Sacral Neuromodulation for Treatment of Refractory Lower Urinary Tract Symptoms

Alex Kavanagh, PGY3
Mar 30/2011

Goals

1. Define sacral neuromodulation (SNM) and review the clinical implementation

2. Provide patient selection algorithms

3. Review evidence on efficacy of SNM for treatment of refractory:
   • Non-obstructive urinary retention
   • Frequency-urgency syndrome
   • Urgency incontinence.
Outline

- Sacral Neuromodulation
- Mechanism of Action
- Patient Selection
- Evidence
- Long term Results
- Resources

Definitions

- International Continence Society (2002) documentation lacks an official definition for *neuromodulation*

Neuromodulation

- The use of electrical stimuli on nerves to alter neurotransmission processes in non-neurogenic and neurogenic conditions.

CW Urology (64)

Neuromodulation - Functional Definition

Any medical intervention which acts on nerves to alter the neurotransmission processes of other nerves.
Neuromodulator

- Stimulus used to alter the nervous system
  - Sacral neuromodulator (SNM)
  - Peripheral or transcutaneous implantable nerve stimulator
  - Medication (Botox)
  - Posterior tibial nerve stimulation (PTNS)
  - Transcutaneous posterior tibial nerve stimulation (TPTNS)

History

- 1800’s Danish Surgeon (Saxtorph)
  - Electrifies metal rod in the urethra
  - Provoked bladder contraction

- 1960’s Caldwell /Dees
  - Stimulate spinal cord /pelvic nerve
  - Bladder and urethral sphincter contraction

- 1980’s Tanangho and Schmidt
  - Bladder pacemaker in dogs
  - Rhizotomy required

Urology CW9 (64)
History

- 1984 - Tanagho and Schmidt
  - Activation external sphincter
  - Reflex inhibition of detrusor activity
  - Foundation of sacral neuromodulation

- 1997 - InterStim Therapy
  - Medtronics, MN, USA
  - FDA approval 1997
  - Currently >100K units in clinical application

Interstim Sacral Neuromodulation (Medtronics, MN, USA)

- An implantable device that stimulates the sacral nerves modulating the neural reflexes that influence the bladder, sphincter, and pelvic floor.
Clinical Applications

- FDA Approved Indications (1997)
  - Non-obstructive urinary retention
  - Urgency Incontinence
  - Urgency-Frequency Syndromes

- Expanding non-approved applications
  - Fecal incontinence
  - Interstitial cystitis
  - Chronic pelvic pain syndromes
  - Pediatric voiding dysfunction
  - Neurogenic Bladder

Interstim II Device (Medtronics)

- Provides low voltage electrical stimulation to sacral nerves via tined electrode
  - Dimensions: 4 x 5 cm
  - Battery Life: 4.4 year
  - Weight: 22g
  - Estimated cost (1Y): $22K USD

- Two stage implantation procedure


Medtronic Inc
Watanabe Urology 76(4), 2010
Stage 1 - Testing

- Local anesthetic /conscious sedation
- Foramina needle inserted into S3 foramina (fluoroscopy)
- Electrical stimulation performed to verify position
  - Motor stimulation with ‘bellows’ contraction of the anus
- Stylet removed and tined permanent lead introduced.


Stage 1

Stage 1

- Extension cable added and external modulator device connected.
- One week trial to evaluate voiding symptoms.

Stage 2

- Voiding diary obtained
- If > 50% improvement in baseline symptoms
- Modulator implanted in subcutaneous tissue of ipsilateral buttock
Outline

- Sacral Neuromodulation
- Mechanism of Action
- Patient Selection
- Evidence
- Long term Results
- Resources

Summary - Mechanism of Action

- Largely unknown mechanism of action

"I think you should be more explicit here in step two."
Summary - Mechanism of Action

Proposed mechanisms

- Selective afferent inhibition
- Guarding reflex with non-obstructive retention
- Micturition reflex with urgency and urge incontinence via C fiber afferents
- Direct activation of efferents to rhabdosphincter reflexively causes detrusor relaxation


Bladder Neurophysiology

- Bladder Efferents (Motor response)
- Bladder Afferents (Sensory input)
- Reflex arcs
  - Positive and negative feedback to optimize control
- Interneurons
  - Optimization of neural networks

![Diagram showing the key nerves and neurotransmitters of the sympathetic (SYM), parasympathetic (PSYM), and somatic nervous systems involved in bladder control.](image)
Efferent: **Control**

**Voiding Phase**

- Parasympathetic (Pelvic Nerve)
  - Contracts Detrusor
- Hypogastric and pudendal nerves switched off during micturition.

![Diagram of Voiding Phase](image)


---

Efferent: **Control**

**Storage Phase**

- Somatic pudendal nerve (Onuf’s Nucleus)
  - Contracts rhabdosphincter
- Hypogastric nerve (T10-L2)
  - Contracts internal sphincter
  - a-1 adrenergic receptor
  - Relaxes bladder
  - b-3 adrenergic receptors.

![Diagram of Storage Phase](image)

Bladder Afferents:

**Sensation**

- **Somatic afferent: Pudendal Nerve**
  - Genital organs, urethra, prostate, anal canal, skin.

- **Autonomic afferents: Hypogastric and Pelvic Nerve**
  - Bladder fullness / pain
  - Two types of axons:
    - A-delta fibers - sense mechanoreceptors, detect fullness
    - C-fibers - detect noxious signals and pain


Bladder Afferent Pathways

- **C-Fiber Afferents**
  - Normally
    - mechano-insensitive and unresponsive to bladder distension (silent C-fibers)
  - Neurologic or inflammatory diseases
    - become sensitized to bladder distension and trigger micturition reflexes.

Hyperactivity may be caused by the formation of new reflex circuits mediated by C-fiber afferents

Storage Reflexes

- **Guarding reflex:**
  - Bladder-external urethral sphincter reflex
  - Crucial role to prevent stress incontinence.
  - Sudden increase in bladder pressure occurs (cough)
  - bladder afferent → Onuf's nucleus → pudendal urethral efferents → contract external urethral sphincter

Voiding Reflex

**Micturition Reflex:**
- Bladder-Bladder Reflex
- Activated when bladder beyond capacity.
- Contracts bladder and relaxes of outlet
- Once this reflex is turned “on” it remains on to empty the bladder completely.
Role of Interneurons

- Interneurons allow for coordinated communication between sympathetic, parasympathetic and somatic efferents
- Role in Bladder Reflexes
  - Synapse with bladder efferent parasympathetic neurons to form the Micturition reflex


Mechanism of Action: Retention

- Non-obstructive Urinary Retention
  - Proposed Cause: Failure to inhibit the guarding reflex
  - Result: Pelvic floor spasm leading to urinary retention

- Proposed resolution with SNM
  - Reduced afferent sympathetic input during guarding reflex
  - Decreased stimulation of external sphincter / pelvic floor

Elkelini et al. Urogynecol J (2010) 21
Mechanism of Action: Hyperactivity

Detrusor Hyperactivity

- Proposed cause: Increased afferent input leading to reflex voiding through new reflex circuits
  - C fiber afferents develop new circuits
  - Source of afferent input may be
    - sphincter, colon, vagina, cervix, or skin

- Result:
  - Complex network of new bladder reflexes with lowered threshold for contraction.
  - Leads to chronic urgency and frequency of voiding.

Elkelini et al. Urogynecol J (2010) 21

Mechanism of Action: Hyperactivity

- Proposed Resolution with SNM
  - Inhibiting sacral interneurons and C fiber afferents
  - Inhibiting micturition reflex
    - Preventing reflex micturition, but not voluntary voiding
  - Direct activation of efferent fibers to the rhabdosphincter reflexively causes relaxation of the detrusor

Elkelini et al. Urogynecol J (2010) 21
Outline

- Sacral Neuromodulation
- Mechanism of Action
- **Patient Selection**
- Evidence
- Long term Results
- Resources

Definition: Non-obstructive Urinary Retention

- Fowler’s Syndrome
  - Primarily female < 30 years
  - Idiopathic urinary retention without urgency
  - Bladder capacity > 1L
  - Absent neurologic / lab features to suggest neurologic dz
  - Hyperactivity on EMG tracing (patterns consistent with a failure of muscle relaxation)

Urology CW9 (59)
Definition: Frequency-Urgency Syndromes

• Terminology: Overactive bladder syndrome, Urgency syndrome or Urgency-Frequency syndrome

• Definition: Urgency-Frequency Syndrome
  • Urgency with or without incontinence, usually with frequency and nocturia

• Definition: Urge urinary incontinence (UI)
  • involuntary leakage (of urine) accompanied by or preceded by urgency


Disease Prevalence - Urinary Urgency Frequency Frequency

• 16.5% of US population (2003)

• 30% actively seeking care ~8.0 million

• Patients who cannot tolerate pharmacotherapy (~55%) 4.0 million

• Patients with continued symptoms actively seeking further treatment (~70%) 2.8 million

Medtronic Market Research 1998
Clinical Evaluation

- Complete medical history
  - Pelvic surgery or radiation
  - Medications that can cause cystitis
  - Autoimmune diseases
  - Gynecological or bowel symptoms

- Voiding History
  - Storage and voiding symptoms
  - Triggers such as diet, intercourse or menses
  - Duration

Clinical Evaluation

- Urinalysis / urine culture
  - Urinary cytology in select cases

- Physical examination
  - MSK and screening neurologic examination
  - Rectal examination in males
  - Pelvic examination in females

- Cystoscopy

- Imaging (MR, u/s, CT)

- Urodynamics
  - Rule out neurogenic bladder
Treatment Continuum - Frequency-Urgency +/– UUI

- Pharmacologic
  - Anticholinergic / antispasmodic agents
  - Tricyclic antidepressants
- Behavioral
  - Trigger avoidance / dietary modification
  - Biofeedback / pelvic floor rehabilitation
- Neuromodulation
  - Sacral nerve modulation (SNM)
  - Botox
  - Posterior tibial nerve stimulation
- Surgical
  - Urinary diversion
  - Continent pouch

When to consider SNM?

- Frequency-Urgency with or without urge incontinence
- Failure to respond to traditional therapies:
  - Behavioral modification
  - Pelvic floor physiotherapy
  - Anticholinergic therapy

- Non-obstructive urinary retention
  - Failure to respond to traditional therapies:
    - Optimization of dysfunctional voiding
    - Bowel optimization
    - Medication optimization (anticholinergic s/e)
Treatment Algorithm: Urgency-Frequency Syndrome / UUI

Initial Screening
  Voids Diary
  Urodynamic Workup
  Behavioral Techniques
  Interventional Techniques
  Medications
  +
  Continue as Appropriate
  -
  SNS Test Stimulation

Treatment Algorithm: Idiopathic Urinary Retention

Initial Screening
  Voids Diary
  Urodynamic Workup
  Rule Out Obstruction
  Medications and/or Catheterization
  +
  Continue as Appropriate
  -
  SNS Test Stimulation
Prognostic Markers

- **Gold standard is a successful trial of lead implantation**
- There are no prognostic markers that predict the success of SNM

Butrick et al. Int Urogynecol J (2010) 21 (Suppl 2)

Negative Prognostic Markers

- Independent factors associated with a lower response rate
  - Age > 55 years
  - Presence of > 3 chronic conditions
  - Severity of intravertebral disk disease (especially with neurogenic bladder)
  - Duration of complaints > 7 months

Contraindications

- **Absolute**
  - Anatomic abnormality which precludes localization / implantation
  - Inadequate response to clinical trial
  - Limited cognitive function

- **Relative**
  - Anticipated future MRI
  - High risk of site infection
  - Severe or rapidly progressive neurologic disease

Butrick et al. Int Urogynecol J (2010) 21 (Suppl 2)

Outline

- Sacral Neuromodulation
- Mechanism of Action
- Patient Selection
- **Evidence**
- Long term Results
- Resources
Summary of Significant Evidence

- Cochrane Review of SNM on LUTS
  - Single completed review
- Frequency-Urgency +/- Urgency Incontinence
  - 2 RCT’s (Level 2)
- Non-obstructive Urinary Retention
  - 1 RCT (Level 2)

Urgency Incontinence

- Schmidt et al (SNS Study Group) J. Urol (162) 1999

Study Design

- Non-blinded
- Prospective Multicenter Randomized Controlled Trial (16)
- Primary outcome variable: Voiding Diary
- Secondary outcomes:
  - SF-36 Health Questionnaire
  - Urodynamics
  - Quantification when stimulator turned off
Patient Population
- Predominantly female (>80%)
- 98% had no prior medical therapy
- Excluded patients with neurologic conditions (MS, SCI, CVA)

All patients: Baseline severe, frequent episodes of urge incontinence (per voiding diary).
- Mean daily incontinence episodes 8.9
- Mean leak severity ranking was 1.9
  - 1 = drops of leakage; 2 = teaspoon; 3 = soaked clothing
- Mean of 4.8 absorbent pads

Methodology
- 155 patients SNM testing phase
- > 50% baseline improvement in symptoms qualified for stage 2 (implantation)
  - 76 suitable for implant
- Randomized to
  - Intervention (immediate activation) (36 patients)
  - Control arm (6 month delay with standard therapy followed by activation) (42 patients)
Urgency Incontinence
Schmidt et al (SNS Study Group) J. Urol (162) 1999

• Results
• Daily incontinence episodes at 6-month (voiding diary)
  • Zero Heavy = small volume or less
  • Significant reduction >= 50%
  • Slight reduction < 50%
  • No reduction = no change or slight increase

![Bar chart showing % of patients with various levels of incontinence reduction]

Urgency Incontinence
Schmidt et al (SNS Study Group) J. Urol (162) 1999

• Clinical Success Rate (up to 18 month follow-up)

<table>
<thead>
<tr>
<th>Clinical Success Criterion</th>
<th>6 months (58 pts)</th>
<th>12 months (38 pts)</th>
<th>18 months (21 pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;= 50% Reduction in leakage episodes</td>
<td>75%</td>
<td>79%</td>
<td>76%</td>
</tr>
<tr>
<td>&gt;= 50% Reduction in Heavy leaking episodes</td>
<td>90%</td>
<td>80%</td>
<td>84%</td>
</tr>
<tr>
<td>&gt;= 50% Reduction in absorbent pad use</td>
<td>83%</td>
<td>76%</td>
<td>76%</td>
</tr>
</tbody>
</table>
Urgency Incontinence

Schmidt et al (SNS Study Group) J. Urol (162) 1999

- Modulator disabled at 6 months
  - Daily incontinence episodes increased from 2.9 to 9.5
  - Average severity ranking of leaks increased from 0.8 to 1.9
  - Average daily absorbent pad use increased from 1.2 to 5.8
    (all p <0.0001)

Urodynamic at 6 month follow-up

- Stimulation group
  - Higher first sensation 222cc (versus 79 cc control)
  - Higher volume first unstable detrusor 151cc (versus 70 cc control)
  - Increased Detrusor stability 56% (versus 16% control)
  - All p<0.005
**Frequency-Urgency Symptoms**

- **Hassouna et al. (SNS Study Group) 2000. J Urol**

  - **Study Design**
    - Multicenter, non-blinded RCT
    - 51 patients randomized, 21 followed to 2Y.
    - Similar metrics to Schmidt (diary, UDS, SF36, unit off)
    - Added voids/day, volume/void
    - Added patients with prior therapy
    - Degree of urgency before void:
      - 0—none, 1—mild, 2—moderate, or 3—severe

  

**Urgency-Frequency Symptoms**

- **Hassouna et al. (SNS Study Group) 2000. J Urol**

  - Average voids per day at 6 months

  ![Graph](image)

  - Significant reduction—50% or greater reduction or return to normal (4-7 voids / day)
  - Slight reduction - less than 50%
  - No-reduction - no change or slight increase
Urgency-Frequency Symptoms

Hassouna et al. (SNS Study Group) 2000. J Urol

- Average voided volume at 6 months

<table>
<thead>
<tr>
<th>Percentage of Patients</th>
<th>Stimulation (n=25)</th>
<th>Control (n=25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Significant Increase</td>
<td>64</td>
<td>4</td>
</tr>
<tr>
<td>Slight Increase</td>
<td>28</td>
<td>23</td>
</tr>
<tr>
<td>No Increase</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Explanted</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- Significant increase >= 50% or greater increase
- Slight increase <50% increase
- No-reduction - no change or slight decrease

Voiding Parameters

Hassouna et al. (SNS Study Group) 2000. J Urol

- Mean voiding parameters 12 months

<table>
<thead>
<tr>
<th>Test Variable</th>
<th>Control</th>
<th>Av. 12 months</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No voids / day</td>
<td>16.6</td>
<td>9.0</td>
<td>0.0001</td>
</tr>
<tr>
<td>Vol. Voided/void</td>
<td>132 cc</td>
<td>233 cc</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Degree of Urgency</td>
<td>2.2</td>
<td>1.8</td>
<td>0.005</td>
</tr>
</tbody>
</table>

- NOTE: Degree of urgency is in the setting of increased voided volume and increased voids / day
Urgency-Frequency Symptoms
Hassouna et al. (SNS Study Group) 2000. J Urol

- Clinical Success Criterion at 2Y follow-up

<table>
<thead>
<tr>
<th></th>
<th>6 months (56 pts)</th>
<th>12 months (46 pts)</th>
<th>2Y (21 pts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;=50% reduction in voids / day</td>
<td>46%</td>
<td>54%</td>
<td>43%</td>
</tr>
<tr>
<td>&gt;=50% increase in voided volume</td>
<td>53%</td>
<td>57%</td>
<td>62%</td>
</tr>
<tr>
<td>Increased voided volume with same or less degree of urgency</td>
<td>84%</td>
<td>80%</td>
<td>81%</td>
</tr>
</tbody>
</table>

- 6 month inactivation trial
  - Average voids / day increased from 8.6 to 13.9 (p < 0.0003),
  - Voided volume decreased from 242 to 144 ml. (p < 0.0001)
  - Degree of urgency before void increased from 1.5 to 2.1 (p < 0.0003).
Non-Obstructive Urinary Retention

- Jonas et al 2001 J. Urol (165)

**Study Design**
- Non-blinded, Multicenter randomized controlled trial
- Treatment arm: immediate implant
- Control arm: delayed implantation at 6 months
- Primary outcome variable: voiding diary (number of catheterizations, volume obtained, voids / day)

**Patient Population**
- 177 Patient with complete / partial retention
- All patients: Hypocontractile detrusor, or functional outlet obstruction due to urethral overactivity
- Testing phase completed
- 38% (68 patients) qualified for implantation

- Randomized
  - Intervention (immediate activation) (37 patients)
  - Control arm (6 month delay with standard therapy followed by activation) (31 patients)
Non-Obstructive Urinary Retention

Jonas et al 2001 J. Urol (165)

• 6 month follow-up

<table>
<thead>
<tr>
<th></th>
<th>Baseline (mean)</th>
<th>Modulator Activated (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume / catheterization</td>
<td>339 ml</td>
<td>49 ml</td>
</tr>
<tr>
<td>Catheterizations/ day</td>
<td>5.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Voided volume / day</td>
<td>722 ml</td>
<td>1808 ml</td>
</tr>
</tbody>
</table>

• 18 month follow-up

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Baseline 6 Mos.</th>
<th>Therapy Evaluation Test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. catheter vol. (ml.)</td>
<td>153</td>
<td>3.1</td>
<td>0.003</td>
</tr>
<tr>
<td>No. catheterizations/day</td>
<td>4.0</td>
<td>2.5</td>
<td>0.0001</td>
</tr>
<tr>
<td>Total catheter vol./day (ml.)</td>
<td>137 264</td>
<td>554 1,360</td>
<td>0.0001</td>
</tr>
<tr>
<td>No. voids/day</td>
<td>3.2</td>
<td>1.7</td>
<td>0.003</td>
</tr>
<tr>
<td>Vol. voided/void (ml.)</td>
<td>19† 242</td>
<td>339 ml</td>
<td>0.0001</td>
</tr>
<tr>
<td>Total vol. voided/day</td>
<td>560</td>
<td>1808 ml</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Outlook

• Sacral Neuromodulation
• Mechanism of Action
• Patient Selection
• Evidence
• Long term Results
• Resources
Long Term Data

- Al-Zahrani et al. (2011) J. Urol

- Study Design
  - 14 year experience with SNM
  - Median follow-up time 50.7 months
  - Followed all implantations (196) between 1994-2008
  - Clinical success criterion
    - Frequency-Urgency / Urge Incontinence
    - Global response assessment scale (GRA) provided to patients
    - Success defined as a moderate or higher improvement on GRA
    - Non-obstructive urinary retention:
      - > 50% reduction in catheterizations

Results

Al-Zahrani et al. (2011) J. Urol

- The long-term success rate (good and good response)
  - 87.5% in non-obstructive urinary retention
  - 84.8% in urgency incontinence
  - 72% in bladder pain syndromes
Long Term Data

  - Multicenter prospective trial (5 year follow-up)
  - 163 patients enrolled
    - 63% Urge Incontinence
    - 16% Urgency-Frequency
    - 20% Non-obstructive Retention
  - Clinical Success
    - > 50% improvement in voiding diary from baseline

- Results: Successful Outcome in
  - 68% of patients with urge incontinence
  - 56% with urgency frequency and
  - 71% with retention

Complications

**Hijaz et a. Urology 68(3) 2006**

- 214 (2002-4) patients stage one tined lead implantation
  - Indications
    - 68% Urgency-Frequency +/- UUI
    - 17.4% Non-obstructive urinary retention
    - 14.6% Interstitial cystitis
  - 75% proceeded to second stage implant (buttock IPG)
  - Follow-up: 16 months; Complications categorized as
    - Infection
    - Mechanical problems
    - Response related dysfunction
      - Revision versus explantation performed
Complications

Hijaz et al. Urology 68(3) 2006

- Reprogramming Rate:
  - 2.6 visits over 16 months
- Explantation: 17 patients (10.5%)
  - Infection: 8 patients (5%)
  - Failure to maintain response: 9 patients (5.6%)
- Revisions: 26 patients (16.1%)
  - Decline in clinical response: 17 patients (10.5%)
  - IPG site pain: 4 patients (2.5%)
  - Lead migration: 1 patient (0.6%)
  - Infection: 4 patients (2.5%)
  - Draining sinus: 4 patients (2.5%)

Cost Analysis Compared to Alternative Therapy

- Review of Medicare / Medicaid fee schedules
- SNM determined to be highest cost of implementation at 3Y
- Botox assumed 6 months efficacy cycle
- Surgical complications / revisions included in analysis.

<table>
<thead>
<tr>
<th>Treatment Modality</th>
<th>Average cost at 1Y ($USD)</th>
<th>Average cost at 2Y ($USD)</th>
<th>Average cost at 3Y ($USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNM</td>
<td>$23614</td>
<td>$24961</td>
<td>$26269</td>
</tr>
<tr>
<td>Botox injection</td>
<td>$2626</td>
<td>$5176</td>
<td>$7651</td>
</tr>
<tr>
<td>Augmentation Cystoplasty</td>
<td>$11637</td>
<td>$12992</td>
<td>$14337</td>
</tr>
</tbody>
</table>

Wantabe et al 2010 Urol 76(4)
Patient Satisfaction
Leong et al. Urology 185(1) 2011

- Questionnaire: 275 patients with SNM
- Indications for implant:
  - Urgency-Frequency syndrome (55%)
  - Non-obstructive urinary retention (24%)
  - OAB with retention (20%)
  - Pelvic pain syndrome (1%)
- Median follow-up period: 77 months

Primary outcome variable:
- Patient satisfaction found to be 85%

Side-effects reported in 56%
- Pain at IPG site
- Decreased efficacy
- 89% of patients that did experience side effects did not consider them significant enough to seek medical care
- 90% indicated that they would pursue the same treatment again for their voiding symptoms
- 91% indicated that they would recommend the treatment to a friend with similar voiding symptoms
Outline

- Sacral Neuromodulation
- Mechanism of Action
- Patient Selection
- Evidence
- Long term Results
- Resources

Resources

- Overview paper

- Medtronic Website
  - http://www.medtronic.com/

- Surgery in Motion (Interstim SNM video series)
  - www.europeanurology.com/surgery-in-motion
Thanks

- Dr Stothers