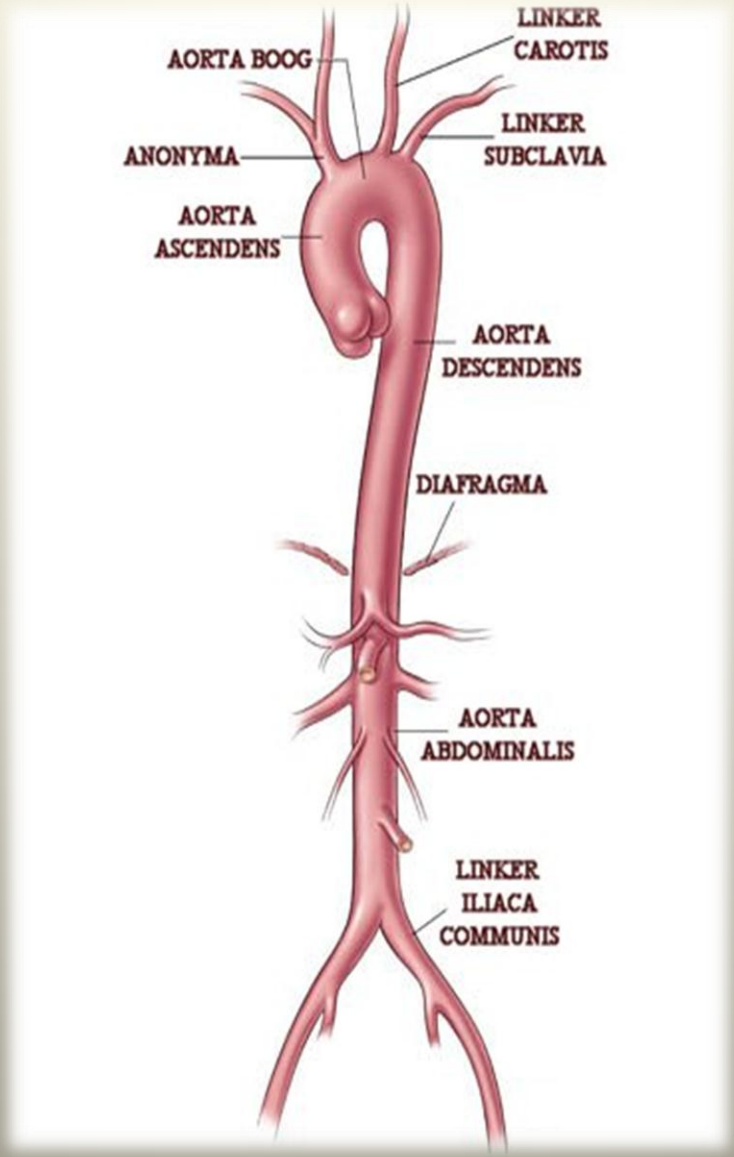
SURGICAL APPROACH OF VISCERAL, SPINAL CORD AND CEREBRAL PROTECTION

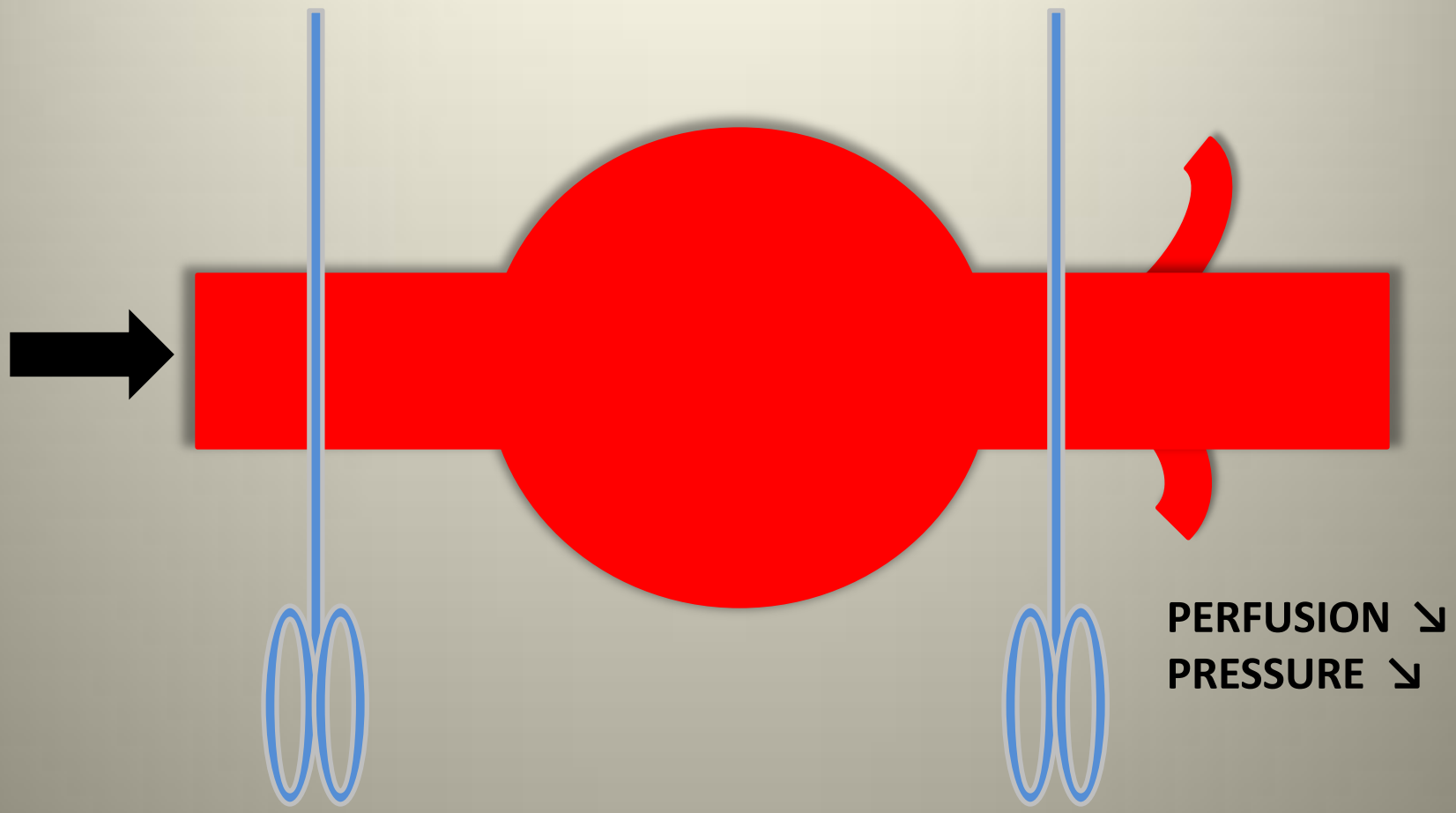
DR.MARC SCHEPENS
AZ ST.JAN BRUGGE
BELGIUM


LINKER
CAROTIS
AORTA BOOG
LINKER
SUBCLAVIA
ANONYMA
AORTA
ASCENDENS
AORTA
DESCENDENS
DIAFRAGMA
AORTA
ABDOMINALIS
LINKER
ILIACA
COMMUNIS

ISCHEMIA OF END-ORGANS

PROTECTION OF END-ORGANS

HOW TO DO IT ?


PERFUSION ↘
PRESSURE ↘

ARTERIAL INFLOW

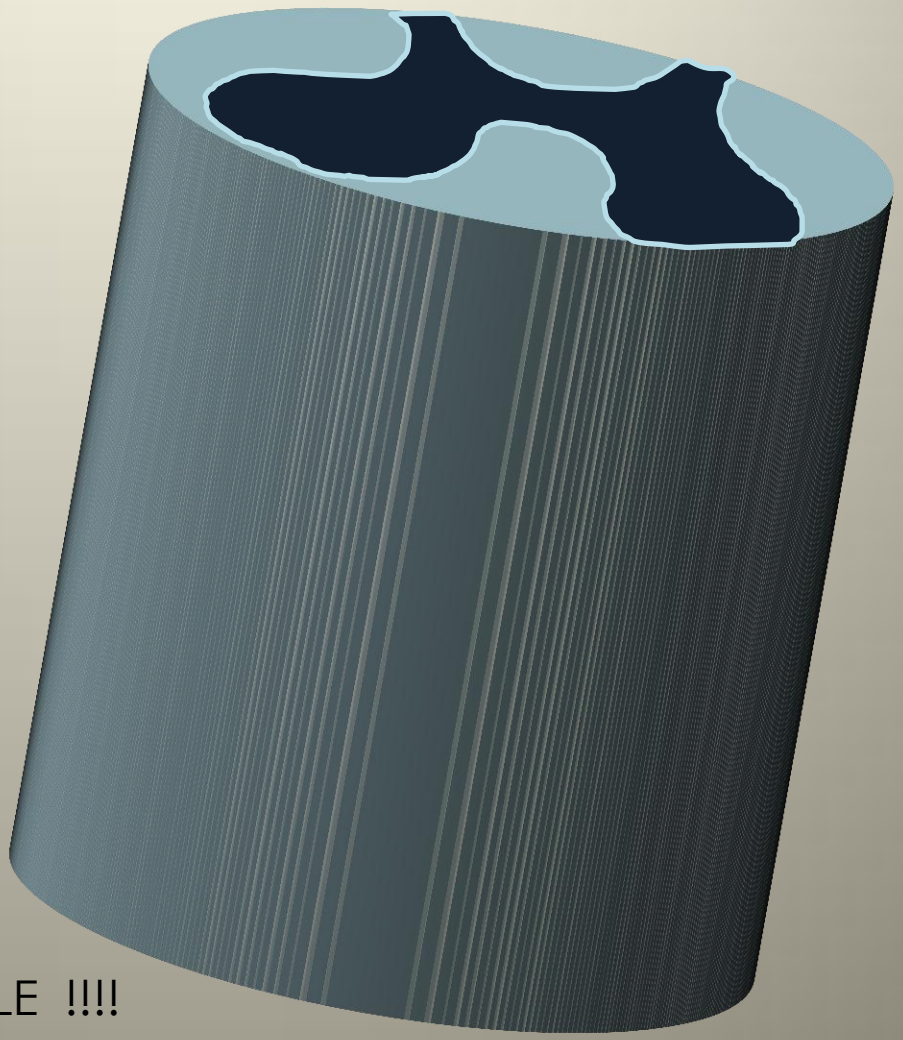
FUNCTIONAL INTEGRITY

TOLERABLE ISCHEMIC TIMES

KIDNEYS	30 MINUTES
GUTS	> 120 MINUTES
LOWER LEGS	> 200 MINUTES
SPINAL CORD	?? COLLATERAL CIRCULATION 30 MINUTES ?
BRAIN	3 MINUTES
HEART	?? COLLATERAL CIRCULATION Max 4 hours

SPINAL CORD PROTECTION

HYPOPERFUSION
HYPOTENSION
SPASM
STEAL
EDEMA
THROMBOSIS
REPERFUSION INJURY



MONRO-KELLY PRINCIPLE !!!!

INCIDENCE OF PARAPLEGIA/PARAPARESIS

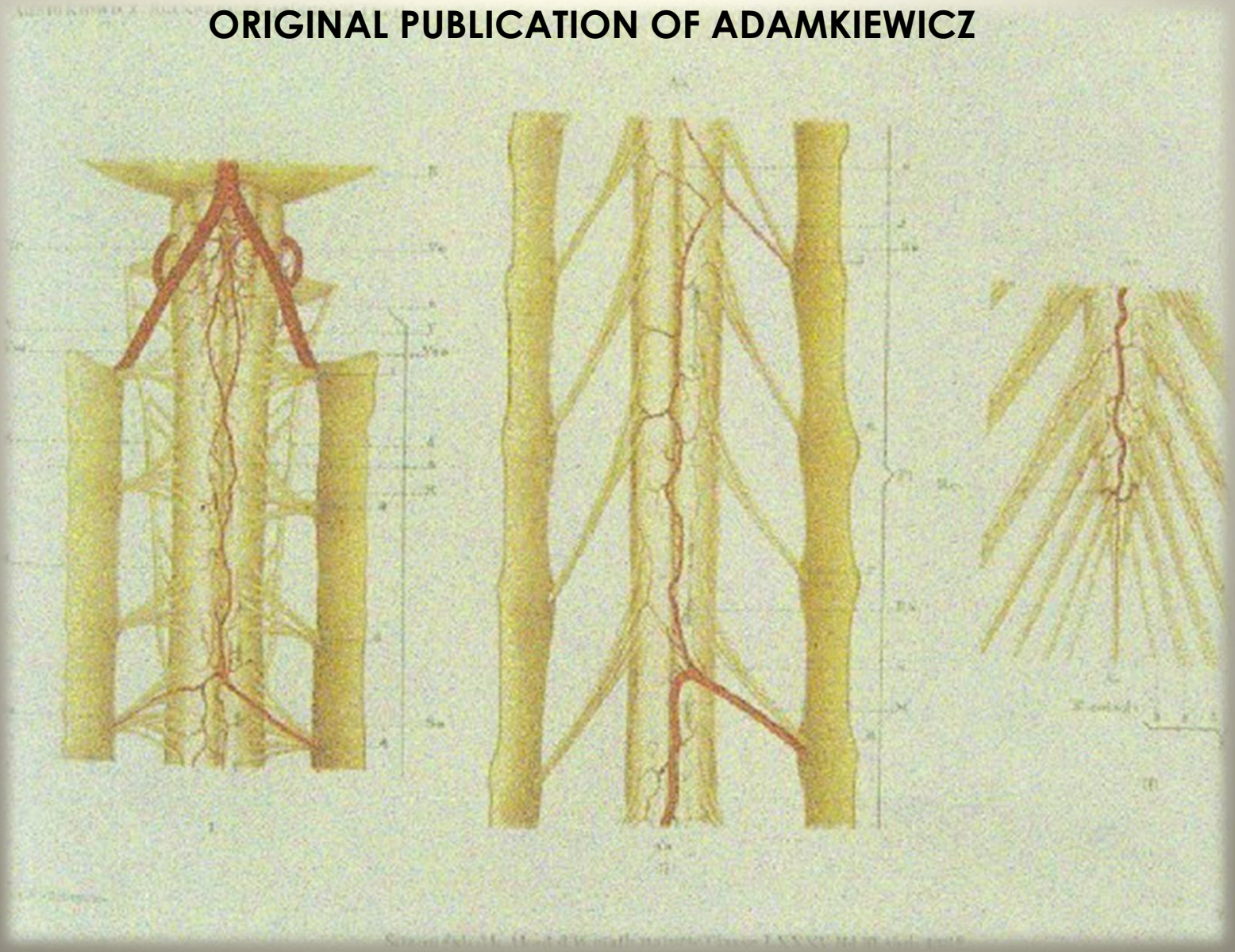
IN THORACOABDOMINAL AORTIC SURGERY

-SUBSTANTIAL REDUCTION OVER LAST 10 YEARS
-3 % TO 5 %

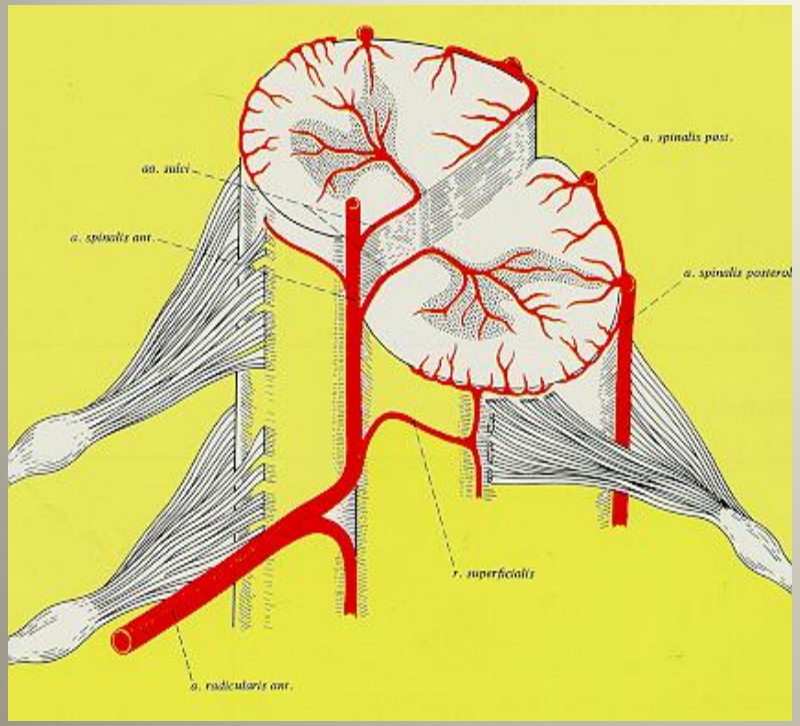
IN AORTIC ARCH SURGERY

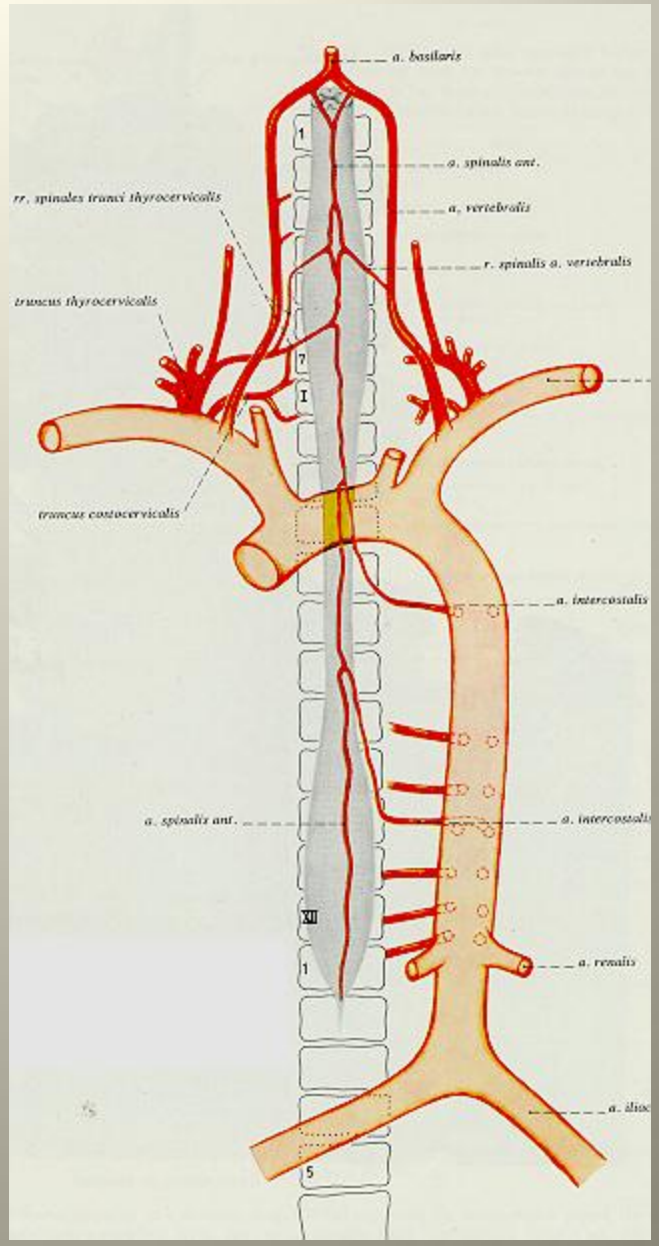
-LESS THAN 1 %
-NOT A PROBLEM

ORIGINAL PUBLICATION OF ADAMKIEWICZ



ADAMKIEWICZ A. DIE BLUTGEFÄSSE DES MENSCHLICHEN RŰCKENMARKEOBERFLÄCHE. AKAD WISS 1881;84 und 1882;85


a. spinalis post.
aa. sulci
a. spinalis ant.
a. spinalis posterol
r. superficialis
a. radicularis ant.


a. basilaris
a. spinalis ant.
rr. spinales trunci thyrocervicalis
a. vertebralis
r. spinalis a. vertebralis
truncus thyrocervicalis
truncus costocervicalis
a. intercostalis
a. spinalis ant.
a. intercostalis
a. renalis
a. iliac
1
7
I
XII
1
5

CROSS-CLAMP TIME
30 MINUTES

SPINAL CORD FUNCTIONAL INTEGRITY

LEFT HEART BYPASS

CEREBROSPINAL FLUID DRAINAGE

(PERMISSIVE) HYPOTHERMIA

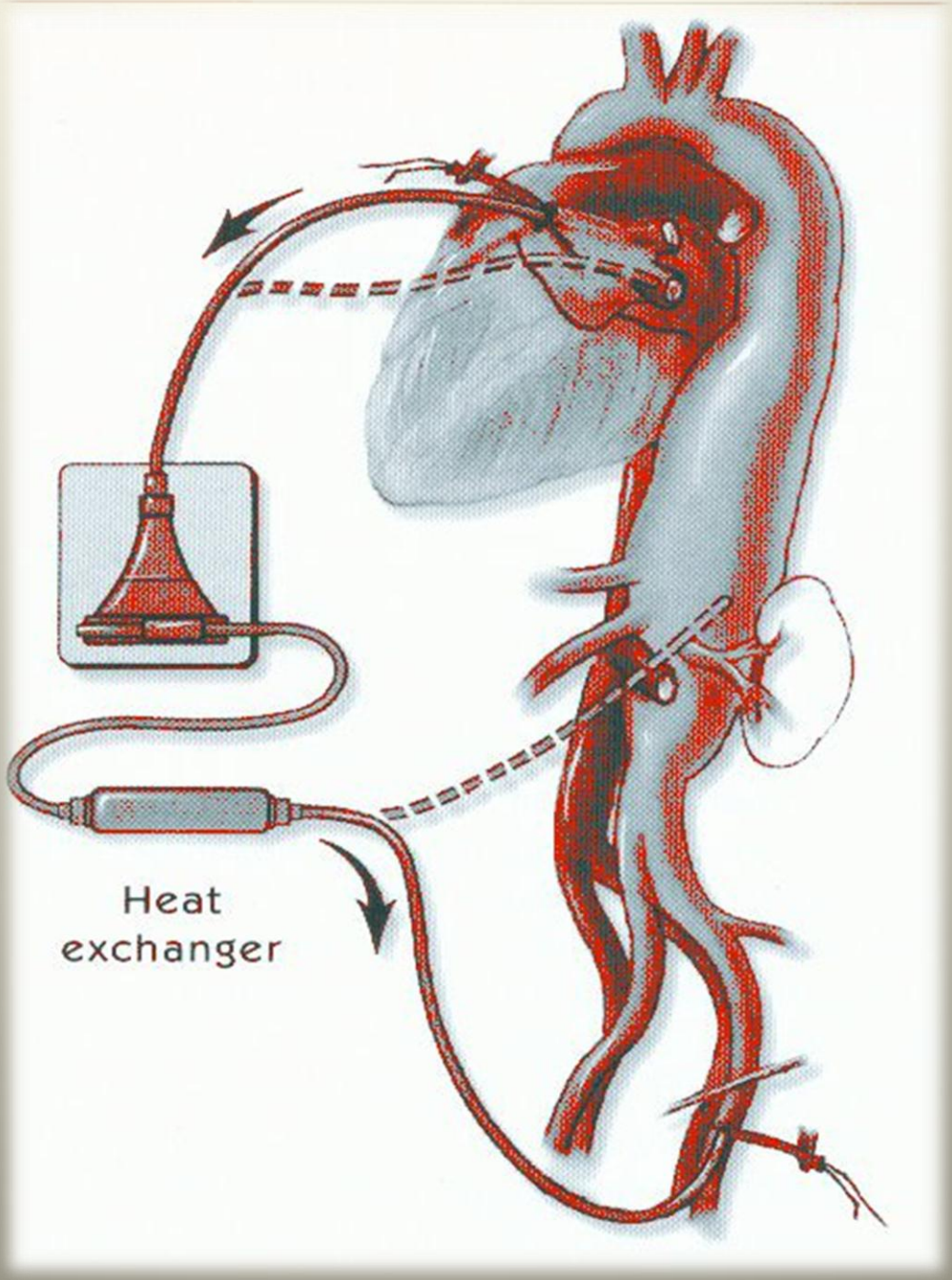
EVOKED POTENTIAL MONITORING

REIMPLANTATION OF CRITICAL INTERCOSTAL/LUMBAR ARTERIES

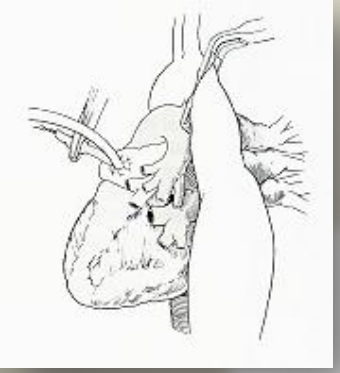
LEFT HEART BYPASS

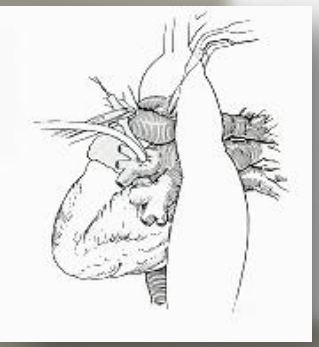
REDUCTION OF NEUROLOGIC DEFICITS FROM 21 % TO 3 % DUE TO THE INTRODUCTION OF LEFT HEART BYPASS

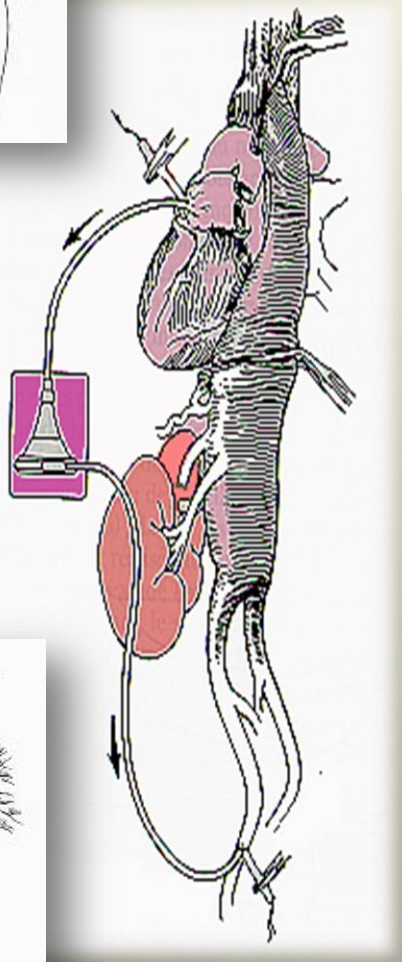
Safi et al. Ann Thorac Surg 2005;80:2173-9


Heat
exchanger

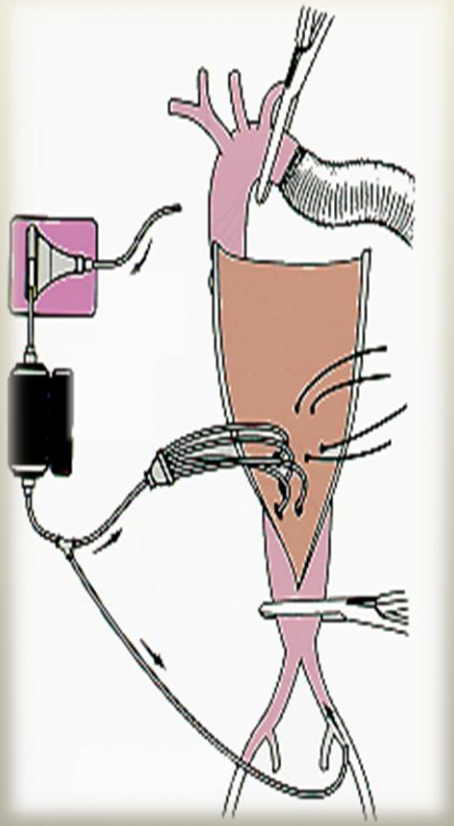
LEFT HEART BYPASS







BASIC SET-UP

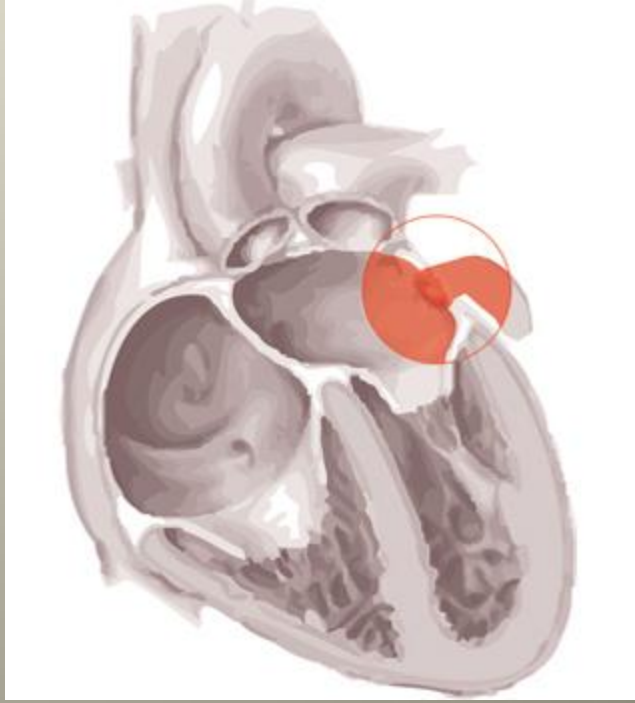


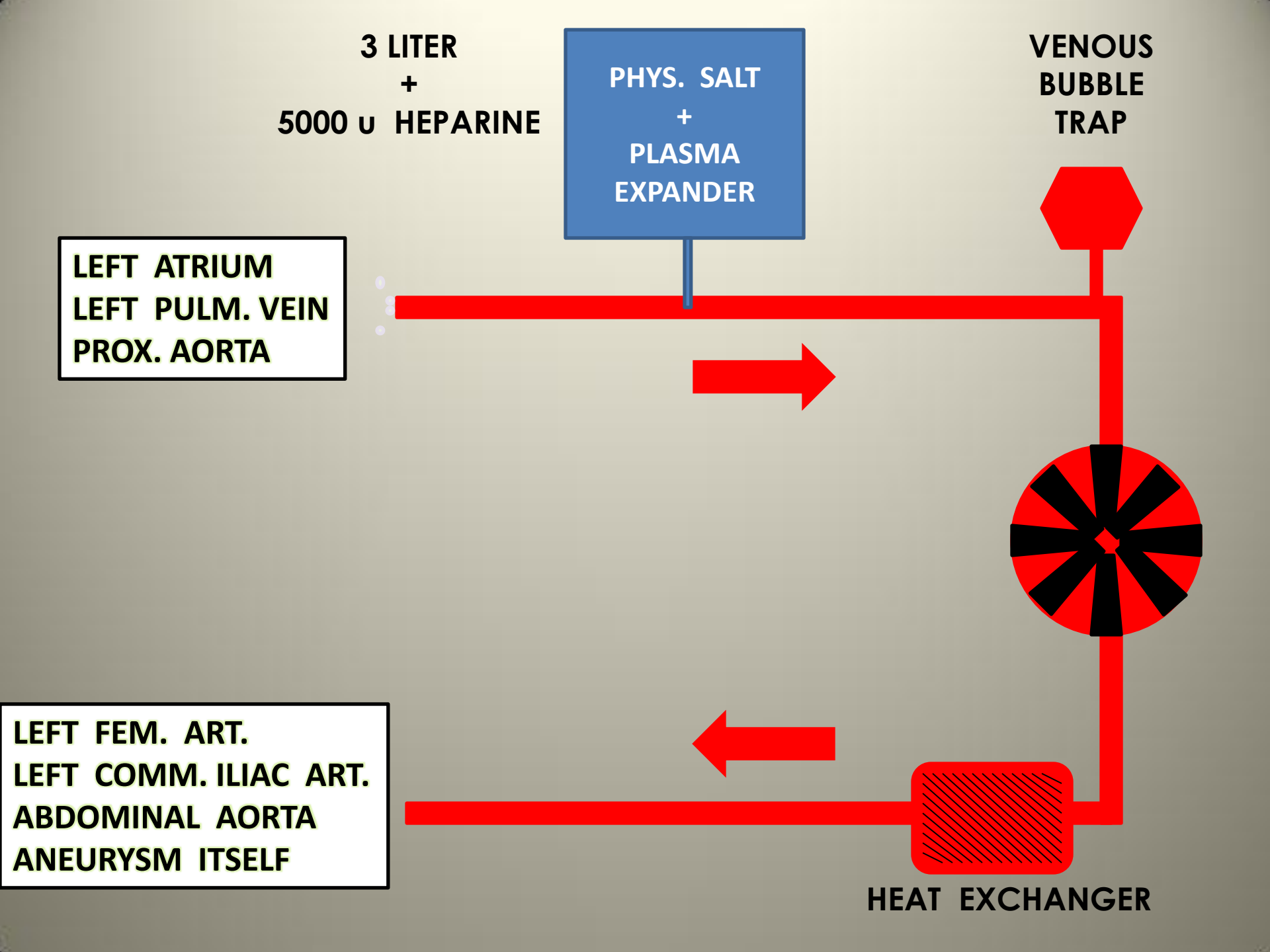
VISCERAL PERFUSION

- NO HEPARINE
- OPTIMAL CONTROL OF HEMODYNAMICS
- REWARMING
- SPINAL MONITORING
- VISCERAL PERFUSION
- REDUCTION OF ISCHEMIA VIA STAGED CLAMPING

LEFT ATRIUM

1. FRAGILE
2. RYTHM DISTURBANCES
3. AIR EMBOLISM




3 LITER
+
5000 u HEPARINE
PHYS. SALT
+
PLASMA
EXPANDER
VENOUS
BUBBLE
TRAP
LEFT ATRIUM
LEFT PULM. VEIN
PROX. AORTA
LEFT FEM. ART.
LEFT COMM. ILIAC ART.
ABDOMINAL AORTA
ANEURYSM ITSELF
HEAT EXCHANGER

PERMISSIVE HYPOTHERMIA

EVOKED POTENTIAL MONITORING

SEP

brain

via
posterior
horn

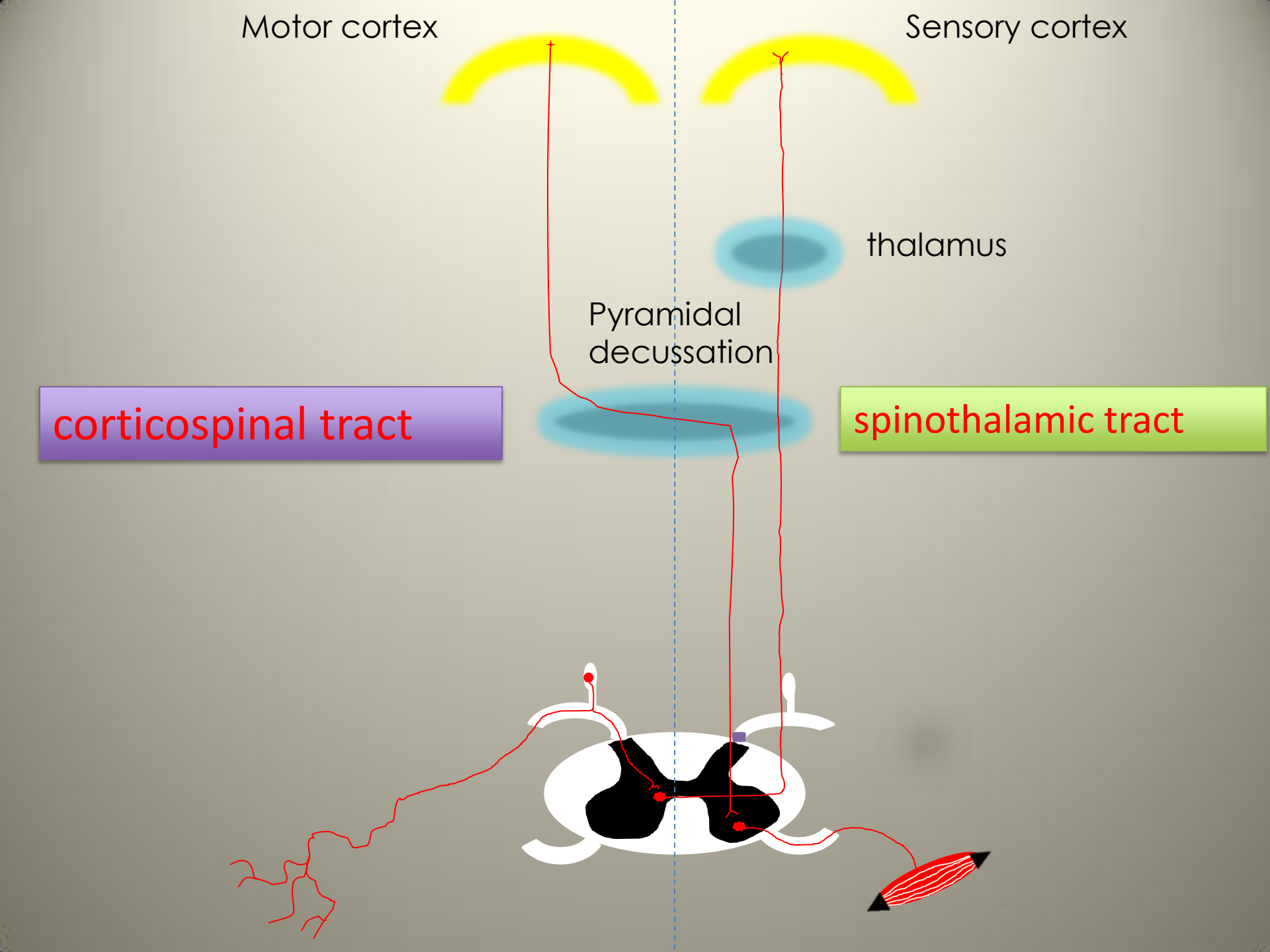
peripheral nerve

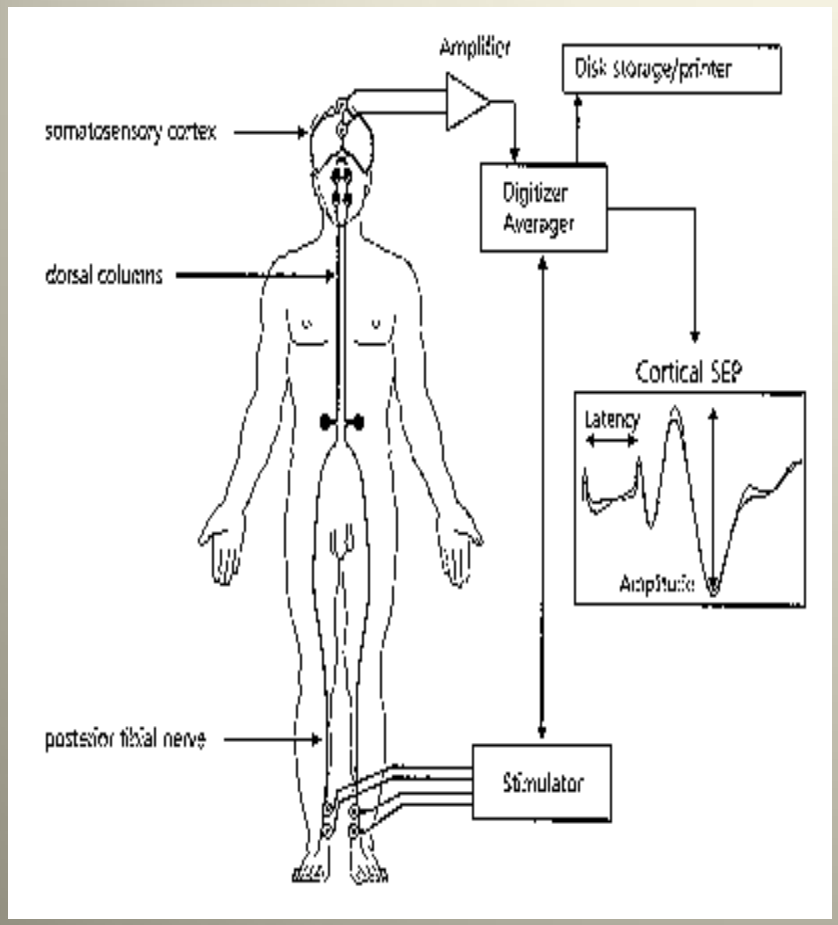
MEP

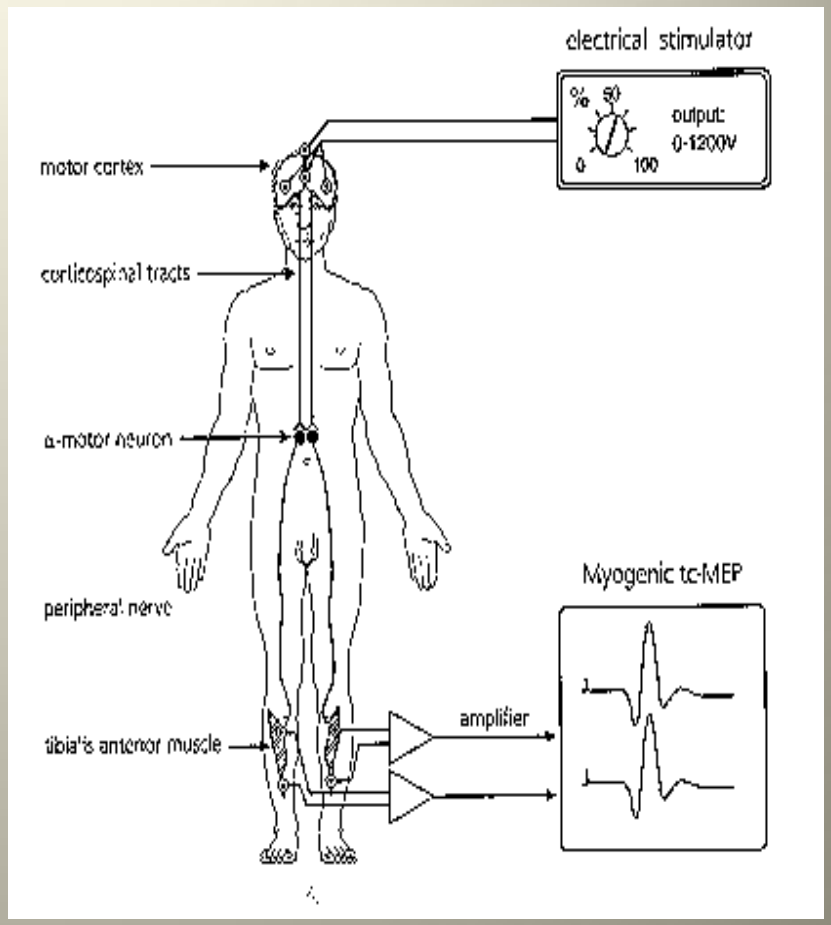
brain

via
anterior
horn

peripheral nerve


Motor cortex
Sensory cortex
thalamus
Pyramidal decussation
corticospinal tract
spinothalamic tract


Amplifier
Disk storage/printer
somatosensory cortex
Digitizer
Averager
dorsal columns
Cortical SEP
Latency
Amplitude
posterior tibial nerve
Stimulator


electrical stimulator
%
50
output:
0-1200V
0
100
motor cortex
corticospinal tracts
α-motor neuron
Myogenic tc-MEP
peripheral nerve
amplifier
tibialis anterior muscle

SEP

MEP

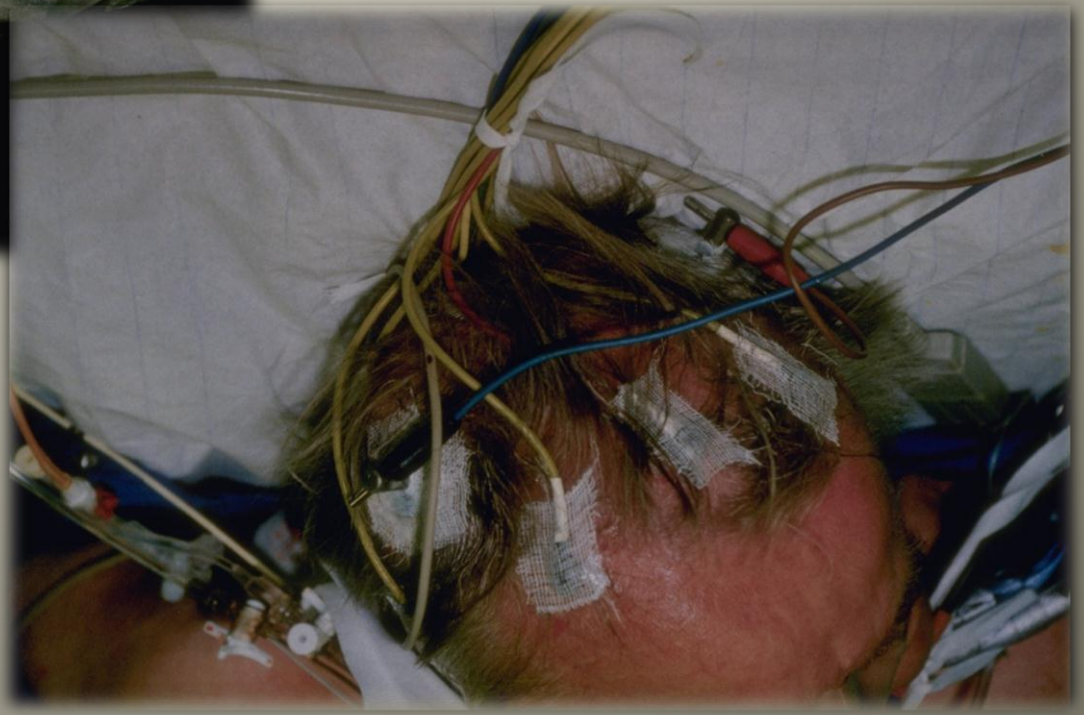
EP'S ALLOW FOR ADJUSTMENT OF OPERATIVE STRATEGY

INCREASE OF PROXIMAL BLOOD PRESSURE
INCREASE OF DISTAL PERFUSION PRESSURE
DRAIN CSF-FLUID

NORMAL SEP AND MEP HAVE A STRONG NEGATIVE PREDICTIVE VALUE

NO LOSS OF SIGNALS = NORMAL FUNCTIONING

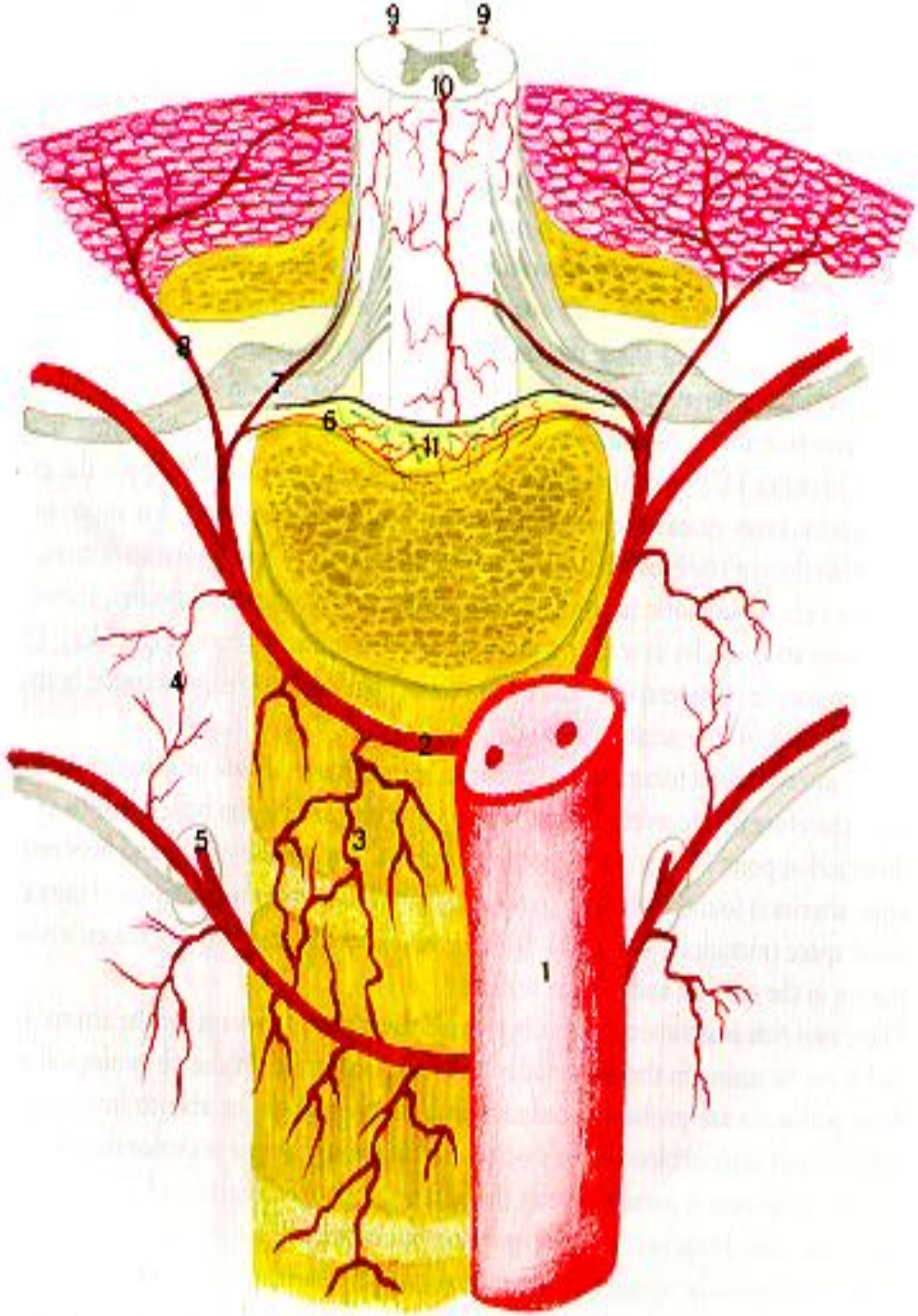
REQUIRES SPECIAL TRAINED PERSONNEL



FALSE NEGATIVES
AND FALSE POSITIVES

ALMOST ALL INHALED OR INTRAVENOUS ANESTHETICS MAY RESULT IN EP-CHANGES THAT ARE INDISTINGUISHABLE FROM REAL NEURAL ISCHEMIA

REIMPLANTATION OF CRITICAL ARTERIES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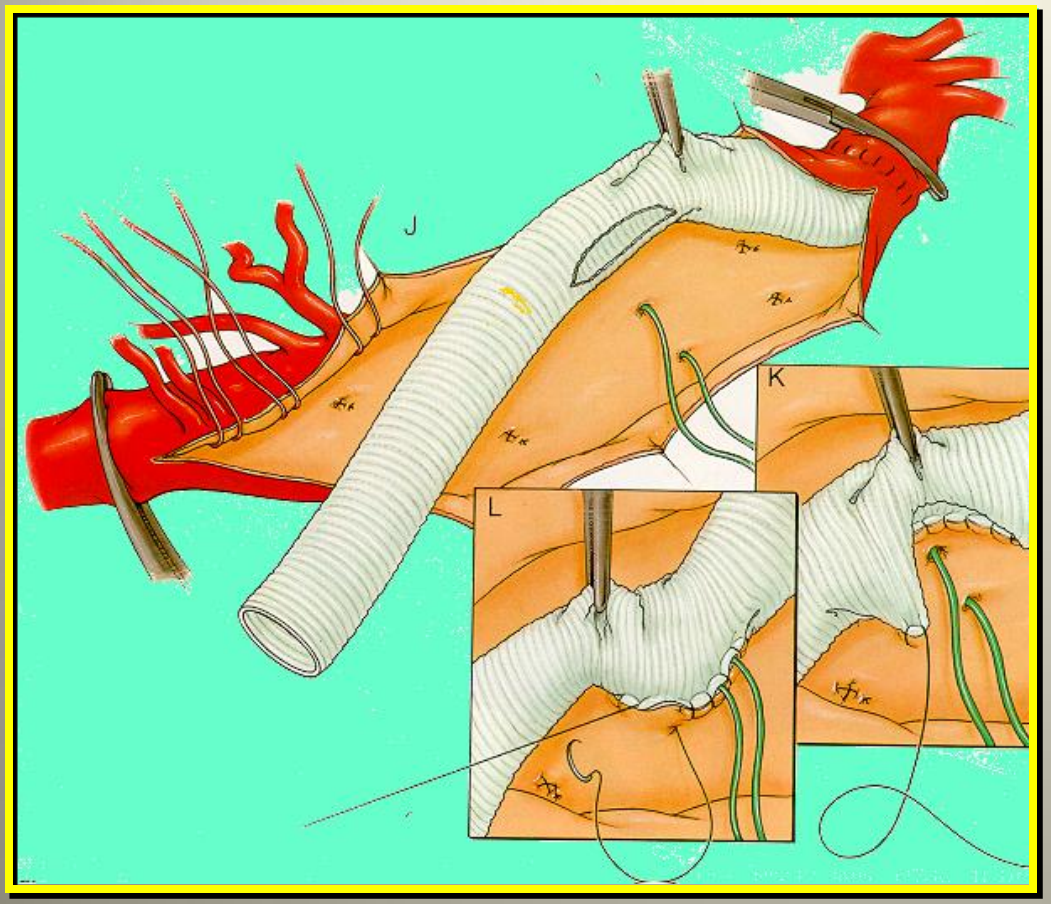
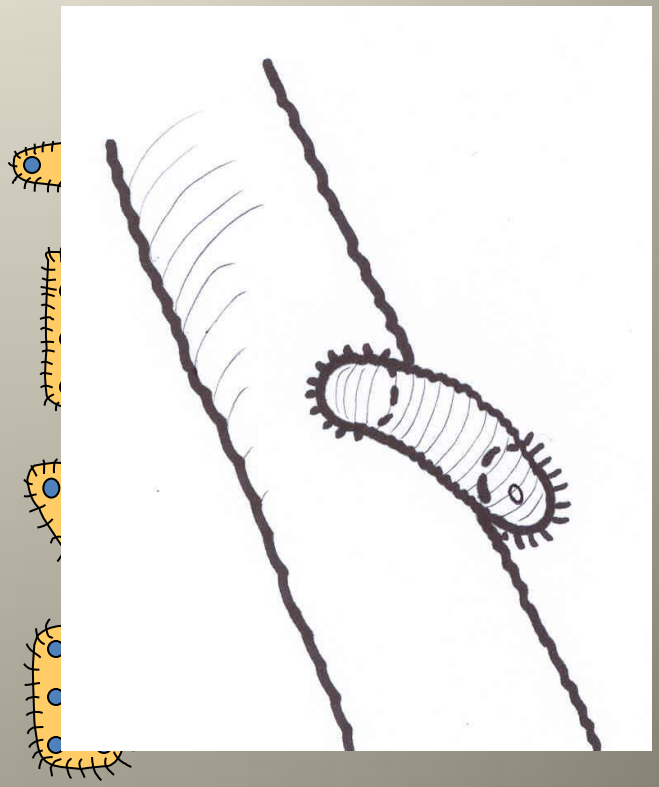
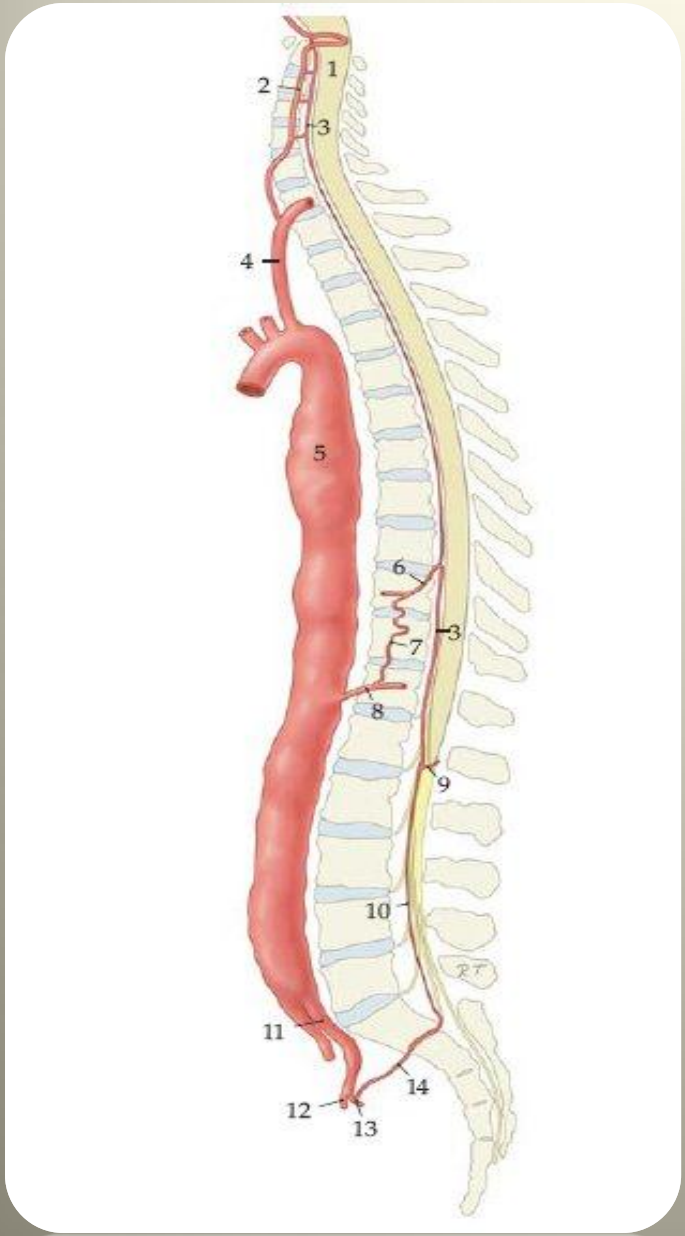
INTERCOSTAL / LUMBAR ARTERIES



DIRECT REIMPLANTATION INTO THE VASCULAR PROSTHESIS

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12
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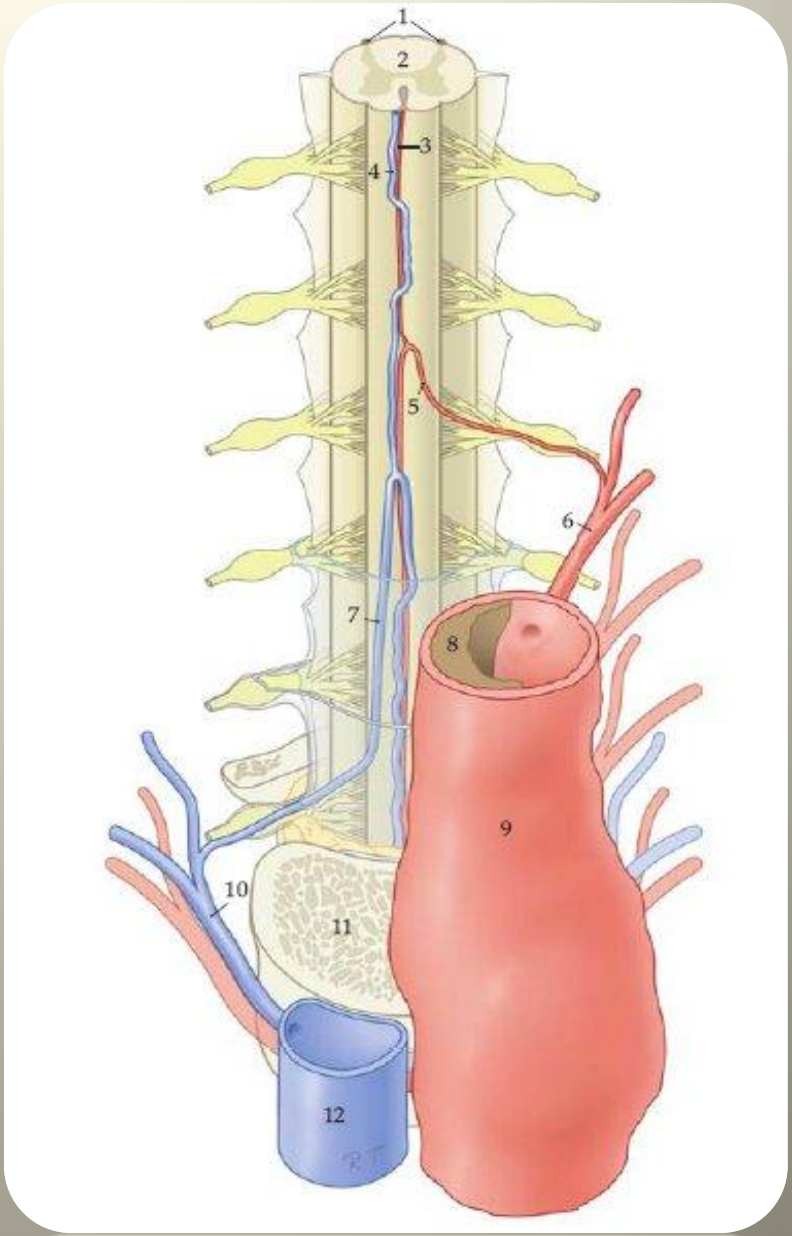
14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12

AORTIC DISSECTION IS A PROTECTIVE FACTOR FOR SPINAL CORD DAMAGE

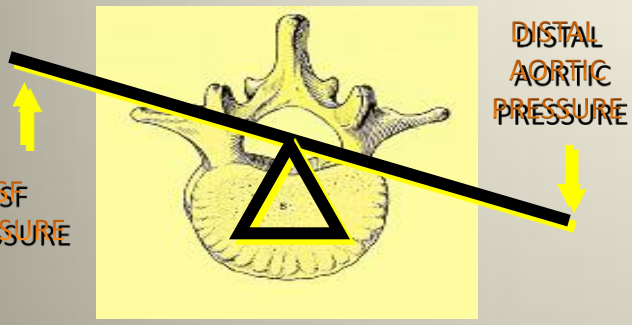
COSELLI ET AL. ANN THORAC SURG 1997;63:28-36
SCHEPENS ET AL. EUR J VASC ENDOVASC SURG 2009;37:640-5

PRESENCE OF AORTIC DISSECTION	0,40 ODDS RATIO

CEREBROSPINAL FLUID DRAINAGE

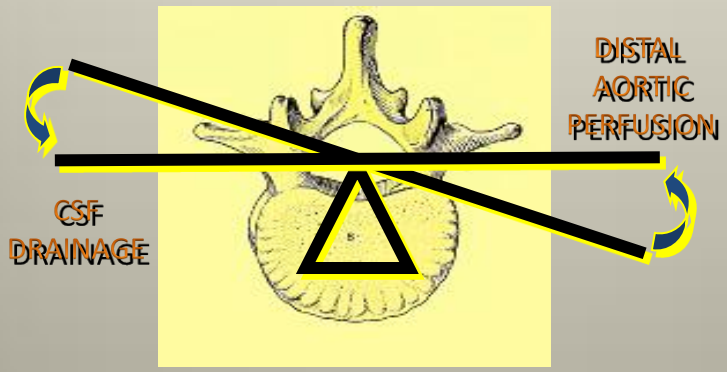
WHY ?

AORTIC CROSS-CLAMPING

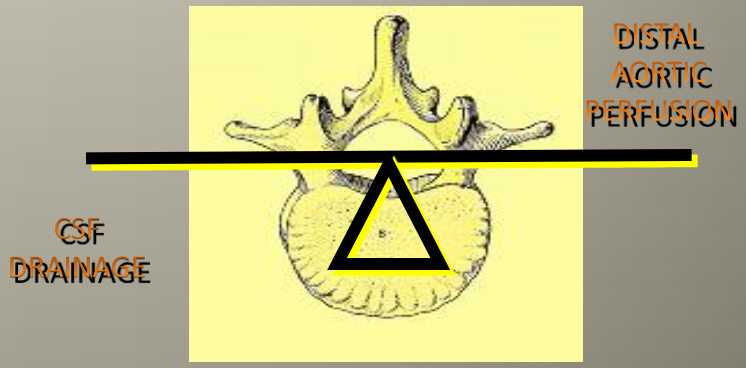


SPINAL CORD PERFUSION PRESSURE = MEAN ARTERIAL PRESSURE – CSF-PRESSURE

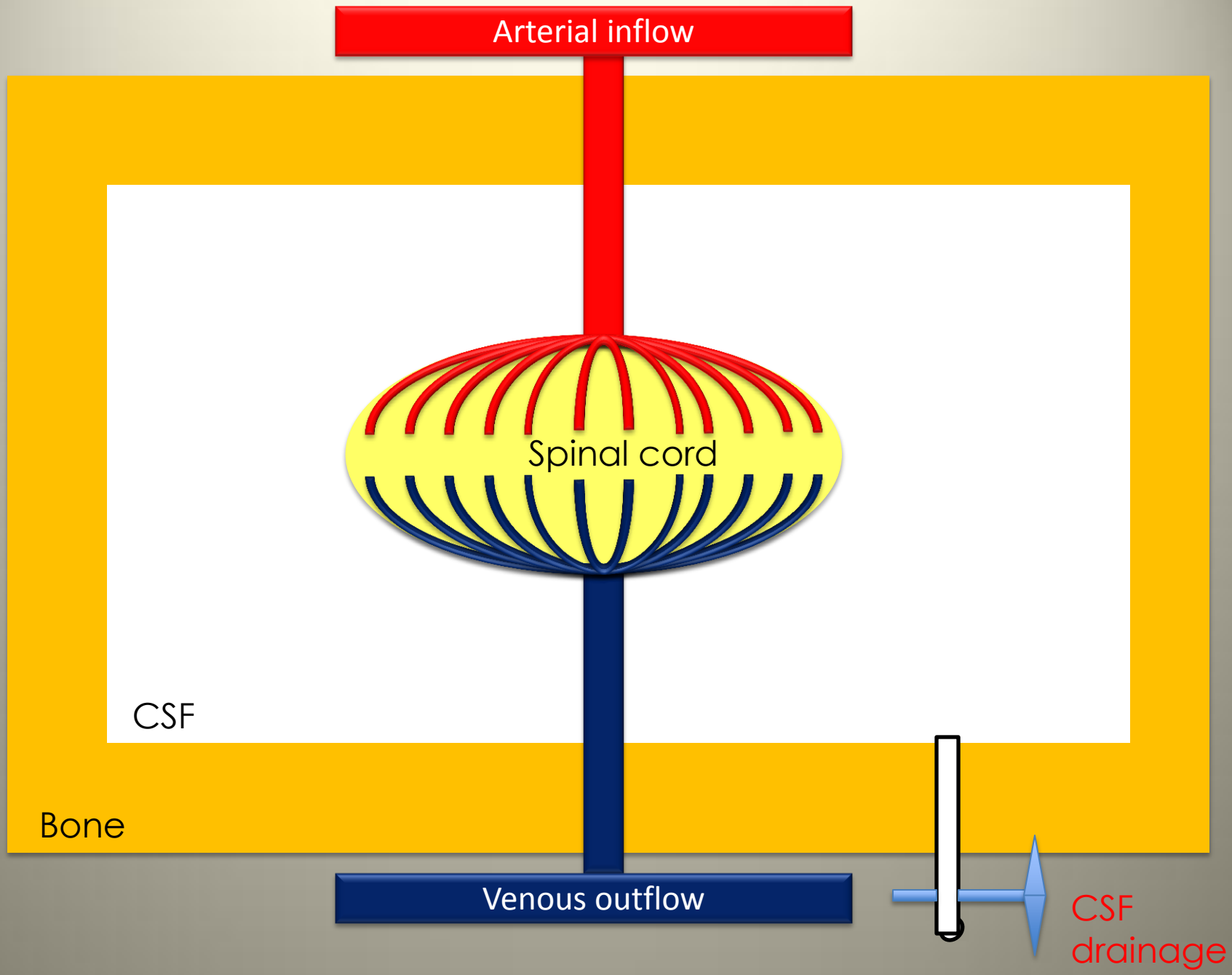
AORTIC CROSS-CLAMPING



SPINAL CORD PROTECTION

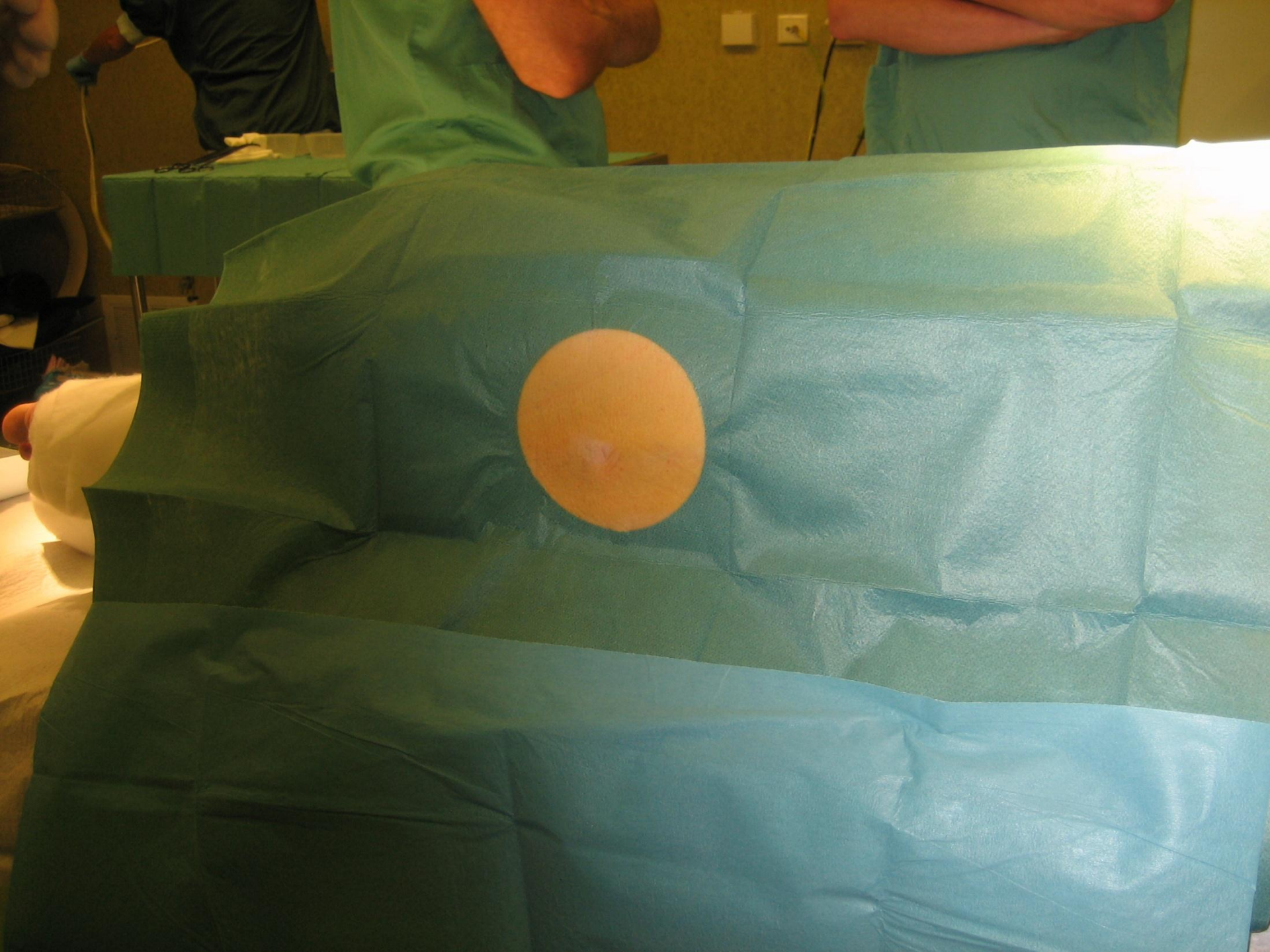


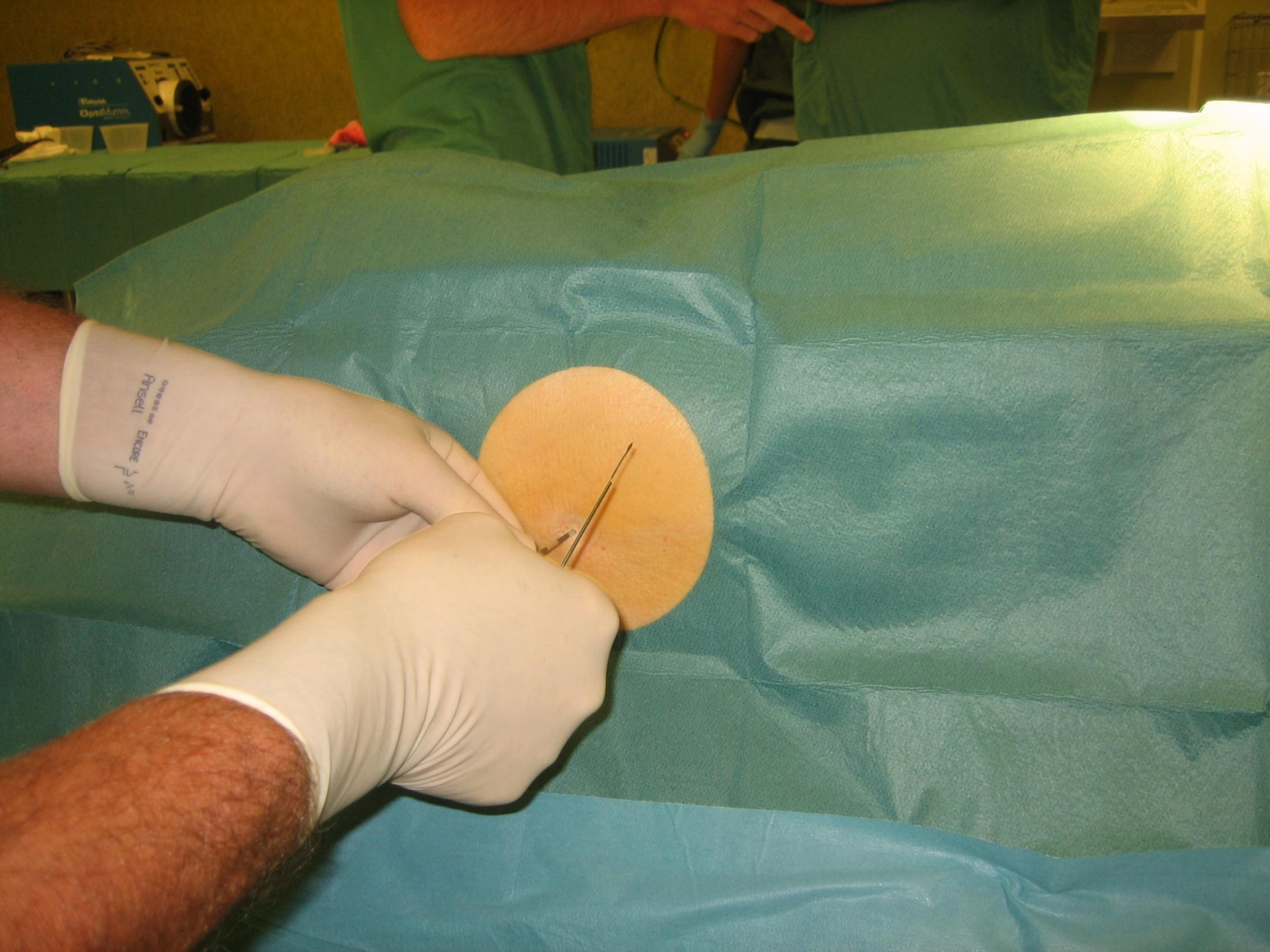
SPINAL CORD PROTECTION

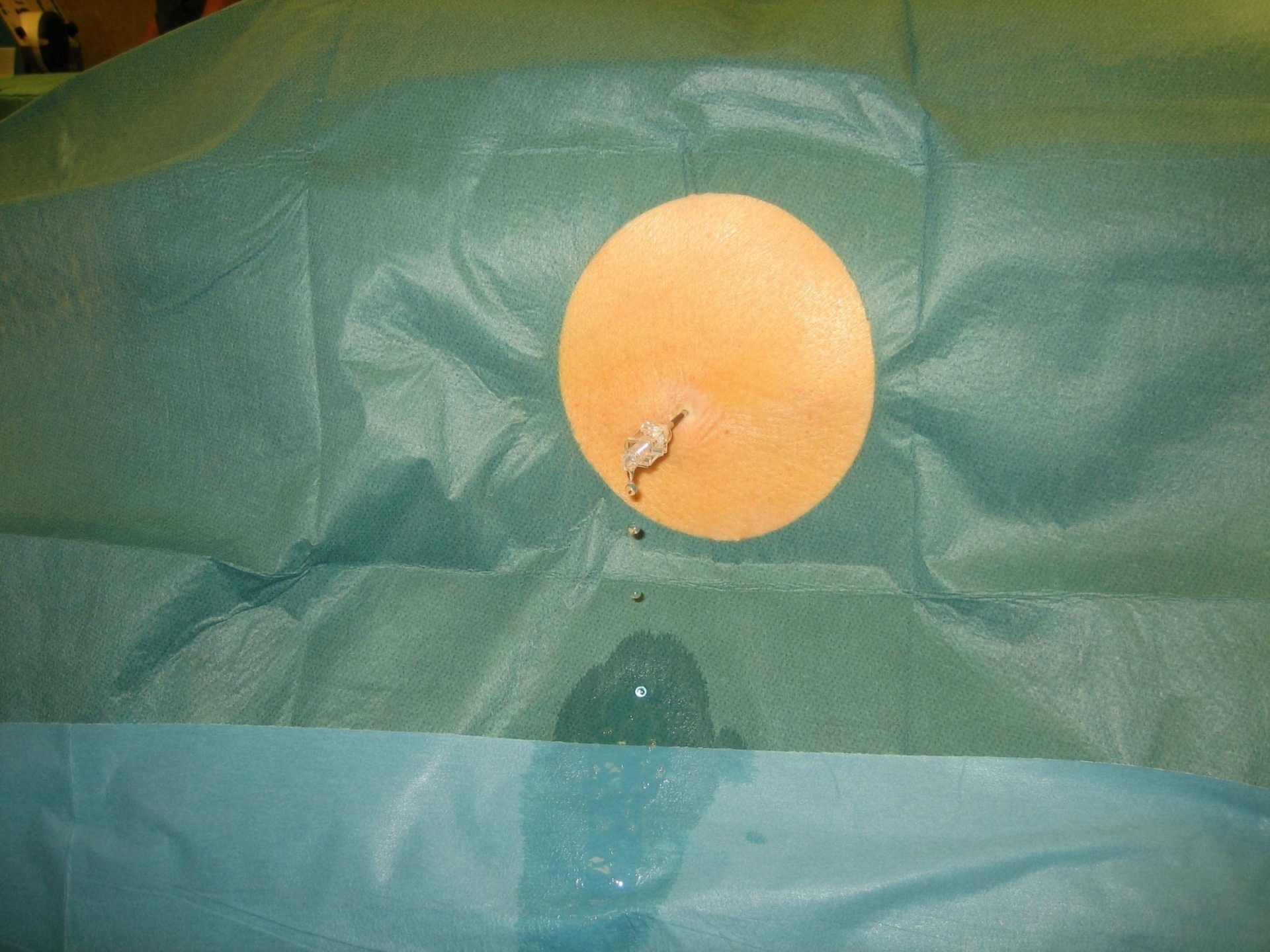

Arterial inflow
Spinal cord
CSF
Bone
Venous outflow
CSF
drainage

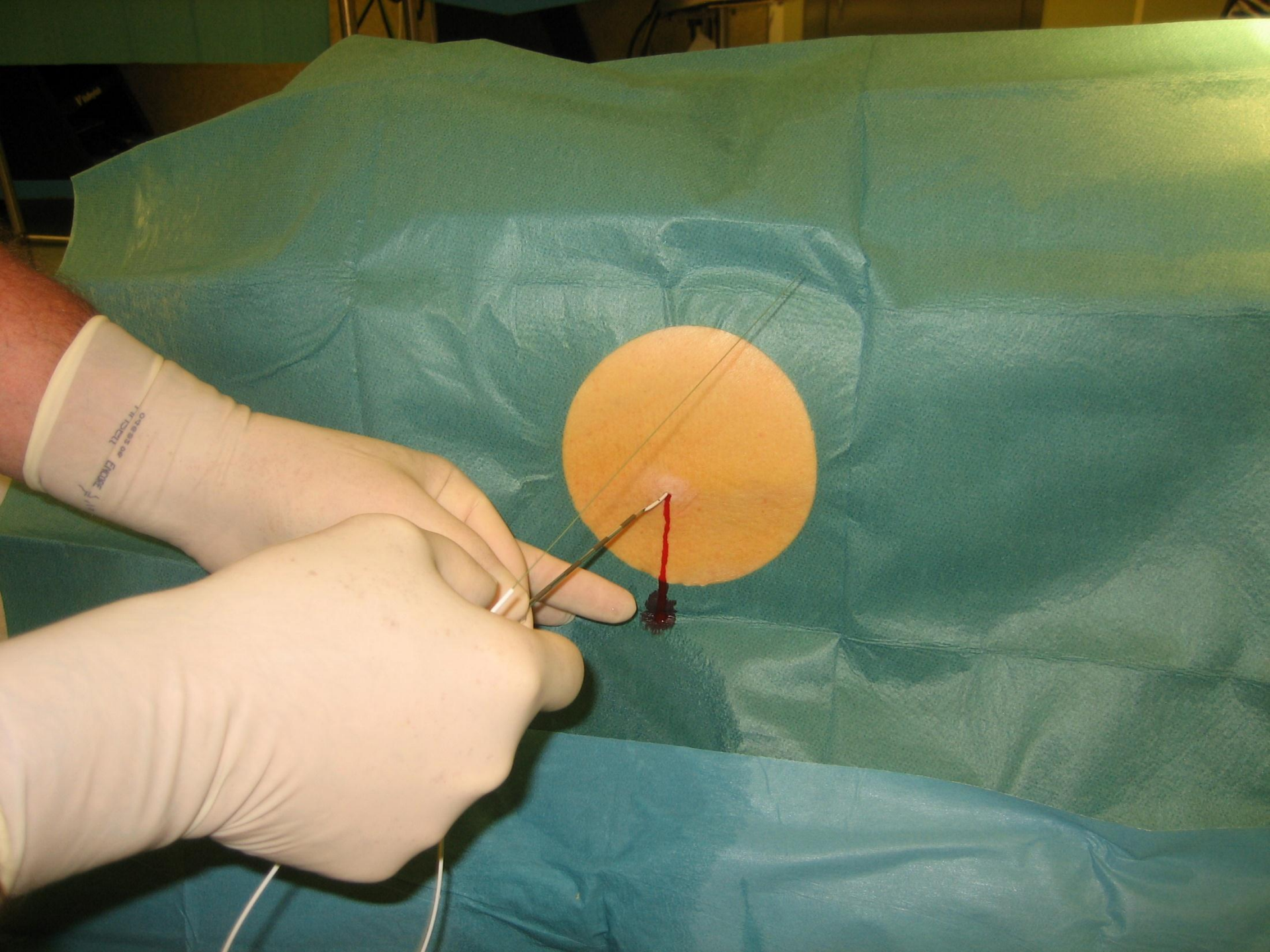
HOW ?

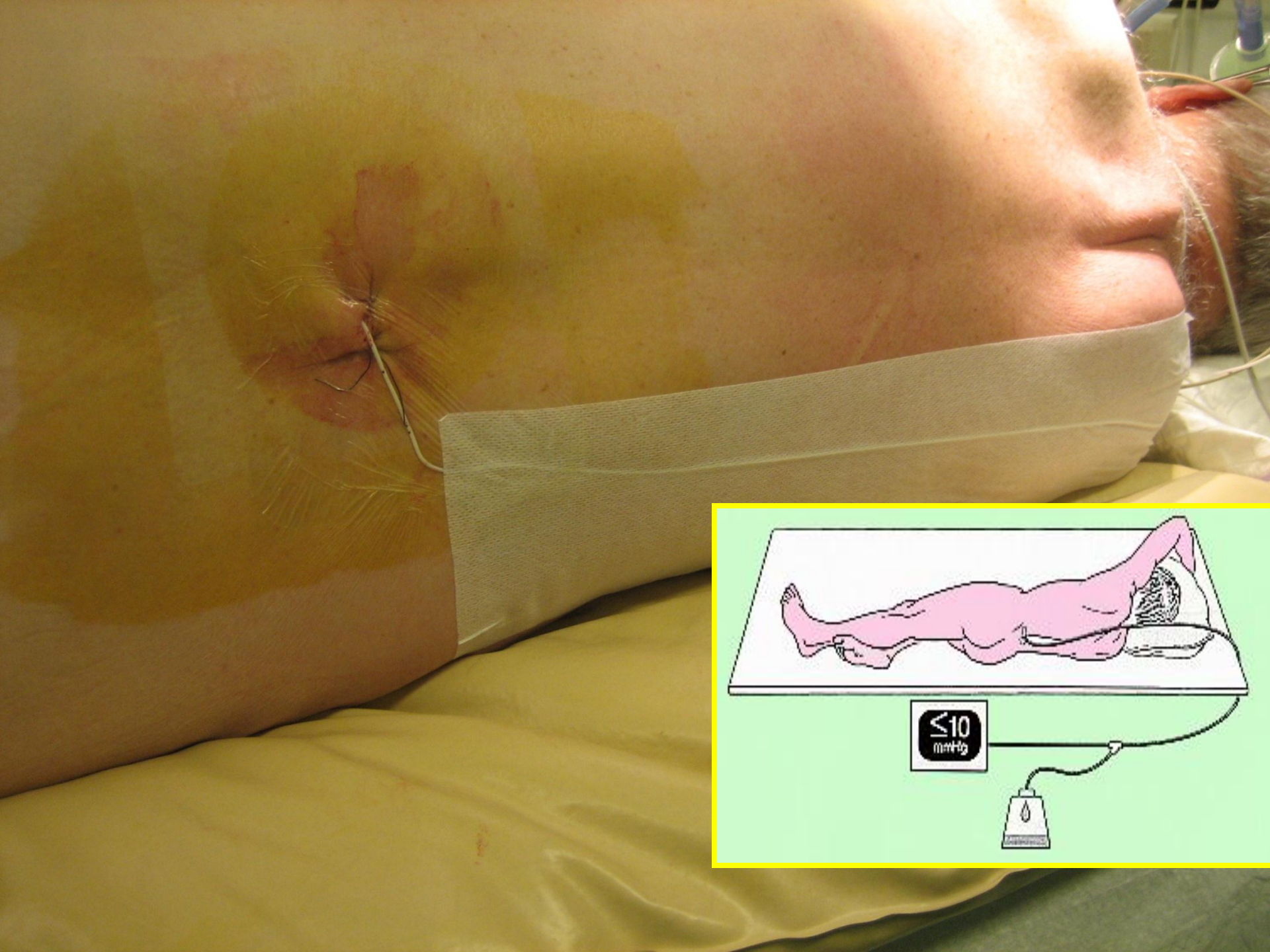

INTEGRA™
ABRIR ESTE EXTREMO
ABRIR DESTE LADO

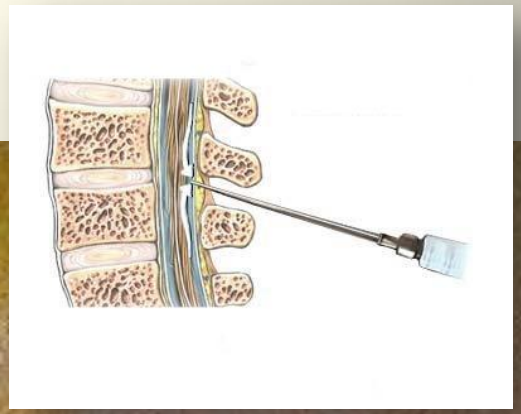



Ansell
Encore






≤10
mmHg



THE COMBINATION OF LEFT HEART BYPASS AND CSF-DRAINAGE IS PARTICULAR PROTECTIVE

Safi et al. Ann Thorac Surg 1998;66:1204-9
Schepens et al. Eur J Vasc Endovasc Surg 2009;37:640-5

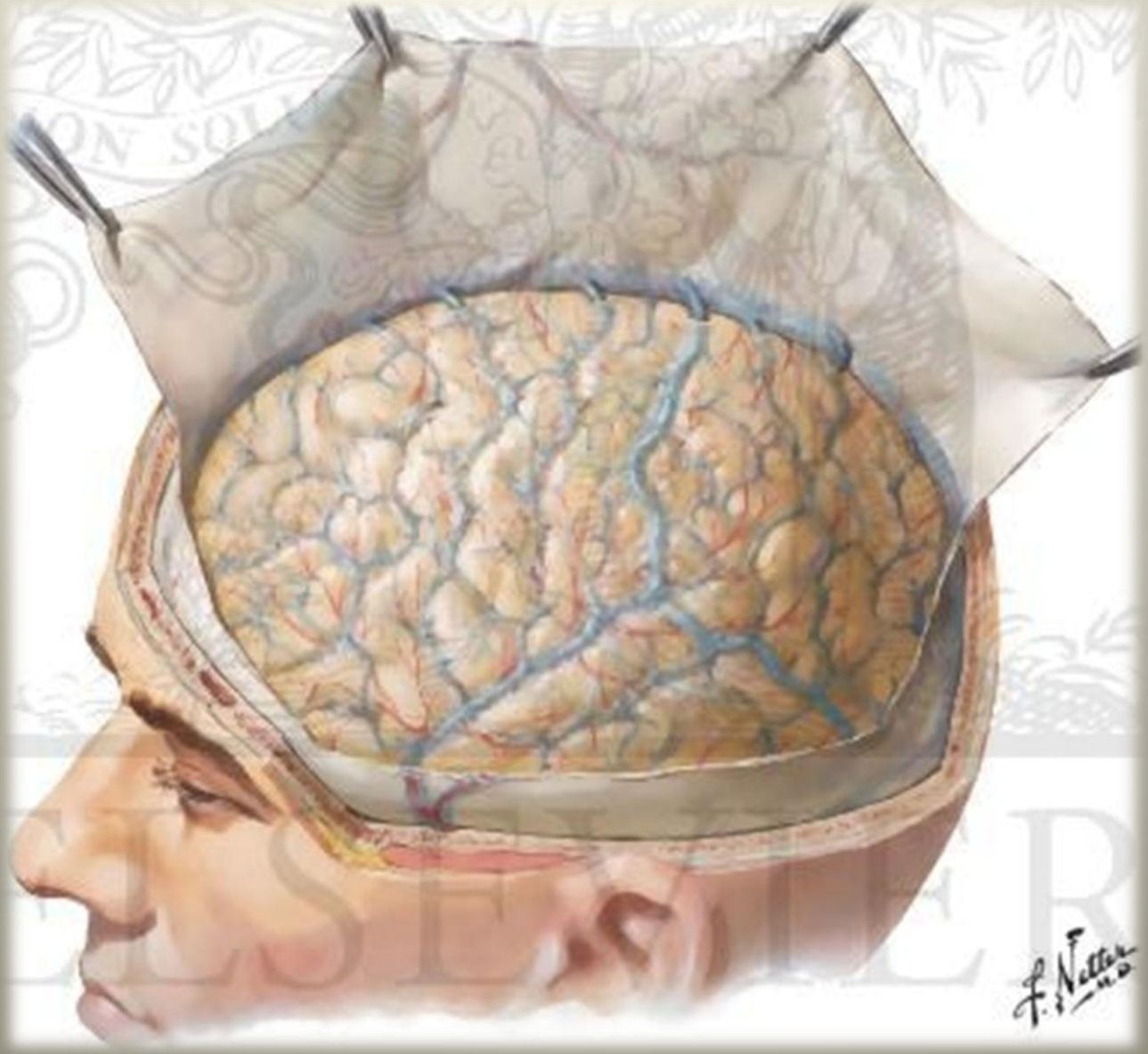
CSF X MEP 0.28 ODDS RATIO

RISKS ?

RISKS OF SPINAL FLUID DRAINAGE

Complication	n	% (n/1107)
CSF leak	7	0.64
Intracranial hemorrhage	5	0.45
Meningitis	2	0.2
Headache	2	0.2
Fractured catheter	1	0.1
Total	**17**	**1.5**

Estera et al. Ann Thorac Surg 2009;88:9-15


F. Netter M.D.

HOW LONG ?

3 consecutive days

< 10 mm Hg

Drainage – measurement –drainage - measurement

DELAYED SPINAL CORD DAMAGE

Delayed Spinal Cord Deficits After Thoracoabdominal Aortic Aneurysm Repair

Daniel R. Wong, MD, MPH, Joseph S. Coselli, MD, Karen Amerman, MS, CRNA, John Bozinovski, MD, Stacey A. Carter, BA, William K. Vaughn, PhD, and Scott A. LeMaire, MD

Background. Limited information is available about the treatment and outcomes of delayed paraplegia after thoracoabdominal aortic aneurysm (TAAA) repair. The objective of this study was to assess factors that precipitate and favorably affect delayed-onset neurologic deficits.

Methods. Over a 19-year period, 2,368 TAAA repairs were performed. Of the 93 patients (3.9%) who had postoperative paraplegia or paraparesis, 34 (37%) initially had intact neurologic function, but a delayed spinal cord deficit developed. We retrospectively examined clinical factors and events associated with development of the deficits, treatments used, and outcomes. Factors related to functional status were evaluated by comparing survivors who were ambulatory at discharge or transfer with those who were not.

Results. The delayed deficits occurred between 13 hours and 91 days postoperatively and were associated with a period of hypotension in 9 patients (26%). Two patients (6%) died in hospital. Of the 32 patients discharged or transferred, 13 (41%) were ambulatory. Poor functional outcomes were associated with female sex, intraoperative cerebrospinal fluid drainage, fewer intercostal arteries reattached, and administration of corticosteroids or osmotic diuretics. The actuarial survival rate at 2 years was 80% , 13% for the ambulatory patients and 32% 12% for the nonambulatory patients (*p* _ 0.002).

Conclusions. Although precipitating episodes of hypoperfusion were common, most cases of delayed paraplegia occurred without such events, suggesting that other factors may play an important role in the development of this complication. Ambulatory status at discharge significantly predicts midterm survival.

(Ann Thorac Surg 2007;83:1345–55)

DELAYED DEFICITS

13 HOURS – 91 DAYS

ARTERIAL HYPOTENSION

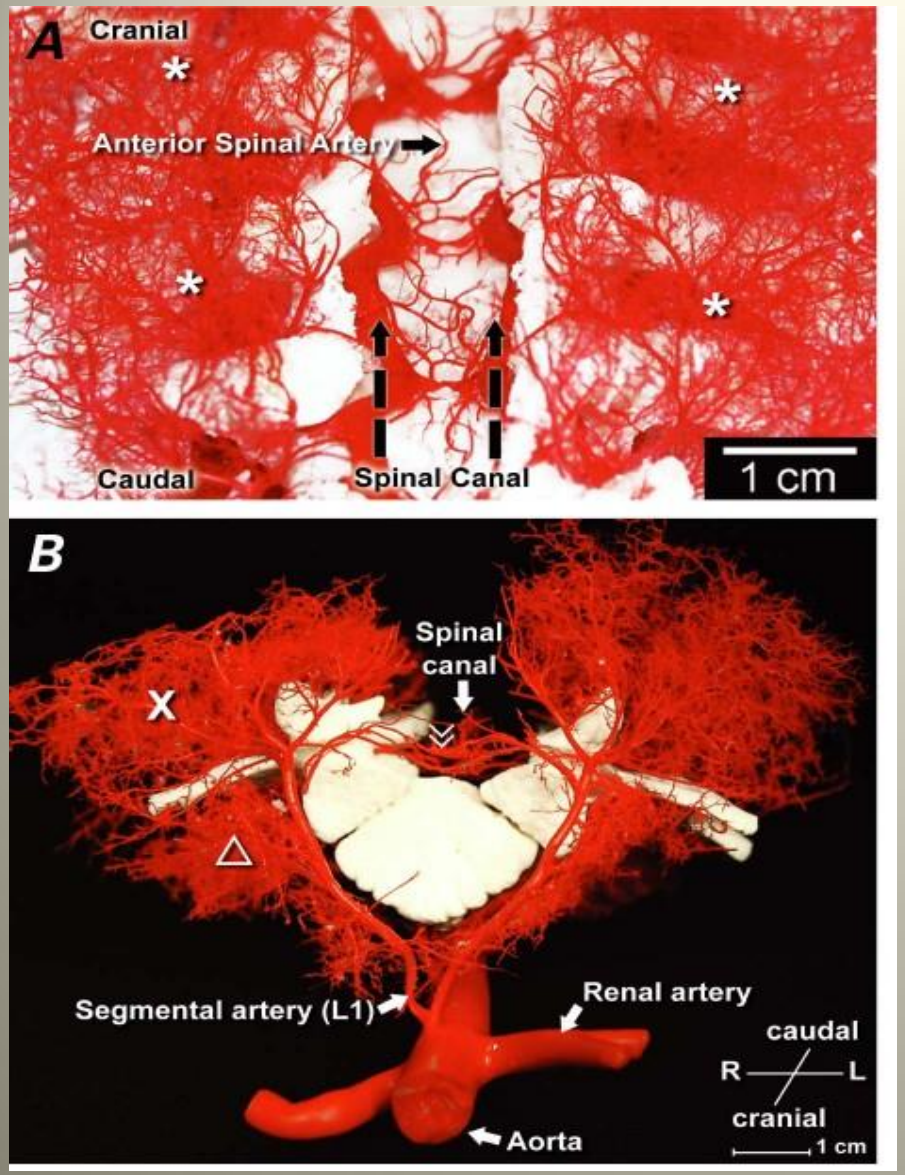
HYPOXEMIA

RYTHM DISTURBANCES (AF)

LOW HEMOGLOBINE

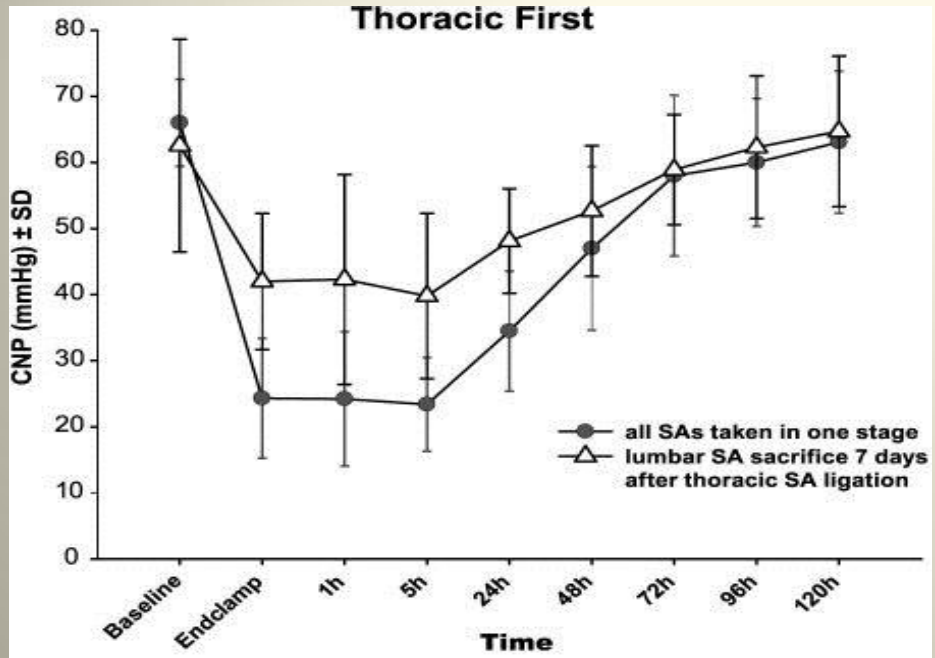
THERAPEUTIC MANEUVERS USED TO TREAT DELAYED-ONSET PARAPLEGIA

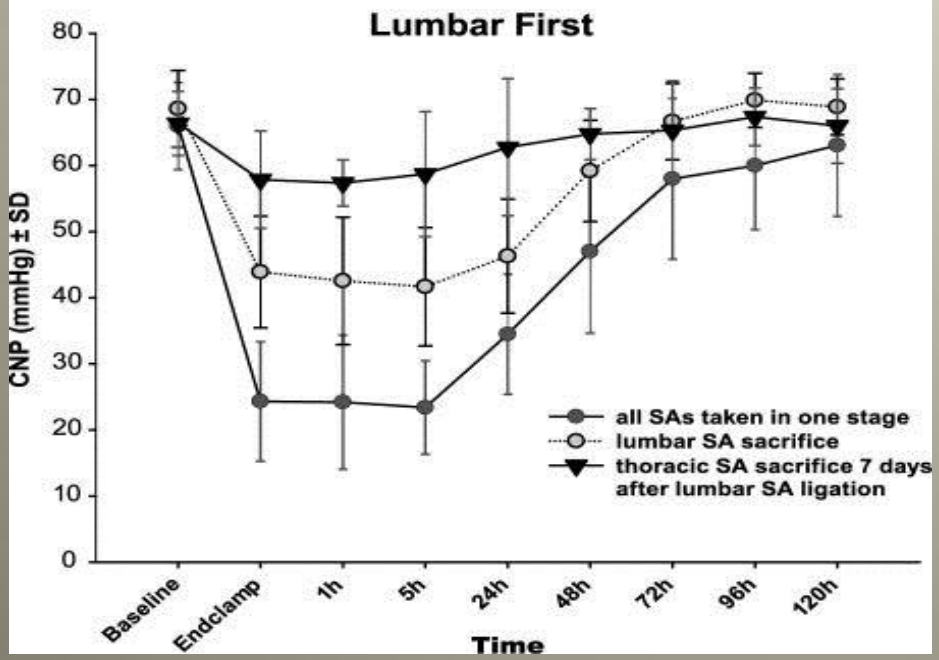
Vasopressor agents	21%
Corticosteroids	82%
PRBC transfusion	6%
Osmotic diuresis	76%
Intravenous naloxone	6%
CSF drainage	
Continuation with existing drain	9%
Reinsertion of drain	29%
Insertion of new drain	29%



THE COLLATERAL NETWORK CONCEPT
Eva Griepp, Randall Griepp

Tex Heart Inst J 2010;37(6):672-674.





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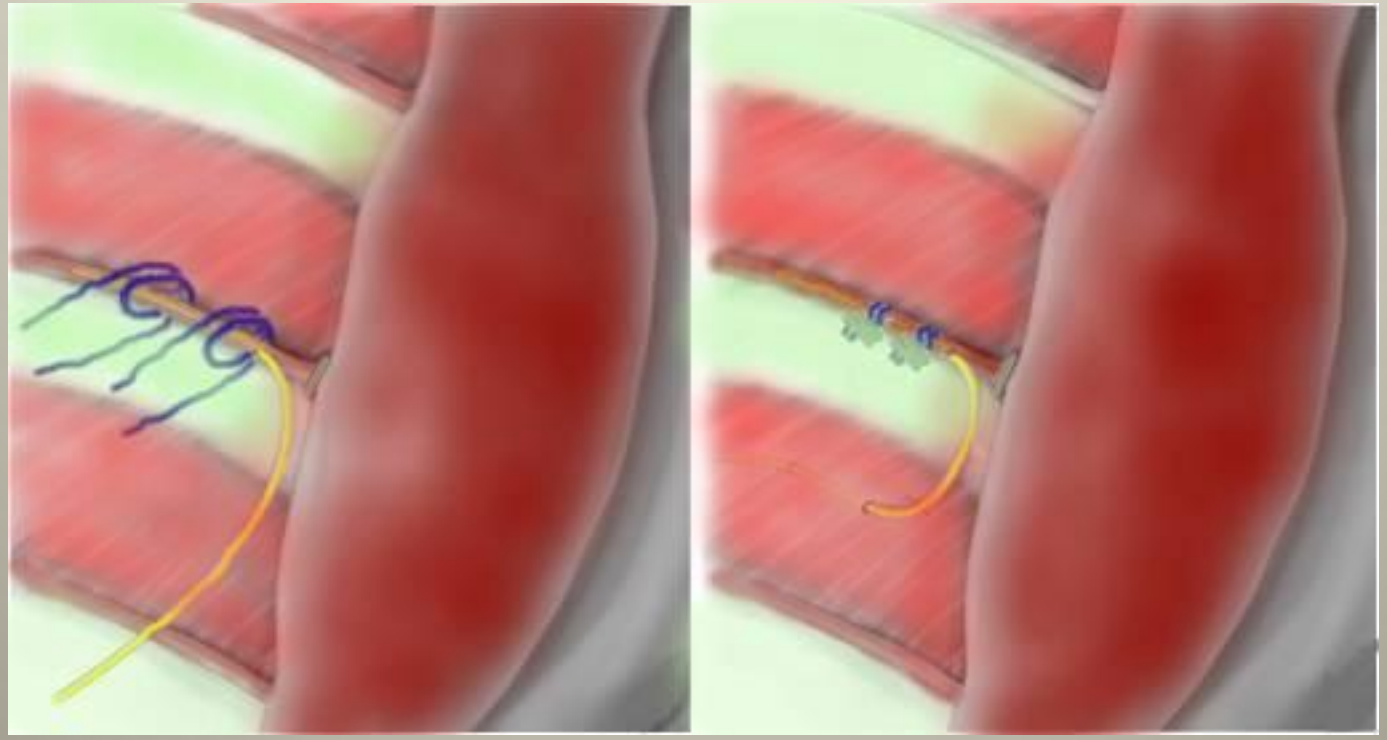
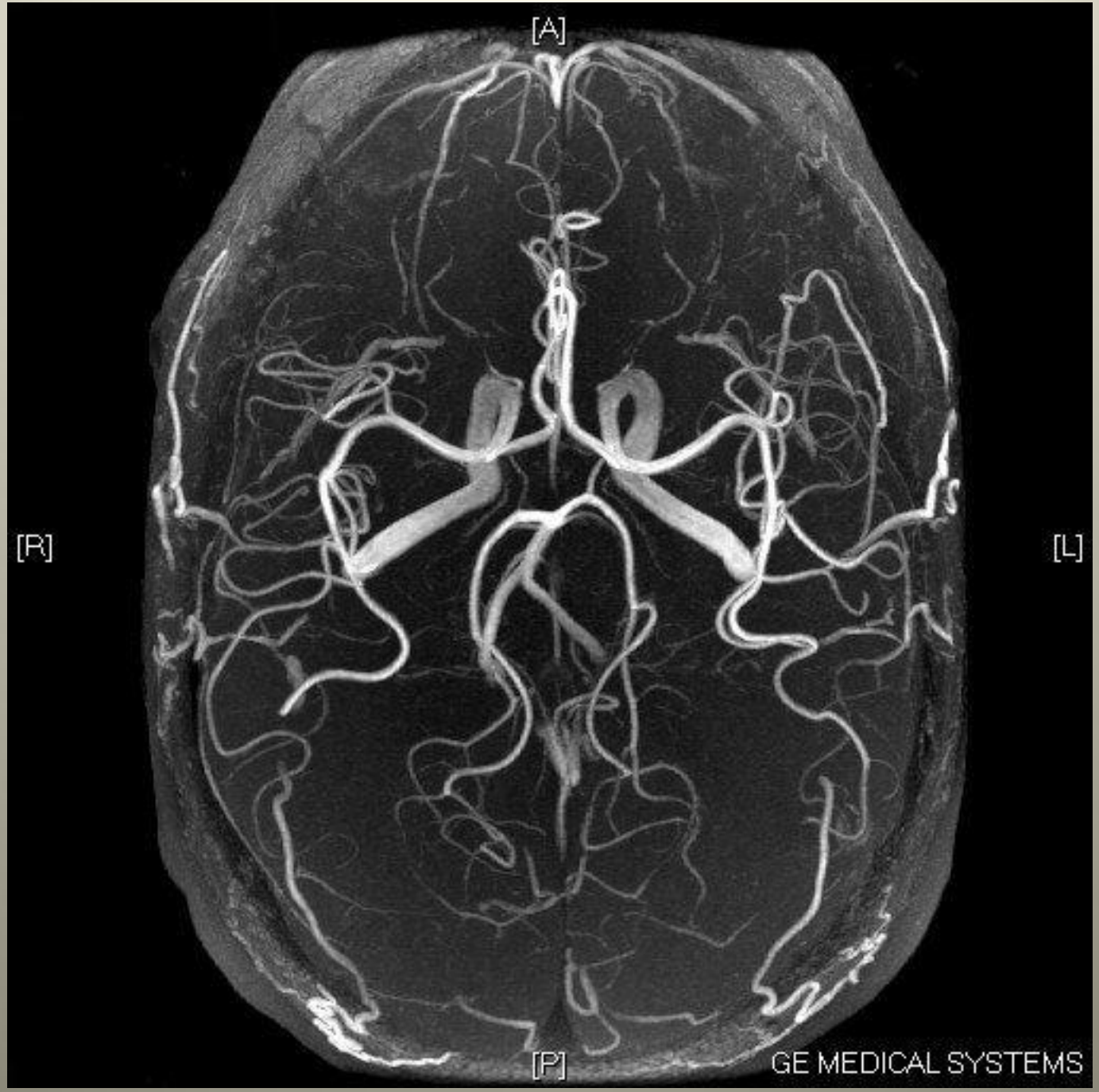


Etz et al. Direct spinal cord perfusion pressure monitoring in extensive distal aortic aneurysm repair
Ann Thorac Surg 2009;87:1764-1774.

CEREBRAL PROTECTION


[A]
[R]
[L]
[P]
GE MEDICAL SYSTEMS

DHCA: deep hypothermic circulatory arrest

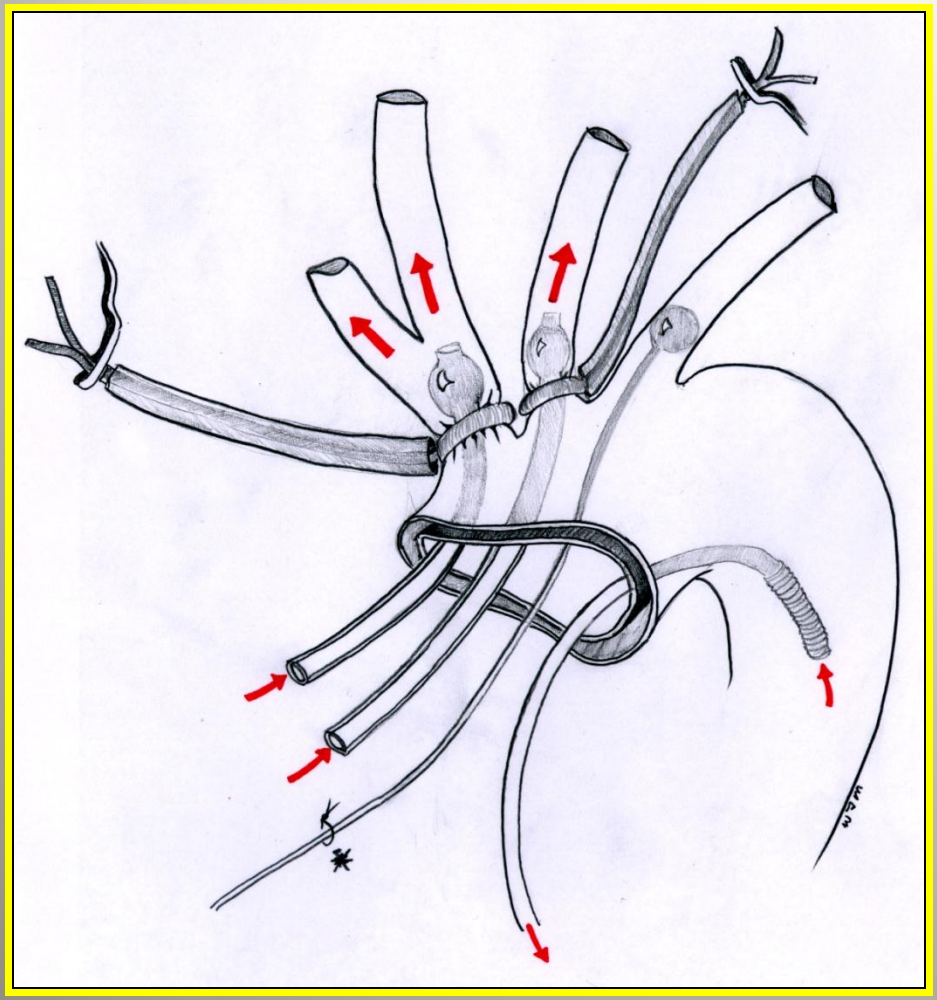
ASCP: antegrade selective cerebral perfusion

RCP: retrograde cerebral perfusion

NEUROMONITORING

1. BILATERAL RADIAL ARTERY PRESSURE
2. ELECTRO-ENCEPHALOGRAPHY
3. BILATERAL TCD
4. NEAR INFRARED SPECTROSCOPY

ASCP	DHCA
No time limits	< 30 – 40 min.
Cannulae	Empty field
No blood	No blood
Glue: partial	Glue : circumferential
Risks of encircling vessels	Cooling and rewarming
Risk of dislodging atherosclerotic debris	Optimal protection of other organs



Antegrade Selective Cerebral Perfusion (ASCP)

Medtronic DLP

- 15 Fr.
- retrograde cardioplegia cannula
- balloon inflatable
- pressure line
- silicone
- armed

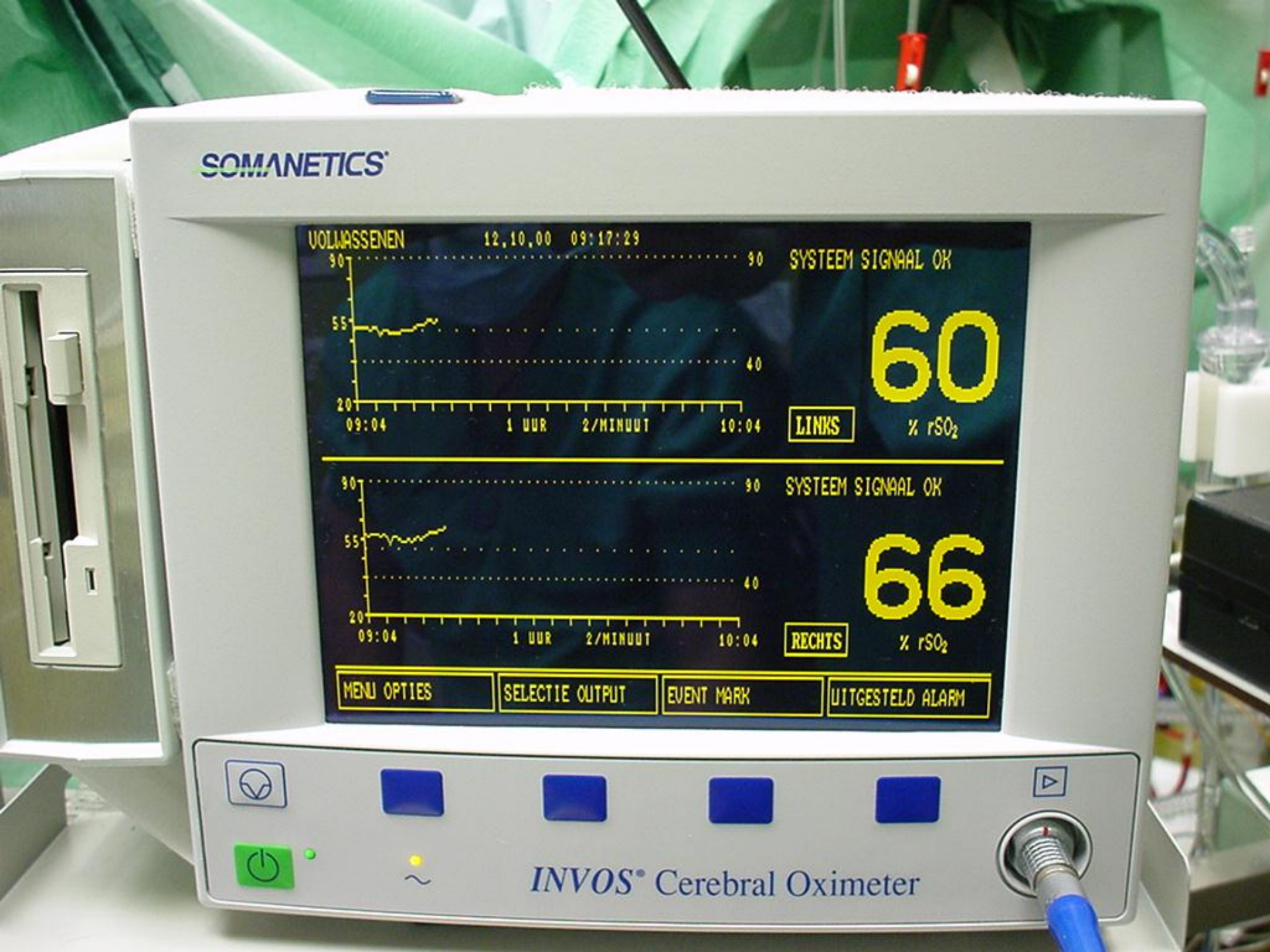
ASCP	DHCA
No time limits	< 30 – 40 min.
Cannulae	Empty field
No blood	No blood
Glue: partial	Glue : circumferential
Risks of encircling vessels	Cooling and rewarming
Risk of dislodging atherosclerotic debris	Optimal protection of other organs

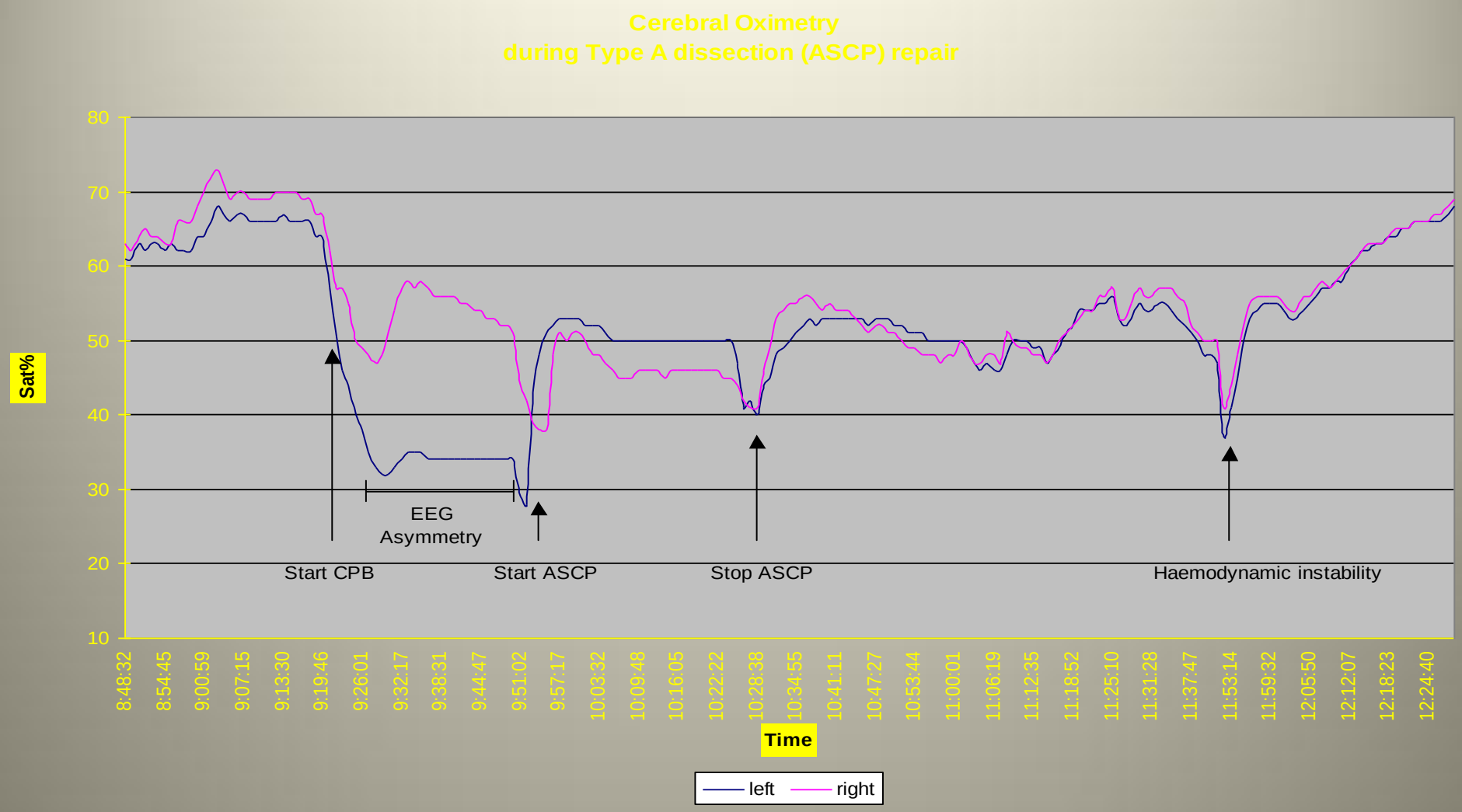
BILATERAL TRANSCRANIAL DOPPLER MONITORING

SOMANETICS

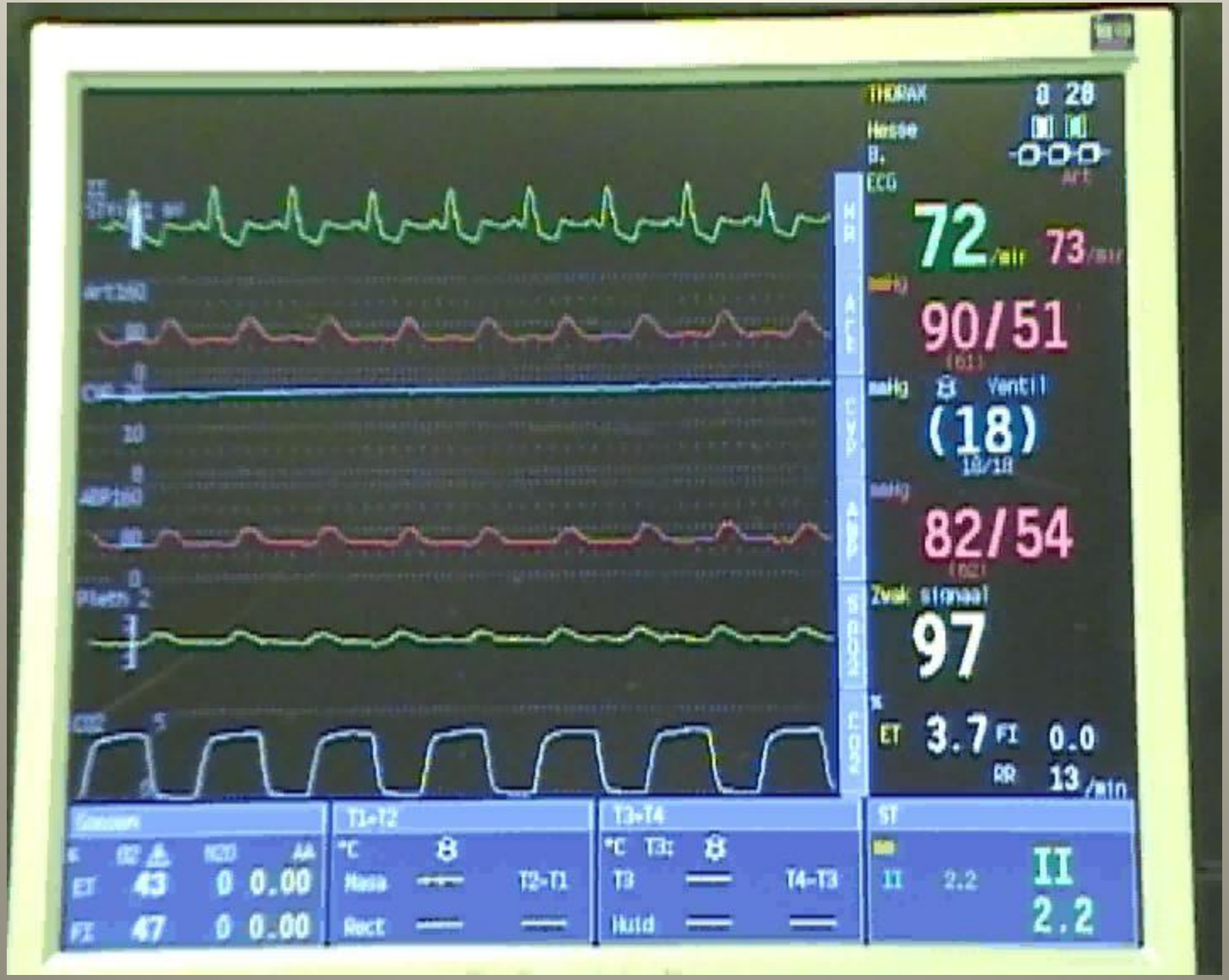
1. Kinking
2. Malpositioning
3. Emboli

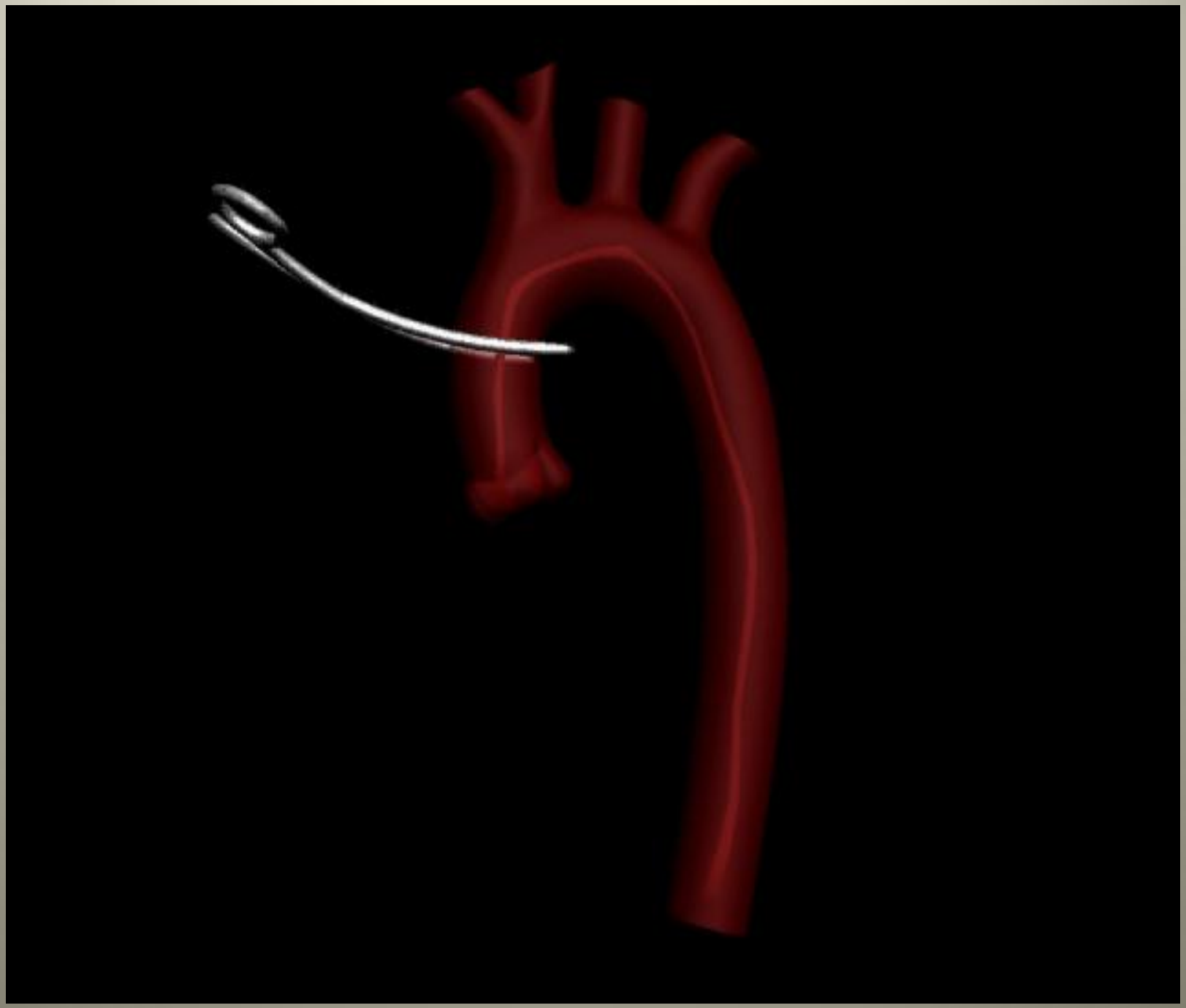
NEAR INFRARED SPECTROSCOPY


SOMANETICS
VOLWASSENEN
12.10.00 09:17:29
90
55
20
90
40
09:04
1 UUR
2/MINUUT
10:04
SYSTEEM SIGNAAL OK
60
LINKS
% rSO2
SYSTEEM SIGNAAL OK
66
RECHTS
% rSO2
MENU OPTIES
SELECTIE OUTPUT
EVENT MARK
UITGESTELD ALARM
INVOS® Cerebral Oximeter


Cerebral Oximetry
during Type A dissection (ASCP) repair
Sat%
80
70
60
50
40
30
20
10
EEG
Asymmetry
Start CPB
Start ASCP
Stop ASCP
Haemodynamic instability
8:48:32
8:54:45
9:00:59
9:07:15
9:13:30
9:19:46
9:26:01
9:32:17
9:38:31
9:44:47
9:51:02
9:57:17
10:03:32
10:09:48
10:16:05
10:22:22
10:28:38
10:34:55
10:41:11
10:47:27
10:53:44
11:00:01
11:06:19
11:12:35
11:18:52
11:25:10
11:31:28
11:37:47
11:53:14
11:59:32
12:05:50
12:12:07
12:18:23
12:24:40
Time
left
right

BILATERAL RADIAL ARTERY PRESSURE MONITORING


THORAX
Hesse
B.
ECG
72
73
90/51
(61)
Ventil
(18)
18/18
82/54
(62)
Zwak signaal
97
ET 3.7
FI 0.0
RR 13
T1-T2
T2-T1
T3-T4
T4-T3
ST
II 2.2
II
2.2

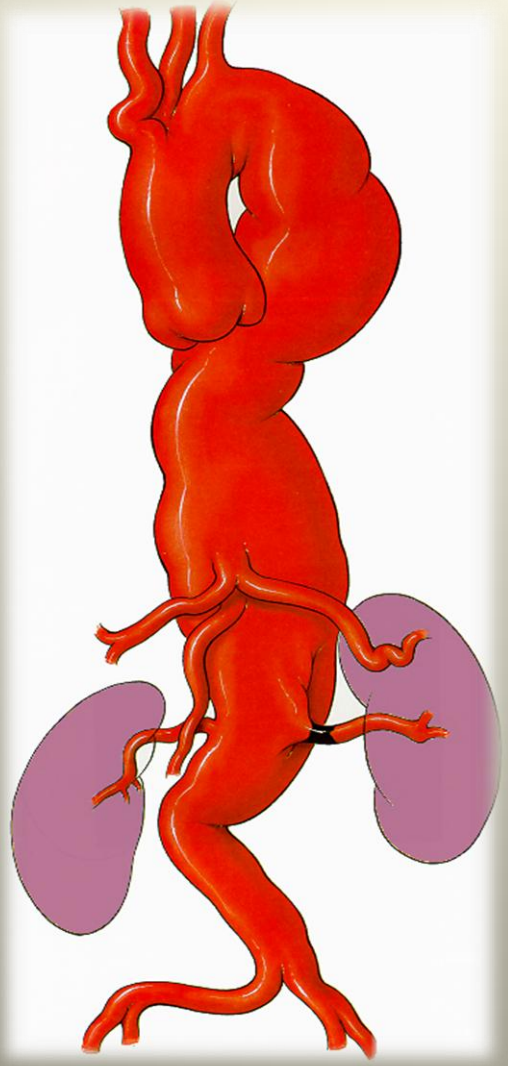


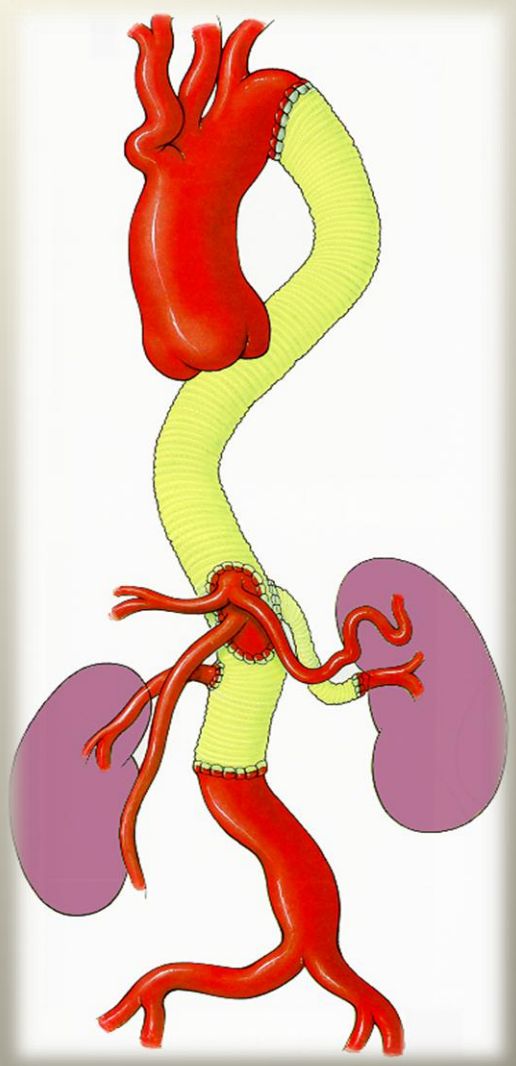
VISCERAL PROTECTION

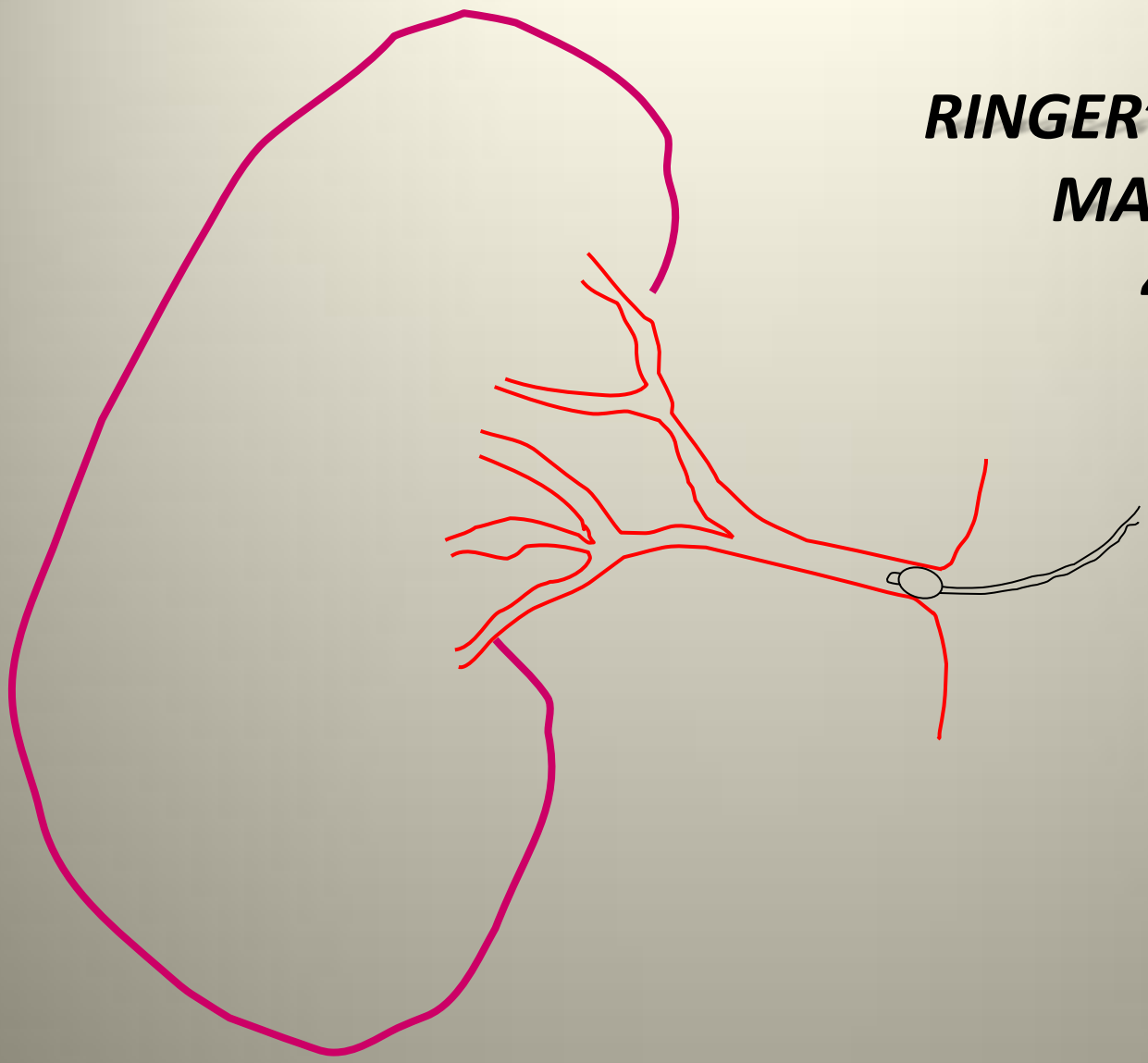
GUTS, LIVER, SPLEEN, STOMACH, …

RENAL PROTECTION

RENAL PROTECTION





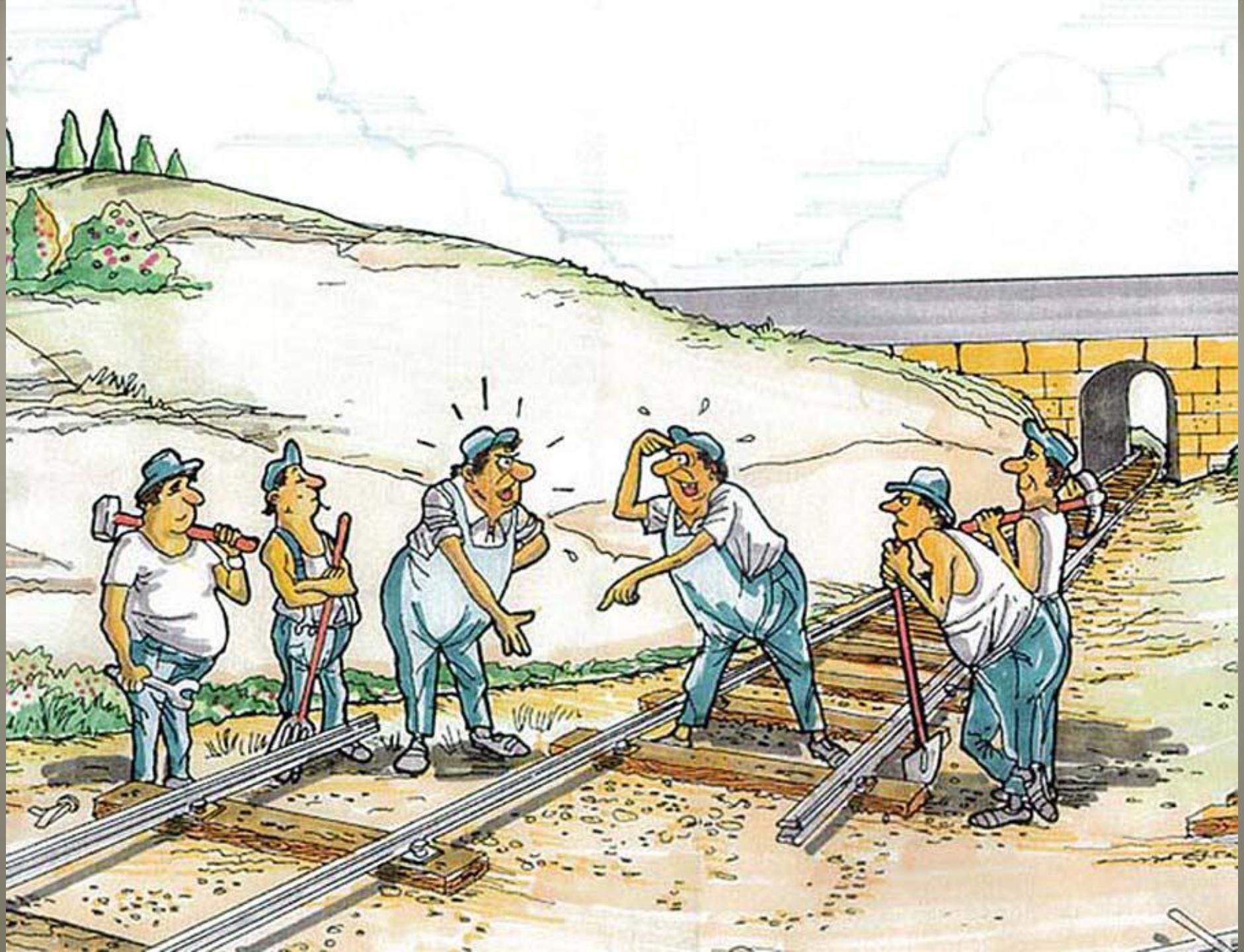


RINGER'S ACETATE

MANNITOL

4^0 C

TEAM WORK



ASSISTANT 1

ASSISTANT 2

ANESTHESIOLOGIST

SURGEON

PERFUSIONIST

SCRUB NURSE

THANK YOU FOR YOUR ATTENTION