 8,4% 100mL IV
- Antistolling:
 - Coumarines: direct Cofact 40 mL + verder o.g.v. INR
 - Ascal / Clopidogrel: direct 2x Trombocyten + DDAVP 0,3 mcg/kg IV
 - Heparine / LMWH: direct Protamine 50mg IV
 - Overig i.o.m. dd hematoloog **5507

Mogelijkheid tot compensatie
(systolische RR > puls / klinische beoordeling)

Transfusie in verhouding 1x EC : 1x Omniplasma
- Gezonde patiënten: start bij Hb <5 mmol/L
- Cardiopulmonaal belast: start bij Hb <6 mmol/L
1x Trombocytenconcentraat als <75 x 10⁹/L

Dreigende verbloeding
(systolische RR < puls / klinische beoordeling)

Producten **Massaal Transfusie Pack** z.s.m. toedienen!

Zo snel mogelijk stollingssuppletie o.g.v. ROTEM:

▪ **FIBTEM A10**

- A10 \leq 5 mm: Fibrinogeen 6000mg IV
- A10 \leq 7 mm: Fibrinogeen 4000mg IV
- A10 \leq 9 mm: Fibrinogeen 2000mg IV
- A10 > 9 mm: Geen Fibrinogeen

▪ **EXTEM CT**

- < 80 sec: Geen Cofact
- \geq 80 sec: Cofact 0.4 mL/kg (afgerond op 10 mL)
- \geq 100 sec: Cofact 0.8 mL/kg (afgerond op 10 mL)

▪ **EXTEM A10**

- A10 < 40 mm: 1x Trombocytenconcentraat
(let op: FIBTEM A10 moet > 9 mm zijn)

▪ **EXTEM ML**

- > 15% in 60 minuten: Tranexaminezuur 15 mg/kg extra



Direct hierna bloedafnames herhalen:

- Bloedgas, ROTEM, Hb, Ht, Trombocyten, PT, APTT, INR, Fibrinogeen, D-dimeer

Transfusiebeleid tot definitieve behandeling:

- Bij dreigende verbloeding → direct herhalen 3x EC : 3x Plasma : 1x TC
- Bij mogelijkheid tot compensatie → 1x EC : 1x Plasma o.g.v. Hb
1x Trombocyten als $< 75 \times 10^9/L$

Stollingscorrectie continueren o.g.v. ROTEM-schema

ROTEM in the Erasmus MC

- Historically TEG was used
- Now ROTEM, especially because of available literature
- Start: ROTEM at the departments
 - Turned out that technicians are better at using ROTEM
 - Often no maintenance done
 - Cleaning of the instrument not optimal
 - Results not in the patient file
- Therefore we moved ROTEM to the laboratory with the use of the connectivity kit (LIVE viewing for everybody, using PID nr patient)
- Everybody is positive!
- Now we use 3 ROTEM Delta and 1 ROTEM Sigma (validation)

ROTEM at the Hemostasis Laboratory Erasmus MC



Dangerous:

I understand all about coagulation,
because I looked at the ROTEM

Limitations

platelet inhibitors:

- no detection of Aspirin®
- no detection of clopidogrel/Plavix®
- no detection of von Willebrand syndrome
- poor sensitivity to Reopro®

anticoagulants:

- poor sensitivity to low molecular weight heparin, Orgaran® and pentasaccharide
- poor sensitivity to oral anticoagulants (coumarins Warfarin®, etc.) and DOACs

Limitations

- ROTEM is not really POCT
- Assays with ROTEM are expensive
(costs >10x more than combination PT-APTT-fibrinogen)
- Differences between ROTEM equipment and reagent

REPORT



SURVEY 2017-M3
ROTEM/TEG
Labcode 246



External quality Control for Assays and Tests
With a focus on Thrombosis and Haemostasis

Survey: 2017-M3

Page 3 of 10

10-oktober-2017

Labcode: 246

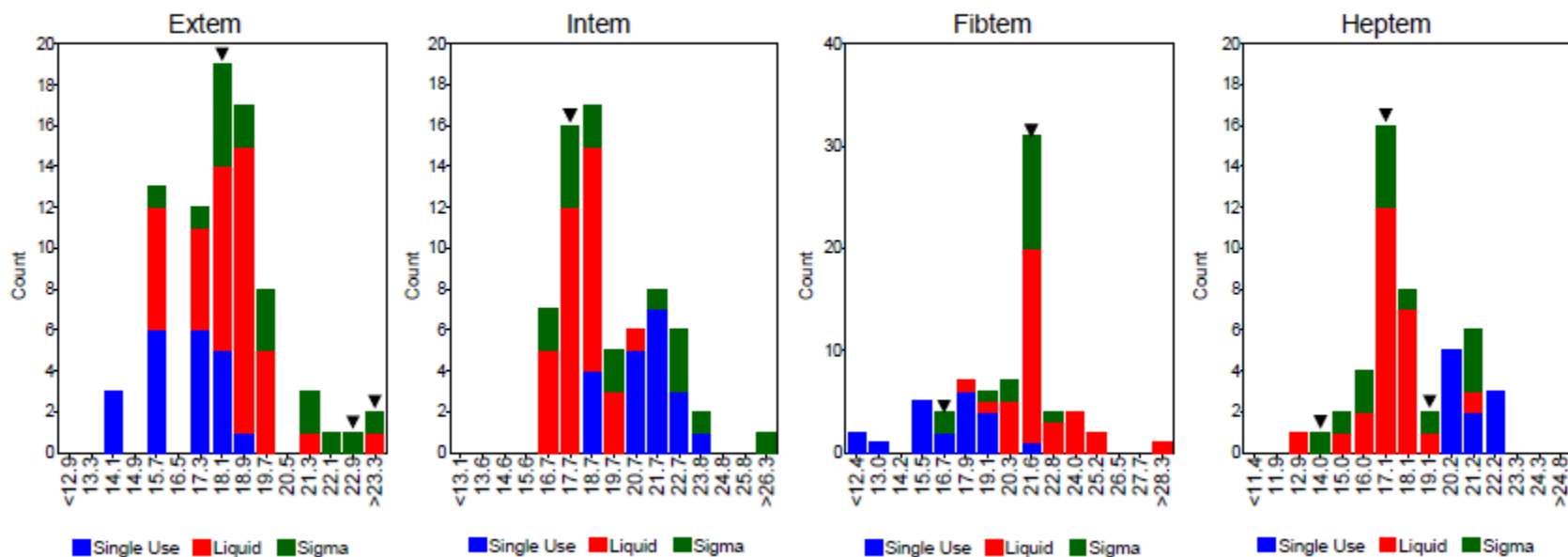
ROTEM/TEG

ROTEM

Sample No 17.132

Sample Details Plasma with an UFH level of approx. 0.25 IU/mL

MCF (mm)



Limitations

- ROTEM is not really POCT
- Assays with ROTEM are expensive
(costs >10x more than combination PT-APTT-fibrinogen)
- Differences between equipment and reagent

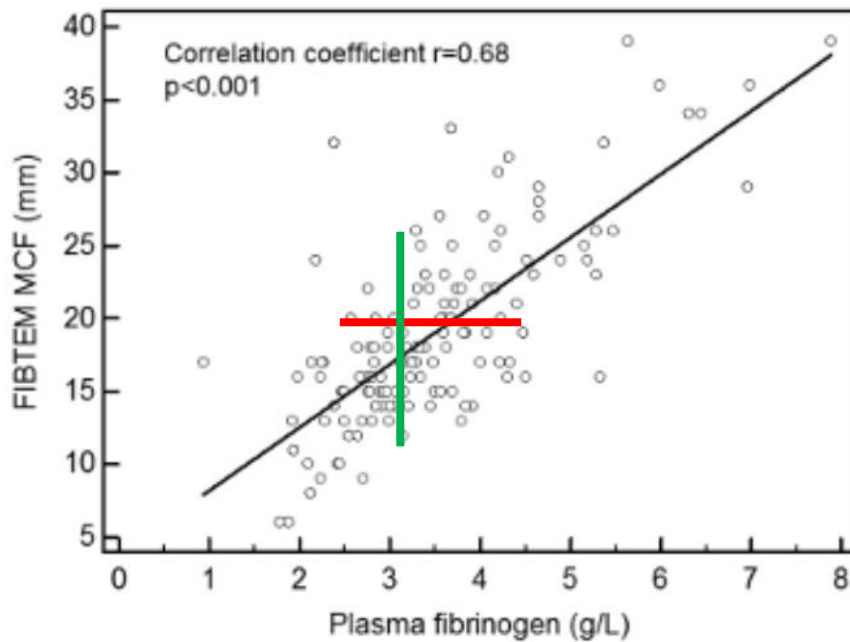
Advantage

- Fast indication of coagulation
- Fast assay for fibrinogen levels

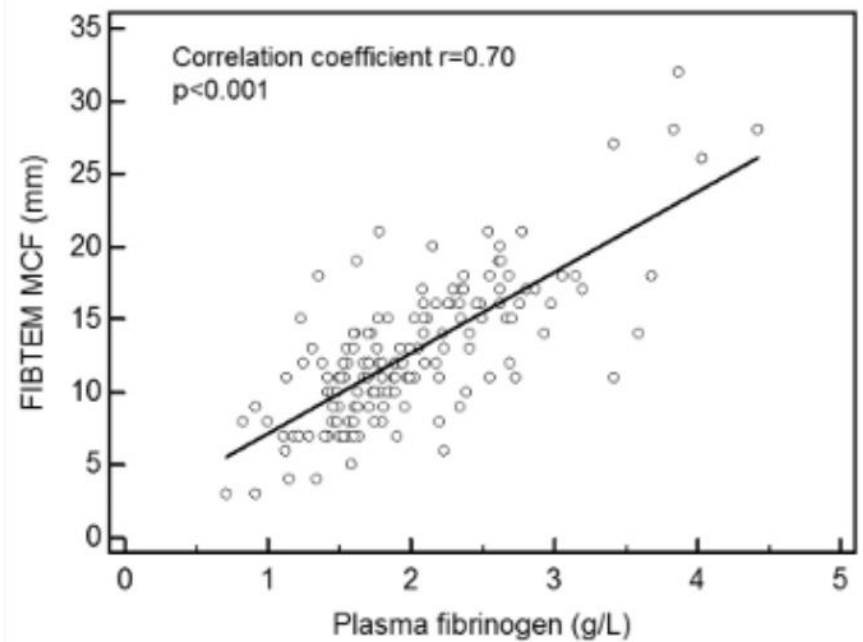
FIBTEM is not a measurement of Fibrinogen concentration

Clauss versus FIBTEM-MCF

Before cardiac surgery



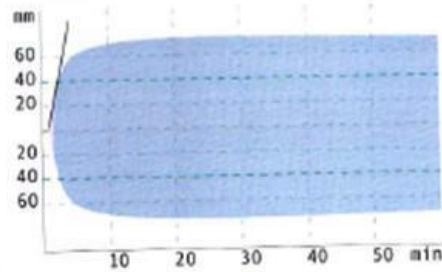
After



Casus I

Erasmus MC
Rotem.ErasmusMC.nl

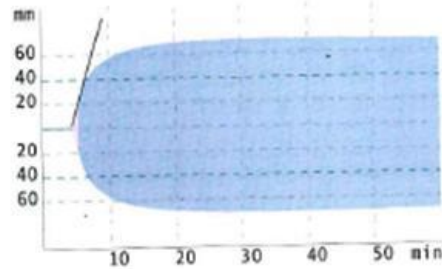
ROTEM A



1 EXTEM

RT: 01:00:01 ST: 2018-02-06T16:55:20

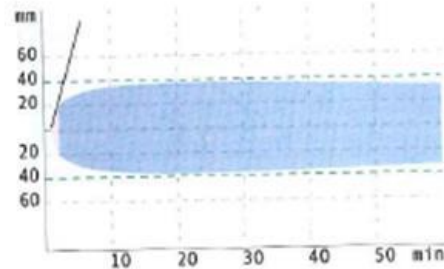
CT	: 67	s	[38 - 79]
CFT	: 37	s	[34 - 159]
α	: 83	°	[63 - 83]
A10	: 72	mm	[43 - 65] ▲
A20	: 75	mm	[50 - 71] ▲
MCF	: 75	mm	[50 - 72] ▲
ML	: *	3	% [0 - 15]



2 INTEM

RT: 01:00:00 ST: 2018-02-06T16:56:07

CT	: 267	s	[100 - 240] ▲
CFT	: 57	s	[30 - 110]
α	: 79	°	[70 - 83]
A10	: 66	mm	[44 - 66]
A20	: 71	mm	[50 - 71]
MCF	: 72	mm	[50 - 72]
ML	: *	2	% [0 - 15]



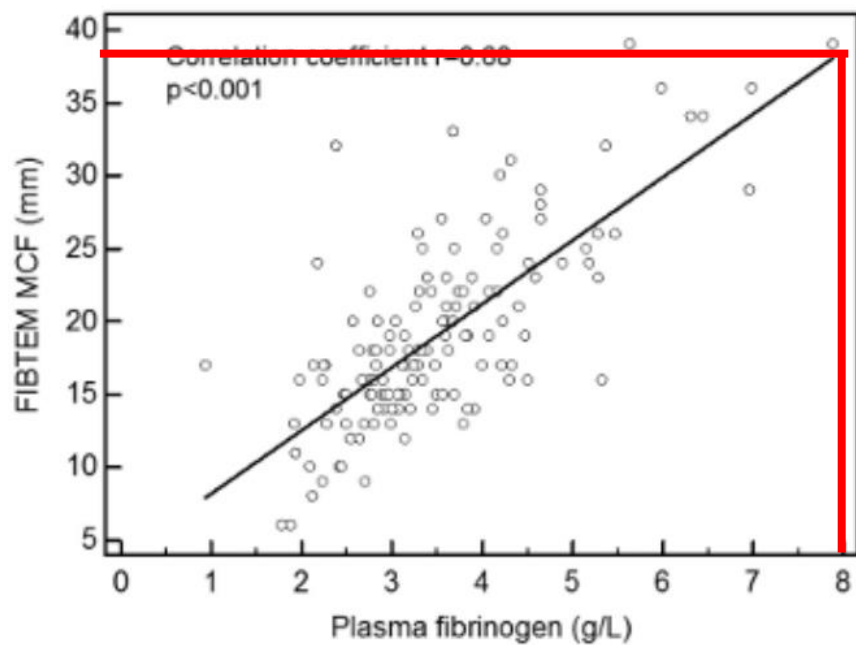
3 FIBTEM

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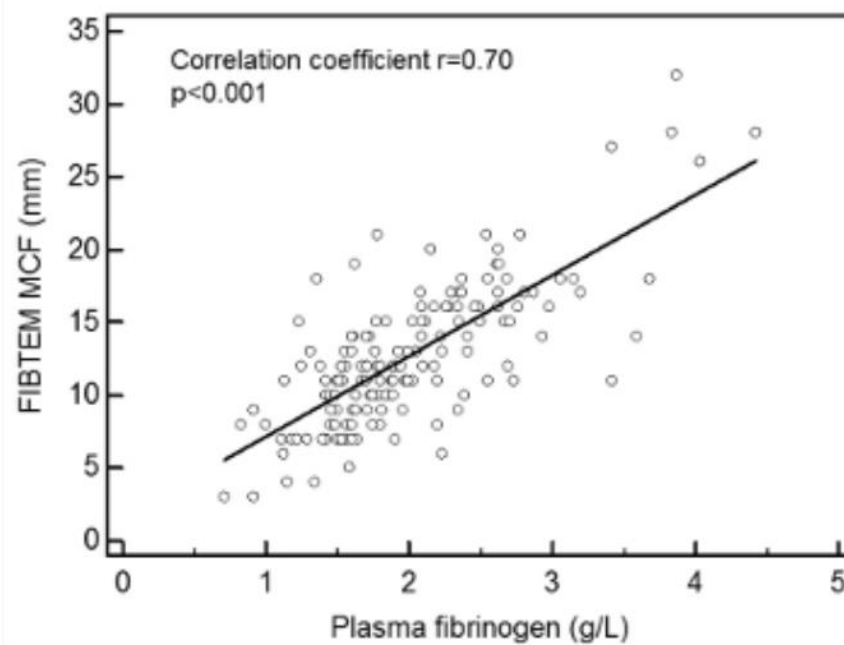
CT	: 68	s	[38 - 62] ▲
CFT	: 70	s	
α	: 78	°	
A10	: 36	mm	[7 - 23] ▲
A20	: 38	mm	[8 - 24] ▲
MCF	: 38	mm	[9 - 25] ▲
ML	: *	12	%

Clauss versus FIBTEM-MCF

Before cardiac surgery



After



Casus I

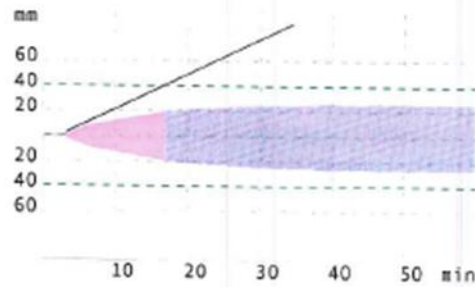
- Man, 49 years old
- Essential thrombocytosis (low risk) with in this context acquired VWD
- Malignant thymome, treated with chemotherapy

- Platelet count: $1084 \cdot 10^9/L$
- PT: 13.3 sec
- APTT: 27 sec
- Fibrinogen: **2.3 g/L**
- VWF: Ag: 0.91 (U/mL)
- VWF:act: 0.69 (U/mL)

Casus II

- Man, born in 1949 (67 jaar)
- 2006 Cryptogenic liver cirrhosis, unexplained (viral, AIH, hemochromatosis, PSC negative)
- 2014 Start of bilirubin increase, decrease albumin and prolonged clotting tests
- 2016 Progressive decrease of liver function, accompanied by kidney insufficiency, decompensation and coagulation abnormalities.

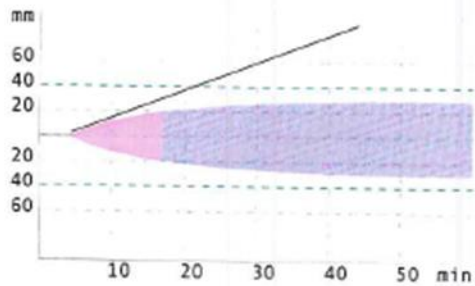
Casus II



1 EXTEM [default]

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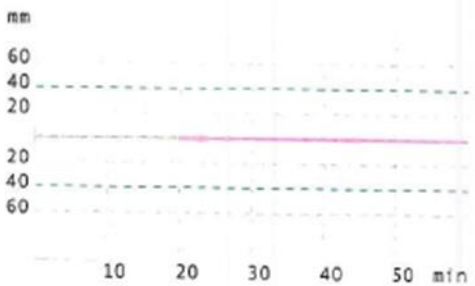
CT	:	194	S	[38	-	79]	▲
CFT	:	814	S	[34	-	159]	▲
α	:	35	°	[63	-	83]	▼
A10	:	17	mm	[43	-	65]	▼
A20	:	23	mm	[50	-	71]	▼
MCF	:	27	mm	[50	-	72]	▼
ML	:	* 4	%	[	0	-	15]	



2 INTEM [default]

RT: 01:00:00 ST: 2016-09-12T12:45:26

CT	:	267	S	[	100	-	240]	▲
CFT	:	747	S	[	30	-	110]	▲
α	:	29	°	[	70	-	83]	▼
A10	:	18	mm	[	44	-	66]	▼
A20	:	25	mm	[	50	-	71]	▼
MCF	:	* 31	mm	[	50	-	72]	
ML	:	* 0	%	[	0	-	15]	



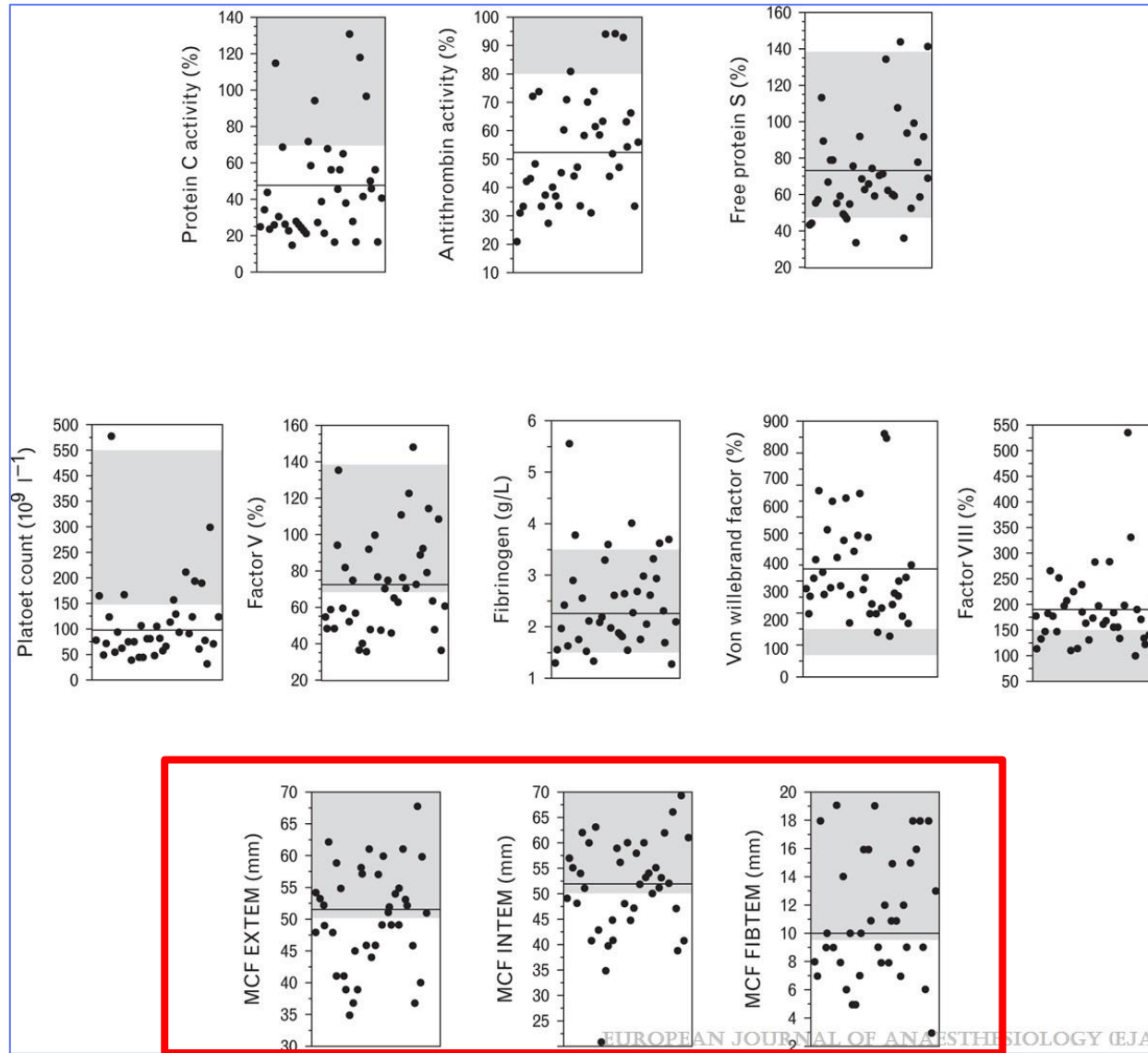
3 FIBTEM [default]

RT: 01:00:00 ST: 2016-09-12T12:46:22

CT	:	1182	S	[	38	-	62]	▲
CFT	:		S					
α	:		°					
A10	:	1	mm	[	7	-	23]	▼
A20	:	2	mm	[	8	-	24]	▼
MCF	:	3	mm	[	9	-	25]	▼
ML	:	* 77	%					

Hemoglobine	BL	mmol/L	5.1	5.1 _L	5.1	5.2 _L	6.1	5.2 _L
Hematocriet	BL	L/L		0.23 _L				0.23 _L
Erythrocyten	BL	10 ¹² /L						2.46 _L
MCV	BL	fL		96		96		95
RDW	BL	%		17.2 ^H		17.3 ^H		17.3 ^H
Trombocyten	BL	10 ⁹ /L		24 _{L!}		24 _L		21 _{L!}
Leukocyten	BL	10 ⁹ /L		8.6		7.9		9.2
A1antitryps.	BL	g/L						
Ceruloplasm.	BL	g/L						
IgG4	BL	g/L						
Bloedgroep	BL							
IRR. Anti st	BL							
Kruisbloed	BL							
TSH	BL	mU/L						
APTT	BL	sec				52 ^H		48 ^H
APTT ratio	BL							
PT	BL	sec				28.1 ^H		28.2 ^H
PT INR	BL					2.5		2.5
Fibrinogeen	BL	g/L				1.5		1.4 _L
Factor V	BL	U/mL						
Antitrombine	BL	U/mL				0.31 _L		
Antiplasmine	BL	U/mL				0.35 _L		
D-dimeren	BL	mg/L				10.90 ^H		

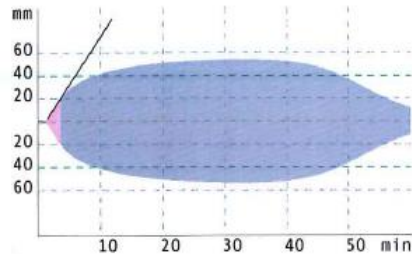
ROTEM tests in patients with cirrhosis



Fibrinolysis

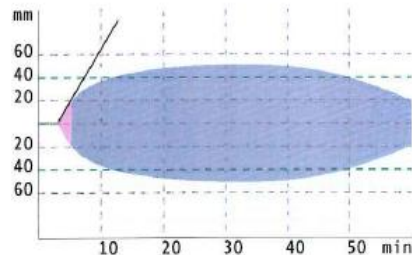
Erasmus MC
Rotem.ErasmusMC.nl

ROTEM Analyser, Tem Innovations
3080



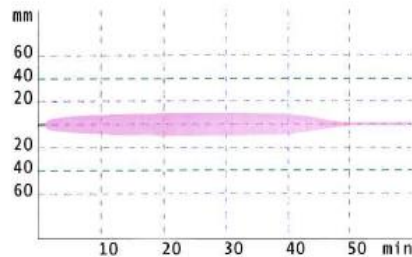
1 EXTEM

RT: 01:00:00		ST: 2018-10-25T15:56:03	
CT	: 96	s	[38 - 79] ▲
CFT	: 125	s	[34 - 159]
α	: 66	°	[63 - 83]
A10	: 44	mm	[43 - 65]
A20	: 52	mm	[50 - 71]
MCF	: 54	mm	[50 - 72]
ML	: * 78	%	[0 - 15]



2 INTEM

RT: 01:00:00		ST: 2018-10-25T15:56:38	
CT	: 201	s	[100 - 240]
CFT	: 123	s	[30 - 110] ▲
α	: 67	°	[70 - 83] ▼
A10	: 43	mm	[44 - 66] ▼
A20	: 50	mm	[50 - 71]
MCF	: 51	mm	[50 - 72]
ML	: * 62	%	[0 - 15]



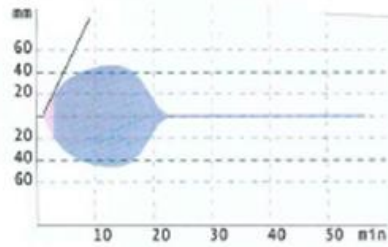
3 FIBTEM

RT: 01:00:01		ST: 2018-10-25T15:57:17	
CT	: 81	s	[38 - 62] ▲
CFT	:	s	
α	:	°	
A10	: 9	mm	[7 - 23]
A20	: 10	mm	[8 - 24]
MCF	: 10	mm	[9 - 25]
ML	: 100	%	

Fibrinolysis

Erasmus MC
Rotem_ErasmusMC.nl

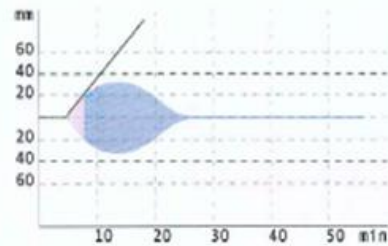
ROTEM Analyser, Ten Innovations
3080



1 EXTEM

RT: _____

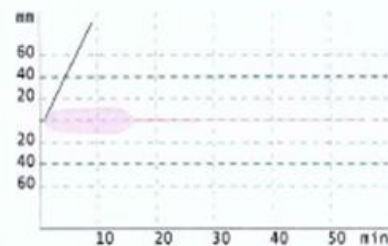
CT	: 71	s	[38 - 79]
CFT	: 109	s	[34 - 159]
α	: 71	°	[63 - 83]
A10	: 46	mm	[43 - 65]
A20	: 7	mm	[50 - 71] ▼
MCF	: 47	mm	[50 - 72] ▼
ML	: 100	%	[0 - 15] ▲



2 INTEM

RT: 00:56:08 ST: 2018-02-06T14:25:48





CT	: 299	s	[100 - 240] ▲
CFT	: 167	s	[30 - 110] ▲
α	: 59	°	[70 - 83] ▼
A10	: 33	mm	[44 - 66] ▼
A20	: 3	mm	[50 - 71] ▼
MCF	: 33	mm	[50 - 72] ▼
ML	: 100	%	[0 - 15] ▲



3 FIBTEM

RT: 00:55:26 ST: 2018-02-06T14:26:28

CT	: 62	s	[38 - 62]
CFT	:	s	
α	: 70	°	
A10	: 12	mm	[7 - 23]
A20	: 0	mm	[8 - 24] ▼
MCF	: 12	mm	[9 - 25]
ML	: 100	%	

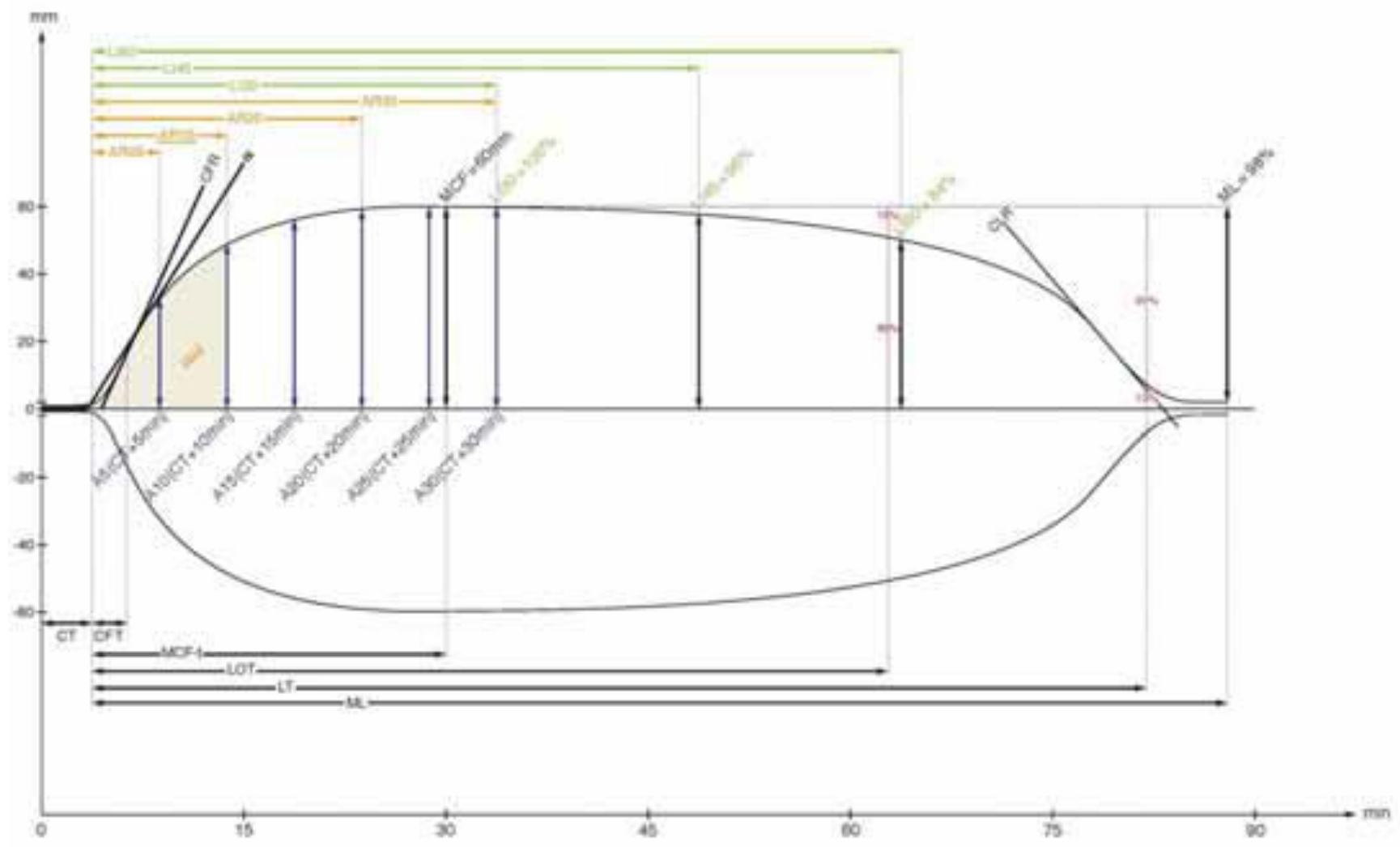
Test	Materiaal	24-05-2016 10:21	24-05-2016 10:30	24-05-2016 12:48	25-05-2016 06:59	27-05-2016 06:28	06-02-2018 14:47 Hoek	06-02-2018 15:00	06-02-2018 15:06	Eenheid
<input type="checkbox"/> APTT	Bloed						54			sec
<input type="checkbox"/> PT	Bloed						15.8			sec
<input type="checkbox"/> PT INR	Bloed						1.4			
<input type="checkbox"/> Fibrinogeen	Bloed						2.6			g/L
<input type="checkbox"/> D-dimeren	Bloed						61.56			mg/L
<input type="checkbox"/> ROTEM EXTEM	Bloed						Zie-Opm 			
<input type="checkbox"/> ROTEM INTEM	Bloed						Zie-Opm 			
<input type="checkbox"/> ROTEM FIBTEM	Bloed						Zie-Opm 			
<input type="checkbox"/> ROTEM HEPTEM	Bloed						Zie-Opm 			

Conclusions

- ROTEM is valuable in massive blood loss protocols, where the risk of coagulation abnormalities is small.
- Many factors are not detected using the ROTEM

Erasmus MC





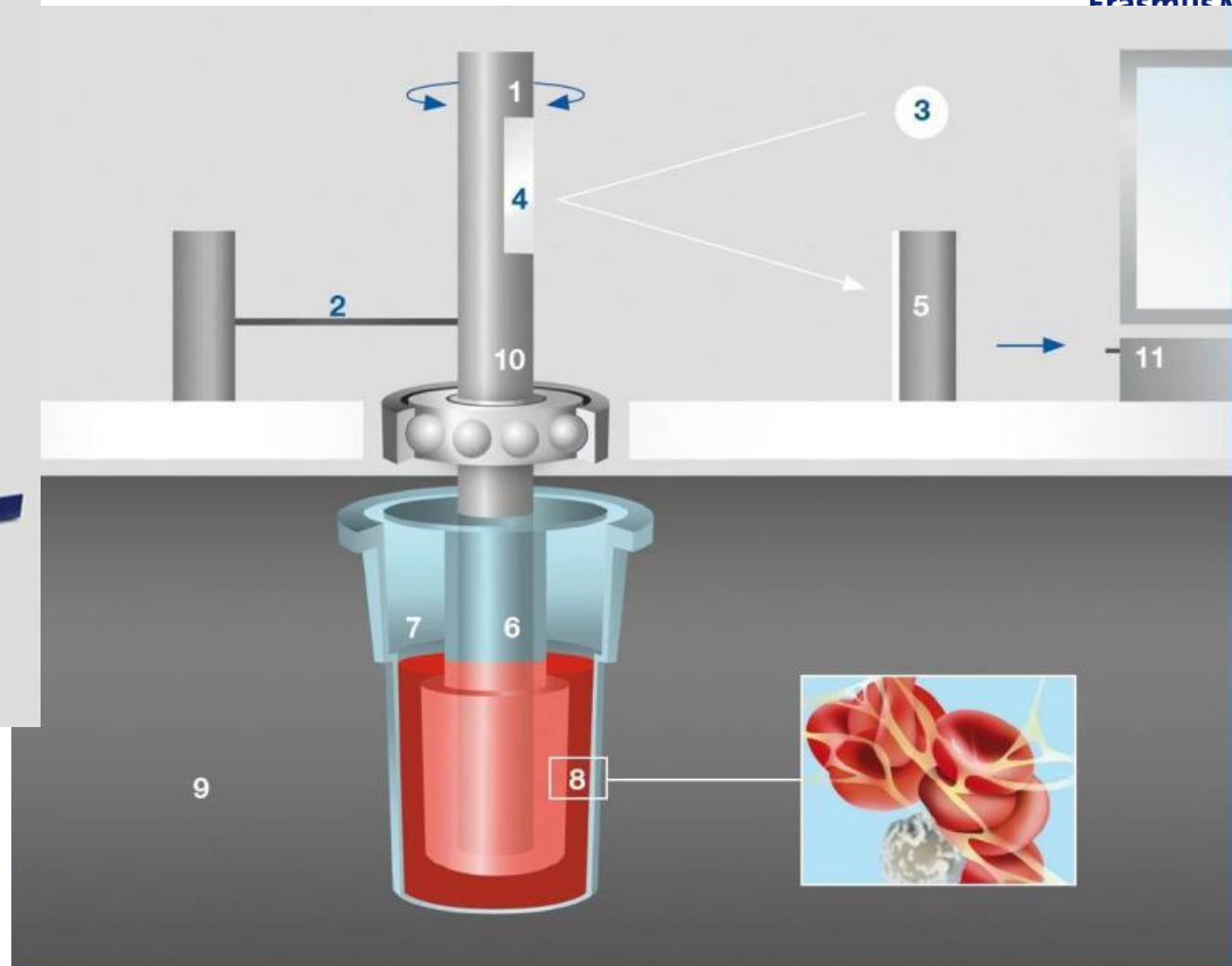


Figure 4-1: Principle of thromboelastometry with ROTEM® *delta*

1 Axis (~4.75 °)

2 Spring
aggregate

3 Light source/diode

4 Mirror

5 Detection device (electric camera)

6 Sensor pin

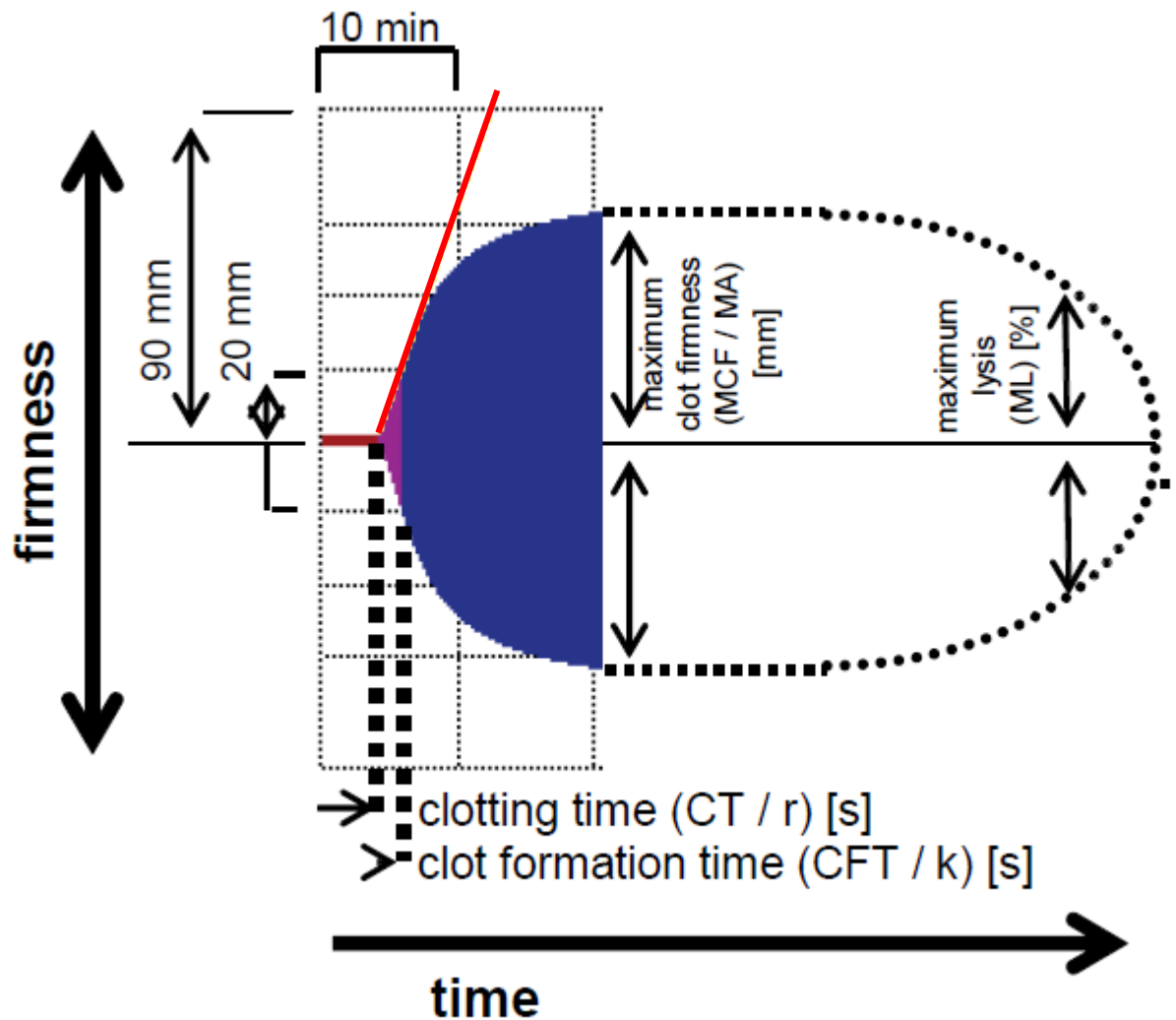
7 Cup filled with blood

8 Fibrin fibres and thrombocyte

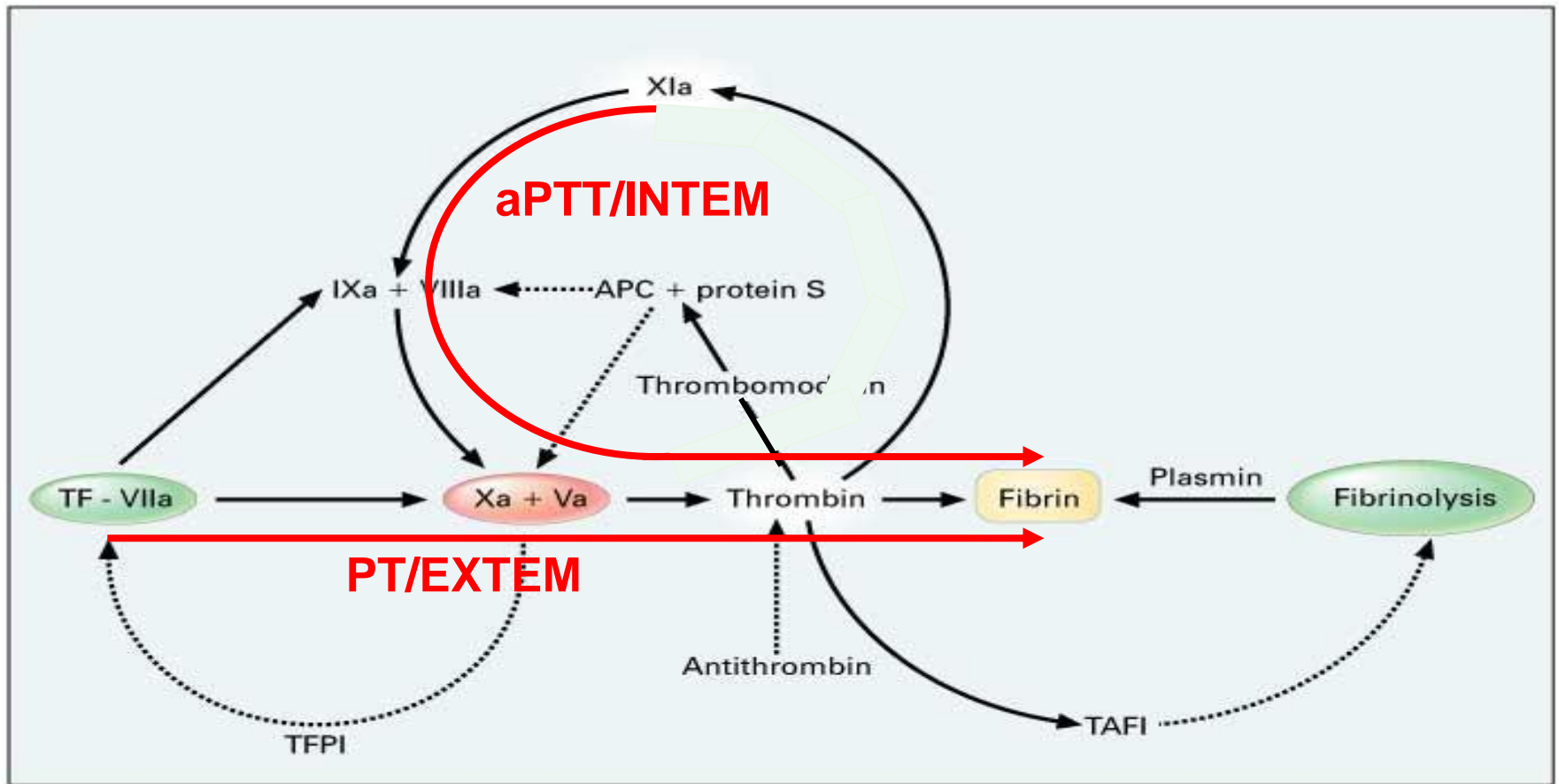
9 Heated cup holder

10 Ball bearings

11 Data processing



PT and APTT



EXTEM

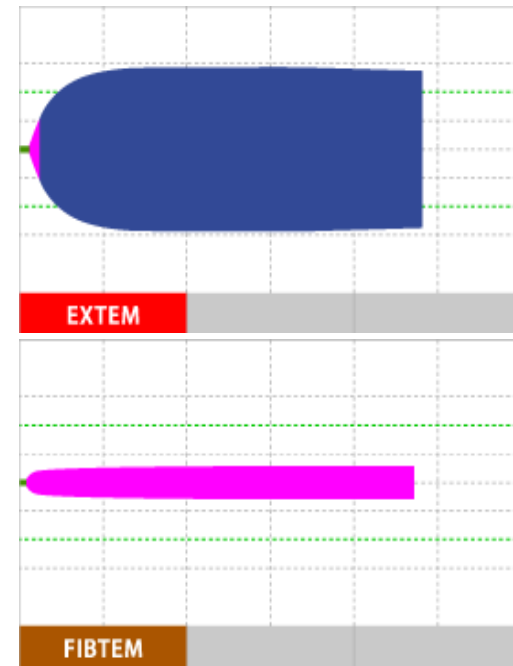
- **Activator:** tissue factor
- **Principle:** mild extrinsic coagulation activation
- **Application:** Global analysis of coagulation, largely heparin insensitive
- **Limitations:**
 - Insensitive to mild coagulation factor deficiencies
 - Insensitive to defects of primary hemostasis (VWD and platelet aggregation)
 - May still be normal when INR is <3-4
 - May show pathological values caused by very high heparin levels

INTEM

- **Activator:** Partial thromboplastin phospholipid made of rabbit brain (chloroform extract), ellagic acid
- **Principle:** mild intrinsic coagulation activation
- **Application :** Global analysis of coagulation
- *Limitations:*
 - Insensitive to mild coagulation factor deficiencies
 - Insensitive to defects of primary hemostasis (VWD and platelet aggregation)

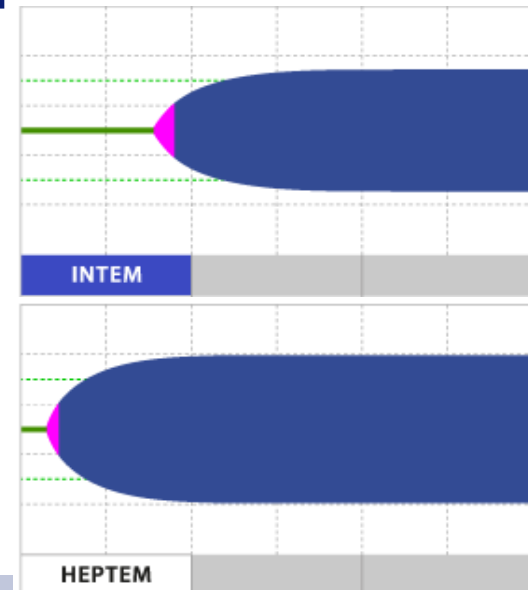
FIBTEM

- **Activator:** Cytochalasin D, recombinant tissue factor and phospholipids, CaCl_2
- **Principle:** mild intrinsic coagulation activation in the presence of a platelet inhibitor
- **Application:**
 - Detection of fibrinogen deficiency and fibrin polymerisation disorders
 - Compared to EXTEM: indirect determination of the platelet component
 - Largely heparin insensitive
- **Limitations:**
 - May be influenced by very high heparin levels
 - Represents only the fibrin component

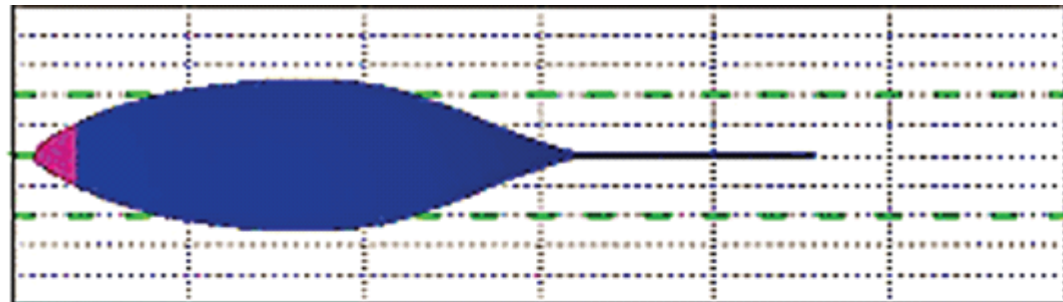


HEPTEM

- **Activator:** Heparinase, partial thromboplastin phospholipid made of rabbit brain, ellagic acid
- **Principle:** mild intrinsic coagulation activation in the presence of heparin degradation
- **Application:**
 - Global analysis of coagulation after the elimination of the influence of heparin
 - In comparison to INTEM: qualitative assay for the presence of heparin.
- **Limitations:**
 - Insensitive to mild coagulation factor deficiencies
 - Insensitive to defects of primary hemostasis (VWD and platelet aggregation)



APTEM: activation as in EXTEM with addition of aprotinin, a fibrinolysis inhibitor. In an assay comparing APTEM to EXTEM massive hyperfibrinolysis can be recognised within 10 – 20 minutes.



EXTEM			
CT: 59s	CFT: 130s	α :	65°
A10: 44mm	MCF: 48mm	ML:	100%



APTEM			
CT: 62s	CFT: 132s	α :	64°
A10: 44mm	MCF: 55mm	ML:	0%

ROTEM® Measurement module

Preparation Multi-TEM Screenshot **Standard overlay** Fabert overlay Help Quit

1: Doe, John EXTEM S

ST: 12:45:26 RT: 00:26:54

CT:	78 s	[0038 -- 0079]
CFT:	235 s	[0034 -- 0159]
α :	49 °	[0063 -- 0083]
A10:	37 mm	[0043 -- 0065]
A20:	47 mm	[0050 -- 0071]
MCF:	• 49 mm	[0050 -- 0072]
ML:	• 0 %	

Patient data Print Stop channel 1 [...]

EXTEM S

INTEM S

FIBTEM S

APTEM S

1: Doe, John

ST: 12:45:26 RT: 00:26:54

CT:	78 s	[0038 -- 0079]
CFT:	235 s	[0034 -- 0159]
α :	49 °	[0063 -- 0083]
A10:	37 mm	[0043 -- 0065]

1: Doe, John

ST: 12:46:13 RT: 00:26:06

CT:	348 s	[0100 -- 0240]
CFT:	138 s	[0030 -- 0110]
α :	65 °	[0070 -- 0083]
A10:	44 mm	[0044 -- 0066]

1: Doe, John

ST: 12:46:52 RT: 00:25:38

CT:	80 s	
CFT:	—	
α :	—	
A10:	6 mm	[0007 -- 0022]

1: Doe, John

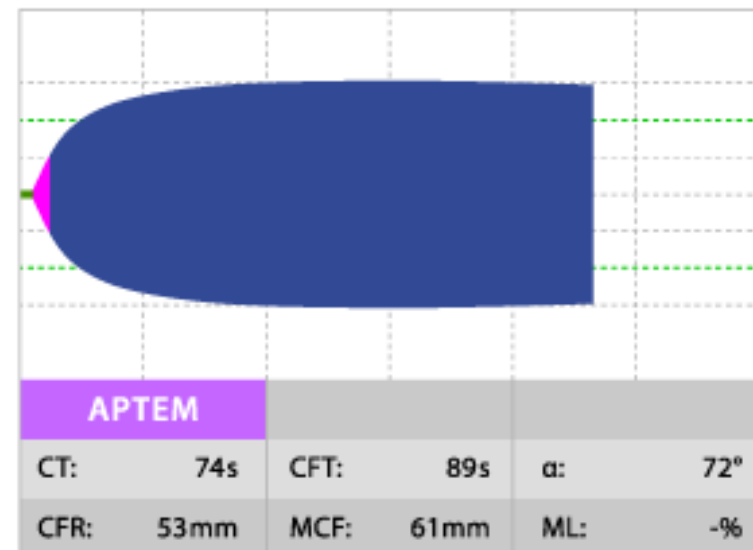
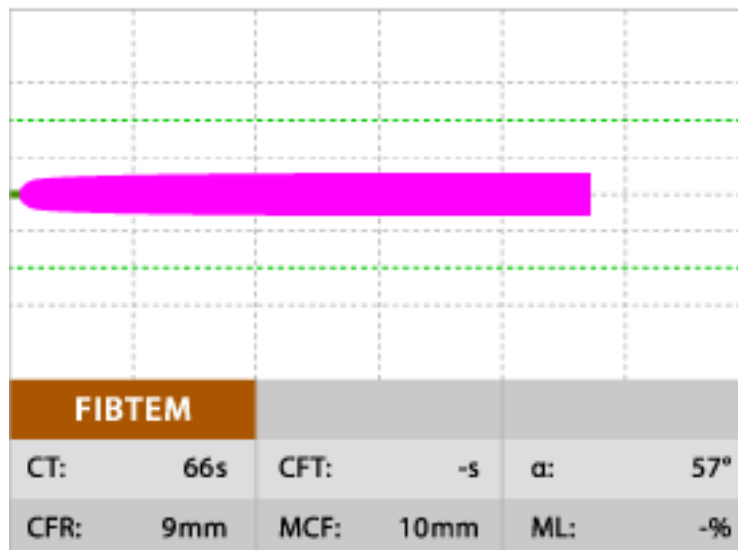
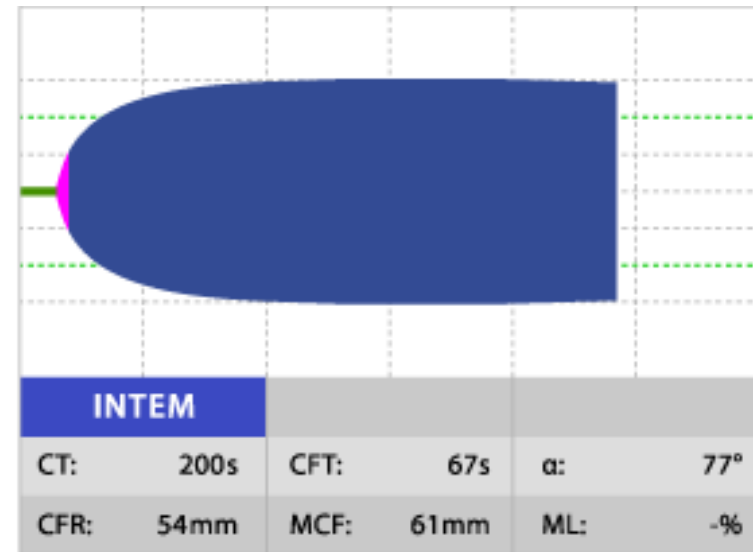
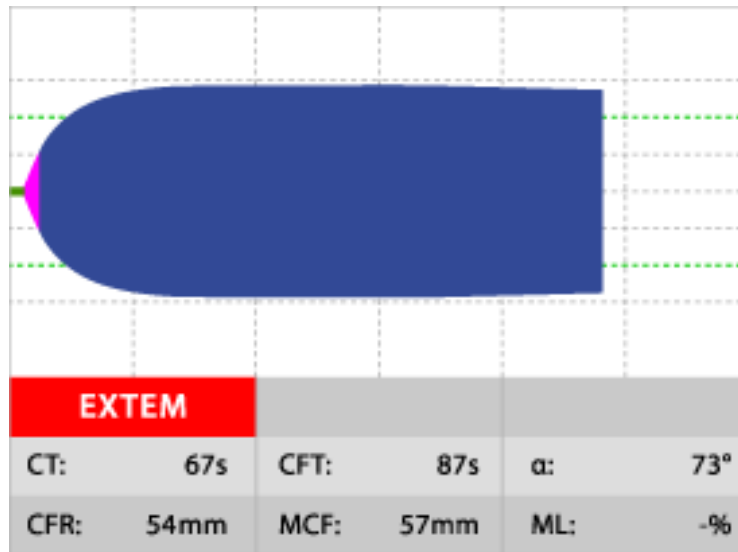
ST: 12:47:30 RT: 00:34:50

CT:	88 s	
CFT:	230 s	
α :	50 °	
A10:	38 mm	

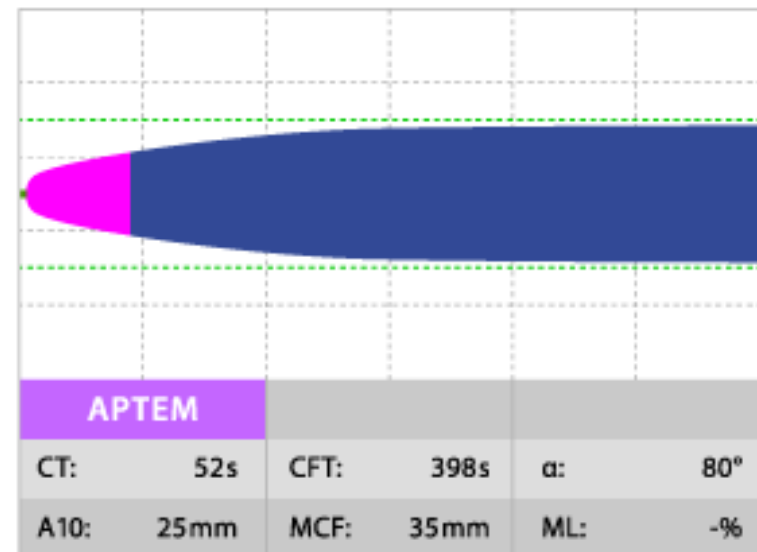
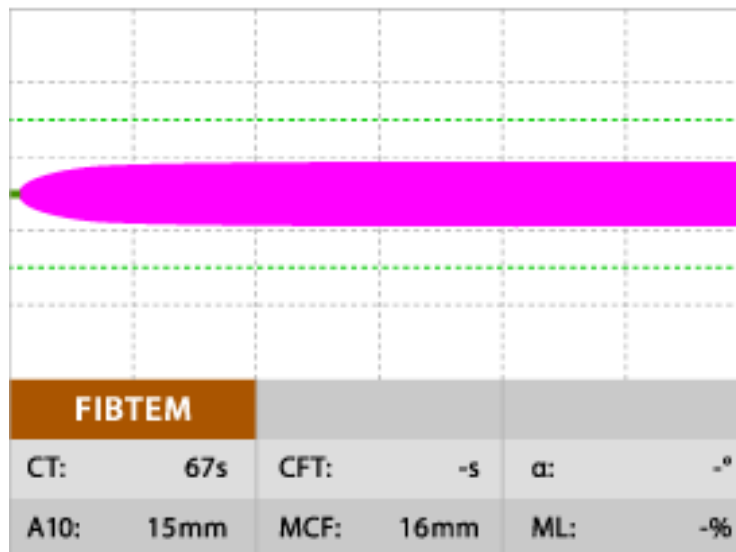
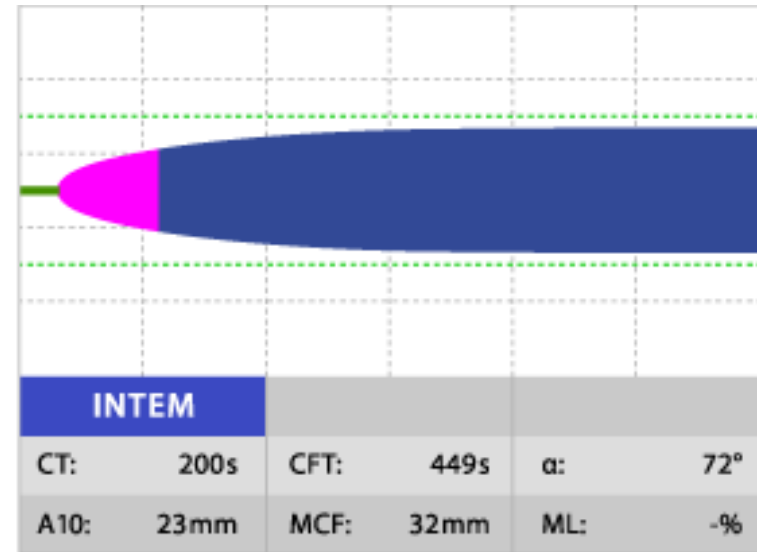
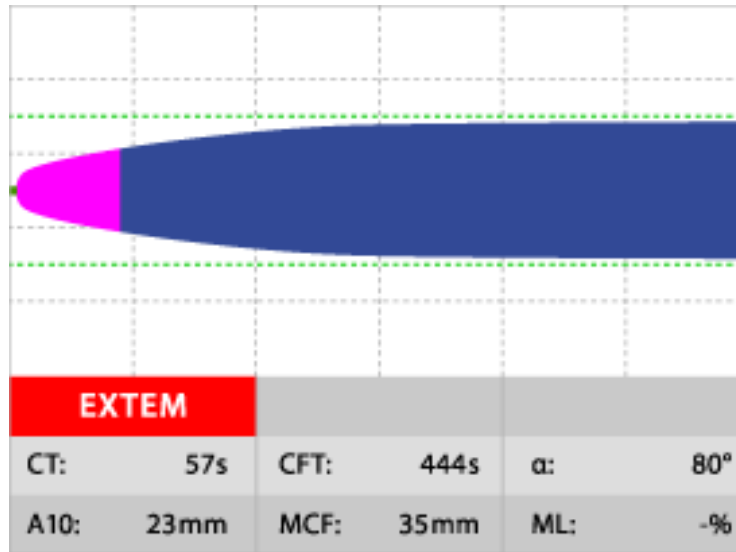
2012-04-16T13:12:20 v2.2.0 User: admin

Temperature: 37.0°C Pre 1 2 3 4

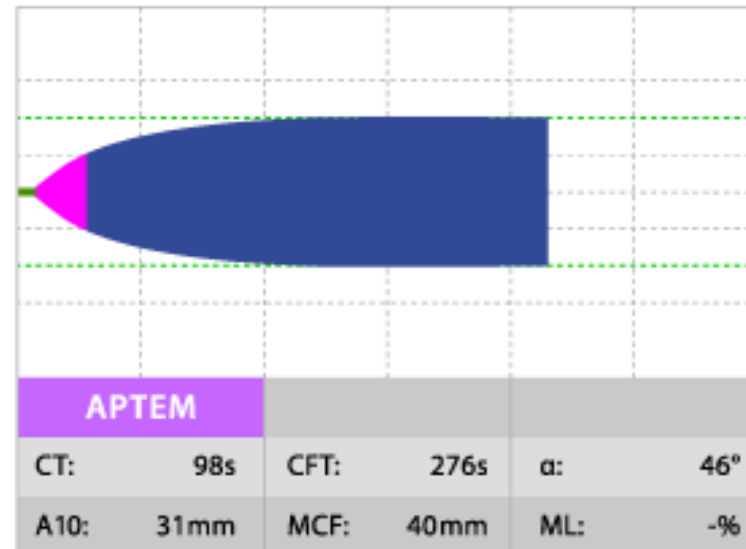
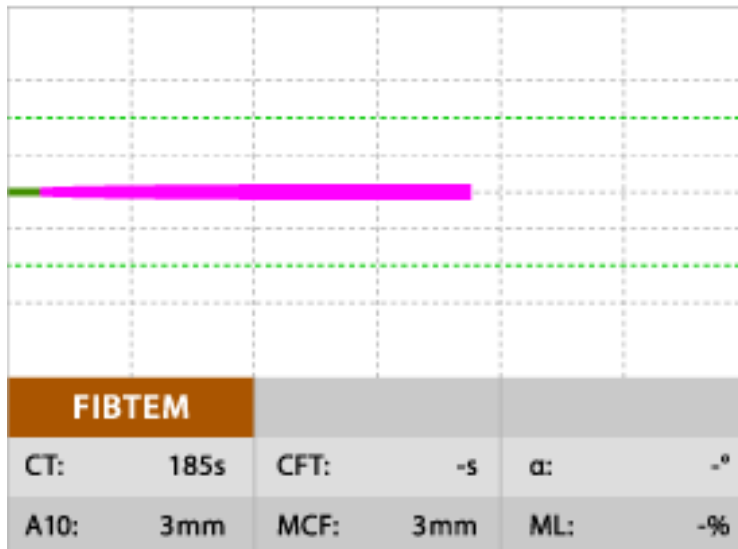
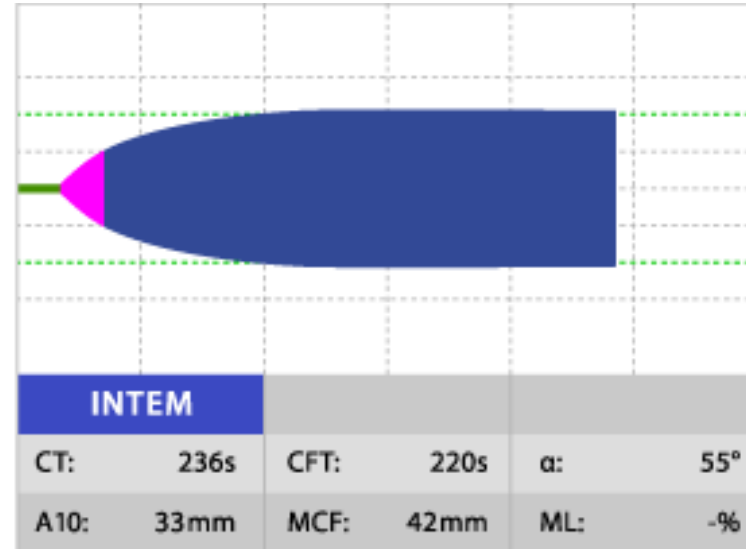
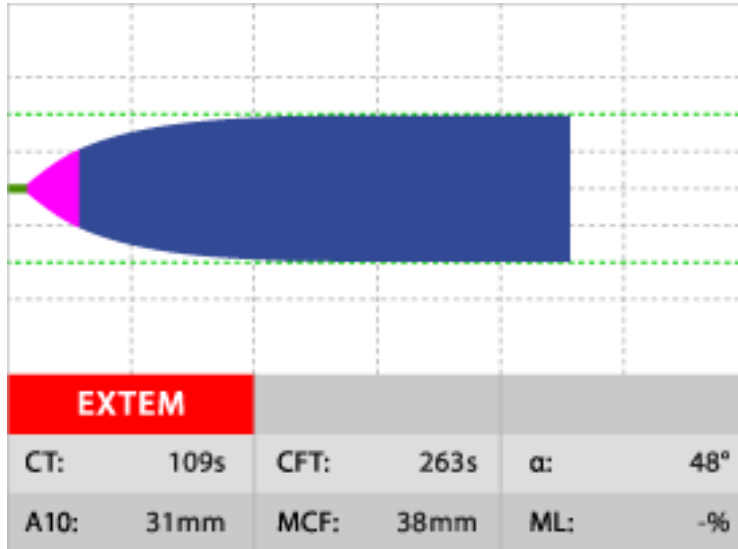
Normal ROTEM pattern



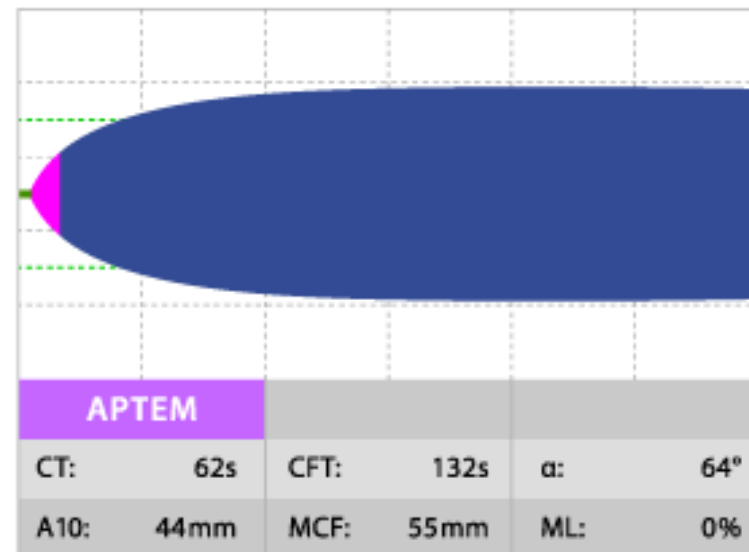
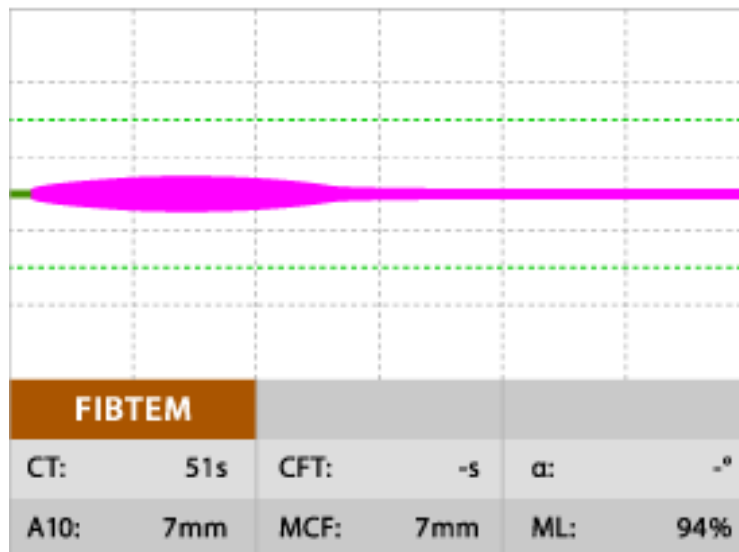
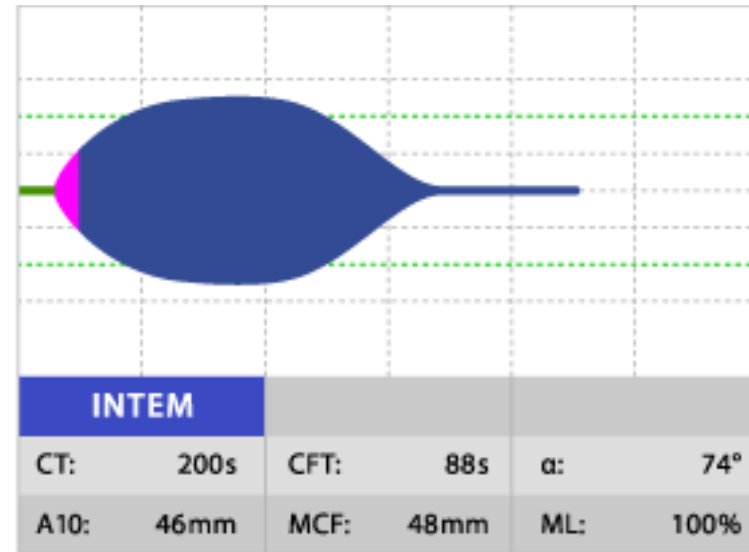
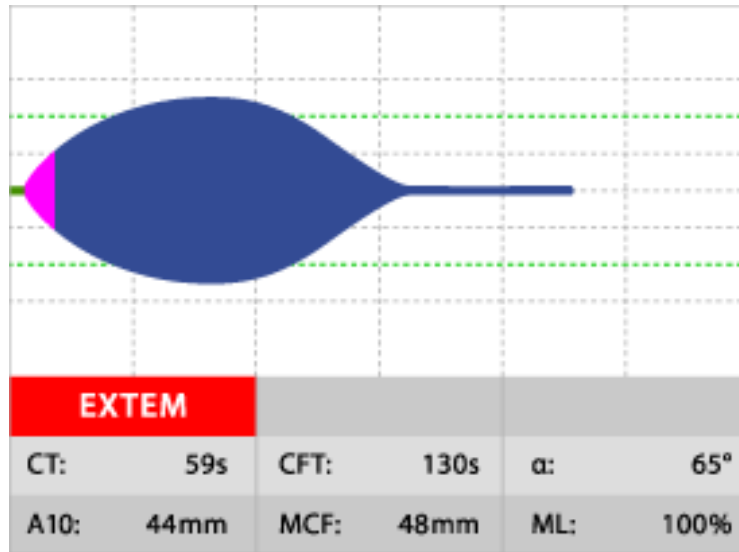
Platelet deficiency



Fibrinogen deficiency



Hyperfibrinolysis



Heparin influence

