Local Anaesthesia
&
Pain Management

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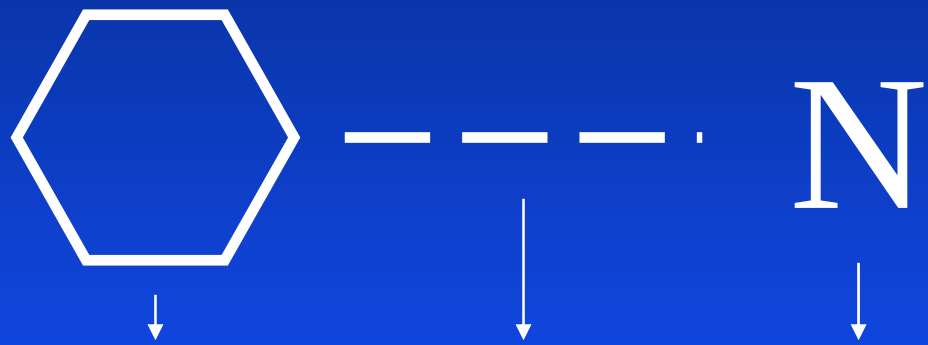
Local Anaesthesia

History

- **Pre 1866** - Compression techniques
- **1866** - “Freezing” with Ether
- **1880** - Ethyl Chloride spray
- **1880→84** - **COCAINE** used by Karl Köller
- **1905** - **PROCAINE** developed
- **1943** - **LIGNOCAINE** synthesised

General Structure –
Local anaesthetics



Unsaturated Ring (Lipophilic)

Intermediate Chain (Ester or Amide)

2 º or 3 º Amine (Hydrophilic)

General Pharmacology

- **Ionisation** -

  Must be **Unionised** (Lipophilic) to penetrate tissues, but **Ionised** at the nerve

- **pKa** -

  pH where Ionised = Unionised

- **Protein binding** -

  Affects the duration of action

Mechanism of action

- Numerous theories
- Main action is at the **Na^+-K^+** ionophore at the nodes of Ranvier

Local Anaesthetic Agents

ESTERS	CLINICAL USES	USUAL CONCEN TRATION	ONSET	DURATION	MAXIMUM DOSE	COMMENTS
a) Procaine	*Infiltration *Peripheral *Spinal	1% 1 - 2% 10%	Fast Slow Moderate	0,5 - 1 *hr* 0,5 - 1 *hr* 0,5 - 1 *hr*	10 *mg kg*$^{-1}$ ⊂ Adrenaline	Procaine has marked vasodilator action and is generally used with Adrenaline 1:200 000 to prolong its effects.
b) Chloro-procaine	*Infiltration *Peripheral *Epidural	1% 2% 2 - 3%	Fast Fast Fast	0,5 - 1 *hr* 0,5 - 1 *hr* 0,5 - 1 *hr*	11 *mg kg*$^{-1}$ 14*mg kg*$^{-1}$ ⊂ Adrenaline	Lowest systemic toxicity due to rapid hydrolysis by plasma cholinesterase. May be neurotoxic intrathecally, due to low pH or preservative.
c) Ametho-/ Tetra- caine	*Topical *Spinal	2% 0,5%	Slow Fast	0,5 *hr* 2 - 4 *hr*	1 *mg kg*$^{-1}$	High potency, and high toxicity.
d) Cocaine	*Surface	4 - 10%	Fast	20 - 30 *min*	3 *mg kg*$^{-1}$	Potent vasoconstrictor. Sensitises adrenergic receptors to endogenous & exogenous sympathomimetic amines. May cause addiction. Addition of Adrenaline is redundant and may be harmful.

AMIDES	CLINICAL USES	USUAL CONCENTRATION	ONSET	DURATION	MAXIMUM DOSE	COMMENTS
a) Lignocaine	*Topical *Infiltration *Peripheral *Epidural *IV block *Spinal	2 - 10% 0,5 - 1% 1 - 1,5% 1 - 2% 0,5% 5%	Fast Fast Fast Fast Fast Fast	0,5 - 1 *hr* 1 - 2 *hr* 1 - 3 *hr* 1 - 2 *hr* Up to 2 *hr* 0,5 - 1,5 *hr*	3 *mg kg*$^{-1}$ 7 *mg kg*$^{-1}$ ⊂ Adrenaline	Remains the most versatile and widely used local anaesthetic. Relatively low systemic toxicity. Rapid onset, moderate potency and moderate duration of action. No vasoactive effects. Addition of adrenaline decreases toxicity. Antidysrrhythmic.
b) Mepivacaine	*Infiltration *Peripheral *Epidural	1 - 2% 1 - 1,5% 1 - 2%	Moderate Fast Fast	 2 - 3 *hr* 1 - 2,5 *hr*	3 *mg kg*$^{-1}$ 5 *mg kg*$^{-1}$ ⊂ Adrenaline	Similar to Lignocaine but lasts longer. Duration prolonged with Adrenaline. Marked accumulative potential and rapid placental transfer.
c) Prilocaine	*IV block *Peripheral *Epidural	0,2- 0,5% 1,5 - 2% 1 - 3%	 Fast Fast	Max 2 *hr* 1,5 - 3 *hr* 1 - 2,5 *hr*	6 *mg kg*$^{-1}$ 9 *mg kg*$^{-1}$ ⊂ Adrenaline	Least toxic amide. Methaemoglobinaemia possible if large doses used. (> 600 *mg*)
d) Etidocaine	*Peripheral *Epidural	0,5 - 1% 1 - 1,5%	Fast Fast	3 - 12 *hr* 2 - 4 *hr*	5 *mg kg*$^{-1}$ ⊂ Adrenaline	Profound motor block.
e) Bupivacaine	*Infiltration *Peripheral *Epidural *Spinal	0,2 - 0,5% 0,2 - 0,5% 0,2 - 0,5% 0,5%	Slow Moderate Fast Fast	4 - 12 *hr* 4 - 12 *hr* 2 - 4 *hr* 2 - 4 *hr*	2 *mg kg*$^{-1}$	Does not cause vasodilatation at site of injection, therefore only modest increase in duration of action with Adrenaline. Popular due to:- Potency (3 - 4 x > than Lignocaine.) Relatively low toxicity. Long duration of action. Relatively safe in obstetrics. Exaggerated cardiotoxicity with intra-venous injection. Low concentrations produce a chiefly sensory block. **Not used in Bier's (IV) block.**
f) Ropivacaine	*Infiltration *Peripheral *Epidural Not yet released for *Spinal	0,2 - 1% 0,2 - 1% 0,2 - 1%	Slow Fast Fast	4 - 12 *hr* 2 - 4 *hr* 2 - 4 *hr*	3 *mg kg*$^{-1}$	New amide local anaesthetic prepared as a pure S-isomer in contrast to others, which are racemic mixtures Recently released in RSA. Similar to Bupivacaine in onset, potency and duration, with less motor block. pKa = Bupivacaine. = 8,1. Less cardiotoxic than Bupivacaine, but still has dysrrhythmic potential.

Toxicity

- May occur if a) Too much is given
  b) Rapidly absorbed
  c) Inadvertently injected IV
- Organ systems involved are the a) **CNS**
  and b) **CVS**
- Hypersensitivity
  Rare with Amino-amides
  but may occur with Amino-esters

Duration of Effect

- Determined by removal from the nerve
  Affected by a) - Perfusion
  b) - Blood concentration
  - Perfusion modified by **Vasoconstrictors**
  - Concentration dependent on **Metabolism**
    Amides - Liver metabolism
    Esters - Cholinesterase metabolism in blood & liver

Vasoconstrictors

- Increases duration of effect
  Decreases toxic effects
- Most popular is **Adrenalin 1:200 000**
  (N.B. Dentists use **1:80 000**)

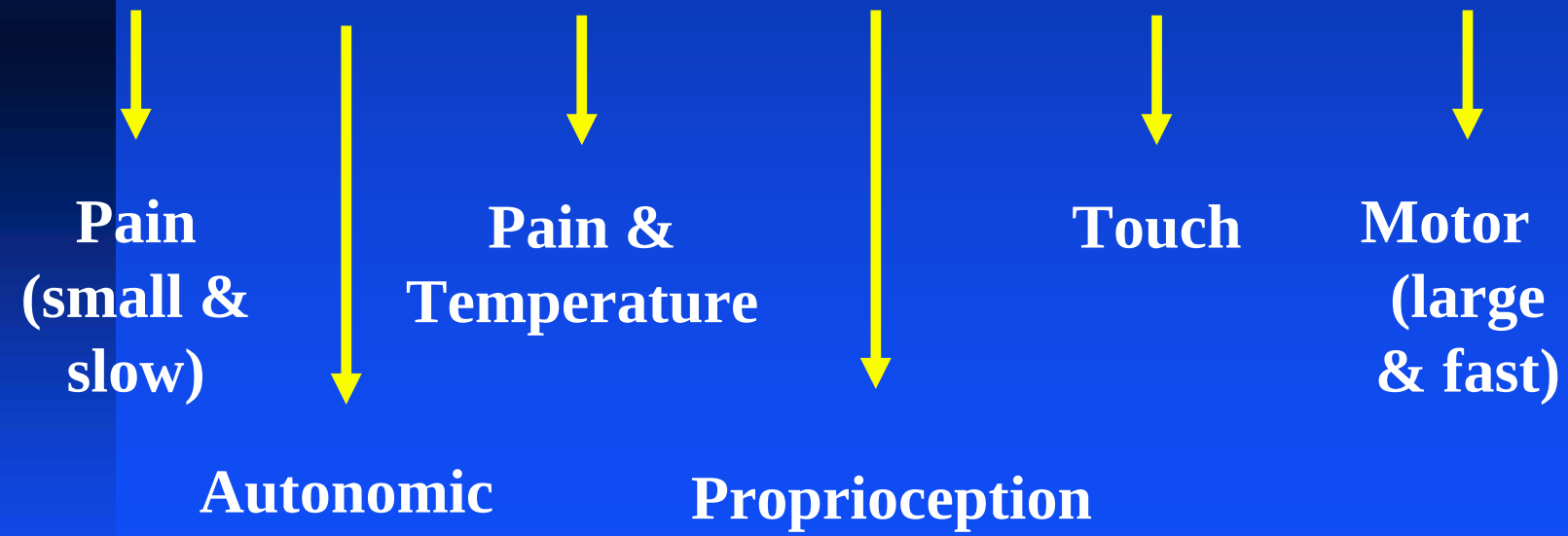
  e.g. **Lignocaine** toxic dose
  without Adrenalin = **3 *mg kg*$^{-1}$**
  with Adrenalin = **7 *mg kg*$^{-1}$**

Action on Nerve Fibres

Fibre type	Myelin	Diameter (Microns μm)	Conduction velocity ($m\ sec^{-1}$)	Function
A- α	+++	15 - 20	70 - 120	Motor
A- β	++	5 - 12	30 - 70	Touch & Pressure
A- γ	++	5 - 10	30 - 70	Proprioception
A- δ	+	2 - 5	12 - 30	Pain & Temperature
B	+	1 - 4	3 - 15	Preganglionic Autonomic
C	-	0,5 - 1	0,5 - 2	Pain & Temperature, Postganglionic Autonomic

- Small fibres blocked first

$$\mathbf{C \rightarrow B \rightarrow A\delta \rightarrow A\gamma \rightarrow A\beta \rightarrow A\alpha}$$



Advantages of Locals

- No specialised equipment needed ∴ Cheap
- Awake patient with little effect on homeostasis ∴ Little monitoring required
- Less manpower, skill & equipment needed
- Rapid recovery & ambulation possible
  Ideal for day-case Surgery
- Good postoperative pain relief

Disadvantages

- Often unacceptable to patients
- Not 100% effective - May get ineffective or patchy blocks
- Some sensation persists
- May need extensive blocks $\therefore \uparrow$ toxicity risk
- Skill is required for certain blocks
- Slow onset and delay of surgery

Contraindications

- **SEPSIS** near field of injection
- **REFUSAL / NON CO-OPERATION** of patient
- **HYPERSENSITIVITY**
- Surgery requiring **EXTENSIVE BLOCKS**
- Bilateral ops or ops requiring > 1 incision

Types of Blocks

- Local application
- Infiltration
- Field block
- Nerve / Plexus blocks
- Body cavity blocks
- Intravenous blocks
- Regional (Neuraxial) blocks

- **Local application**

  Applied as sprays, aerosols, gels / pastes, direct instillation, lozenges, swabs etc.

  Drugs - Lignocaine, Amethocaine, Benzocaine & **EMLA** (**E**utectic **M**ixture of **L**ocal **A**naesthetics)

  Ops - Minor ops on mucous membranes

- **Infiltration**

  Local injection at site of operation

  Drugs - Lignocaine, Bupivacaine & Mepivacaine

  Ops - Minor superficial skin ops, postop analgesia

- **Field block**

  Local anaesthesia injected around op site

  Drugs - as before

  Ops - Excision biopsies, skin ops etc.

- **Nerve / Plexus blocks**

  Specific nerves blocked remote from op site
  Requires anatomical knowledge & skill

  Nerve stimulator may be useful

  e.g. Digital-, Intercostal-, Retro / peri bulbar-, Ankle-, Wrist-, Femoro-Sciatic-, Ilio-Inguinal- blocks etc.

Drugs - same

Ops - numerous

- **Body cavity blocks**

  Instill/Infuse weak solution into body cavity
  e.g. Pleura, Joints, Abdomen etc.

  Drugs - Bupivacaine, Lignocaine

  Ops - Arthroscopy, Cystoscopy &
  Post-op analgesia

- **Intravenous blocks (Bier's block)**

  Local Anaesthetic solution given IV in an exsanguinated and isolated limb

  Tourniquet inflated >> systolic BP
  Block lasts as long as tourniquet inflated (**Do not deflate** before 20 *min*)

  Drugs - **Only** Lignocaine or Prilocaine (Bupivacaine is specifically contraindicated)
  Ops - Hand / arm surgery, ??Foot surgery

- **Regional (Neuraxial) blocks**

  Block conduction in or near the spinal cord

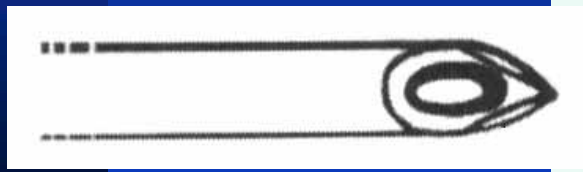
  Results in segmental block of sensory, motor & autonomic function

  Autonomic block causes **hypotension**

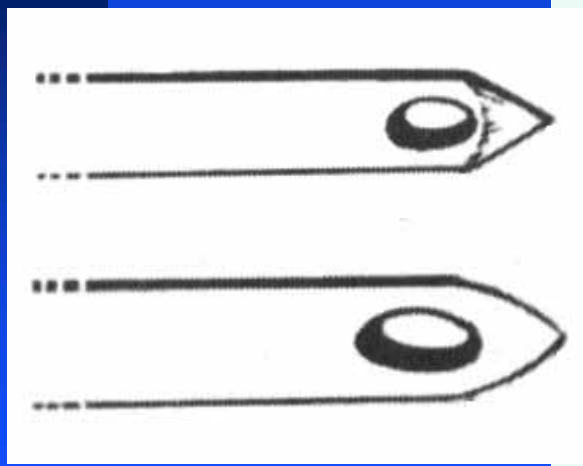
  Treat with fluids or vasoconstrictors e.g. Ephedrine

Spinal

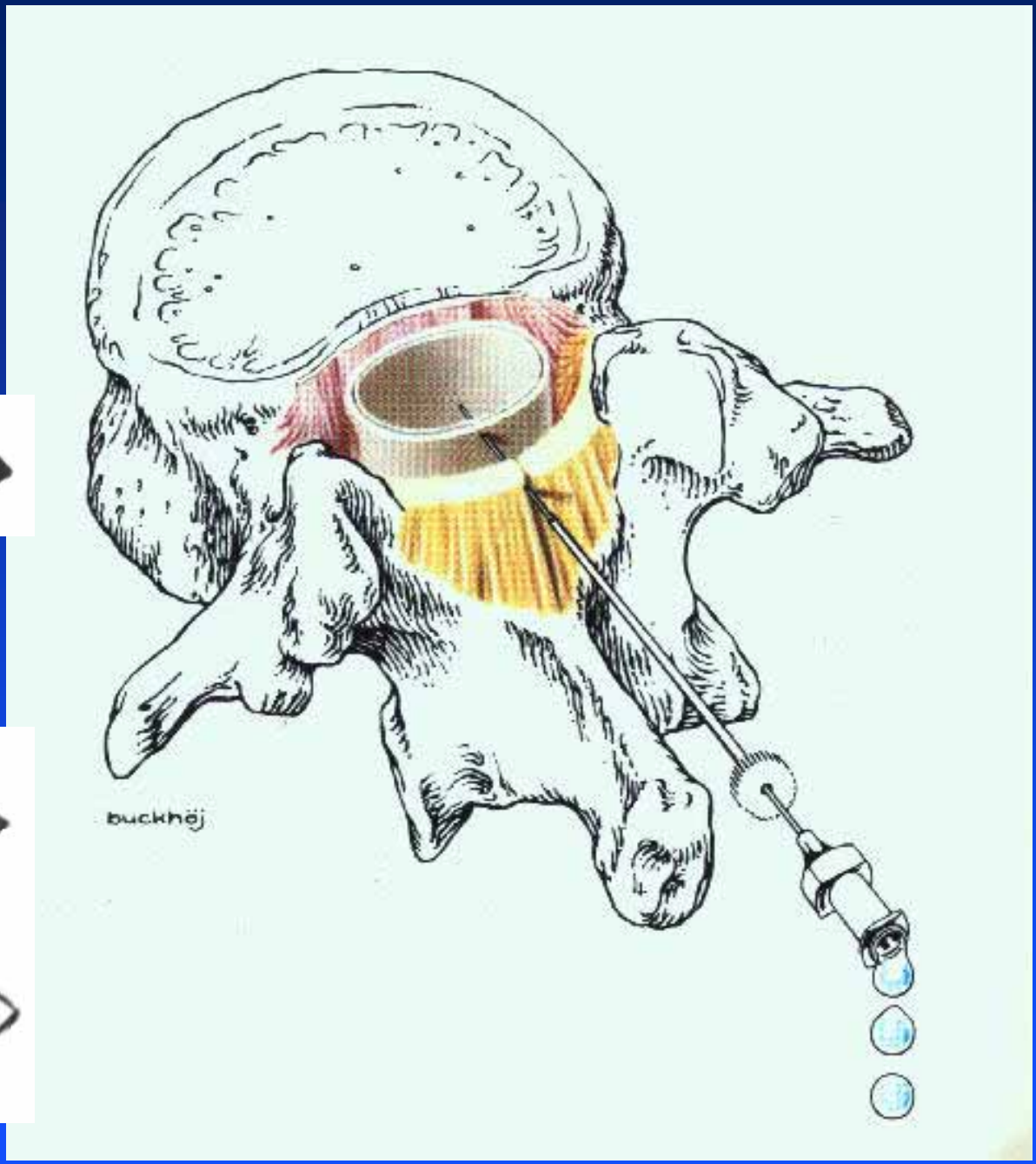
Quincke



Whitacre



Sprotte



- **Subarachnoid (Spinal) - Lumbar**
- **Instill LA solution into the CSF**

Advantages are -

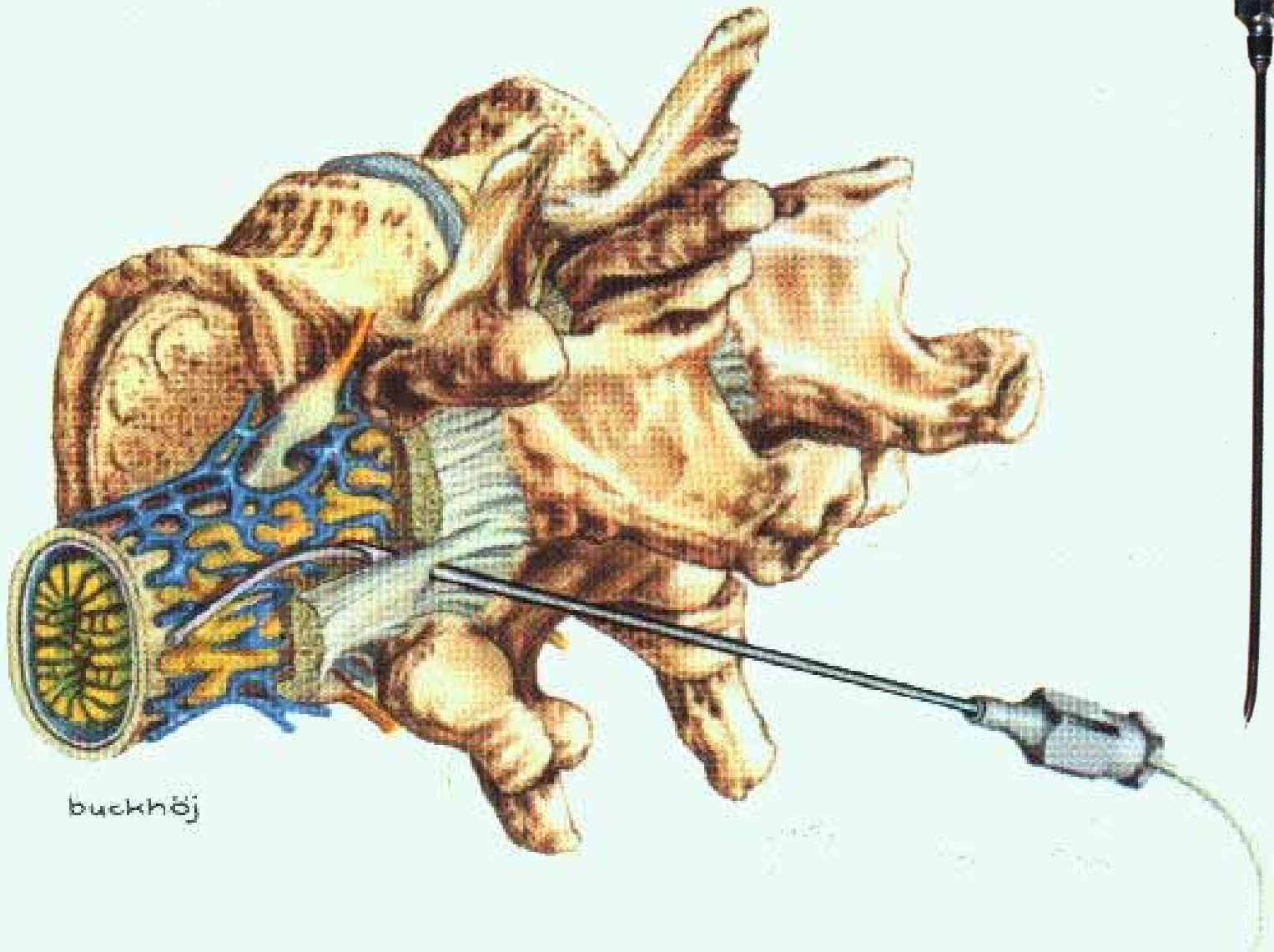
- **Rapidity of onset**
- **Easy endpoint**
- **Predictable**

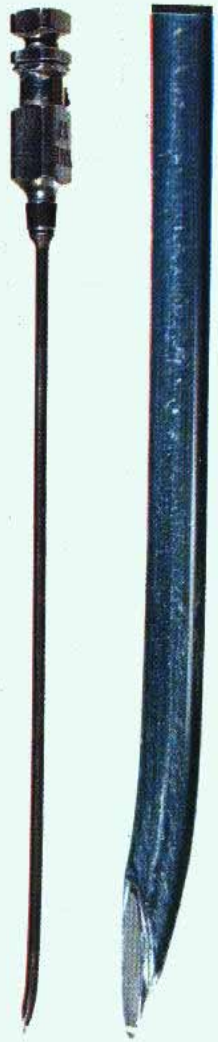
Disadvantages are -

- **"Spinal headache" - Less with fine- and pencil point- needles**
- **Sudden CVS changes e.g. ↓ BP**
- **"One shot" only (at present)**

Epidural

Tuohy





- **Epidural (Peridural) - Lumbar / Thoracic**

LA solution is deposited in the space around the spinal cord, the "Epidural space"

Advantages -

"Top-ups" possible via catheter

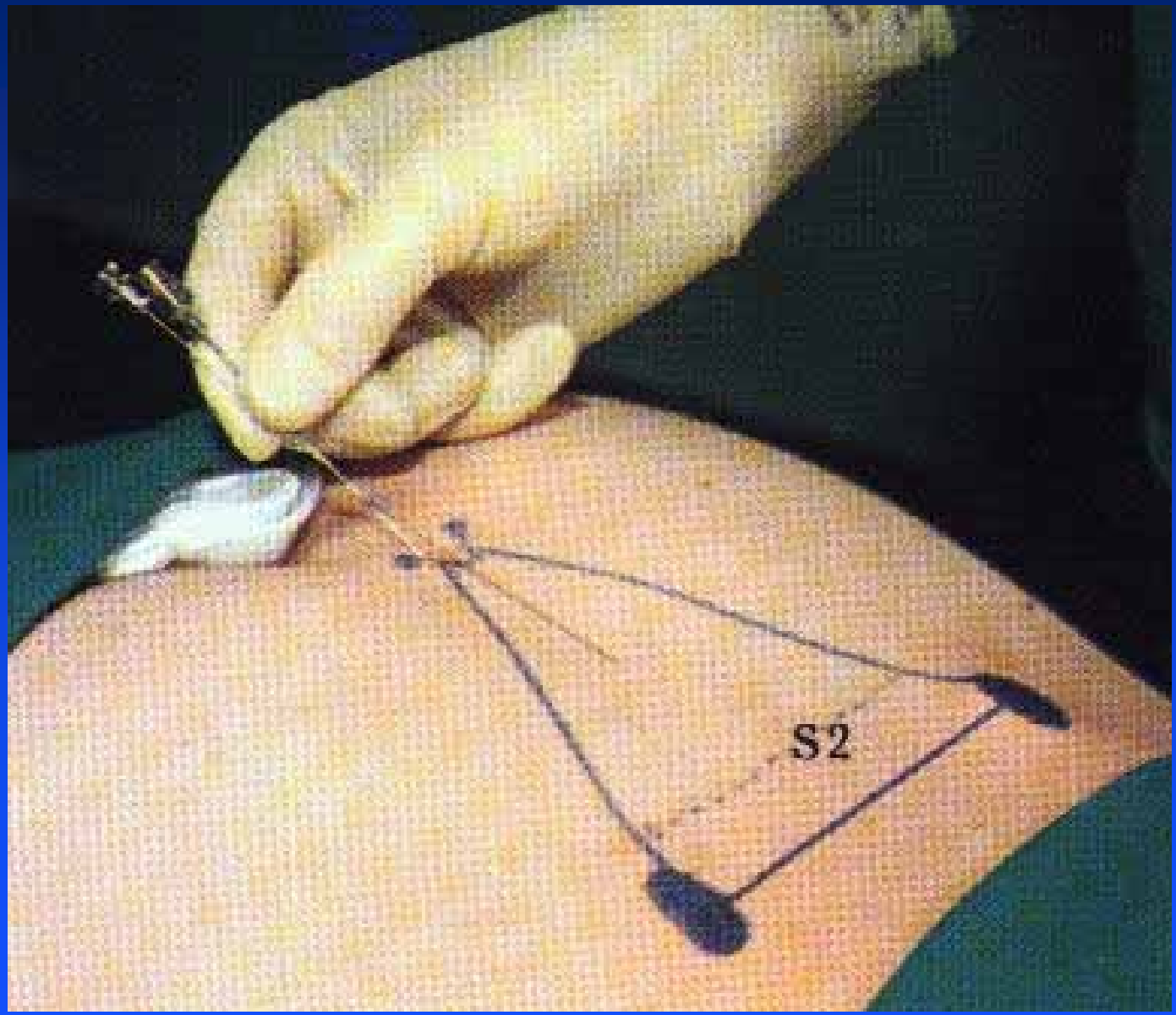
Gradual onset of block i.e. more stable

Disadvantages -

Less predictable & slower

Bigger needle ∴ more painfull

Caudal



- **Caudal**

  A form of Epidural anaesthesia

  The space is entered via the Sacral hiatus

  Commonly used in children for postop analgesia

  May be used in adults

Pain Management

Pain

- Pain is an unpleasant senastion caused by the perception of noxious stimuli in the periphery by the sensory cortex
- There is wide variation in the feeling of pain between different persons and at different times in the same person
  The young and old are more susceptible
- Pain may be modulated by higher centres and by local factors

Pain transmission

- Melzack and Wall postulated the "Gate control theory of pain" which led to a better understanding of the complexities of pain transmission
- Organs involved in the sensation of pain
  - Substantia nigra of the spinal cord
  - Periductal grey in the brain
  - Sensory cortex

The perception of pain is a balance between

a) - Nociception, the noxious stimulus

b) - Central effects, plasticity

c) - Psychological effects, depression and anxiety

d) - Behavioural effects

Acute Pain

- This is a **protective** physiological effect, but counterproductive in the postop setting
- Usually proportional to the injury / stimulus

Chronic pain

- This is **destructive** and serves no purpose
- May be disproportional to the stimulus
- Profound psychological, behavioural and central effects may be present

Acute pain therapy e.g. Postop

Multi-pronged approach in the acute phase

- Opiate analgesia - Oral, IMI, IVI, IV infusion, PCA (**P**atient **C**ontrolled **A**nalgesia), Epidural, PCEA (**P**atient **C**ontrolled **E**pidural **A**nalgesia)
- NSAID's (**N**on-**S**teroidal **A**nti-**I**nflamatory **D**rugs) Beware of the contraindications
- Local anaesthesia

Other treatment modalities include

- "Simple Analgesics" - e.g. Paracetamol
- Sedatives - Meprobamate **(e.g. Stopayne®)**
- Other -
  - Acupuncture
  - TENS (?APLS)
    - **(T**ranscutaneous **E**lectric **N**erve **S**timulation**)**
  - Cryoprobe

Chronic Pain Therapy

- This requires a multi-disciplinary team of :-
  - Psychologists
  - Social workers
  - Physiotherapists
  - Occupational therapists
  - Specialists -
    Psychiatrist
    Physician
    Anaesthetist
    Surgeon
    Neurologist
    Neurosurgeon etc.

- **Chronic pain management requires a stepwise implentation of therapy suited to each individual patient**
- **Each *component* of the pathology must be addressed**

  e.g. Psychological

  Nociceptive

  Coping skills

  Life style adaptation

  Support groups etc.

- **Broadly speaking, chronic pain management may be divided into:-**
  - **Terminal pain management**
    e.g. Cancer pain
  - **Non-terminal pain**
    e.g. Chronic backs, neuralgias etc.

The emphasis for these are different

Treatment modalities

- **Analgesics - Minor - e.g. Paracetamol**
  Opiates - *still* the mainstay
  but addiction is possible
- **NSAID's - Beware side-effects**
- **Sedatives - High affinity for dependence**
- **Anti-depressants - Important**
- **Anti-epileptics – e.g. Carbamazepine**
  N.B. for Central pain

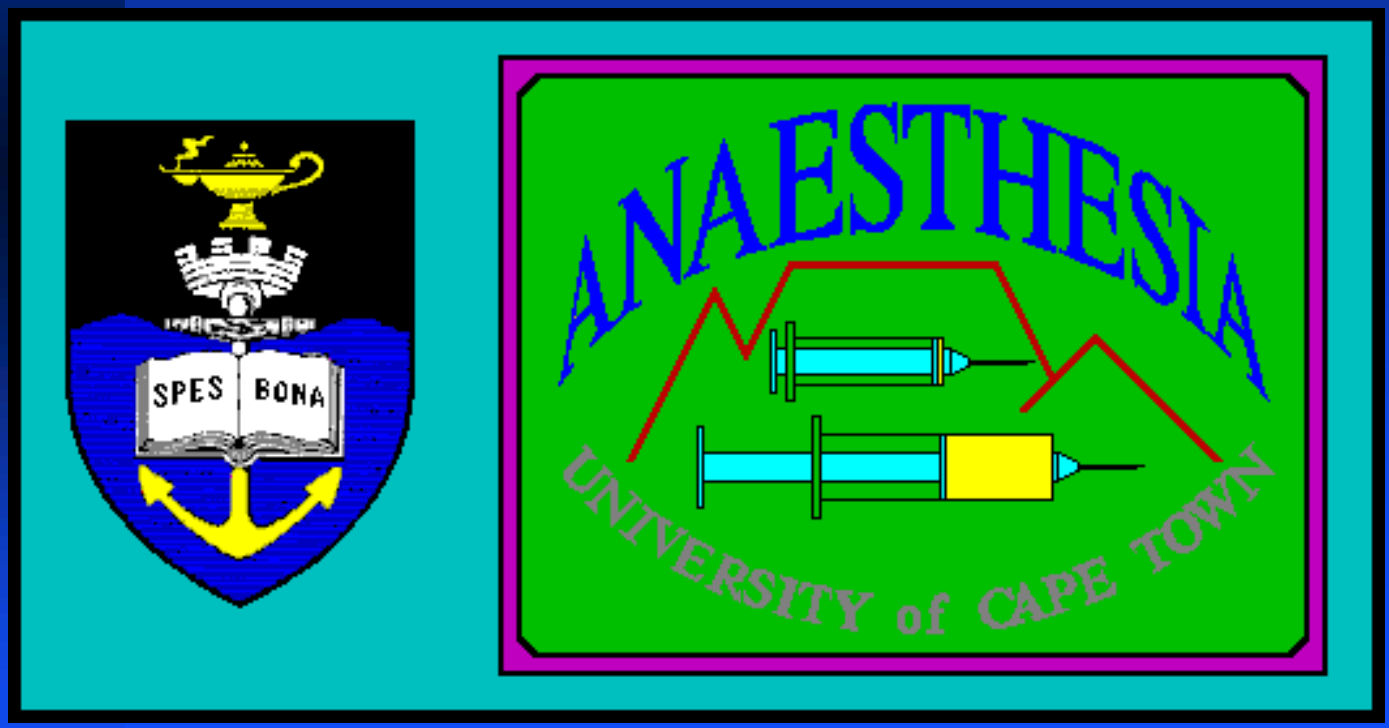
- **Nerve blocks**
  - **Temporary (diagnostic or curative)**
  - **Permanent destructive lesions e.g. Terminal pain**
- **Long term Epidural catheters**
- **Psychotherapy**
- **Other**

  Acupuncture, Electrode implants

Local Anaesthesia

and

Pain management



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