What is the role for neurophysiology in the evaluation of patients with uro-genito-anal dysfunction?

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Definition: *Uroneurophysiological tests are clinical neurophysiological tests applied in the urogenitoanal area.*

Disclaimer: This talk is NOT on the important research potential of „neurophysiology“ in uro-genito-anal dysfunction.
Which are uroneurophysiological tests?

Uroneurophysiological tests:

Electromyography (**EMG**)

Responses recorded from muscle on stimulation of the motor nervous system pathways (**M wave, motor evoked potentials - MEP**)

Potentials recorded from sensory pathways on stimulation in the urogenitoanal area (**neurogram, sensory evoked potentials SEP**)

Sacral reflex responses (**bulbocavernosus reflex, anal reflex…**)

Autonomic nervous system tests* (sympathetic skin response - **SSR**…)

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*The smooth-muscle EMG, which is the only direct test of smooth muscle and its innervation, is for the moment restricted to the research laboratory.*

*(Giuliano and Rowland, 2013)*
Which uroneurophysiological tests are useful?
Which uroneurophysiological tests are useful? **In which patients?**
Are tests useful in all patients with uro-genito-anal symptoms?

**NO!**

*From the uroneurological standpoint:*

Only useful in selected patients whose uro-genito-anal symptoms are **suspected to be NEUROGENIC***.

*Also patients with a particular uro-genito-anal dysfunction in whom a test result changes the choice of treatment.*
The patient has suspected neurogenic uro-genito-anal symptoms!

**Clinical questions:**

WHERE IS THE LESION OF THE NERVOUS SYSTEM?

WHAT IS THE LESION OF THE NERVOUS SYSTEM?
In selected patients an **uroneurological work-up** may be clinically relevant.

**Clinical questions:** Is there a **LESION / DYSFUNCTION** of the nervous system? **Central** nervous system lesion? **Peripheral** nervous system lesion?

**Clinical solutions:** Clinical / “Uroneurological” / Exam + Investigations?
In selected patients an uroneurological work-up may be clinically relevant.

**Clinical ambiguity** Where is the **place for neurophysiology** in the evaluation of patients with uro-genito-anal symptoms/dysfunction?
In selected patients an uroneurophysiological work-up may be clinically relevant.

**Evidence?**

Clinical neurophysiology testing should demonstrate evidence that testing improves outcome (through treatment choice and patient selection).
In selected patients an uroneurophysiological work-up may be clinically relevant.

Evidence?

However, testing and therapeutic intervention are different concepts.

Neurophysiological testing has an important objective, which is not applicable to interventions. *It is to generate knowledge about the situation to be treated in a given patient*, so that the practitioner can formulate rational treatment options based on knowledge rather than do so blindfold; that is, he or she can practice “knowledge-based medicine”.
In selected patients an uroneurophysiological work-up may be clinically relevant.

**Evidence:**

Of course, we should seek evidence for and against testing. Any test should be subjected to three questions:

- Does the test have good **technical** performance?
- Does the test have good **diagnostic** performance, ideally against a “gold standard” measure?
- Does the test have good **therapeutic** performance? (That is, does the use of the test alter clinical management, does the use of the test improve outcome?)
Are the patient’s uro-genito-anal symptoms due to a brain lesion?

**Clinical solutions:** Exam + Structural diagnostics
Are the patient’s **uro-genito-anal** symptoms due to a **brain** lesion?

**Clinical solutions:**

+ **Functional diagnostics?**

Matsuura et al, 2002
Are the patient’s **uro-genito-anal** symptoms due to a **brain** lesion?

**Clinical solutions:**

**Functional diagnostics / Uro-neurophysiological tests?**

**Uro-neurophysiological tests are rarely useful.**

**Exception:**
To demonstrate concommittant lesions within the sacral reflex arc in **politrauma**, neurodegenerative disease **i.e.** Multiple system atrophy - MSA ...

Tests: **CNEMG, BCR**
Are the patient’s \textit{uro-genito-anal} symptoms due to a \textit{spinal cord} lesion?

\textit{Clinical solutions:} Exam + Structural diagnostics
Are the patient’s **uro-genito-anal** symptoms due to a **spinal cord** lesion?

**Clinical solutions:**

+ **Functional diagnostics** / Uro-neurophysiological tests?

Uro-neurophysiological tests are rarely useful, unless the lesion involves the conus or cauda equina.

**Exception:**
To demonstrate a concommittant sacral lesion in a traumatic injury of the cervical spinal cord.

Tests: **CNEMG**, BCR
Preventing uro-genito-anal symptoms due to iatrogenic (surgical) spinal cord lesion

Clinical solutions: Intraoperative monitoring with continuous uro-neurophysiological testing

Uro-neurophysiological tests may be employed in the surgical theatre intraoperatively to alert the surgeon to potential cord damage.

Tests: BCR, SEP, MEP

Are the patient’s uro-genito-anal symptoms due to a peripheral nervous system lesion?

**Clinical solutions:**

Exam + Structural diagnostics?
Are the patient’s **uro-genito-anal** symptoms due to a **peripheral nervous system** lesion?

**Clinical solutions:**

+ **Functional diagnostics**
  
  Sensorimetry / Uroneurophysiological tests
Are the patient’s uro-genito-anal symptoms due to a peripheral nervous system lesion?

**Clinical solutions:** Uroneurophysiological tests?

Electromyography *(EMG)*

Responses recorded from muscle on stimulation of the motor nervous system pathways *(M wave, motor evoked potentials - MEP)*

Potentials recorded from sensory pathways on stimulation in the urogenitoanal area *(neurogram, sensory evoked potentials SEP)*

Sacral reflex responses *(bulbocavernosus reflex, anal reflex...)*

Autonomic nervous system tests *(sympathetic skin response - SSR...)*
Are the patient’s uro-genito-anal symptoms due to a peripheral nervous system lesion?

**Clinical questions:**

*Is the uro-genito-anal dysfunction caused by an isolated lesion to the cauda equina, sacral plexus, pelvic autonomic plexuses, pudendal nerves?*

*Is the uro-genito-anal dysfunction caused by a generalized peripheral neuropathy?*
The patient’s uro-genito-anal symptoms may be due to a generalized peripheral neuropathy.

General electrodiagnostics (nerve conduction studies in lower limbs) more useful in diagnosis of generalized peripheral neuropathy then uroneurophysiological testing.

(Vodušek et al. 1993)
The patient’s **uro-genito-anal** symptoms may be due to an isolated lesion to the cauda equina, sacral plexus, pelvic autonomic plexuses, pudendal nerves.

Uro-neurophysiologic tests are useful in demonstration of isolated somatic neural lesions of the peripheral sacral system.

(Vodušek et al 2009; Tubaro et al 2013)

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Sacral nervous system involvement - *Which uroneurophysiological tests?*

EMG,

Responses recorded from muscle on stimulation of motor pathways (M wave, MEP);

Potentials recorded from sensory pathways on stimulation in the urogenitoanal area (neurogram, SEP),

Sacral reflexes,

Autonomic nervous system tests

Validity?

Sensitivity?

Specificity?

Usefulness?
The single most important test in uro-neurophysiology

- demonstrates PATHOLOGICAL SPONTANEOUS ACTIVITY – muscle denervation,
- demonstrates changes in MOTOR UNIT POTENTIALS (MUPs) - muscle reinnervation,
- collection of some “kinesiologic” data,
- suited for examination of severely denervated muscles,
- enables examination of several muscles in a single session,
- widely available.
Muscles to be examined by concentric needle EMG

The external anal sphincter
- the most practical indicator muscle for lower sacral myotomes

The bulbocavernosus muscle
- to document spontaneous "denervation" activity (it has no "tonic" activity).

The urethral sphincter muscle
- useful in women with unexplained urinary retention

Lower limb muscles should often also be examined to document more extensive proximal lesions (cauda equina/conus medullaris, sacral plexus, etc.).
Demonstration of the sacral lesion:
- non-elicitable reflex,
- reflex latency prolonged.

*Electrophysiologic monitoring during surgical procedures that could damage cauda equina or conus medullaris.*

(Deletis and Vodušek, 1997)
Sensitivity of CNEMG and BCR testing in peripheral lesions:

**Bilateral anal sphincter EMG**

(sensitivity 73% in cauda equina lesions)

**Bilateral bulbocavernosus reflex testing**

(sensitivity 81-83% in cauda equina lesions)

**Bilateral anal sphincter EMG + bilateral bulbocavernosus reflex**

(sensitivity 94-96% in cauda equina lesions)

(Podnar 2008)
Tests of conduction are sensitive to demyelination but not to partial lesions of *axon*al type
Electrophysiologic tests of conduction - useful only in particular clinical settings

Pudendal somatosensory evoked potentials (SEP) /testing the central somato-sensory pathway/
- Potentially useful when sensation in the lower sacral dermatomes is normal, and the sacral reflex is brisk.

Motor evoked potentials (MEP) from sphincter muscles /testing of the central motor pathway/
- Potentially useful when there is no voluntary muscle activation but reflexes are normal.
Are patient’s uro-genito-anal symptoms **neurogenic** if we **demonstrate a lesion of the nervous system**?

Possibly; particularly if other causes are ruled out.

It must be stressed that **uroneurophysiological tests correlate with the PNS lesion** - but not directly with organ function*

*Only a weak correlation has been established between external anal sphincter EMG and sexual dysfunction in cauda equina patients.

*(Podnar et al., 2002)*
CONCLUSIONS:
How relevant is diagnostics?

*Structural* (*and laboratory*) diagnostic findings

- define the *(nature of)* the lesion

- define the possibilities of *causal therapy*
**Functional diagnostic findings**

(uroneurophysiological testing; urodynamics)

- define neural control *dysfunction*

- may aid in (rehabilitative) *management*
In most patient groups with **neurogenic incontinence** or **neurogenic urinary retention**, the pathophysiology is unpredictable and comprehensive **urodynamic evaluation** is essential in order to practice knowledge-based medicine.

**CONCLUSIONS:**
How relevant is diagnostics?
In selected patients from these groups, uroneurophysiological testing will clarify issues related to the neural control of lower urinary tract, relevant for understanding pathophysiology.

In most patients, a precise definition of the neurologic lesion will not lead to a difference in management.
As is generally true for electrophysiological tests, uroneurophysiological tests are particularly useful for substantiating the clinical diagnosis of a peripheral nerve lesion.

The potential usefulness of testing in an individual patient needs to be analysed in the overall clinical setting.

The indications for testing are guided primarily by expert opinion, not on definitely established criteria derived from controlled studies.
CONCLUSIONS:
**Useful tests** in suspected peripheral sacral nervous system involvement

- cNEMG exploration of pelvic floor muscles
- and testing (on stimulation of penis /clitoris) the **sacral reflex** (i.e. BCR)

(Vodušek et al. 2005)
CONCLUSIONS: What can tests reveal?

CNEMG and testing BCR provide a robust basic “battery of tests” to demonstrate

a) preservation of the S2-S4 reflex arc,

b) muscle denervation,

c) reinnervation of muscle.

(Vodušek et al. 2005)
**Urodynamic testing** (along with “*kinesiological*” EMG) may usefully inform on lower urinary tract (dys)function.

The need to examine electrophysiologically the **central neural pathways** to/from S3-S4 segments (i.e. measure SEP and MEP) rarely arises in the clinical setting.

(Vodušek et al. 2005)
CONCLUSIONS: Testing incontinent patients?

In the incontinent patient without other signs or symptoms of a neurologic condition, neurophysiological testing is generally unnecessary.

In patients with stress/urge, or mixed urinary incontinence electrophysiological testing is as a rule non-contributory.
CONCLUSIONS:
Testing incontinent patients in retention?

**Urethral sphincter concentric needle EMG** may be rarely useful even in patients without neurological symptoms - in the documentation of abnormal spontaneous activity in the form of profuse repetitive discharges in women with unresolved dysfunctional voiding / urinary retention.

*(Supporting – in the appropriate clinical circumstances – the diagnosis of Fowler’s syndrome).*
CONCLUDING QUESTION

Is exact diagnosis of the organ neural control relevant - for final neurological diagnosis?

for treatment?
CONCLUDING SUGGESTIONS:

**INDICATIONS** for Sacral Neurophysiology:

- Traumatic and compressive **spinal lesions** (*lesions of the cauda equina/conus medullaris*)
- Traumatic and compressive **pelvic lesions** (*lesions of the sacral plexus or pudendal nerves*)
- Spinal **dysraphism**
- Atypical parkinsonism and complex **autonomic failure** (*MSA*)

*Particularly before invasive therapy!*
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Thank you!