Monitoring of Peripheral Nerve Surgery

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Introduction

- Majority of serious nerve injuries leave nerves in continuity
- Inspection alone can be deceptive
- Even presence of gross fascicular continuity does not guarantee useful recovery
- Stimulation alone is not useful for many months after injury
Benefits of Operative Recording

- Evaluates early indications of regeneration
  - Connection with muscle is not necessary
  - Especially valuable for traumatic injury
  - Supplies information not available by any other method!!!!!!
- Indicates functional status of exposed nerve
- Enhance localization of discrete lesion
- Decision-making is no longer intuitive
- Outcome is the best possible for the patient
- Caution – using motor function can be misleading!
  - Stimulation synchronizes very small motor units making them appear functional when they are not
  - CNAP much more reliable
Experimental Lesions in Primates

visual inspection is not reliable –
not substantiated by histology
The Regenerating Axon

- Wallerian degeneration p. 72 hrs
- Schwann cells lose contact with axon
- “The window of opportunity” for regeneration
Initial primate studies were done in vivo on lesioned nerves

Two types of injury were studied: crush and severance and suture

Positive NAP’s antedated EMG recovery by weeks to months

Negative NAP’s correlated with poor regeneration and recovery

Presence of a NAP required 4000 fibers >5µ in diameter
Compound Nerve Action Potential (CNAP)

- Measure of *functional* axons in a segment of nerve
- Localizes functional and non-functional segments
- Instrumentation readily available
- Caveat: Fine fibers
Median Nerve Above Elbow

Normal CNAP From Median Nerve
Ulnar Nerve at and above elbow

Sliding electrode along nerve identifies the function of underlying axons
“Partial” Nerve Injury: Nerve Remains in Continuity

- Term implies some portion left normal
- “Mixed” Nerve Injury is a better term
- Some parts of the nerve may have to be treated differently
- Operative studies are helpful
NAP’s recorded in 950 entrapped nerves and usually confirmed EMG studies

Exceptions included Ulnar nerve at elbow and some TOS cases

NAP recordings were used to completely excise neural sheath tumors including neurofibromas
What Would Have Happened to This Lesion 20 Years Ago?

- Preop EMG showed minimal denervation but motor function was also minimal
- Neurapraxic loss
  - Stimulation may pass thru neurapraxic region induced by demyelination
- This lesion proved to be a myosarcoma
- Stimulation showed good function
  - What’s different between voluntary effort and stimulation?
    - Stimulation creates a SINGLE NAP – not affected by rate-dependent block
    - Voluntary effort requires a TRAIN of NAP’s – train fails
How Much Can a Nerve Take?

- Impalement
  - 27 ga needle
  - Injection injuries – 20 ga needle

- Compression
  - Few good studies of acute, transient compression
  - Certainly the ischemia is a factor - time

- Stretch
  - How much?
  - Implications for minimally invasive surgery
NOTE: stretch is expressed as a percent of nerve length!
“Inching” Technique
Patient recordings have involved 1736 patients with 3393 lesions in continuity.

Positive NAP resulting in neurolysis gave a Grade 3 or better function using LSUHSC grading system in 94.7% of neural elements.

Differential fascicular recordings resulted in split repair in 62 nerves with recovery in 58.

Absence of a NAP correlated with a neurotemetic lesion by histologic study.

1111 of 1975 (56%) nerves recovered to ≥Grade 3 levels as a result of repair.
Current Research

- Explore autonomic nerve action potentials
  - Operatively important for pelvic floor robotic surgery

- Explore autonomic muscle activity
  - Very difficult to record smooth muscle activity
  - Why??
Conclusions

- Operative NAP recordings can document presence or absence of neural function.

- NAP recordings can document useful axonal regeneration early after insult – can’t get this information ANY OTHER WAY.

- NAP recordings are helpful with some entrapments and most neural sheath tumors.