

Neurostimulation for Chronic Pain: State of the Art

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DISCLOSURES

- Consultant/Equity Owner : Microleads

NEUROSTIMULATION

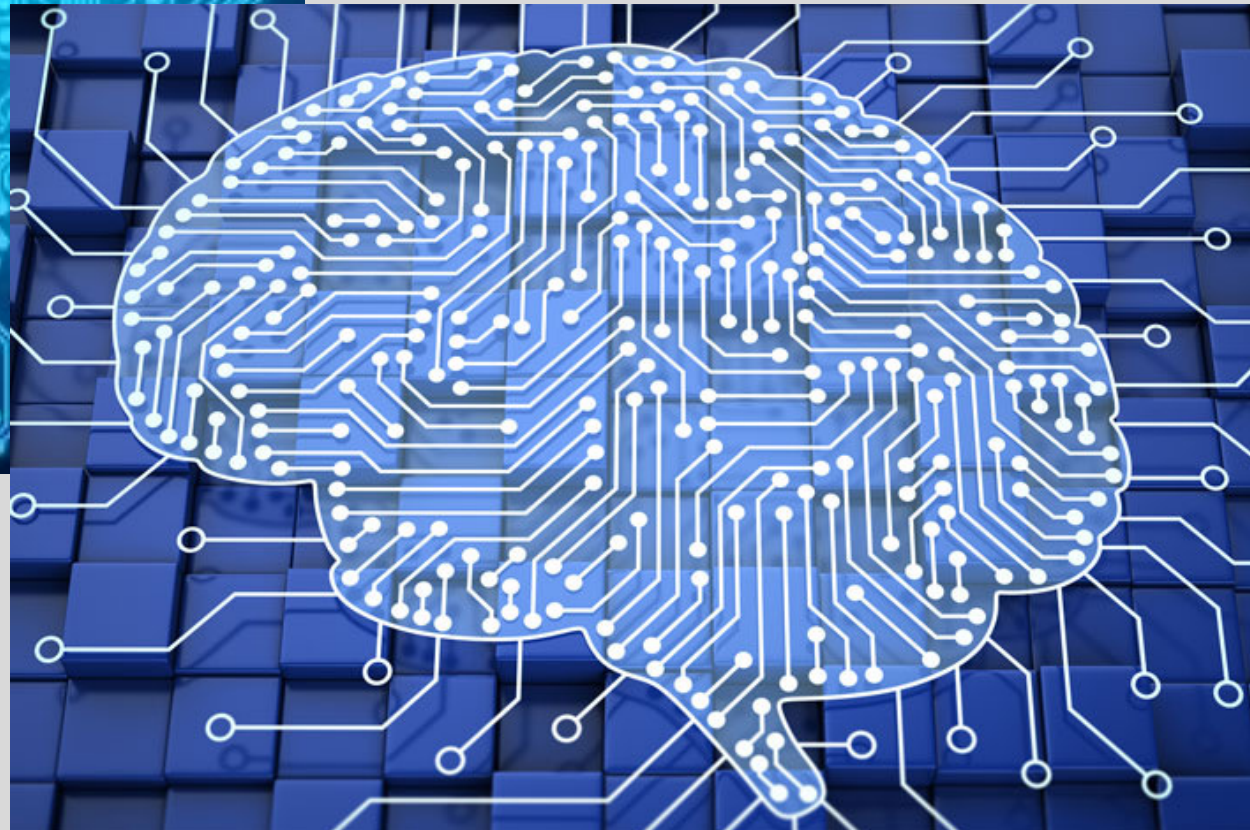
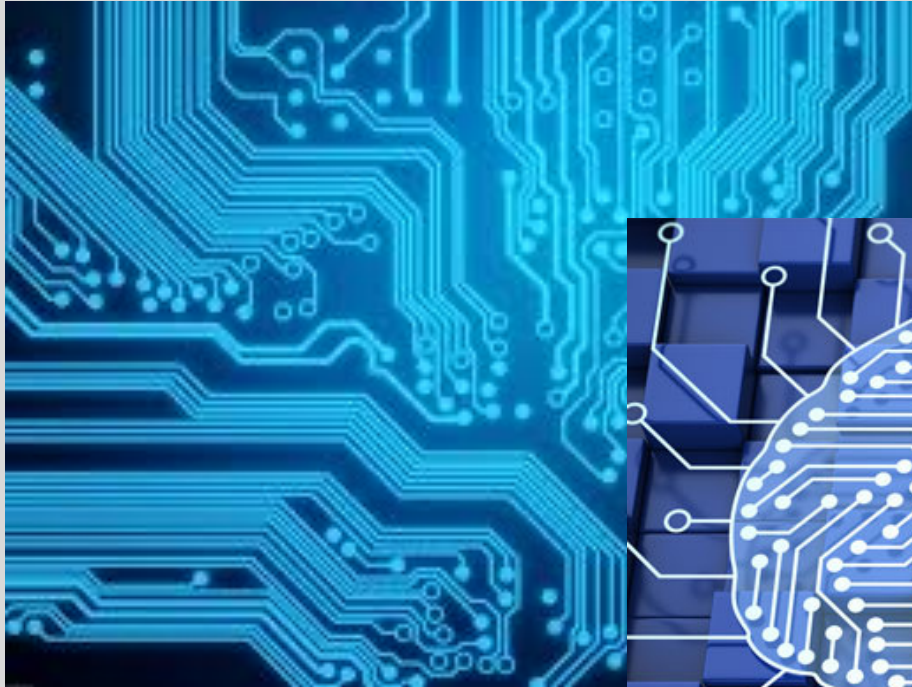
A Continuum

- Torpedo fish for gout (ancient Roman times)

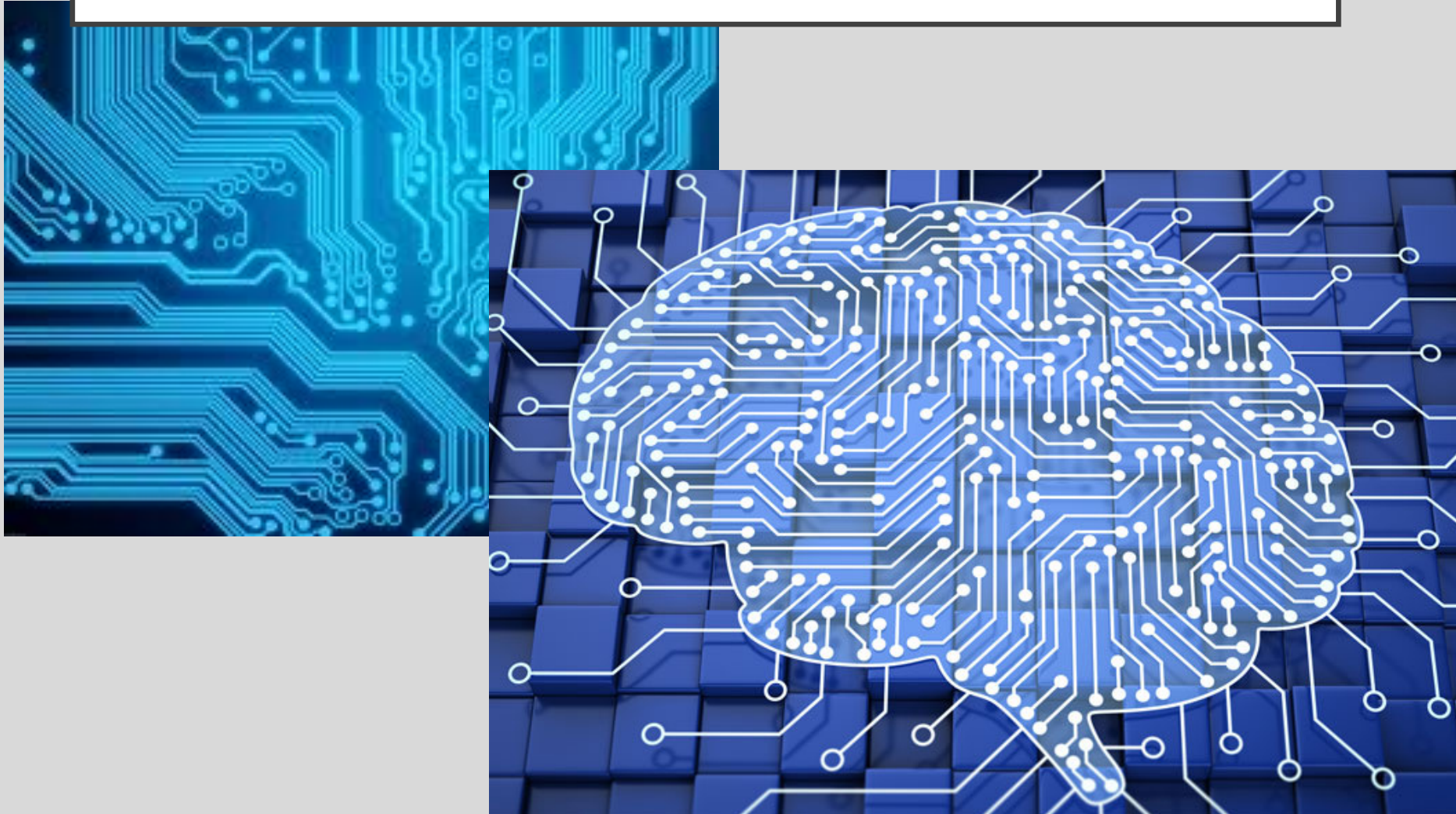
15 AD: prescription by Scribonius Largus: “For all **gout** pain, **the** foot should be placed on a live black **torpedo** fish.



THE NERVOUS SYSTEM IS JUST LIKE A GIANT ELECTRICAL CIRCUIT



WITH NEUROSTIMULATION
WE TRY TO POSITIVELY AFFECT
THE ABNORMAL CIRCUITRIES



BROADER APPLICATIONS OF NEUROSTIMULATION

- ❖ Epilepsy
- ❖ Depression
- ❖ Obesity
- ❖ Sleep Apnea
- ❖ Paralysis

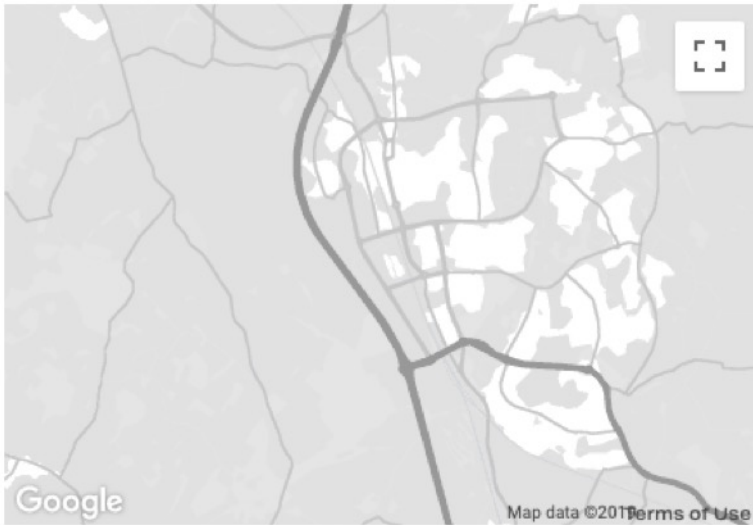
First Step of Neurostimulation Into Mainstream Medicine



PARTNERSHIP

GLAXO SMITH KLINE

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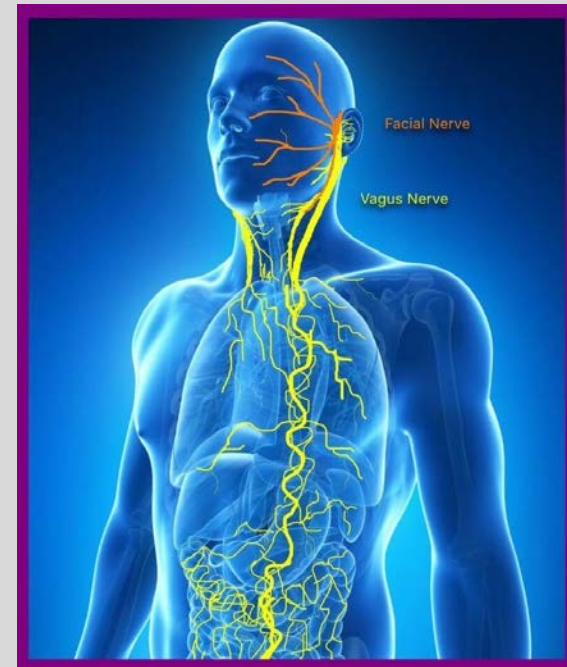


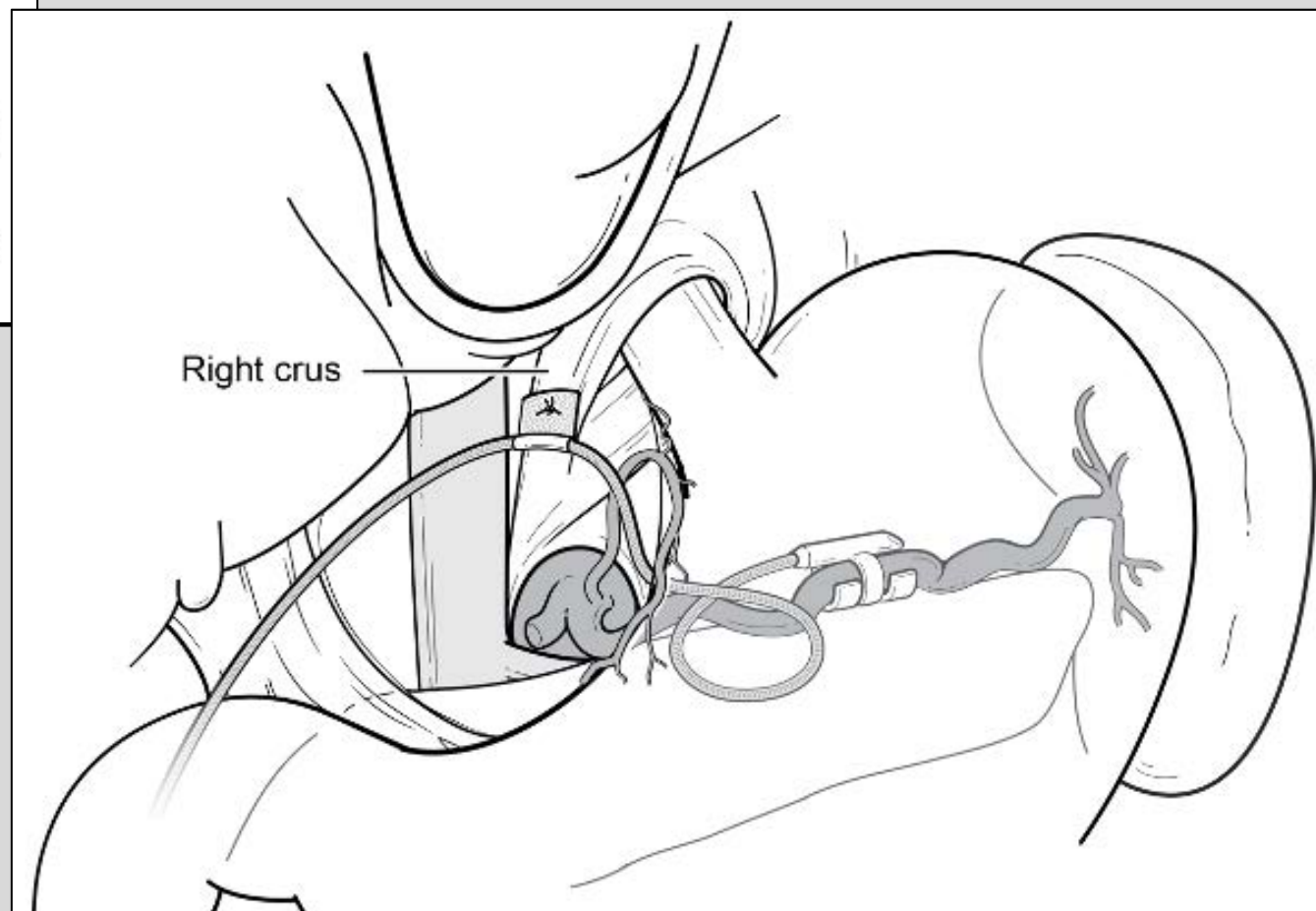
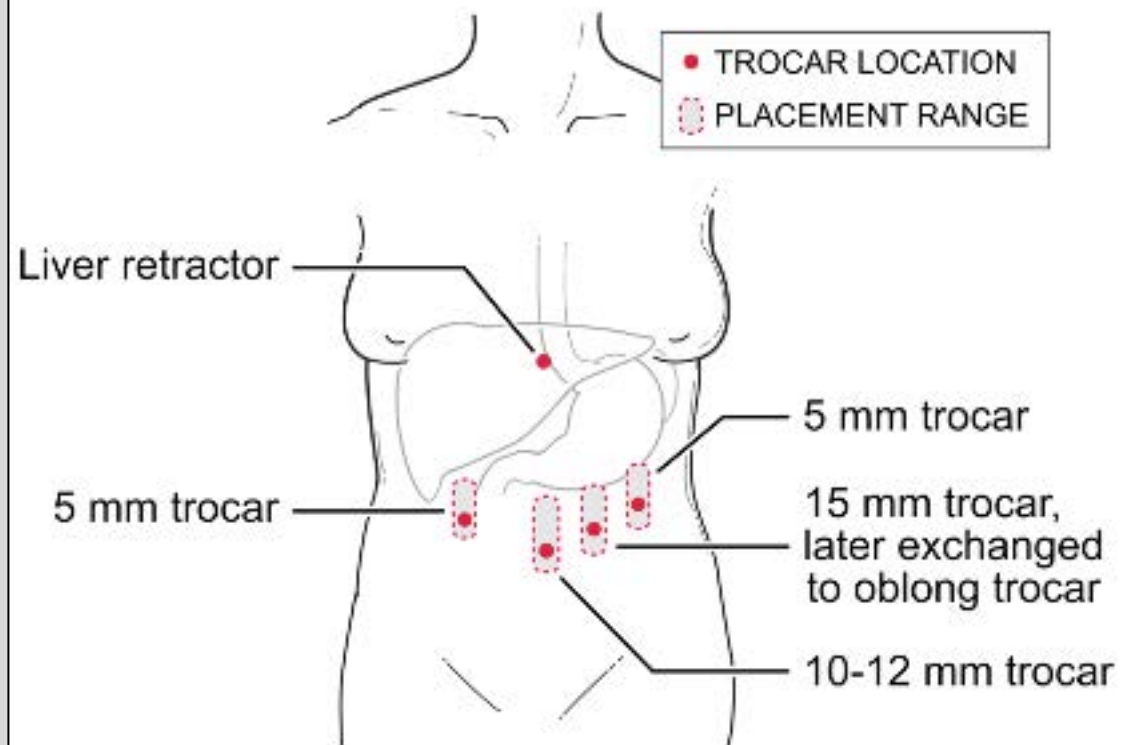
GALVANI SOUTH SAN FRANCISCO

TREAT AUTOIMMUNE DISEASES VIA VAGUS NERVE STIMULATION

First condition to be targeted:

Rheumatoid Arthritis





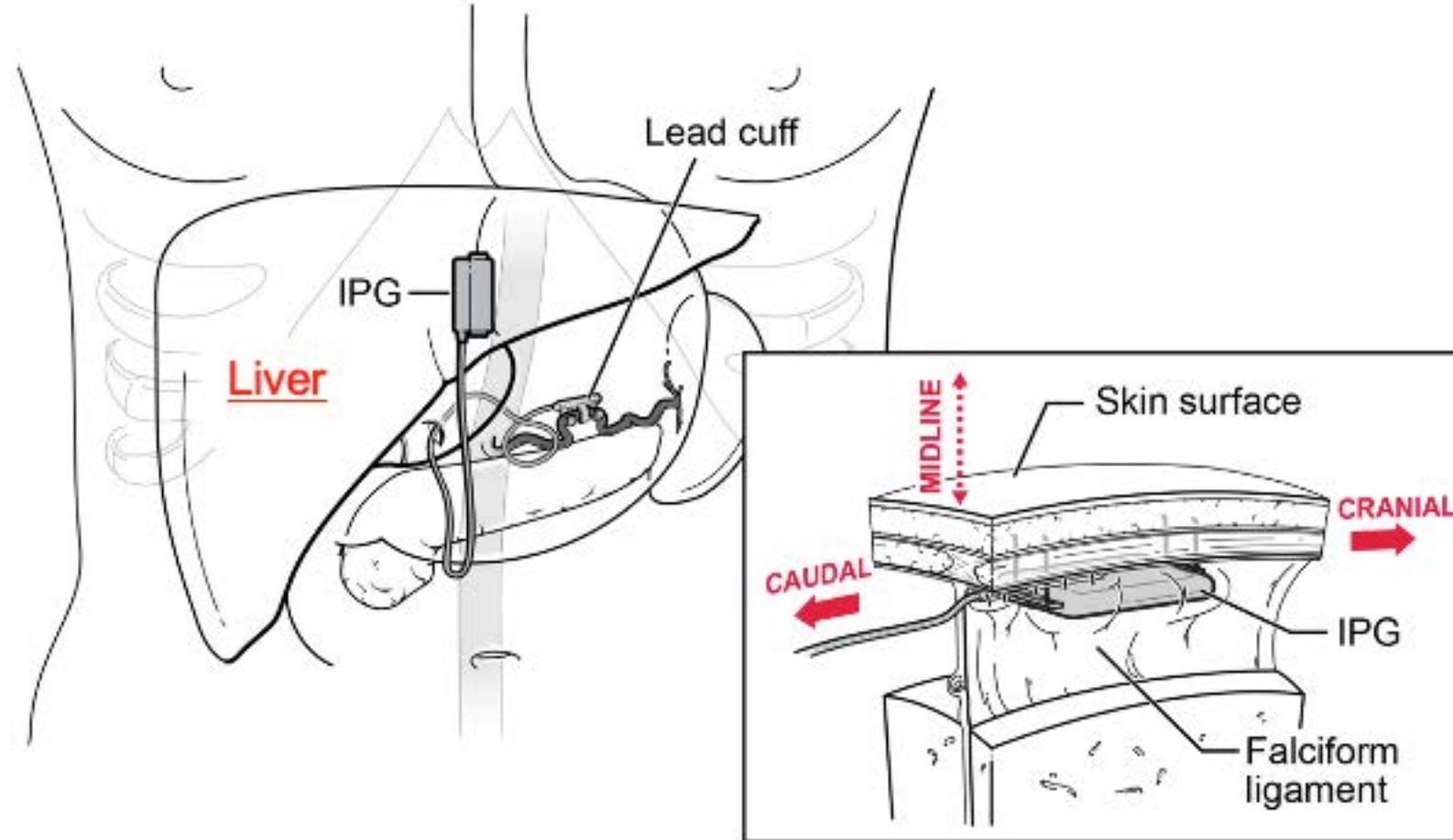
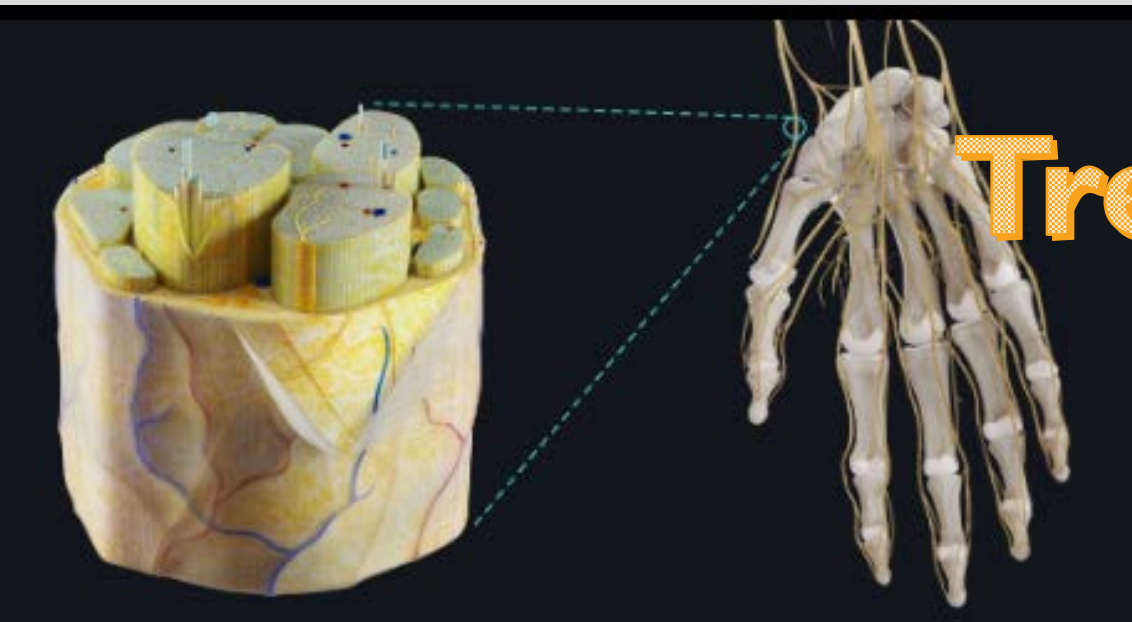


Figure 12. Final system placement. The cuff is placed on the splenic artery in the lesser sac, with the lead running through the gastrohepatic ligament into the subhepatic space and to the IPG which is placed in the pre-peritoneal fat pad associated with the falciform ligament. The exact cranial caudal location will be dictated by the patient's anatomy.

Advanced Neuro-Prosthetics For Hyper-Selective Stimulation of Peripheral Nerves To Restore Sensation and Treat Pain



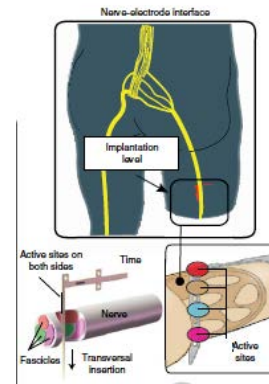
SensArs

Lousanne, Switzerland

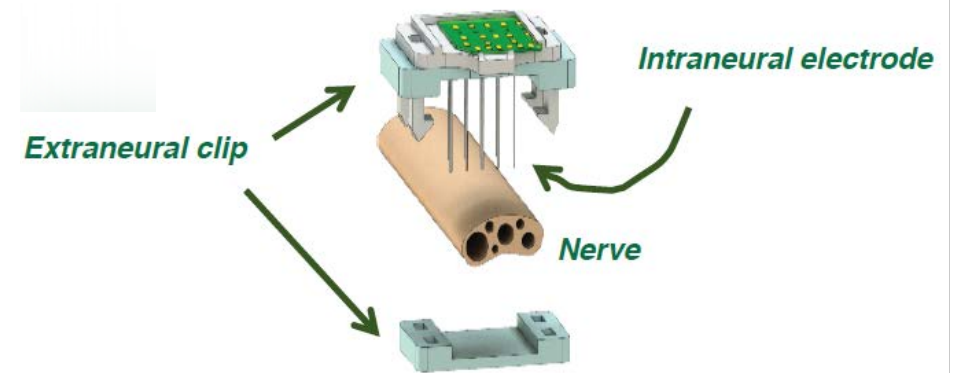
SensArs treats chronic neuropathic pain and reduces movement disability due to sensory loss by highly selective peripheral nerve stimulation



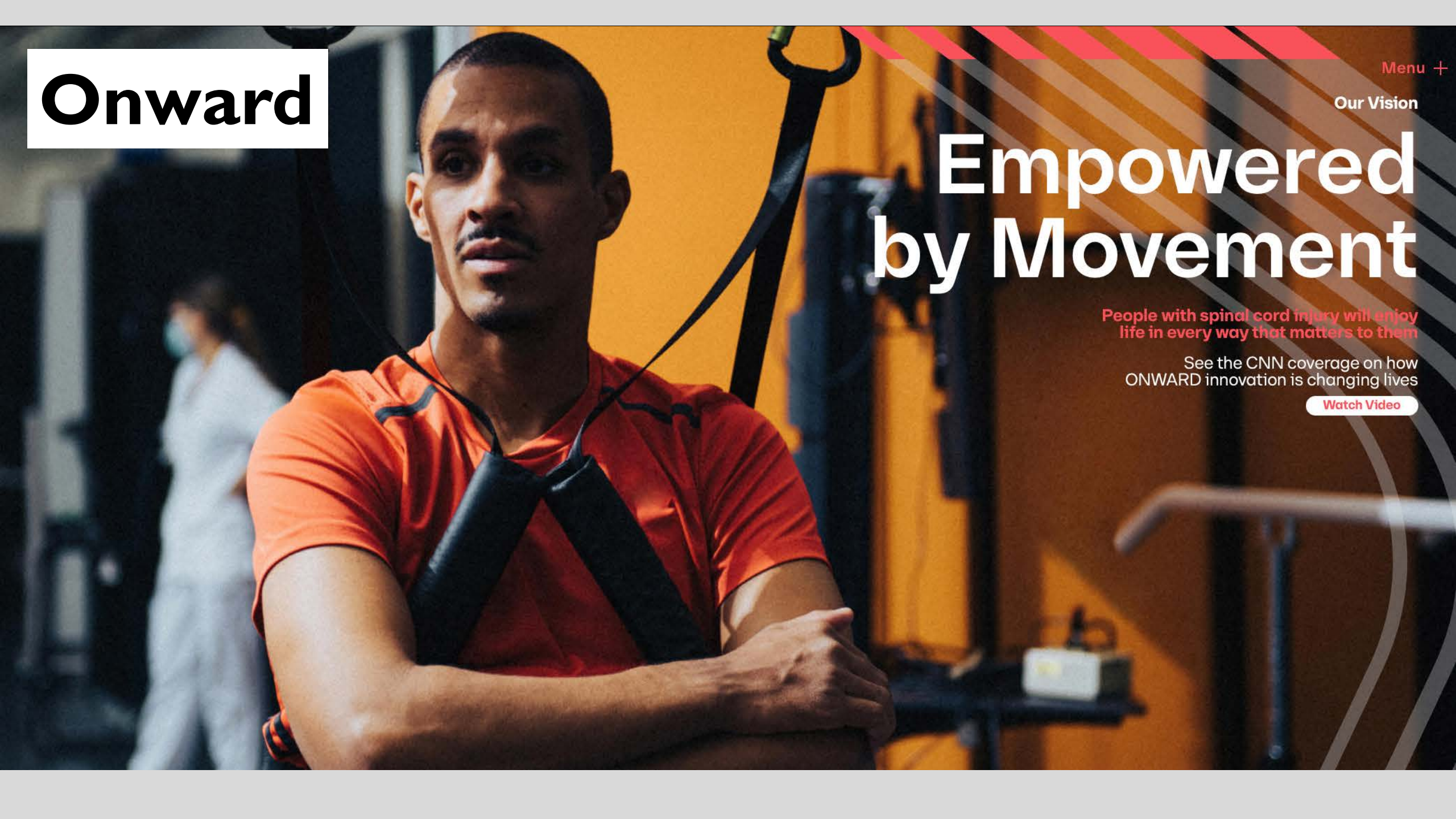
- The implantable electrode is inserted transversally inside the nerve.
- This allows focused stimulation into the sensory nerves, which bring information of touch and movement to the brain.
- The stimulation of these nerves elicits natural sensations from the extremities (arms and legs). Because of the selectivity of the electrode, natural sensations can be elicited precisely in the spot where the pain is perceived. This process can eliminate neuropathic pain



Neural clip electrode



**Make
Paralyzed People
Walk**

A man with a mustache, wearing an orange t-shirt, is shown from the chest up. He is holding a black suspension training strap that is attached to a point above him. He is looking off to the side with a focused expression. The background is a gym with orange walls and various exercise equipment. A person in a white lab coat and mask is visible in the background, slightly out of focus.

Onward

Menu +

Our Vision

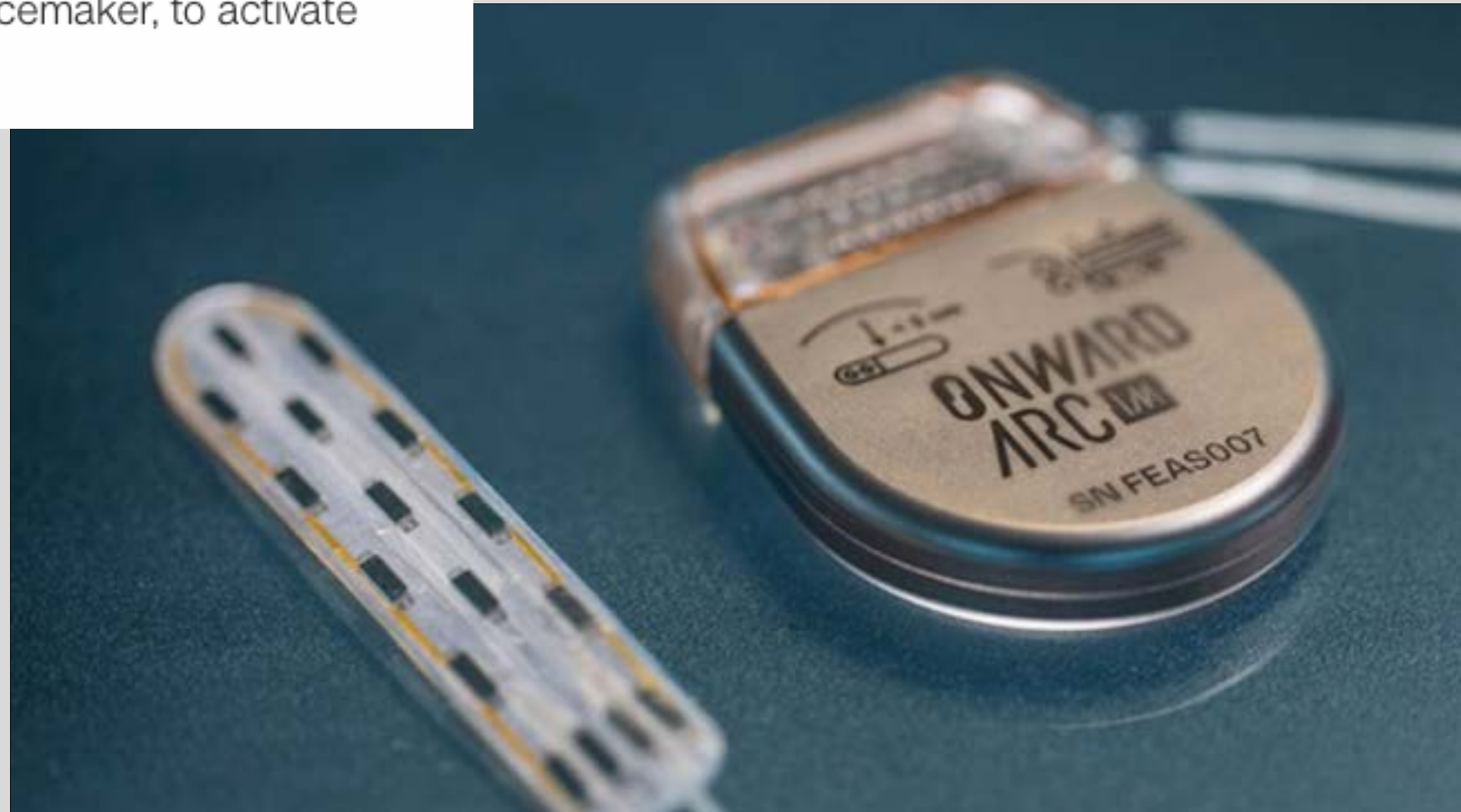
Empowered by Movement

People with spinal cord injury will enjoy
life in every way that matters to them

See the CNN coverage on how
ONWARD innovation is changing lives

[Watch Video](#)

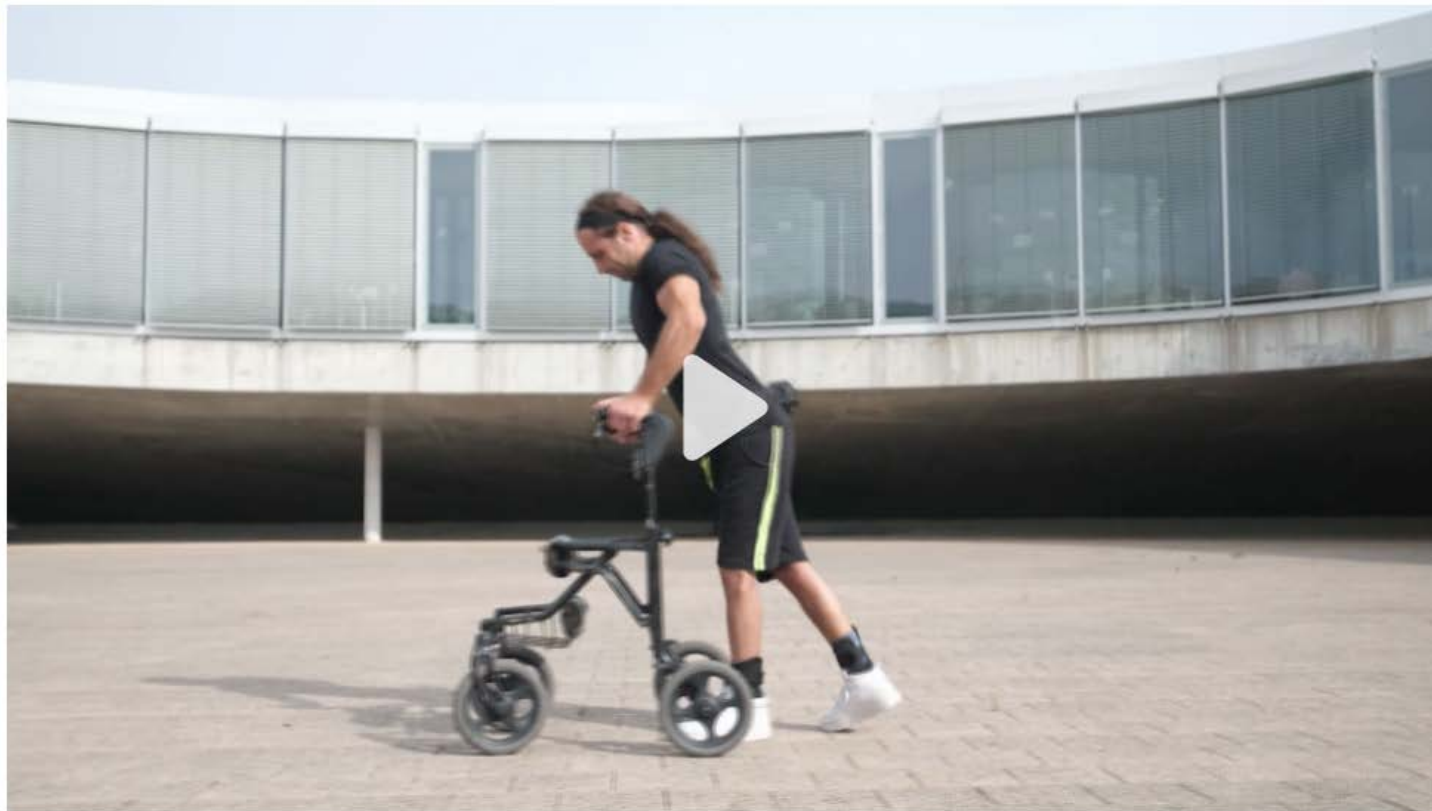
All the patients in the trial had a complete loss of voluntary movement below their injuries. Two also had a complete loss of sensation. But with the devices in place, the researchers could use a tablet computer to initiate unique sequences of electrical pulses, sent to the epidural electrodes via the pacemaker, to activate the participants' muscles.



New spinal cord stimulation study puts people with paralysis on their feet again

By Tasnim Ahmed, CNN

Updated 2:08 PM EST, Mon February 7, 2022



Transcutaneous Vagus Nerve Stimulation



Using gammaCore to treat migraine pain

At the earliest sign of pain:

Give yourself a treatment consisting of 2 two-minute gammaCore (nVNS) stimulations.

- Apply the conductive gel before each stimulation. After 2 minutes, gammaCore will beep twice and automatically turn off. The device should remain off for 10 seconds after each stimulation
- Stimulations can be administered on the same side of the neck, or you can switch sides, if preferred
- If pain remains 20 minutes after the start of treatment 1, apply 2 more stimulations
- Two more stimulations may be applied if pain remains 2 hours after the start of treatment 1



Using gammaCore to prevent migraine headache

Daily:

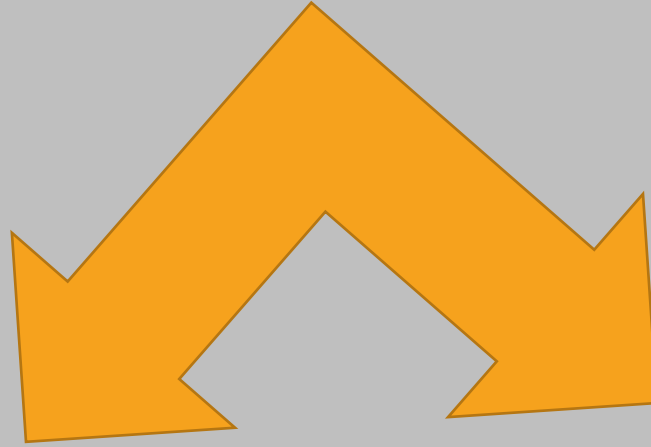
Give yourself 3 treatments (morning, mid-day, and night) consisting of two consecutive 2-minute stimulations.

- The first daily treatment should be applied within 1 hour of waking. The second daily treatment should be applied 4-6 hours after the first treatment. The third daily treatment should be applied at night.
- Apply conductive gel before each stimulation. After 2 minutes, gammaCore will beep twice and automatically discontinue stimulation.
- Stimulations during a treatment should be applied on the same side of the neck. Additional treatments may be applied to either side of the neck.

This is a suggested treatment. Please speak with your healthcare provider to determine the right plan for you.



Neurostimulation



Restorative

Pain Blocking

Restorative Neurostimulation

Motor Stimulation of the Multifidus Muscle for Chronic Low Back Pain

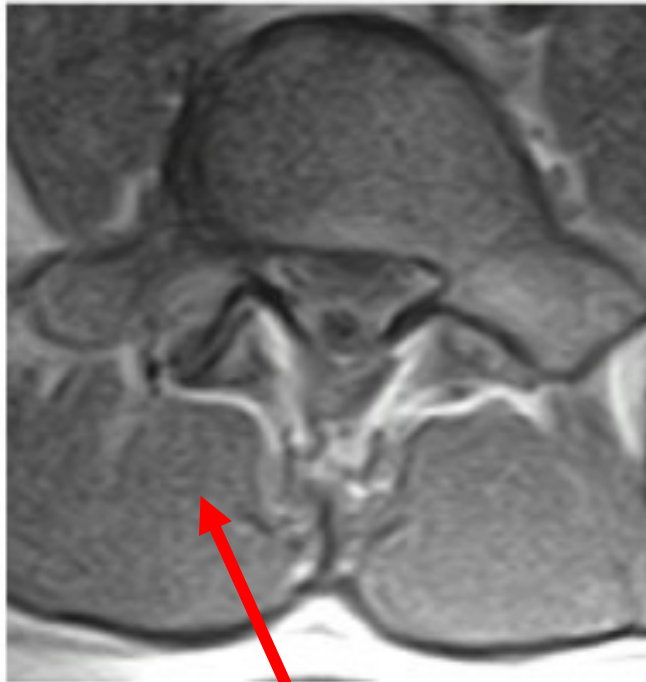


The multifidus provides segmental stability of individual joints of the spine, and it does so in anticipation of movement.

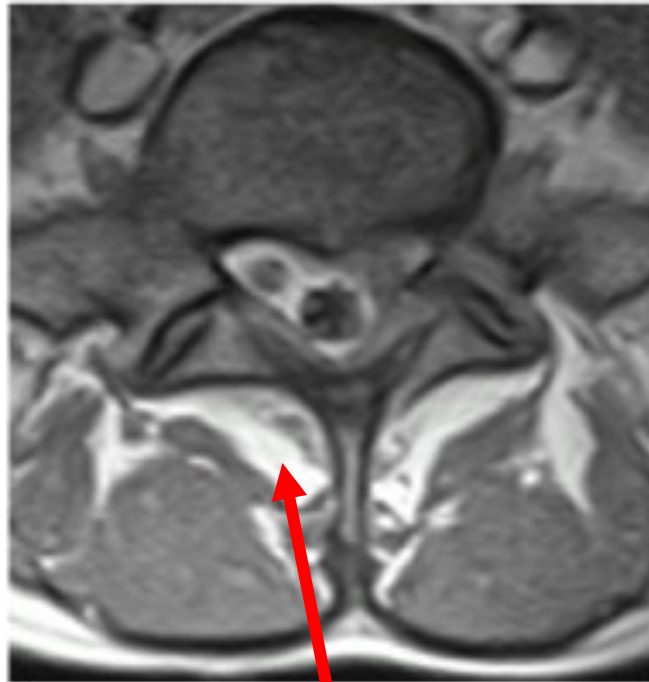
It also has the capacity to move the spine.

This dual capacity is interesting, and important to our ability to precisely stabilize and move individual segments of the spine to achieve a myriad of movements.

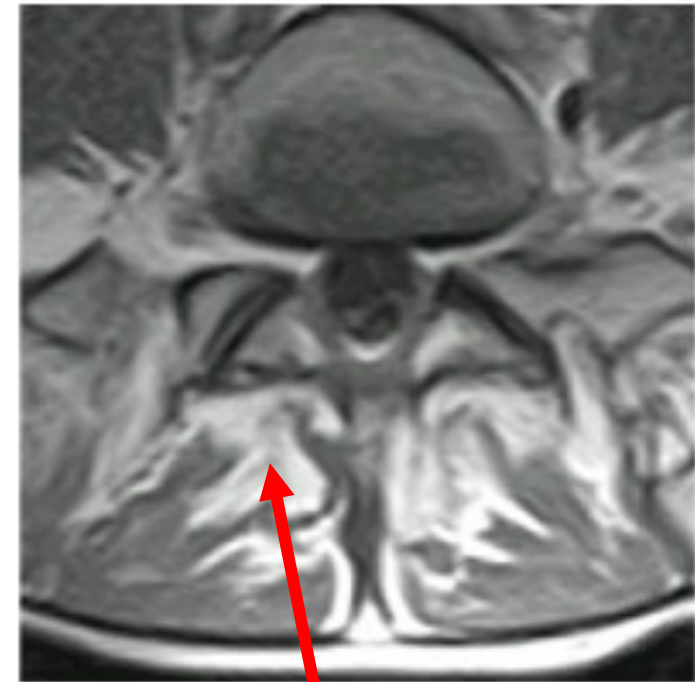
- Research shows that people with low back pain often have significant atrophy of this muscle.
- Atrophy and weakness of the multifidus will lead to decreased stability of the spine, and can result in a vicious cycle of low back pain



Grade 0 (none)



Grade 1 (slight)

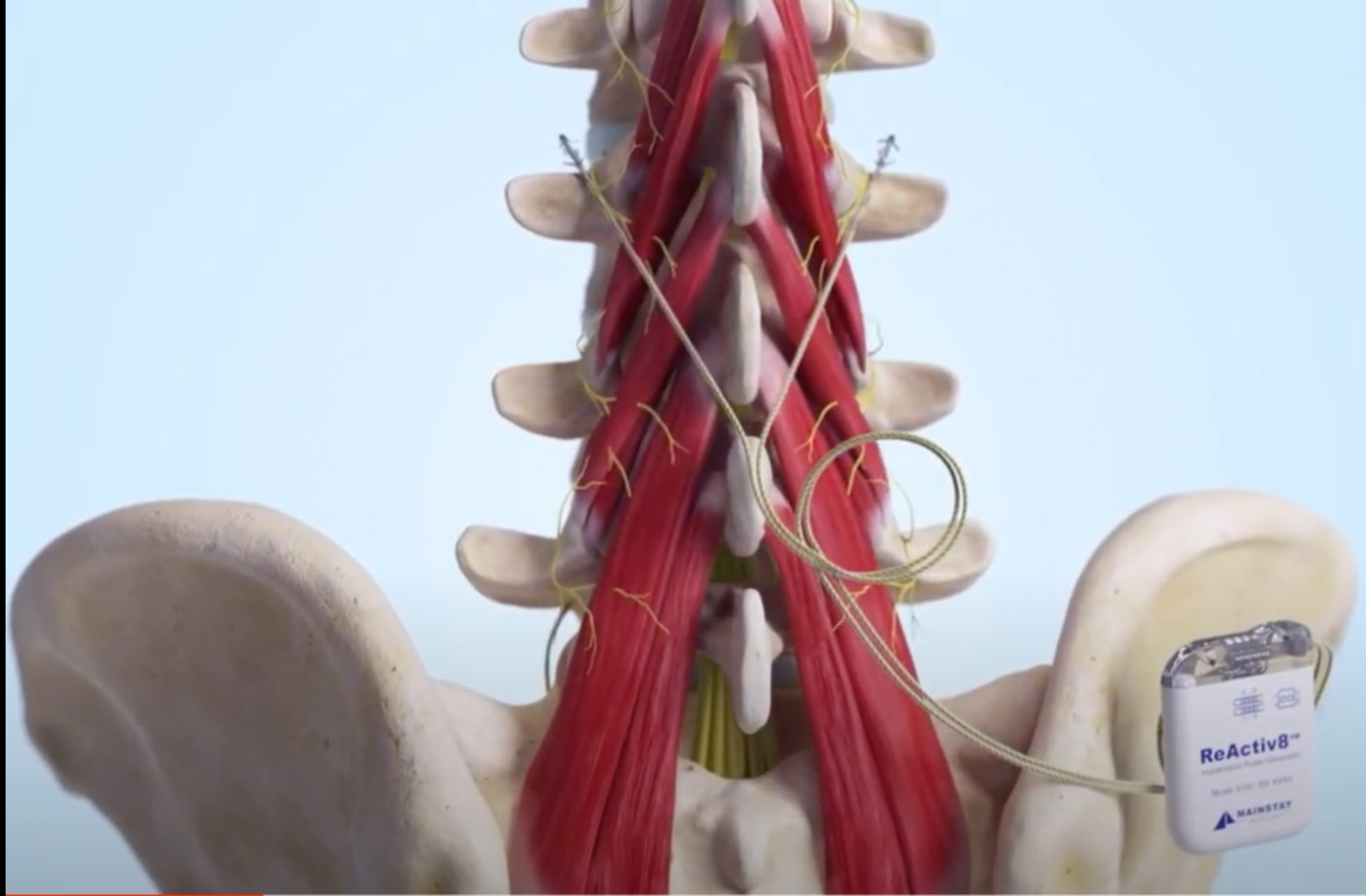


Grade 2 (severe)

Mainstay ReActiv8

- Active implantable medical device designed to treat people with chronic mechanical low back pain (CLBP).
 - Bilateral electrical stimulation of the L2 medial branch of the dorsal ramus nerve as it crosses the transverse process at L3. This nerve supplies the lumbar multifidus muscle.
 - Stimulation of the nerve elicits contraction of the muscle, which can lead to improvement in CLBP and its disabling effects.
-
- The pulse generator is programmed to deliver electrical stimulation expected to elicit episodic contractions of the multifidus muscle.
 - Stimulation is delivered for 30 minutes twice/day





Indications

1. Age ≥ 22 years, ≤ 75 years
2. Chronic Low Back Pain that has persisted >90 days prior to the baseline visit.
3. Continuing Low Back Pain despite >90 days of medical management.
4. Evidence of lumbar multifidus muscle dysfunction.

Contra- Indications

1. Pathology seen on MRI that is clearly identified and is likely the cause of the CLBP that is amenable to surgery.
2. Lumbar spine stenosis
3. Neurological deficit possibly associated with the back pain (e.g. foot drop).
4. Back pain due to inflammation or damage to the spinal cord or adjacent structures (e.g. arachnoiditis or syringomyelia).

Pain Blocking Neurostimulation

Peripheral Nervous System

Central Nervous System

Extra-Spinal

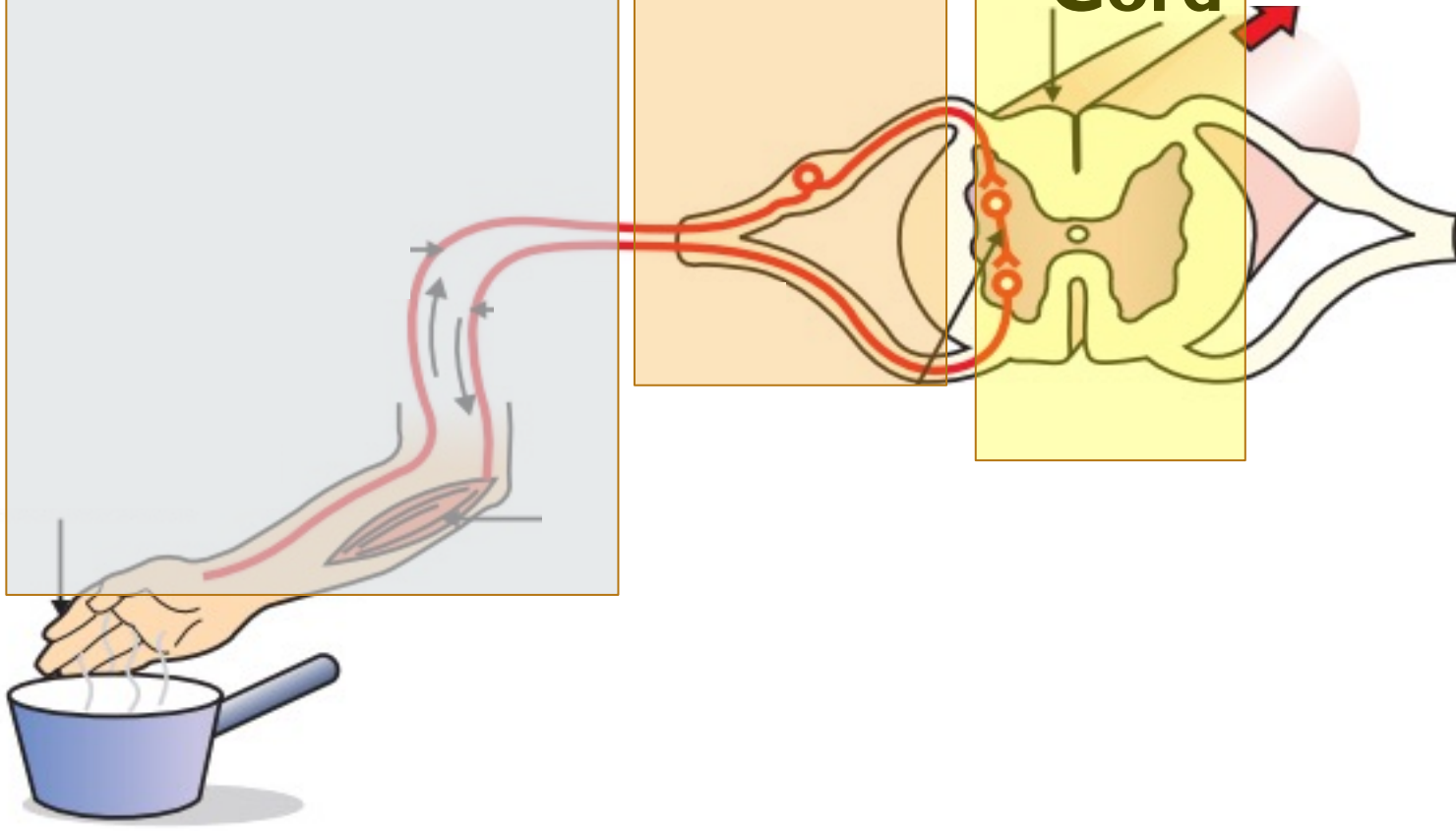
- Plexus
- Nerves
- Small subcutaneous nerve fibers

Intra-Spinal

- Nerve Root
- DRG

Spinal Cord

Brain



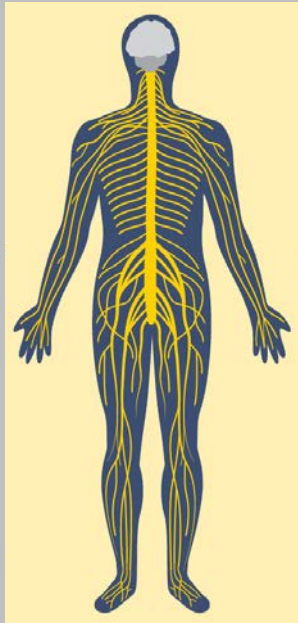
Stimulation of the Extra-Spinal Peripheral Nervous System (PNS)

True PNS

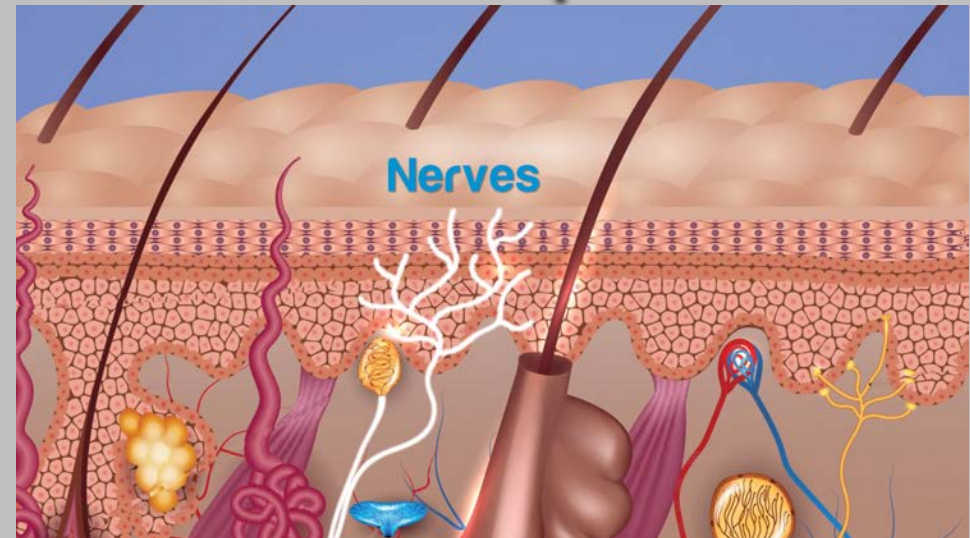


Peripheral "Field" Stimulation

Large Named Peripheral Nerves

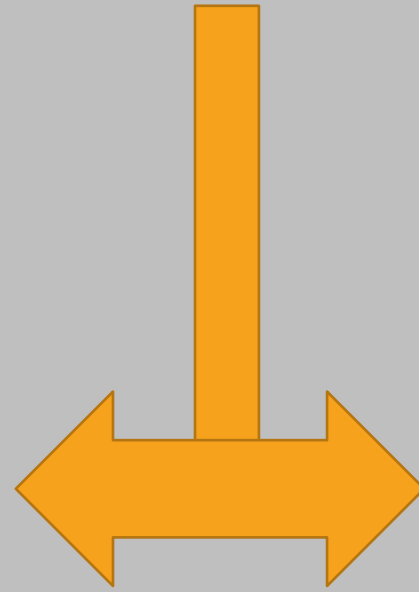


Network of Small Un-Named
Branches of Peripheral Nerves



Stimulation of the Intra-Spinal Peripheral Nervous System (PNS)

Dorsal Root
Ganglion (DRG)



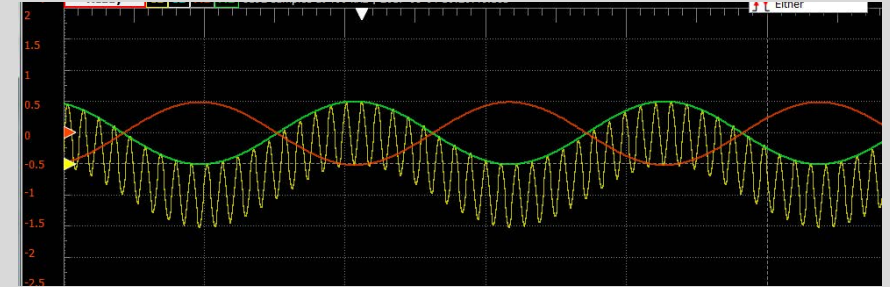
Nerve Roots

Pain Blocking Neurostimulation

Intraspinal Stimulation Advances

Many different newly developed

- waveforms
- algorithms

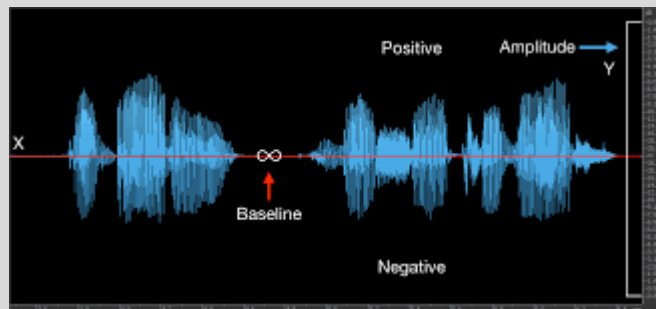


- Burst
- Micro Burst
- Higher Frequencies (1 to 10 KHz)
- DTM
- Contour and Fast Algorithms



Greatly increased possibility of finding the most effective waveforms to control the pain signals

- Waveform Automation

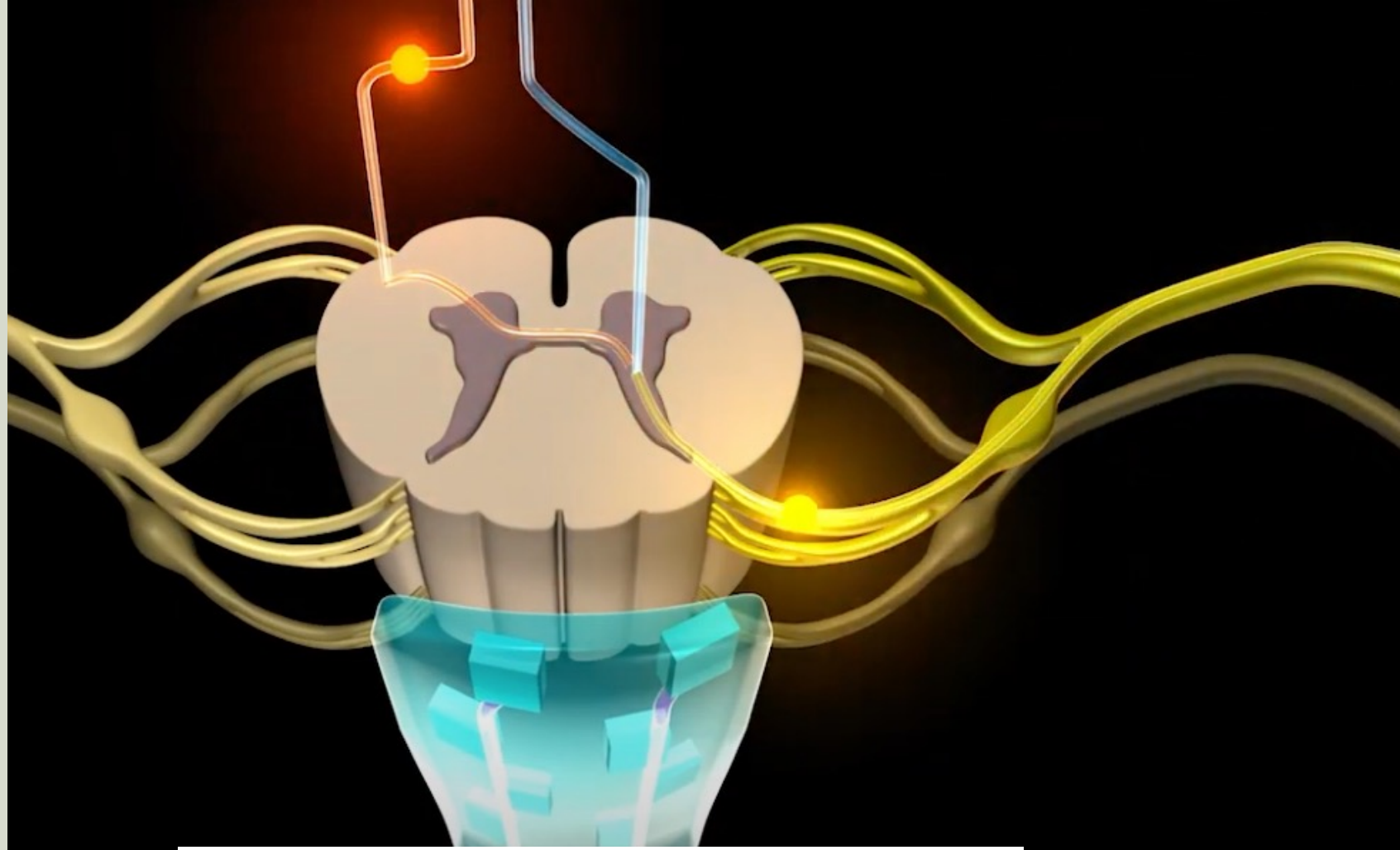


Greatly increased probability of preventing habituation by the nervous system

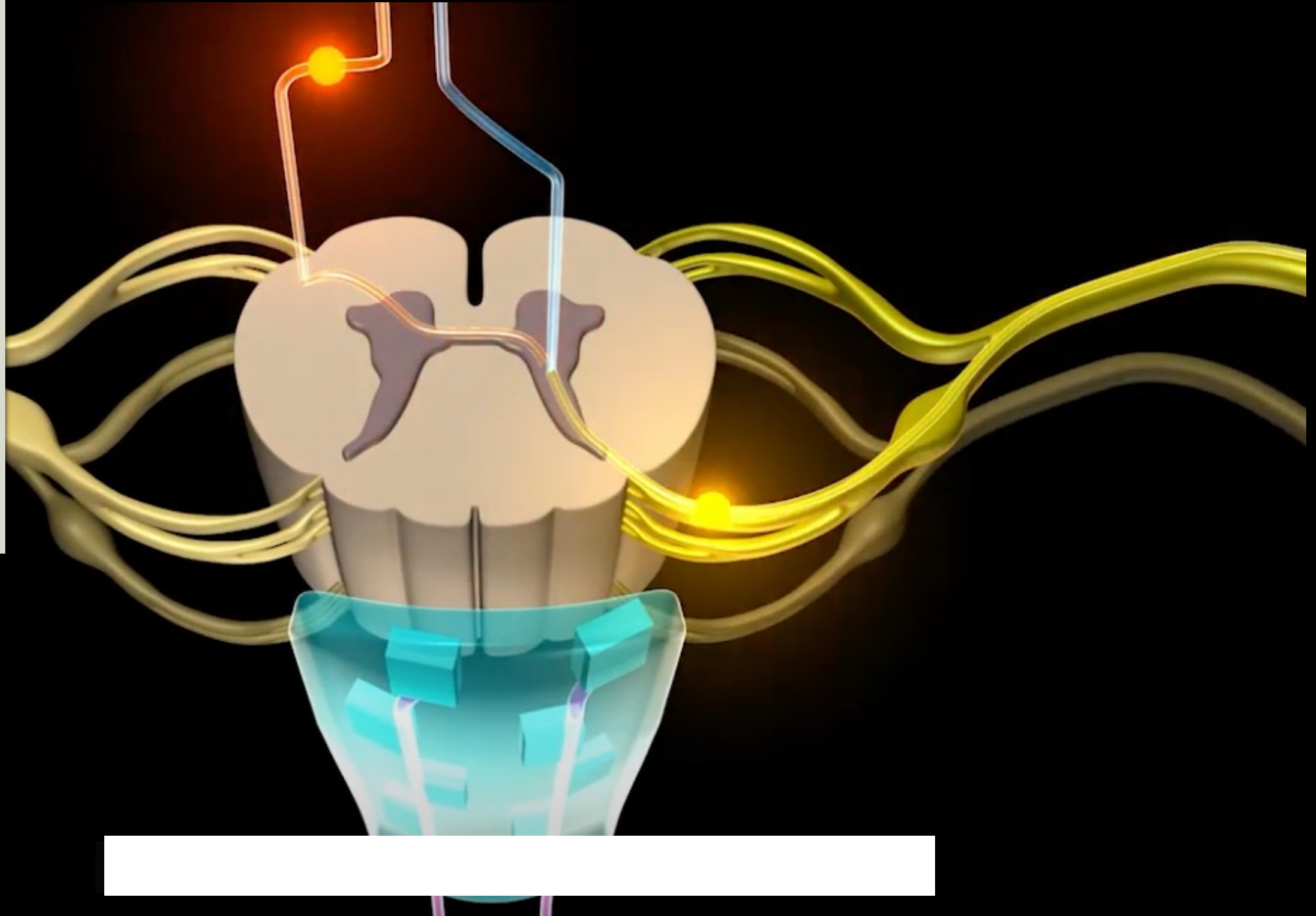


Closed-Loop Spinal Cord Stimulation

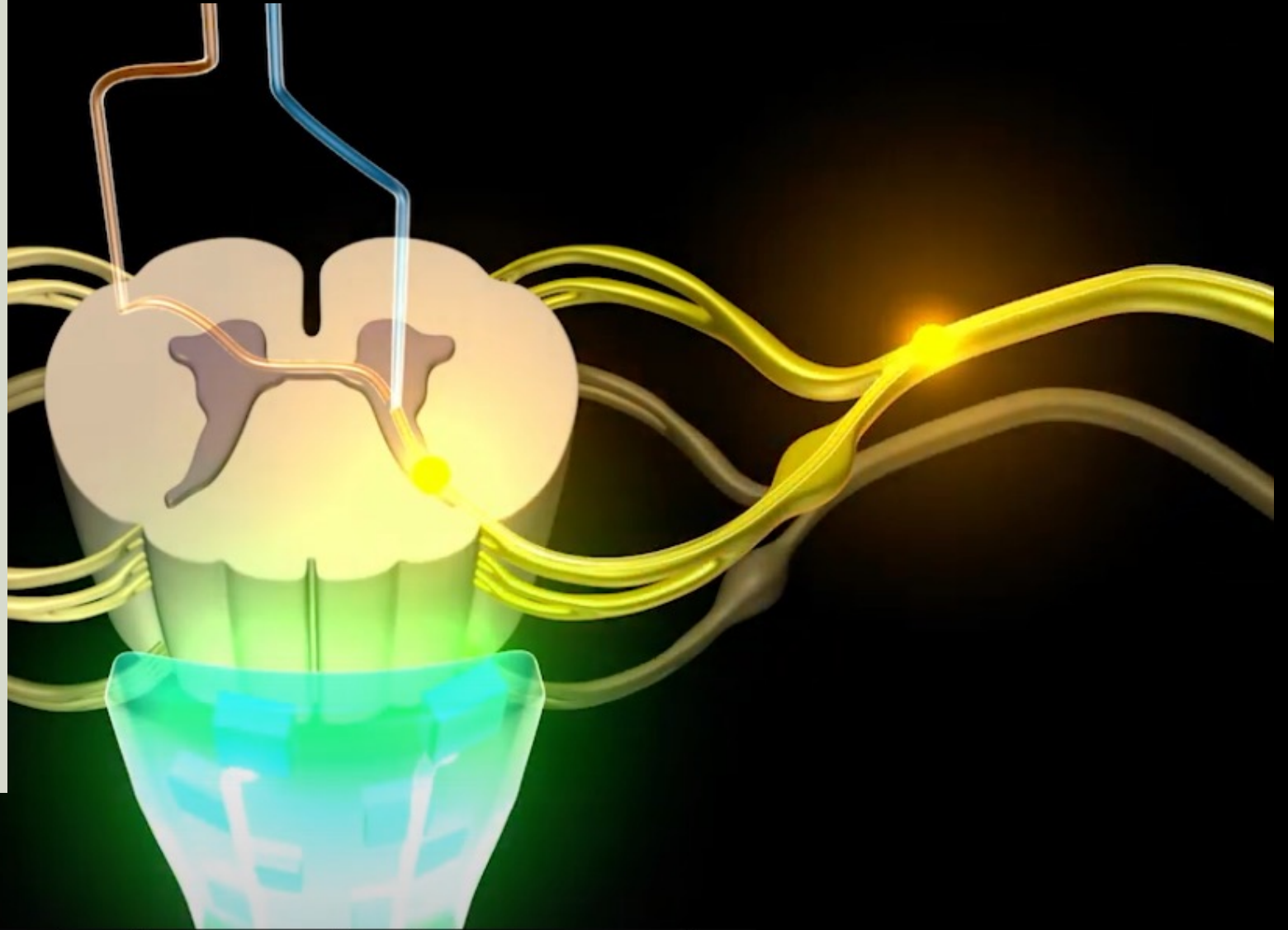
- With a conventional spinal cord stimulator, the same amount of electrical impulses is delivered to the spinal cord.
- However, with activity and position changes, the amount of electricity that reaches the spinal cord may vary substantially.
- The amount of stimulation might therefore be too weak or too strong for the patient



The Closed-Loop System uses a stimulator that communicates in real time with the spinal cord neurons



- It measures the spinal cord response to stimulation and adjusts every pulse according to activity .
- This optimize activation within the patient's therapeutic window

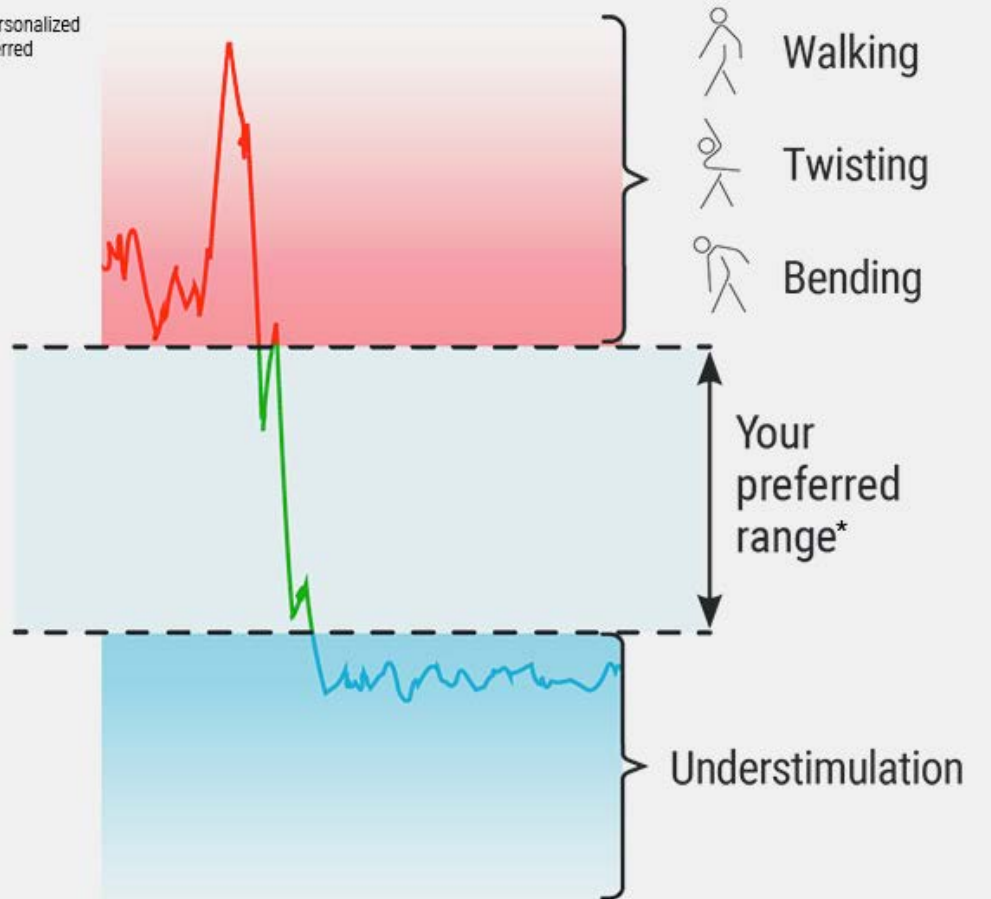


Manual

Requires manual adjustment of your therapy to keep stimulation comfortable (up to 30 x per day)⁶

*Therapy settings are personalized to each patient and preferred ranges may vary.

Traditional fixed-output SCS⁵

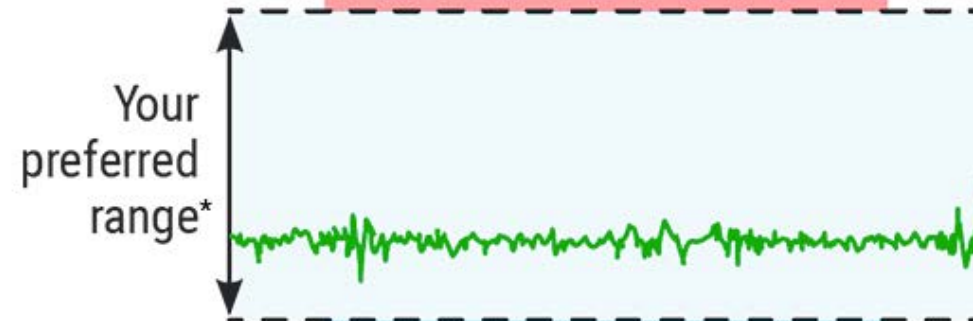


Results may vary.

Automatic

Stimulation is designed to automatically adjust to stay within your preferred range of therapy

*Therapy settings are personalized to each patient and preferred ranges may vary.



Pain Blocking Neurostimulation In Acute Hospital Setting

Lizzy

- 14 y/o girl
- Intractable abdominal pain and complete gastroparesis following a viral infection
- Already has a gastric stimulator for gastroparesis
- Terrible pain.
- Had to be kept in a “Precedex (dexmedetomidine) coma”
- Had been in the ICU for 2 months
- Could not be weaned off the Precedex (dexmedetomidine)



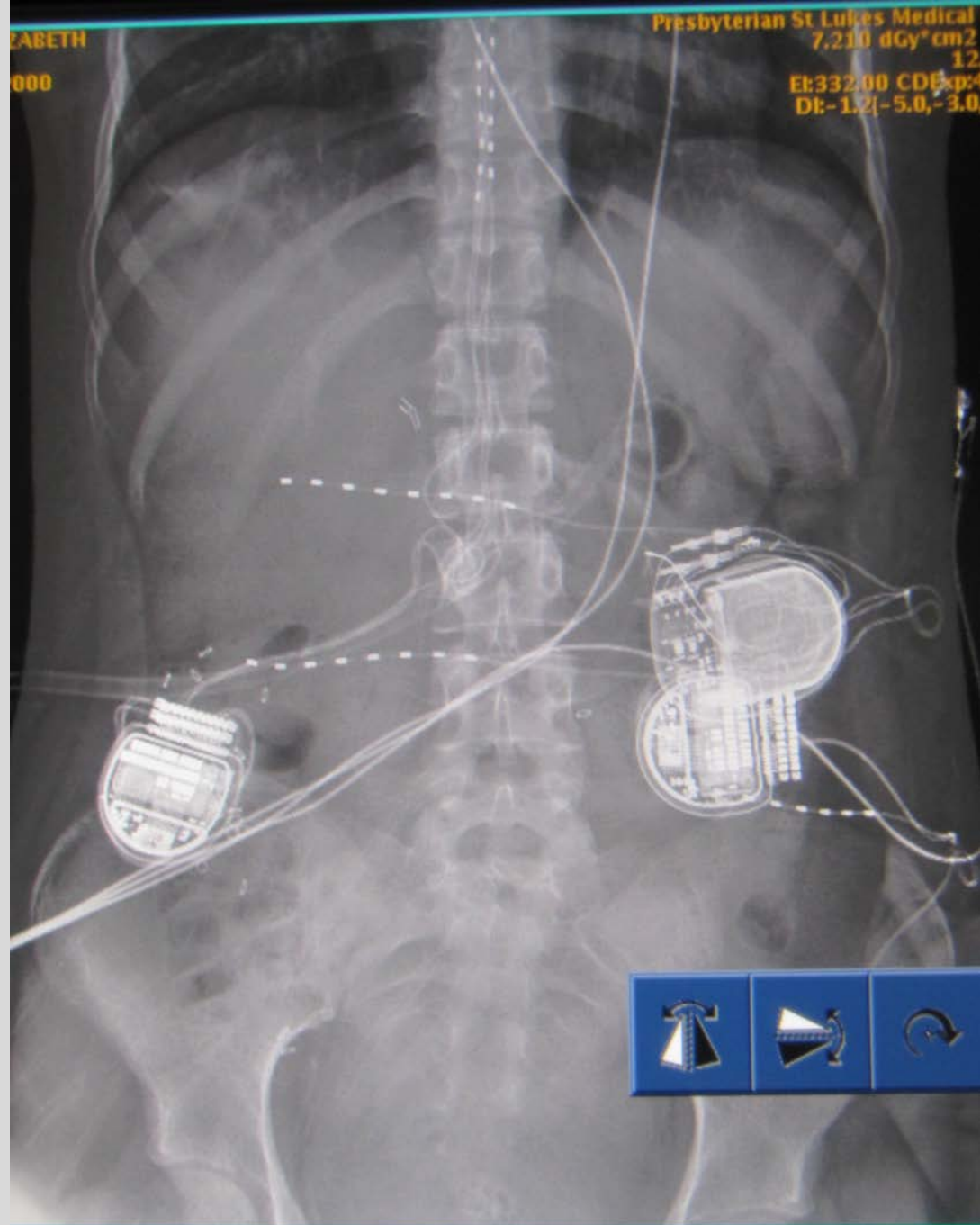




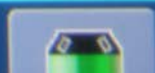
EASETH

000

Presbyterian St Lukes Medical
7.210 dGy*cm2
12
Et:332.00 CDExp:4
Dt:-1.2|-5.0,-3.0



Continue.







Sometimes you need all the guns

- 40 y/o Israeli man
- Former Israeli Special Forces
- Working for Miami Police fell while pursuing a felon
- Multiple leg fractures. Several surgeries
- CRPS right leg
- Amputation
- Pain continues
- 2 types of pain
 - -Stump pain. Terrible completely incapacitating pain episodes
 - -Phantom pain
- First procedure: address stump pain
- Peripheral field stimulation trial: (Almost) Complete pain relief

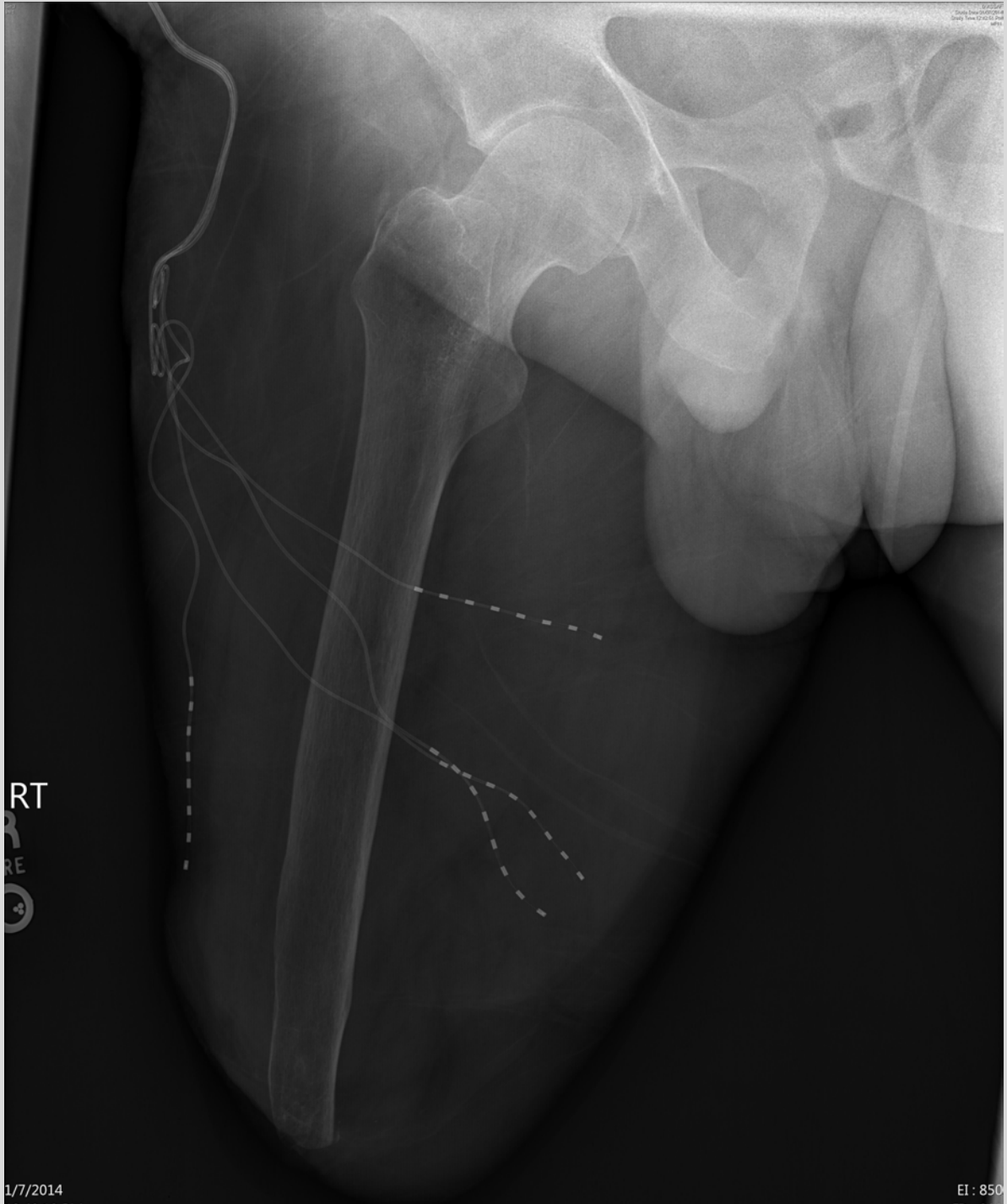








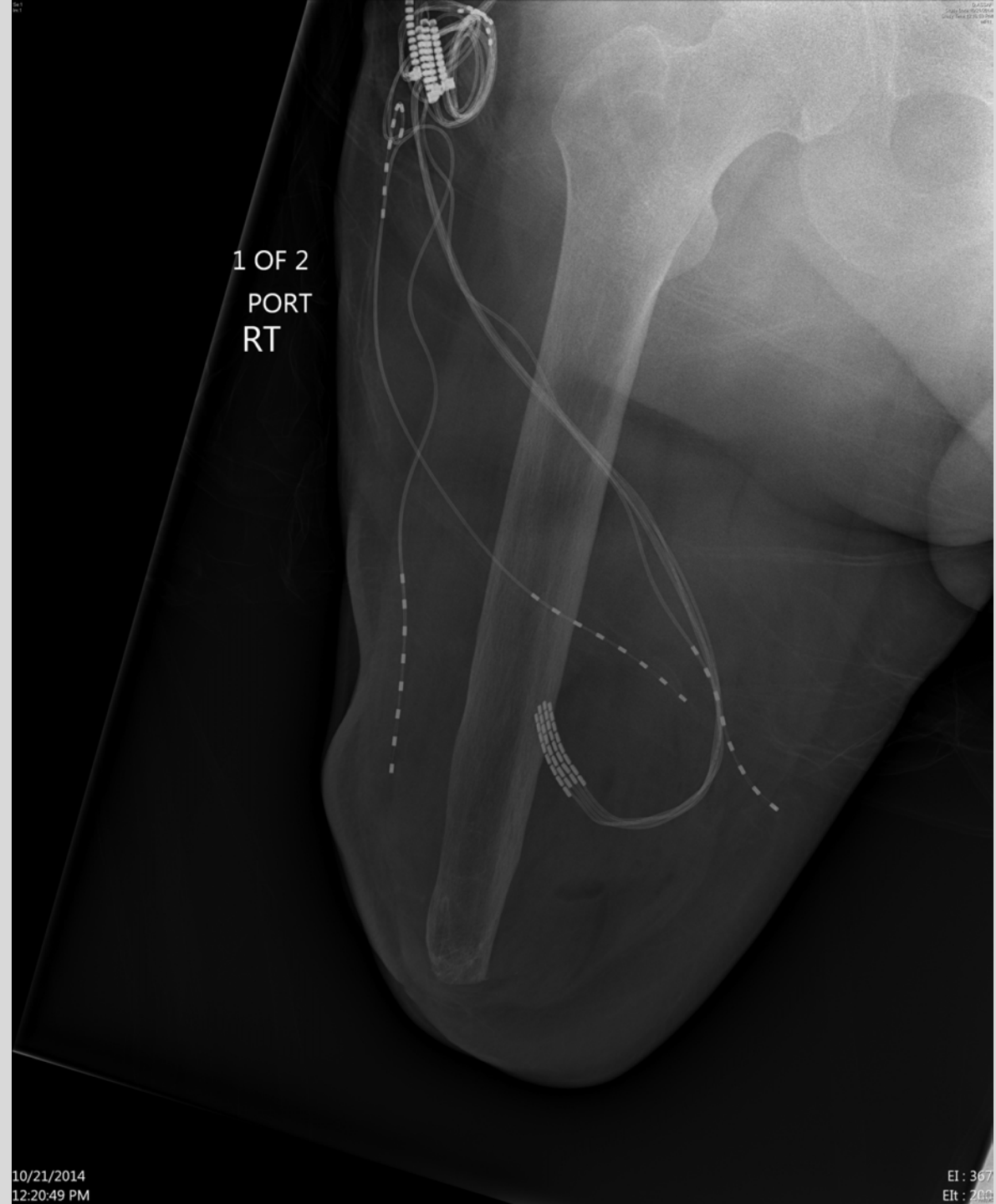




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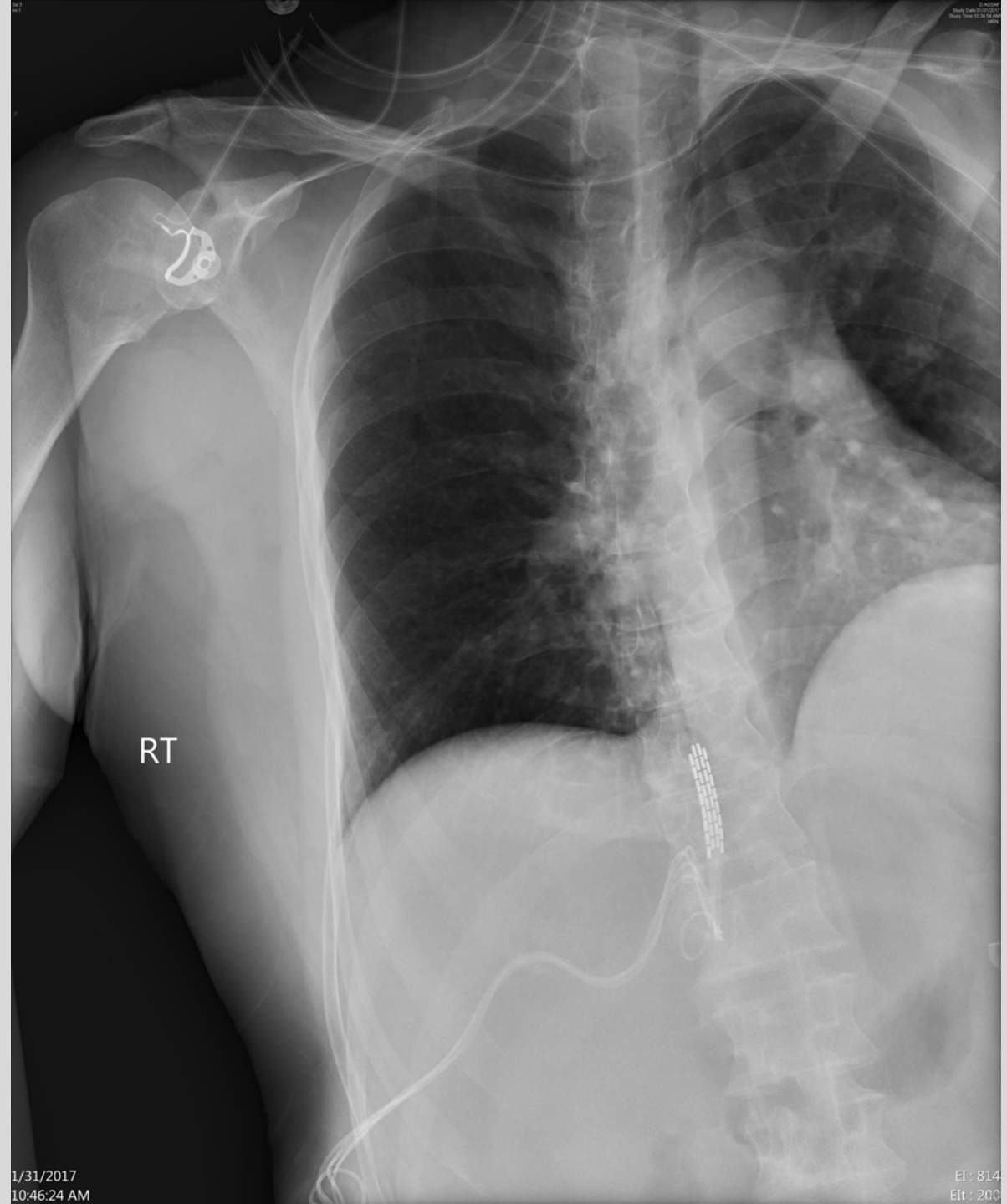
- **Stump pain under control**
- **Phantom pain becomes a bigger issue**

- **Stimulator on the Sciatic Nerve**
- **Excellent efficacy on phantom pain**



Pain spreads more proximally into the thigh

- **Spinal Cord Stimulator**



Dr. Lehrman

Osseous Integration







Testicular/Scrotal Pain

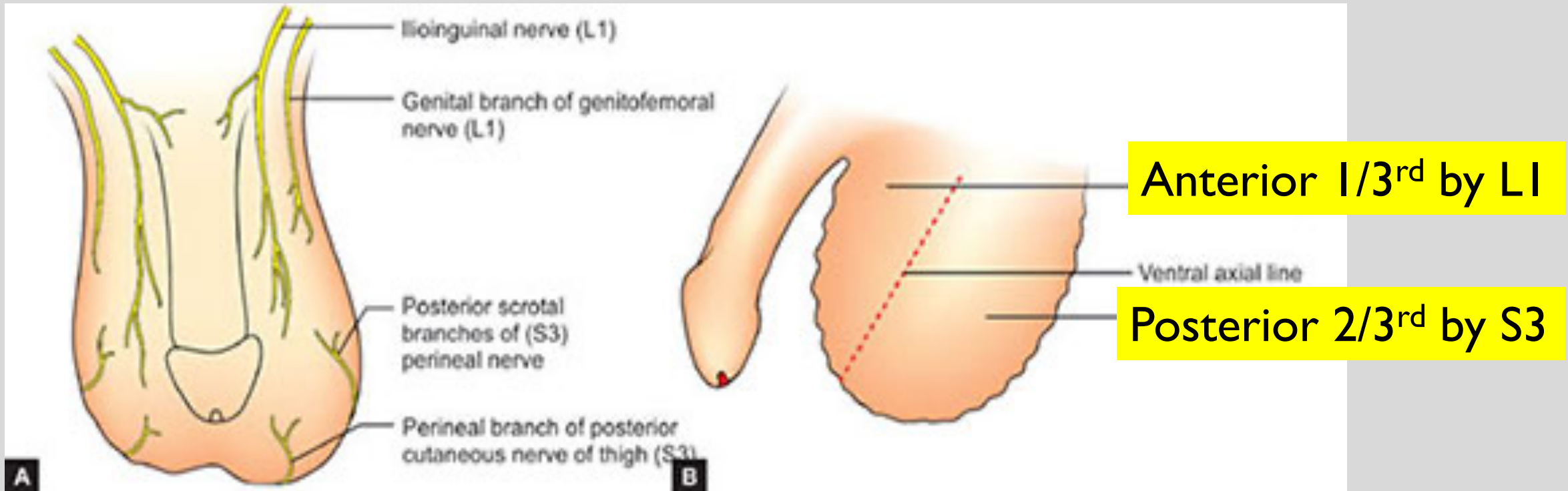
Out of the Box Thinking



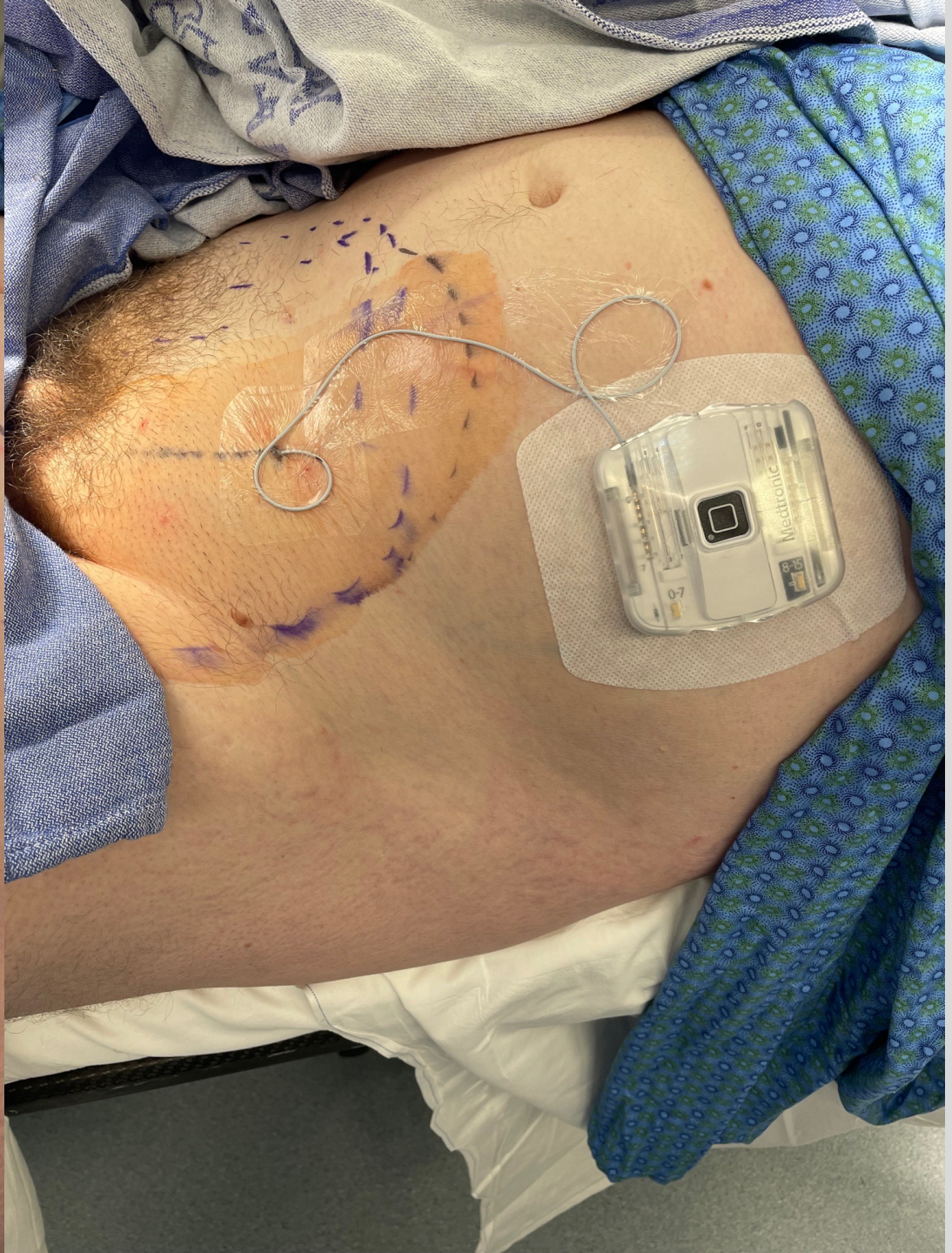
Most common causes

- Inguinal hernia surgery
- Vasectomy
- Testicular cancer
- Trauma

Scrotum has Dual Innervation

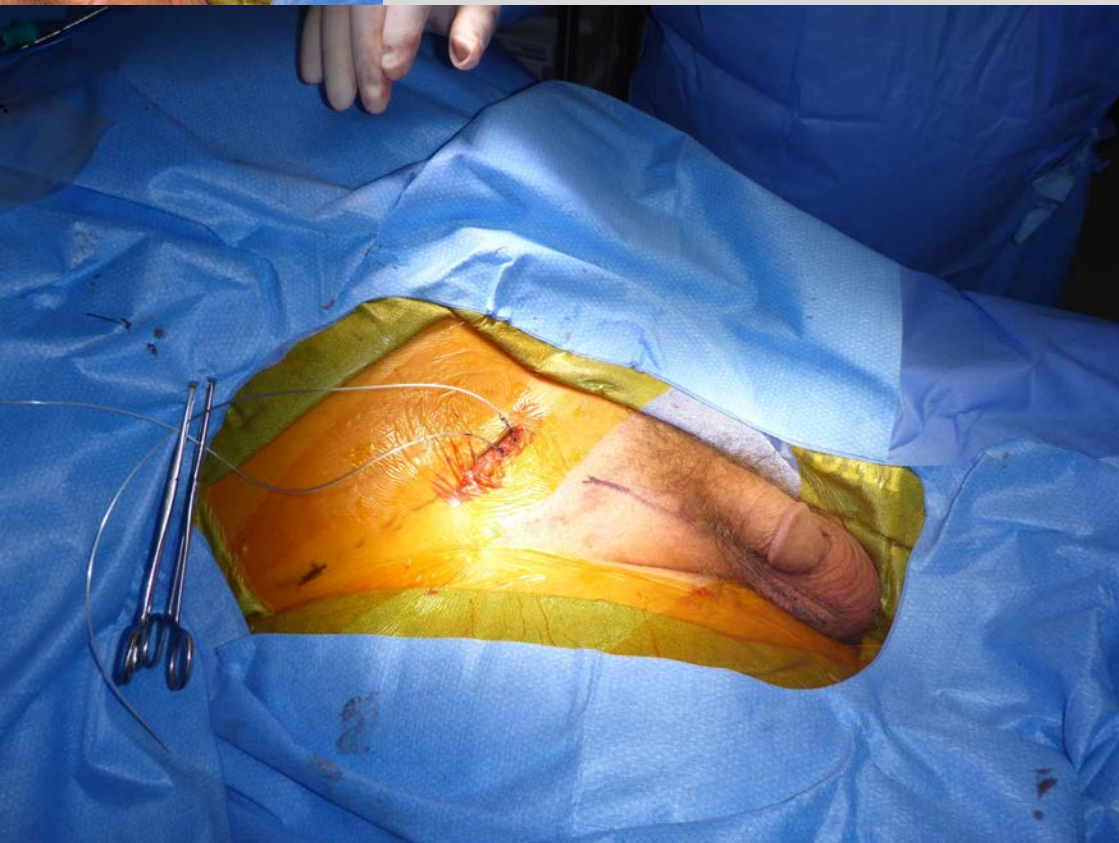
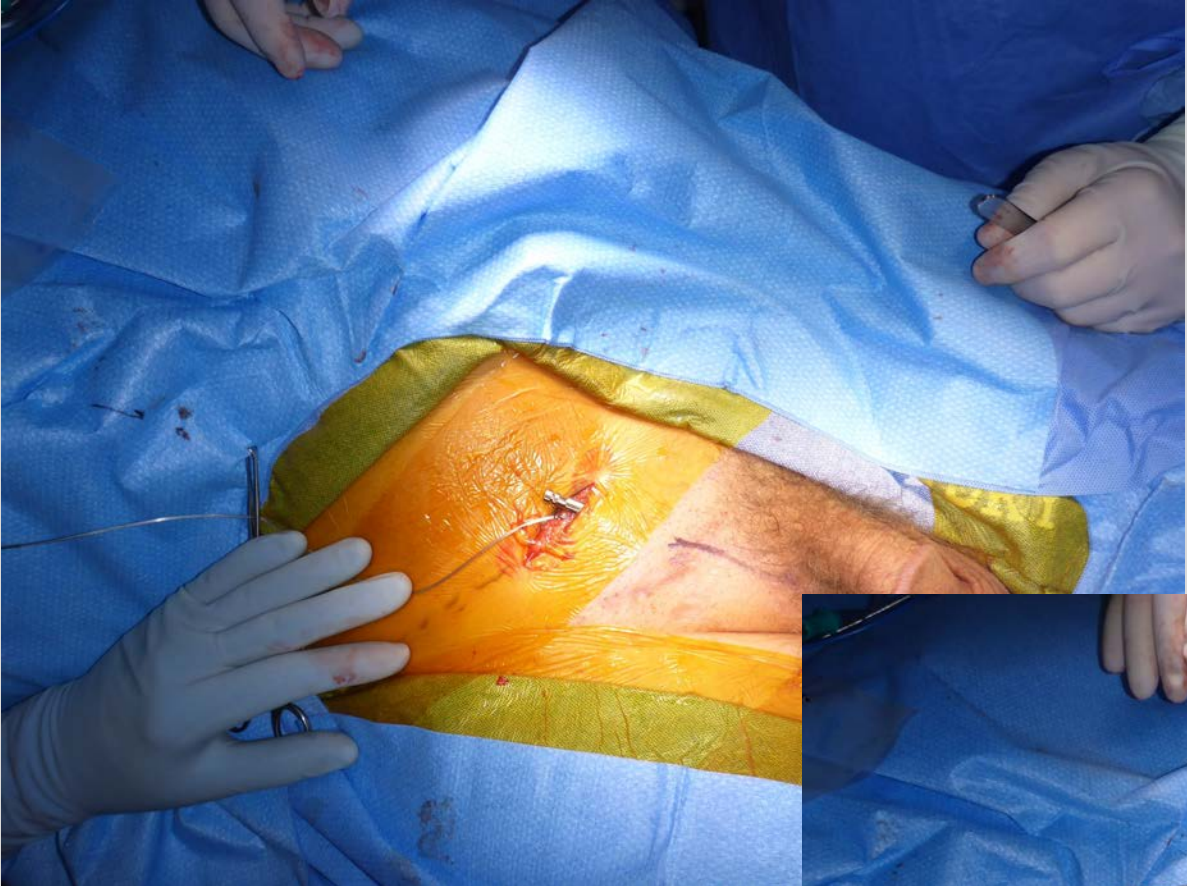


- Almost impossible to stimulate the scrotum/testicle from the spine
- With L1 root stimulation paresthesiae and pain relief are mostly felt in the inguinal region but not in the anterior scrotum
- With S3 root stimulation paresthesiae and pain relief are mostly felt in the buttock/rectum/perineum but not in the posterior scrotum
- Even with stimulation of the genito-femoral/ ileo-inguinal nerve most of the pain relief is felt in the groin/inguinal region, but not in the scrotum

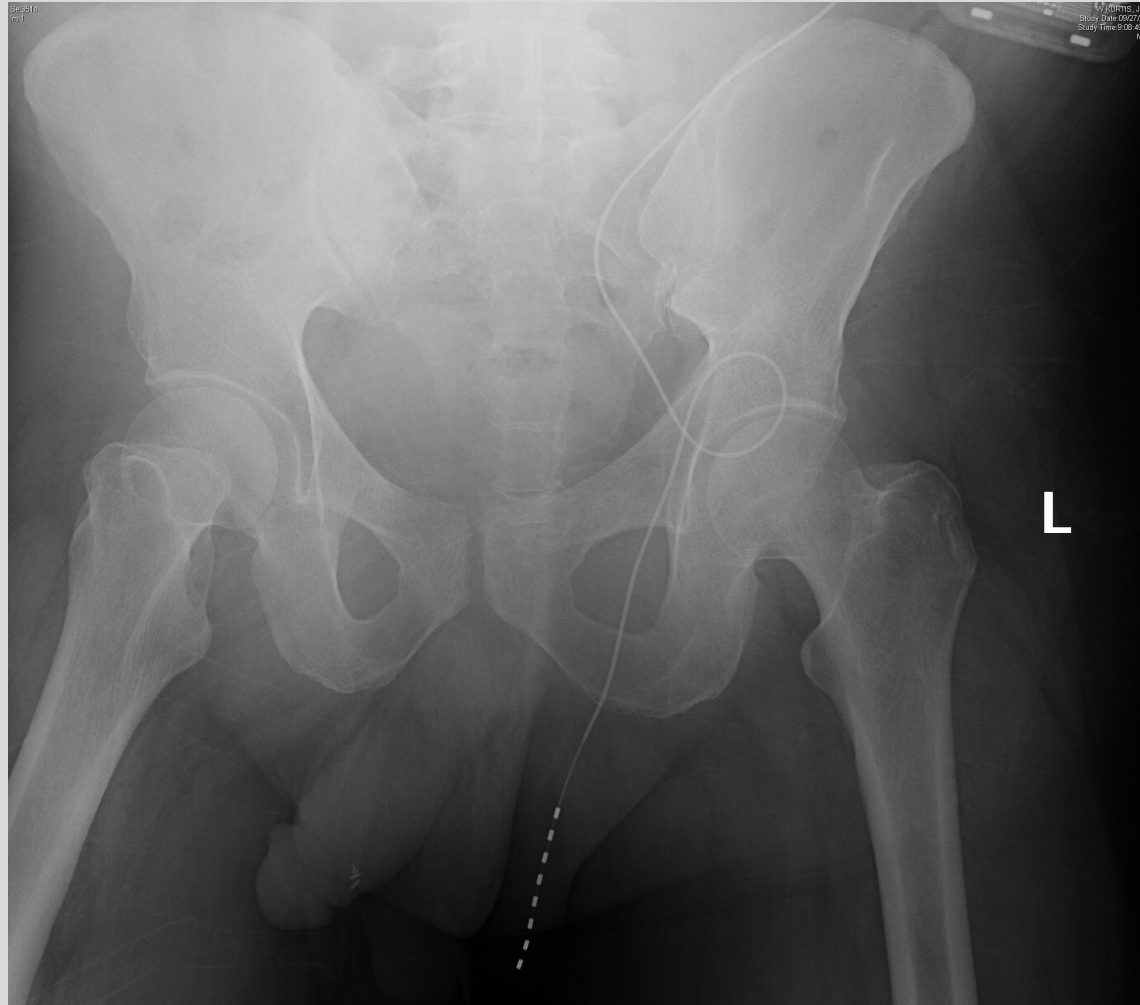








Why not put the electrode directly in the scrotum?



The electrode must be placed exactly in the area of pain





THANK YOU

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