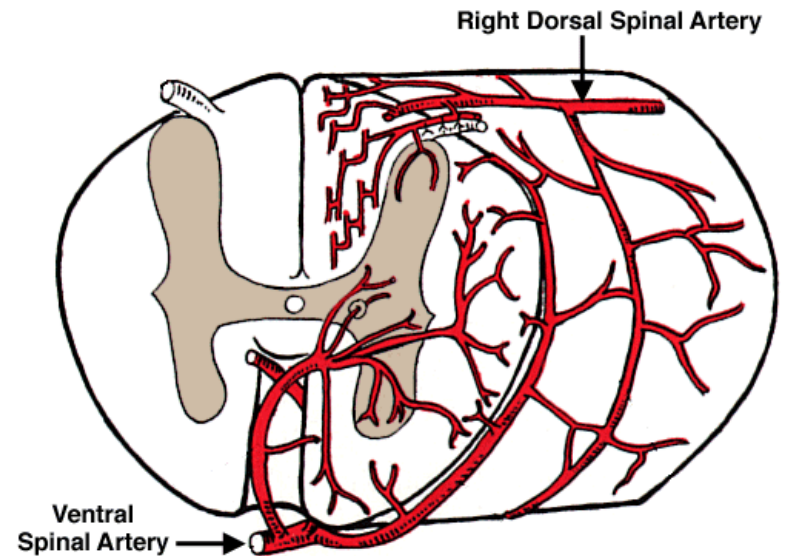
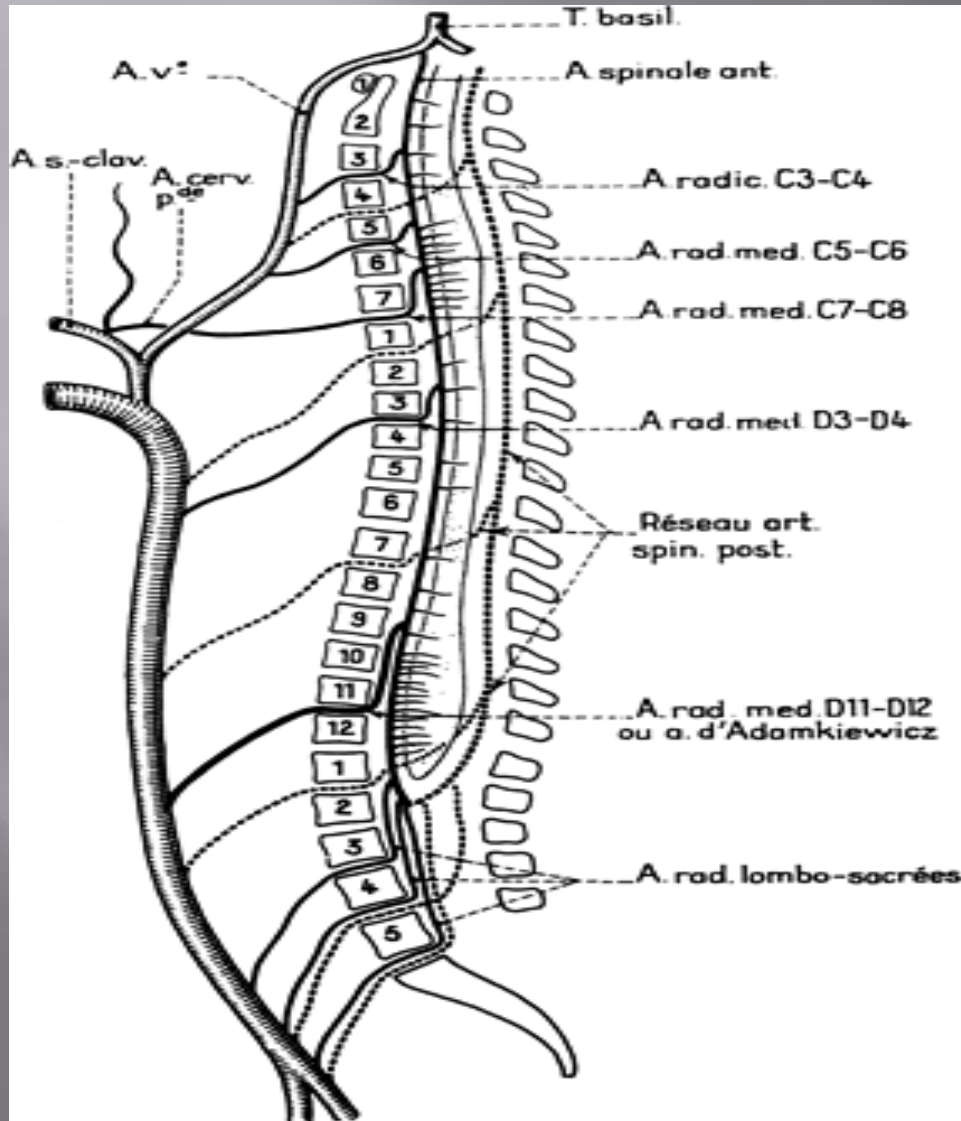


SPINAL CORD PROTECTION STRATEGIES WORK SHOP

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Spinal Cord Blood Supply



Incidence

- ▣ 2.5% paraplegia/paraparesis (EUROSTAR)
- ▣ Some studies up to 8%
- ▣ **Immediate, recurrent and delayed**
37% deficits are delayed: present 13 hours – 91 days post op
>50% will resolve with treatment
- ▣ **Associated morbidity and mortality.**
2 year Survival 32% vs 80% with non ambulatory deficit

SCI Risk factors

- ▣ Previous AAA
 - ▣ L subclavian occlusion
 - ▣ Emergency procedure
 - ▣ >205mm or >3 stent grafts
-
- ▣ Hypotension (MAP <70, or systolic<80mmHg)
 - ▣ Renal impairment
 - ▣ Involvement AKA / Hypogastric

Surgical Considerations

CT or MR angiography : AKA identification

Internal iliac blood flow

Distal aortic perfusion

X clamp time

Reimplantation intercostals

**Revascularisation L subclavian, hypogastric
arteries**

Staged procedures

Paraplegia prevention endografts

Thromboembolism

Anaesthetic Factors

- ▣ Maintenance Spinal Cord Perfusion Pressure (SCPP)
- ▣ CSF Drainage
- ▣ CSF targets
- ▣ Intra operative Monitoring
- ▣ Hypothermia
- ▣ Pharmacological strategies
- ▣ Preconditioning

Spinal Cord Perfusion Pressure

- ▣ $SCPP = MAP - (CSF \text{ Pressure} + CVP)$

Lost autoregulation, pressure dependent

MAP >80mmHg, SCPP >60mmHg

Continuous vs Intermittent monitoring

- ▣ Oxygen delivery

$$DO_2 = CO ((Hb \times SpO_2 \times 1.34) + PaO_2 \times 0.003)$$

CSF Drainage

- ▣ Overall evidence for beneficial effect

Risk reduction in the order of 80%

50% post op deficits can be reversed with spinal drain insertion

Hnath et al 2008 ,n=121, TEVAR, reduction
PNID 8% to 0%

- ▣ Complications significant
- ▣ Standardized management
- ▣ Recent best practice published

Lumbar drain complications

▣ Insertion

Failure, Spinal cord & Nerve root injuries, Bloody tap (5%) Neuraxial haematoma, PDPH(0.5%)

▣ Catheter

Fracture (1.8%), Infection (1.2%), local irritation (15%)

▣ Drainage

Intracranial hypotension, headache, VI n palsy, Intracranial haemorrhage (3%), death (0.6%), Chronic CSF leak.

Issue	Recommendation
Coagulation	No LMWH for 24 h (high dose); 12 h (low dose) No clopidogrel -7d, No ticlopidine 10 14 d, No abciximab -24-48h, No eptifibatide or tirofiban -4-8h, platelets >100-103, INR <1.3, normal APTT
Localized infection	Avoid placement of drain in an area of localized infection
Intracranial pressure Insertion	Avoid placement of drain if patient has evidence of increased intracranial pressure
Asepsis	Alcohol-based chlorhexidine solutions, sterile draping, thorough handwashing with removal of jewelry, sterile surgical gloves, masks, sterile gown
Awake vs asleep	Suggest awake to allow for patient feedback (i.e., pain/paraesthesia)
Timing of insertion	Option to admit to hospital and insert lumbar CSF drain 24 h preoperatively to avoid issues with traumatic tap and systemic anticoagulation
Traumatic/bloody tap	Discuss with surgeon, delay anticoagulation at least 60 min, consider delaying surgery 24 h, higher index suspicion postoperative neuraxial hematoma
Hemodynamics	Avoid hypotension, MAP to maintain SCPP >60 mm Hg, avoid large increases in CVP
Zero transducer	Phlebostatic axis to ensure accurate calculation of SCPP
CSF drainage	CSFP <10 mm Hg or to maintain SCPP >60 mm Hg, no more than 10–15 mL/h CSF drainage, intermittent drainage with continuous monitoring preferred to allow calculation of SCPP and avoid large volumes CSF drainage
Subarachnoid opiates	Avoid, may exacerbate spinal cord ischemia
Hemodynamics	Avoid hypotension
Duration of drainage/monitoring	Avoid prolonged drainage to minimize infection risk, consider keeping drain in place <72 h
Bloody CSF drainage	May indicate ICH, consider imaging brain
New-onset lower extremity neurology	Worsening spinal cord ischemia vs neuraxial hematoma, increase SCPP (increase MAP, decrease CSFP), consider imaging neuraxis.
Coagulation for drain removal	Platelet count >100 103/L3, INR <1.3, normal aPTT delay removal 2–4 h after last heparin dose, hold heparin 1 h after catheter removal.

CSF Markers of Ischaemia

- ▣ **Lactate.**

Anaerobic metabolism, Non specific to symptoms, easy to measure, CSF vs Blood

- ▣ **S100B.**

Soluble astrocyte protein, leaks on cell damage

Increases all patients with surgical trauma.

Elevated 6 hours post clamp.

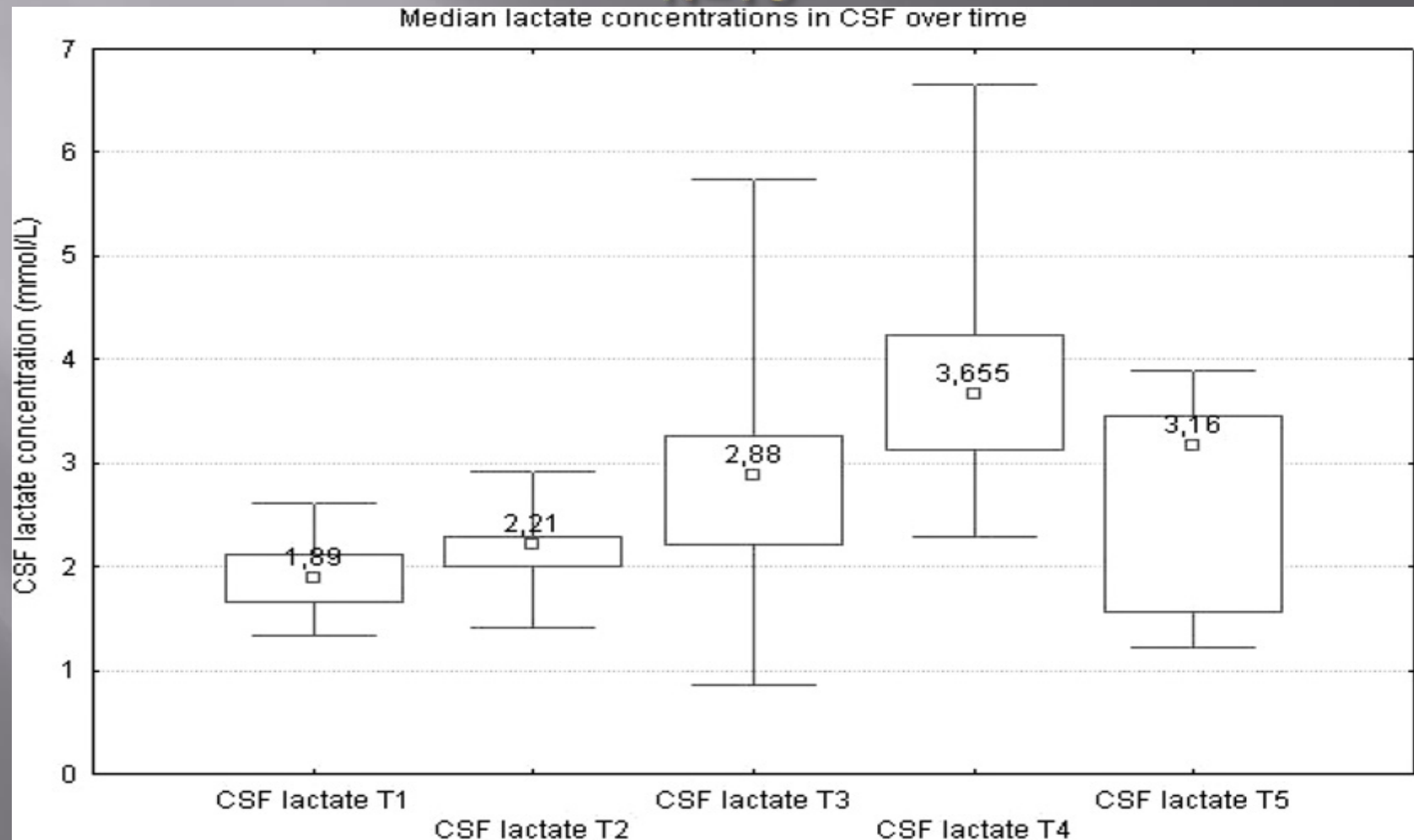
- ▣ **Glial fibrillary acidic protein (GFAP).**

Structural astrocyte protein, reflects apoptosis

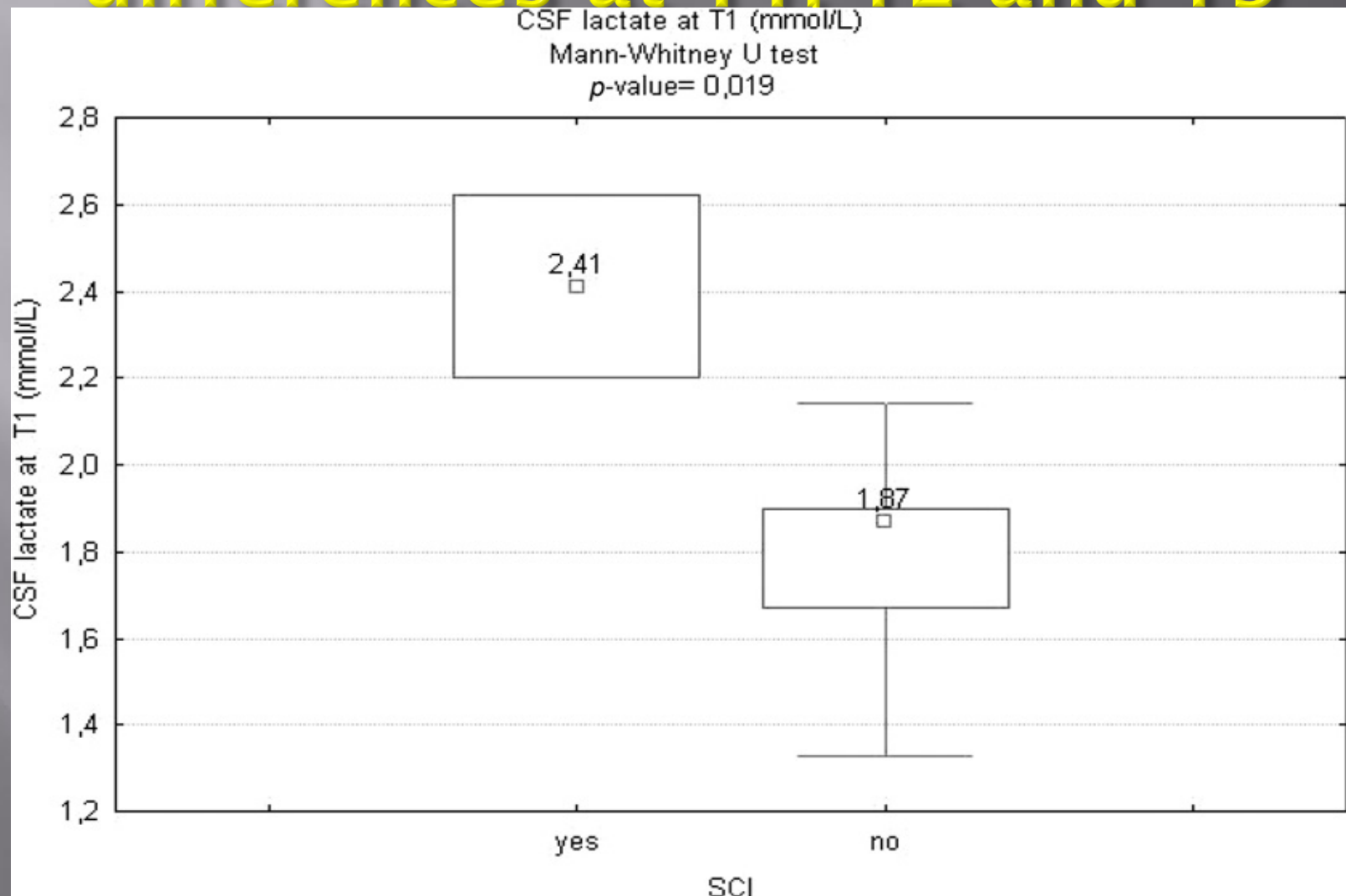
Biggest increase all biomarkers. Increases next day, plus before or in parallel to onset of delayed symptoms.

CSF lactate median concentration at T1 (immediately after the catheter positioning, just before skin incision), T2 (15 minutes after clamping), T3 (just before unclamping), T4 (end of surgery), and T5 (4 hours after the end of surgery).

N=16



Patients with SCI have significant CSF lactate differences at T1, T2 and T3



Monitoring Spinal Cord function

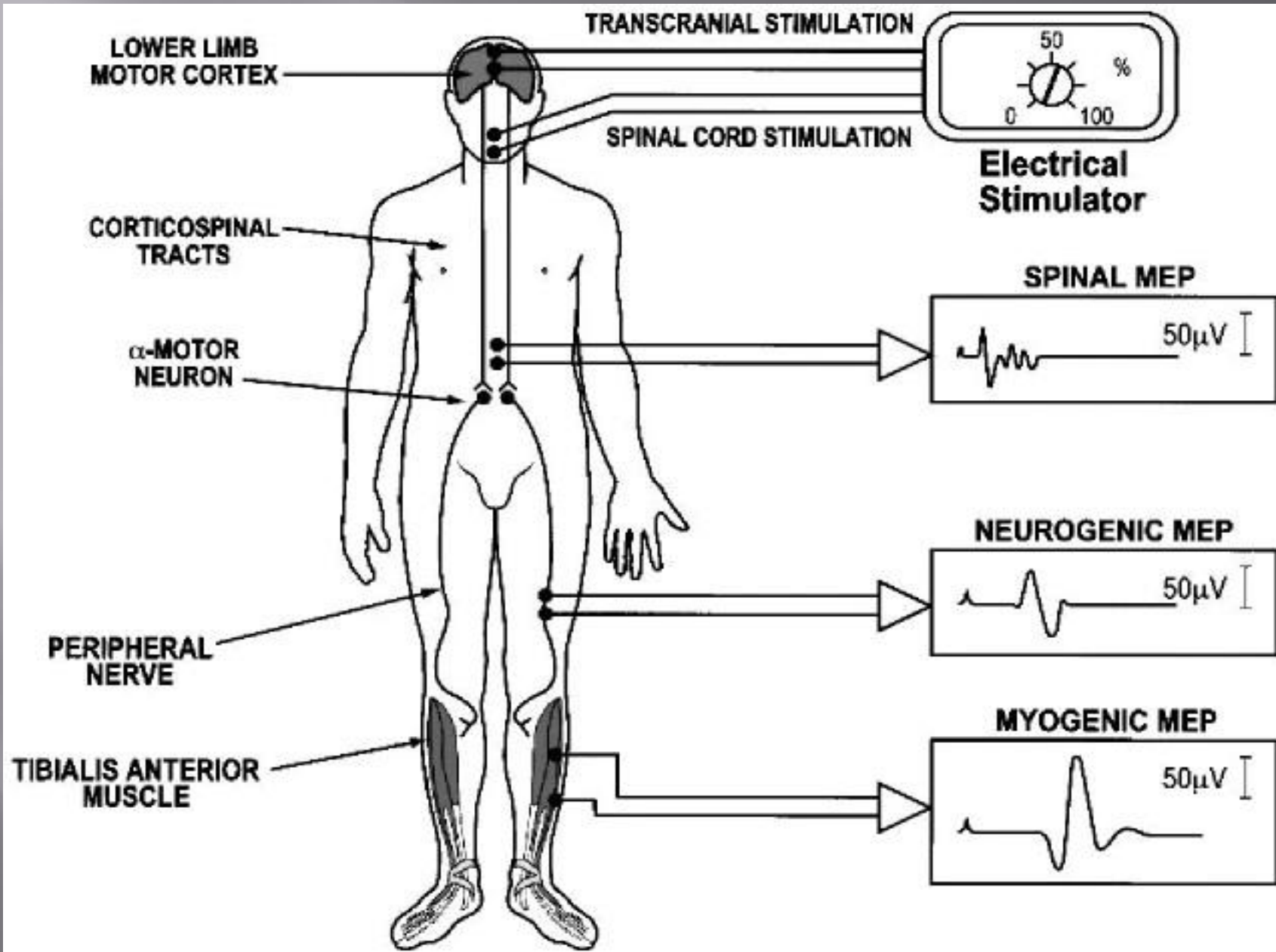
- ▣ Evoked potentials : Motor and Sensory

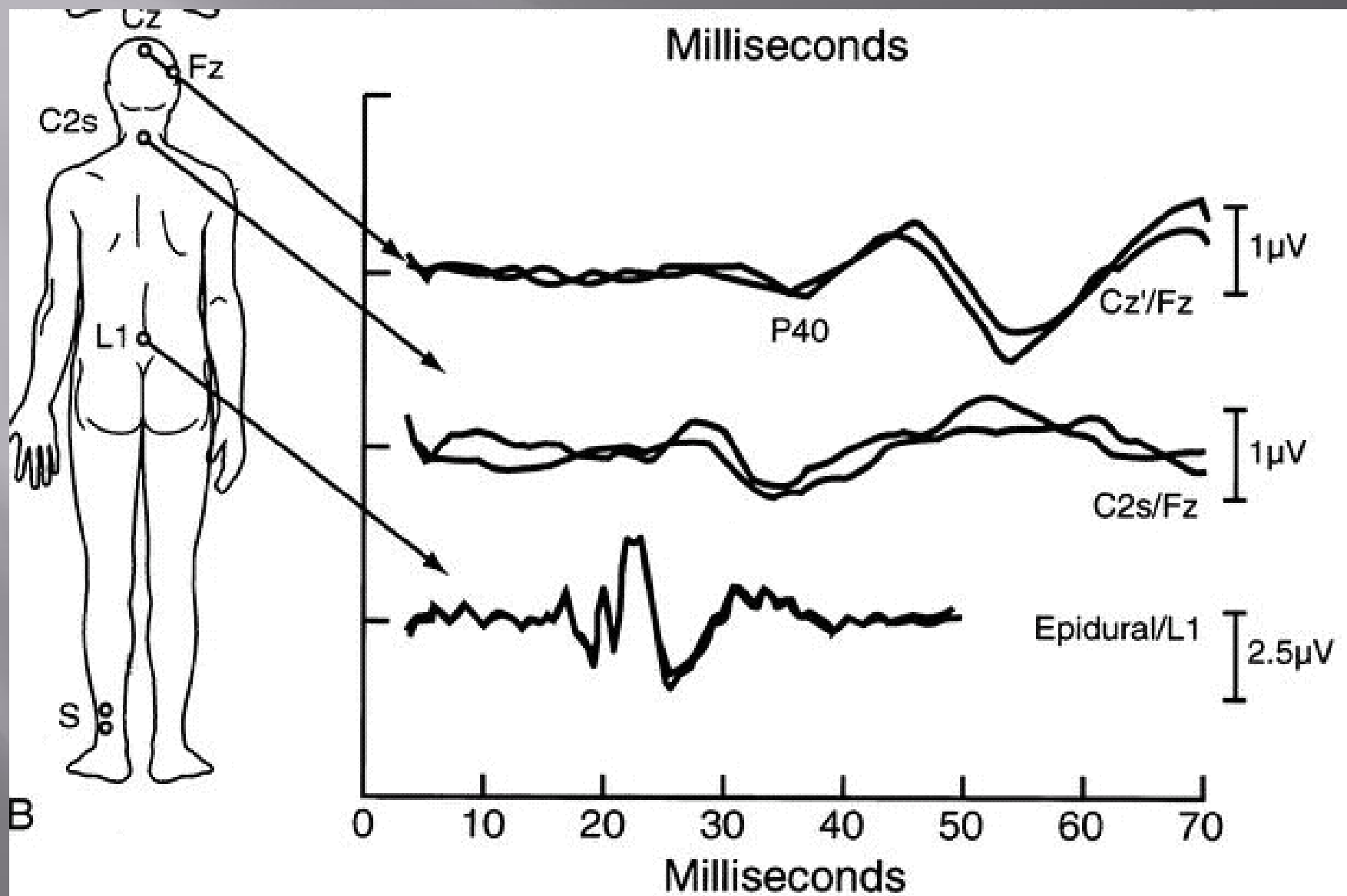
MEP

Motor anterior spinal cord tracts

Can respond more rapidly

**Requires TIVA, abolished by volatiles and
NMB**





Hypothermia

- ▣ DHCA

- ▣ Epidural

4⁰ C isotonic saline instilled into CSF drain

New drains?

- ▣ Systemic

May be achieved with patient cooled to 33⁰C

- ▣ No clear evidence

Pharmacological Strategies

▣ Opiates

CSF opioids exacerbate SCI

Intrathecal μ and δ agonists

IV naloxone used in some centres routinely

▣ $\alpha 2$ agonists

Dexmedetomidine/ Clonidine

Pharmacological Strategies

Anti inflammatory	Antioxidant	Anti excitatory
Steroids	Melatonin	MgSO4
Erythropoietin	N Acetylcysteine	Anti glutamate (riluzole)
Statins	Mannitol	Carbamazepine
		Thiopentone

Ischaemic preconditioning

**Volatile agents and non injury ischaemia
Large trials warranted**

- ▣ 40 adult patients
- ▣ Remote upper limb ischaemia : 3 cycles of 5min upper limb ischaemia, followed by 5min reperfusion.
- ▣ Beneficial spinal cord effects

Summary

- ▣ **Preserve spinal cord blood supply:**

Staged, PPG, branch hypogastric, Lsubclavian revascularisation

- ▣ **Increase ischaemic tolerance:**

Hypothermia, Epidural cooling, pharmacological

- ▣ **Optimise spinal cord perfusion:**

MAP, CSFD, Avoid steal, embolism

- ▣ **Early detection:**

Intraop MEP/SSEP, biochemical tests, early neuro assessment.