

Stimulation of the Peripheral Nervous System

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Disclosures

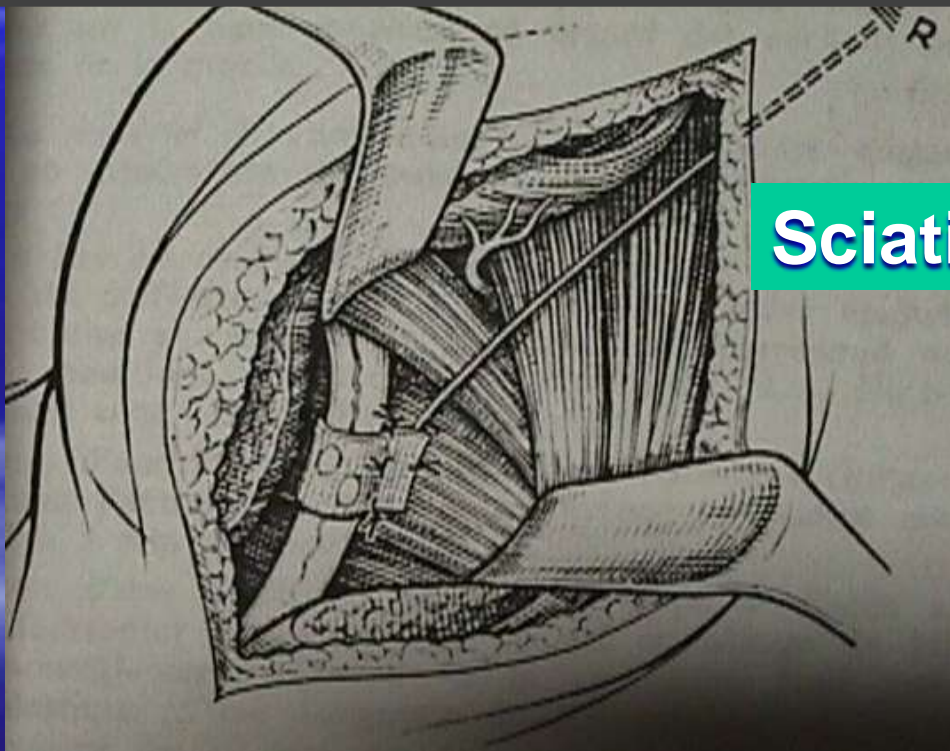
Equity Owner:

- Ripple
- Microleads
- Mudjala

1968

WILLIAM SWEET MD
CHIEF OF NEUROSURGERY
MASSACHUSETTS GENERAL HOSPITAL
BOSTON

FIRST PERIPHERAL NERVE STIMULATOR



Sciatic Nerve

**1967 : First
Spinal Cord
Stimulator**

Cuff electrodes resulted in
severe compression of the nerve



PNS Abandoned

PNS retried in the 80s with paddle leads over the nerves

- Results were good but short lasting.
- Undesirable stimulation of the motor fibers almost always prevented stimulation of the sensory fibers within a useful range
- At the time smallest voltage increments were in the 0.5 V, which did not allow enough “fine tuning” of the stimulation to prevent motor contractions.
- PW adjustments allowed some additional “tweaking”, but not enough to be useful.

PNS retried in the 80s with paddle leads over the nerves

- Three indications for stimulation of the PNS circumvented these issues:
- Tibial nerve stimulation for foot drop. Stimulation of the motor fibers was the desirable outcome
- Vagus nerve stimulator for epilepsy
 - Expandable lead coil
 - Stimulation could be kept sub-threshold for paresthesiae so undesirable motor contractions could be kept to a minimum
- Interstim by Medtronic. Stimulation of the S3 nerve root. Some degree of motor contractions were acceptable and, in some instances, even desirable.

Today

- The current stimulation systems allow stimulation increments of at least 0.1 V with minute increments in the pulse width.
- Much easier to find the “Therapeutic Window” between sensory and motor stimulation.

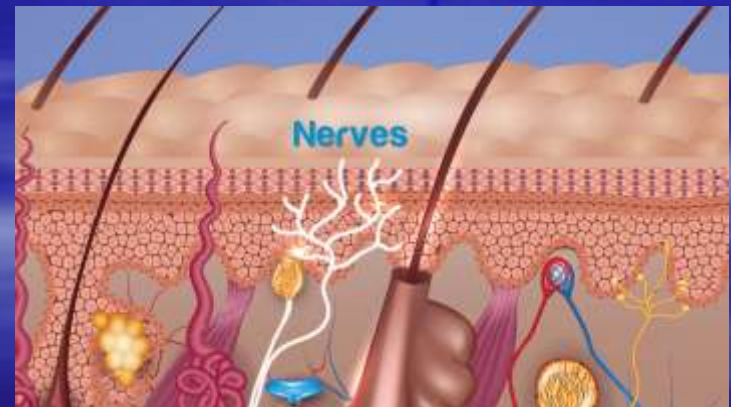
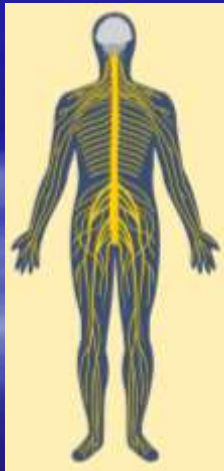
Stimulation of the Peripheral Nervous System (PNS)

True PNS

Peripheral “Field” Stimulation

Large Named Peripheral
Nerves

Network of Small Un-Named
Branches of Peripheral Nerves



- Excellent alternative to Intra-Spinal Stimulation
- Many times a preferable alternative
- Sometimes as a supplement to Intra-Spinal Stimulation

Advantages of PNS over NTRASPINAL STIMULATION

	Advantage Over :	
	SCS	DRG
No need to enter the spinal canal	Yes	Yes
Less risk of extensive neurological damage	Yes	Yes
Much more precise distribution of the stimulation	Yes	
Much greater acceptance by patients	Yes	Yes
More effective in CRPS cases	Yes	

■ Ulnar nerve	<i>Mixed</i>
■ Median Nerve	<i>Mixed</i>
■ Musculocutaneous Nerve	<i>Mixed</i>
■ Superficial Radial Nerve	<i>Sensory</i>
■ Axillary Nerve	<i>Mixed</i>
■ Femoral Nerve	<i>Mixed</i>
■ Sciatic Nerve	<i>Mixed</i>
■ Saphenous Nerve	<i>Sensory</i>
■ Posterior Tibial Nerve	<i>Mixed</i>

Stimulation of the Peripheral Nervous System (PNS)

Equipment

Cylindrical leads

- Specifically designed for PNS and inserted through a needle
- Many with “Tines” to prevent migration
- Most often associated with an external power source

Surgical leads

- Paddle leads
- Cuff leads
- Utilized either with fully implantable IPG or RF system

Stimulation of the Peripheral Nervous System (PNS)

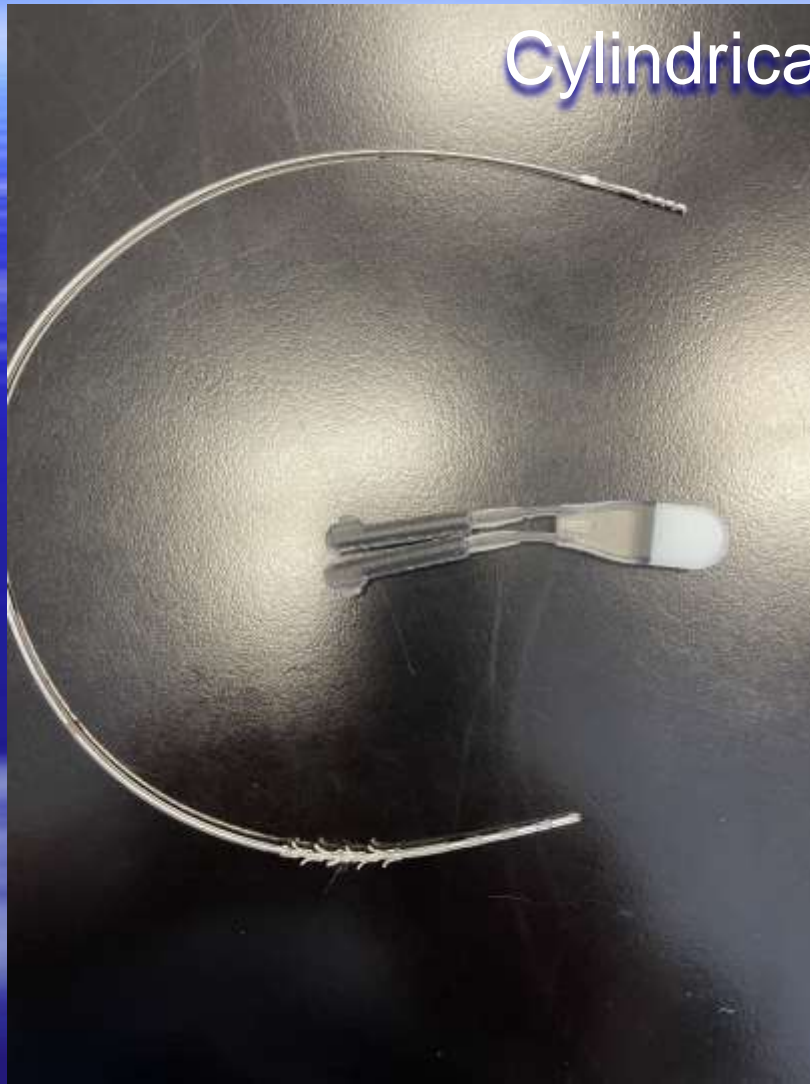
Cylindrical leads



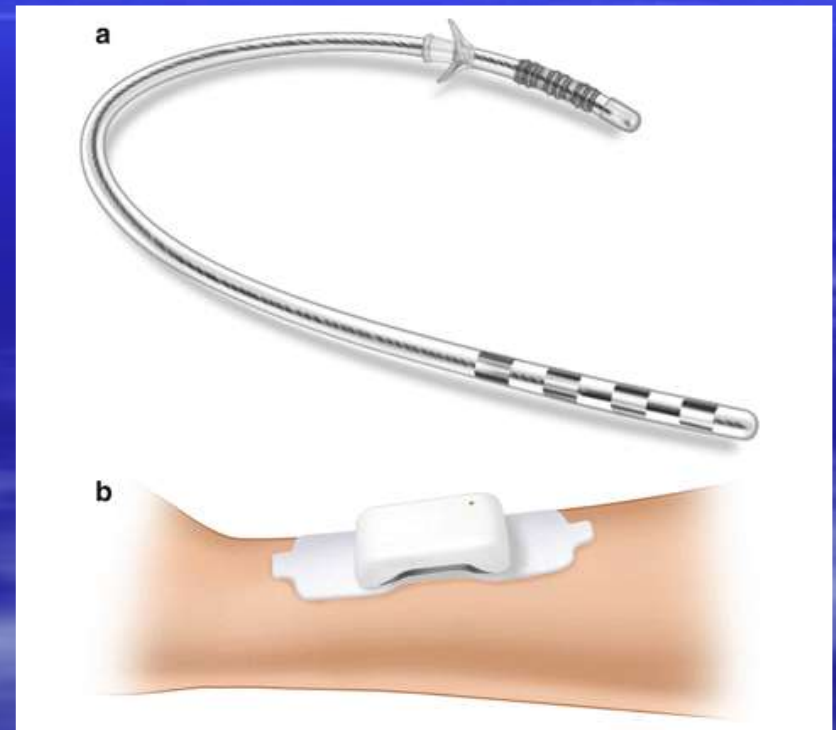
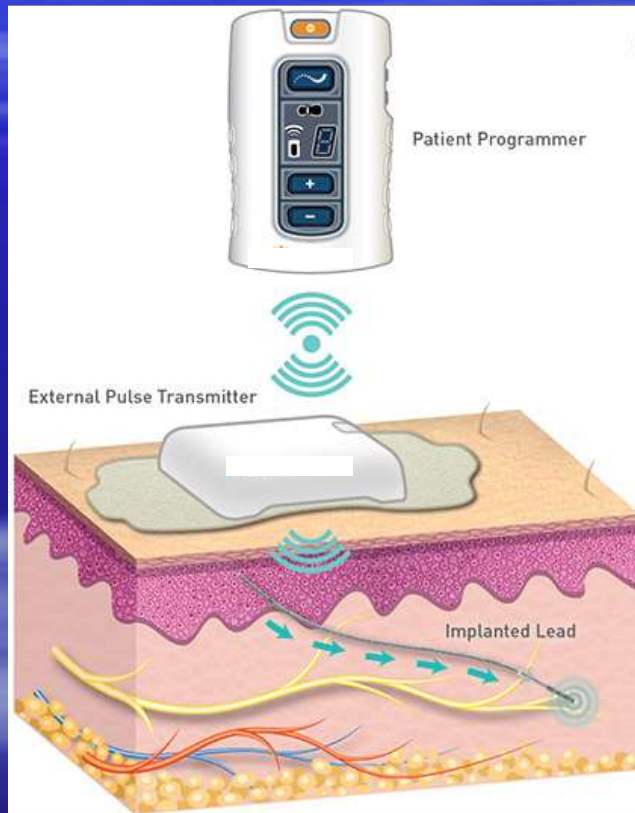
Cylindrical leads



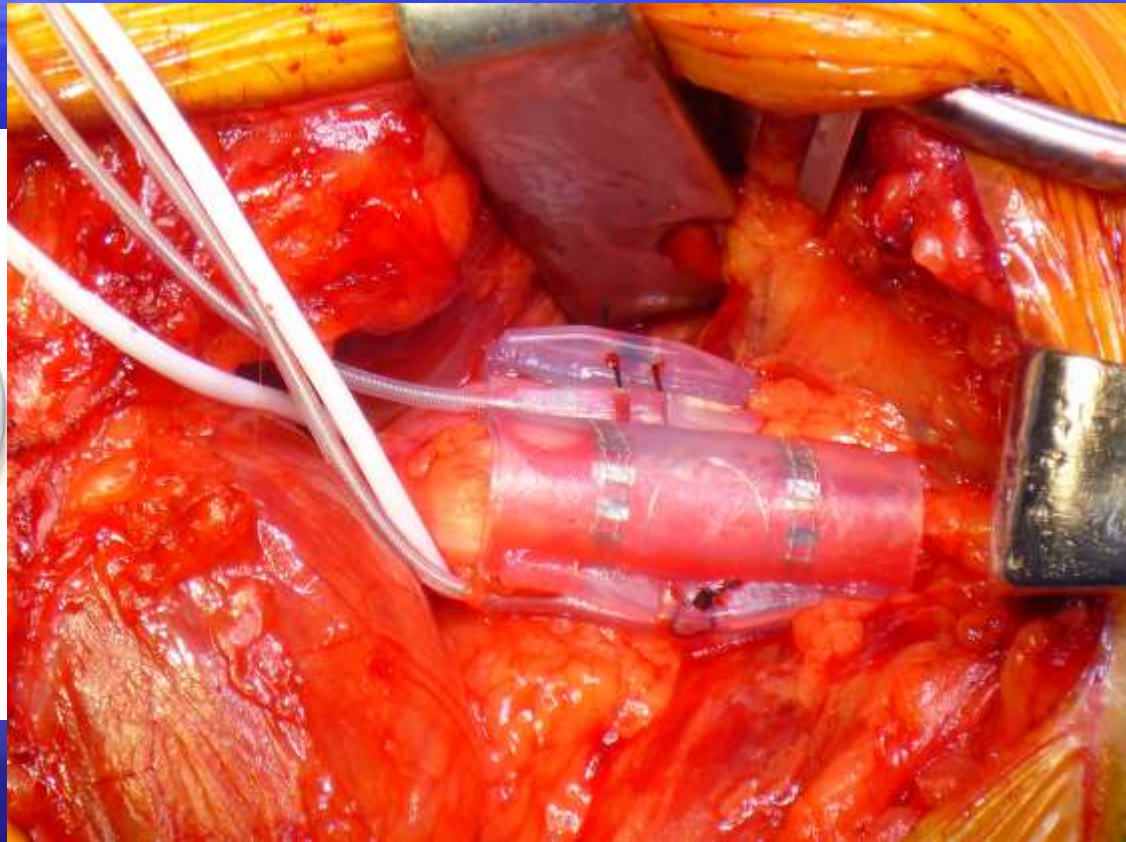
Cylindrical leads



Cylindrical leads



Surgically placed leads: *Cuff leads*



Surgically placed leads: *Paddle leads*



	Cylindrical leads	Surgical leads
Invasiveness	<i>Advantage</i>	
Physical stability		<i>Advantage</i>
Better physical and electrical contact with the nerve		<i>Advantage</i>
More stable stimulation		<i>Advantage</i>
Implant Specialists	<i>Pain Doctors Surgeons</i>	<i>Surgeons</i>

A Systematic Literature Review of Peripheral Nerve Stimulation Therapies for the Treatment of Pain

Timothy R. Deer, MD,* Michael F. Esposito, MD,†W. Porter McRoberts, MD,‡ Jay S. Grider, DO, PhD, MBA, § Dawood Sayed, MD,¶ Paul Verrills, MD,k Tim J. Lamer, MD,kj Corey W. Hunter, MD,** Konstantin V. Slavin, MD,†† Jay M. Shah, MD,‡‡ Jonathan M. Hagedorn, MD, § § Tom Simopoulos, MD,¶¶ David Abejon Gonzalez, MD, PhD,kk Kasra Amirdelfan, MD,kkk Sameer Jain, MD,*** Ajax Yang, MD,††† Rohit Aiyer, MD,‡‡‡ Ajay Antony, MD, § § § Nomen Azeem, MD,¶¶¶ Robert M. Levy, MD, PhD,kkk and Nagy Mekhail, MD, PhD

Pain Medicine, 21(8), 2020, 1590–1603

USPSTF : US Preventive Services Task Force

IPM-QRB: Interventional Pain Management
Techniques—Quality Appraisal of Reliability and
Risk of Bias Assessment.

Scoring tool developed by the American Society
of Interventional Pain Physicians (ASIPP) to
assess RCTs

USPSTF: Level I evidence based upon 14 RCTs for PNS in the treatment of

- migraine headache
- cluster headache
- shoulder pain
- low back pain
- pelvic pain
- neuropathic pain of other origin.

USPSTF criteria suggest that all 14 studies evaluated meet Level I status as RCTs.

Using the mIPMQRB method 12 of the 14 were deemed high quality based on study design and clinically meaningful outcomes.

Two were deemed moderate quality

Of the 14 RCTs selected, two were deemed moderate risk of bias and 12 were scored as low risk of bias using the Cochrane scoring method

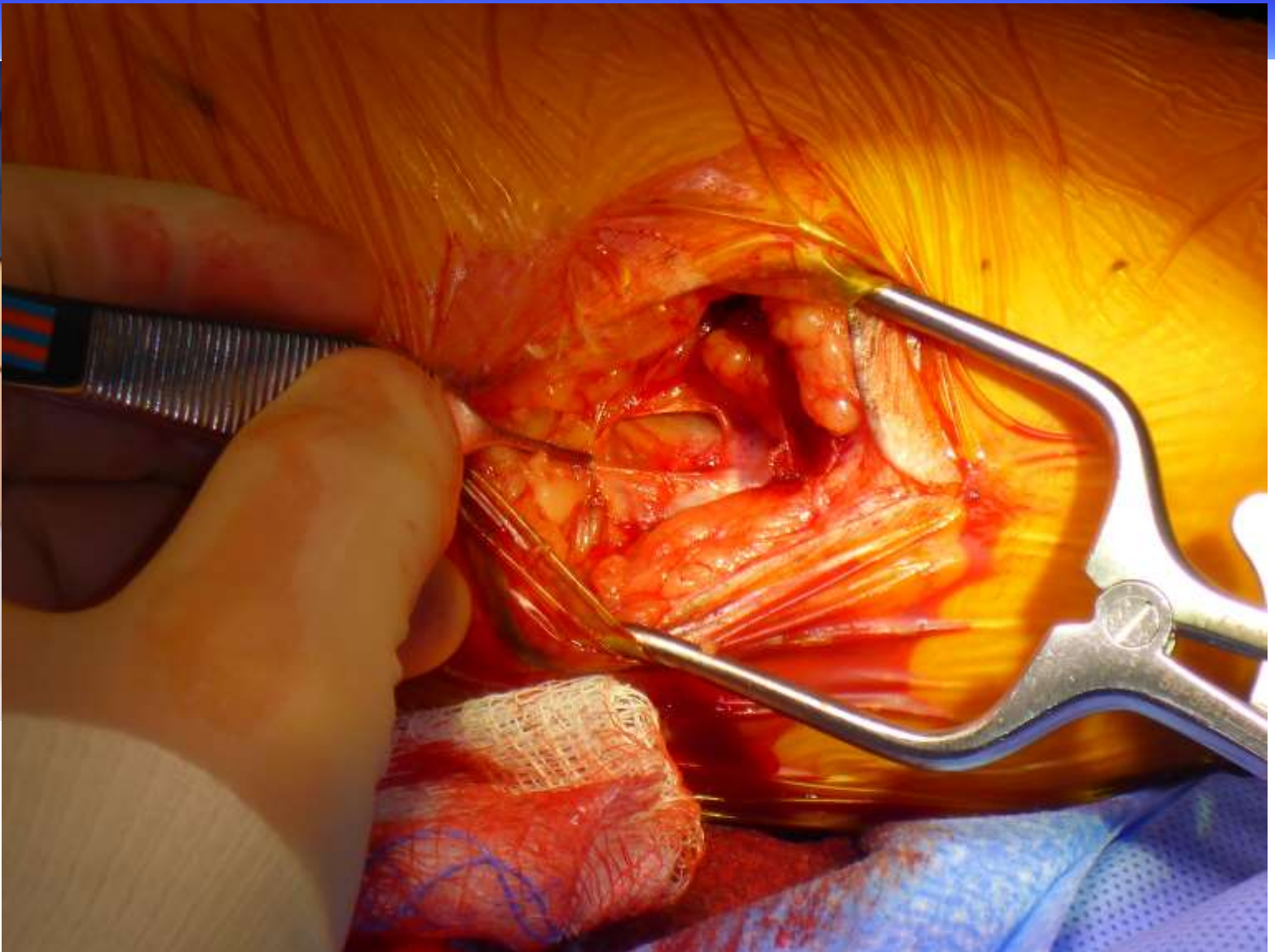
- **mIMP-QRB: Level is based upon specific indications.**

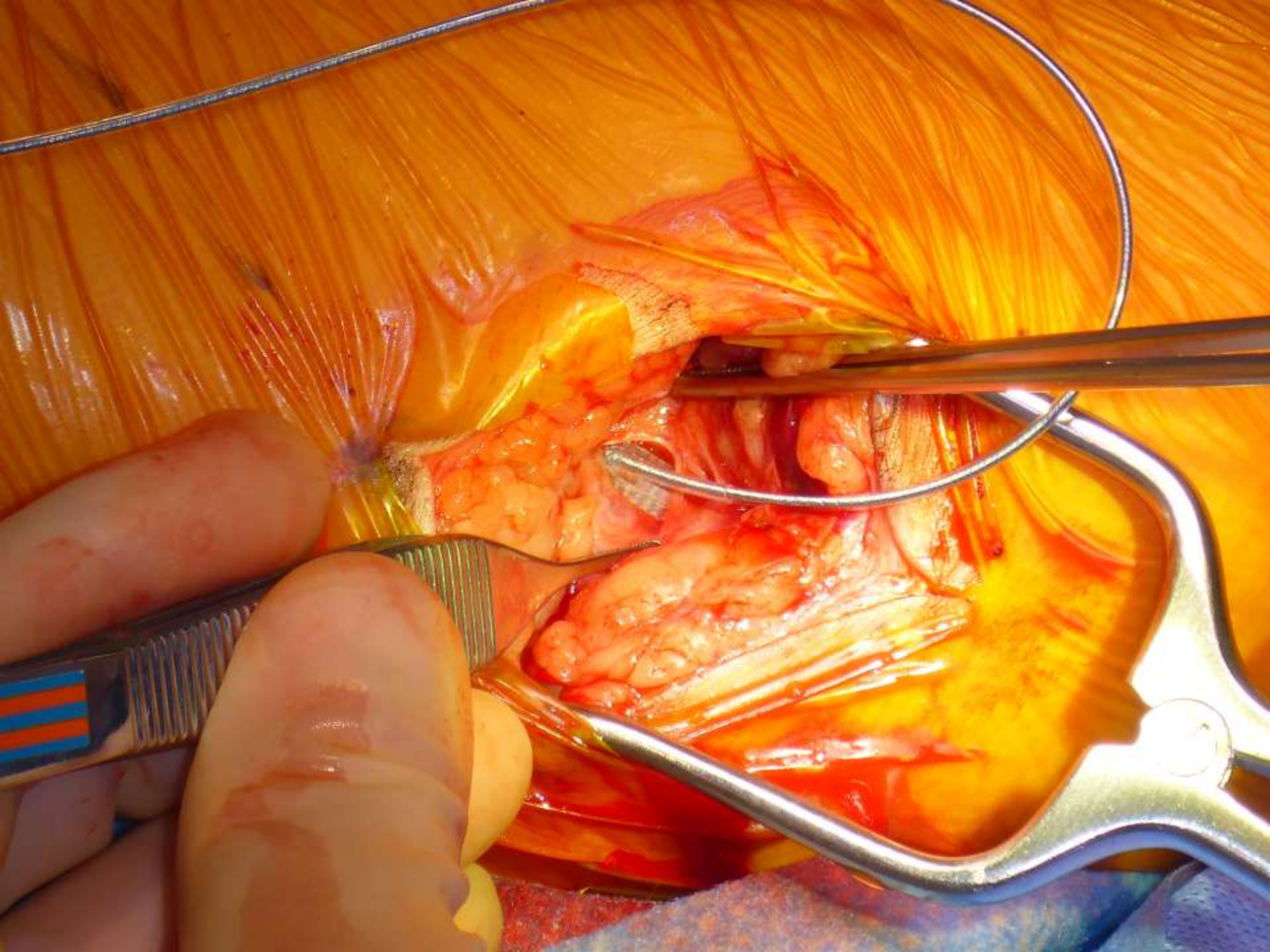
- **Level I for occipital nerve stimulation (ONS) for the treatment of migraine headache based on four high-quality RCTs and one moderate-quality RCT.**
- • **Level I for PNS for the treatment of chronic low back pain (targeting the cluneal nerve and its branches) based on three high-quality RCTs.**
- **Level II for sphenopalatine ganglion (SPG) stimulation for the treatment of cluster headache based on one high-quality RCT.**
- **Level II for PNS for the treatment of poststroke shoulder pain (targeting the axillary and suprascapular nerves) based on one high-quality RCT.**
- **Level II for PNS for the treatment of neuropathic pain of the extremities and trunk based on one high-quality RCT. Common nerves targeted for trunk pain include the ilioinguinal/iliohypogastric, intercostal, and cluneal nerves. Common nerves targeted for the extremity include the median, ulnar, sural, and superficial peroneal nerves and the lateral femoral cutaneous nerves.**
- **Level III for peripheral tibial nerve stimulation (PTNS) for the treatment of chronic pelvic pain based on two low quality RCTs and one moderate-quality RCT.**

Taken together, these 14 RCTs suggest several key points:

1. Multiple studies showing ONS can be beneficial for chronic migraine (CM), medication overuse headache (MOH), and intractable chronic migraine (ICM)
2. Moderate evidence (Level II) that implanted SPG stimulation is effective for cluster headaches
3. Strong evidence (Level I) that PNfS is beneficial for patients with continued low back pain following surgery medications, and/or interventional pain procedures
4. moderate evidence (Level II) that implanted PNS can be expected to provide at least modest improvements in mononeuropathic pain and hemiplegic shoulder pain
5. PTNS may be helpful for overall pain, dyspareunia, and QoL in chronic pelvic pain (Level III)

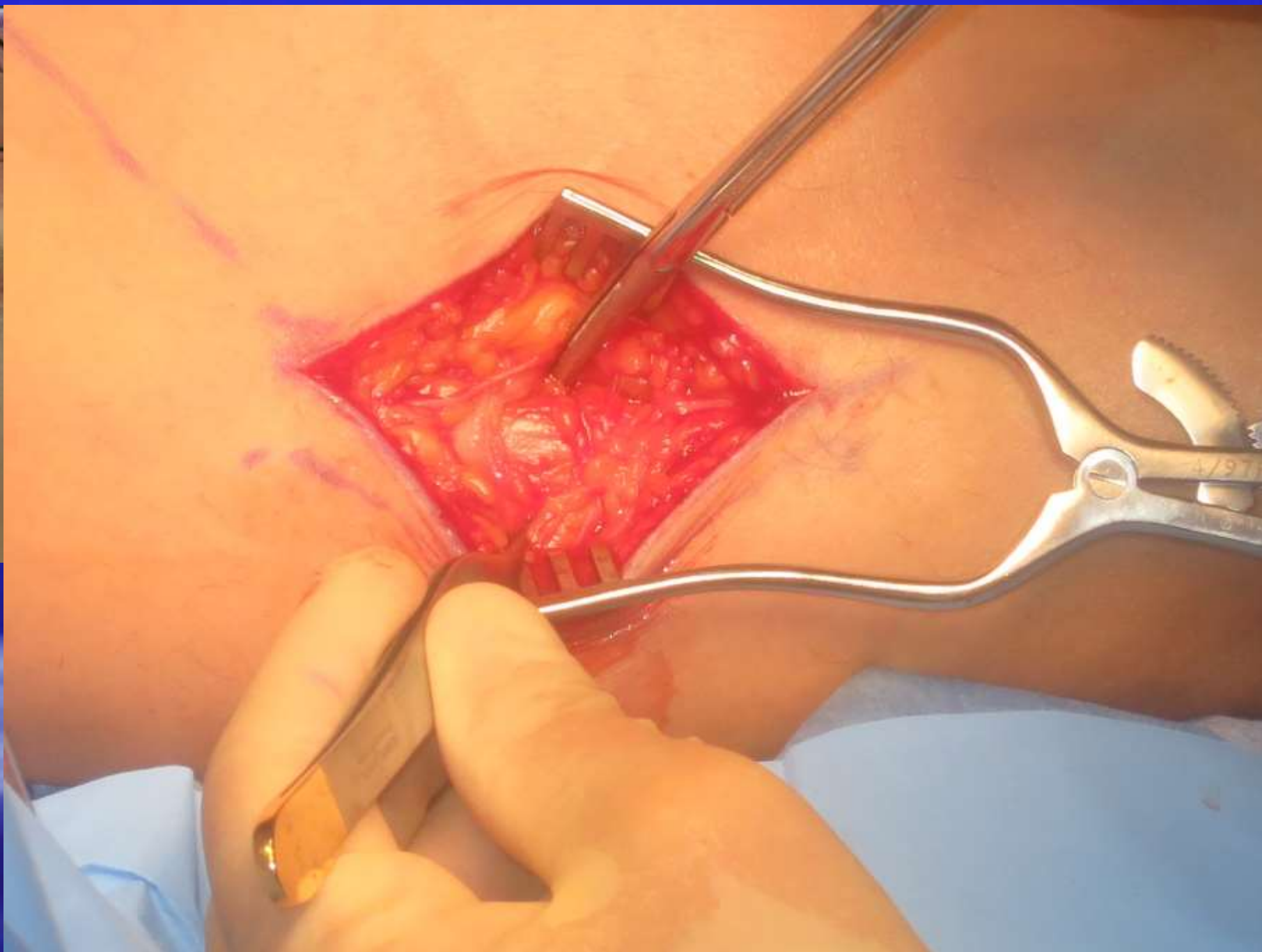
Ulnar Nerve

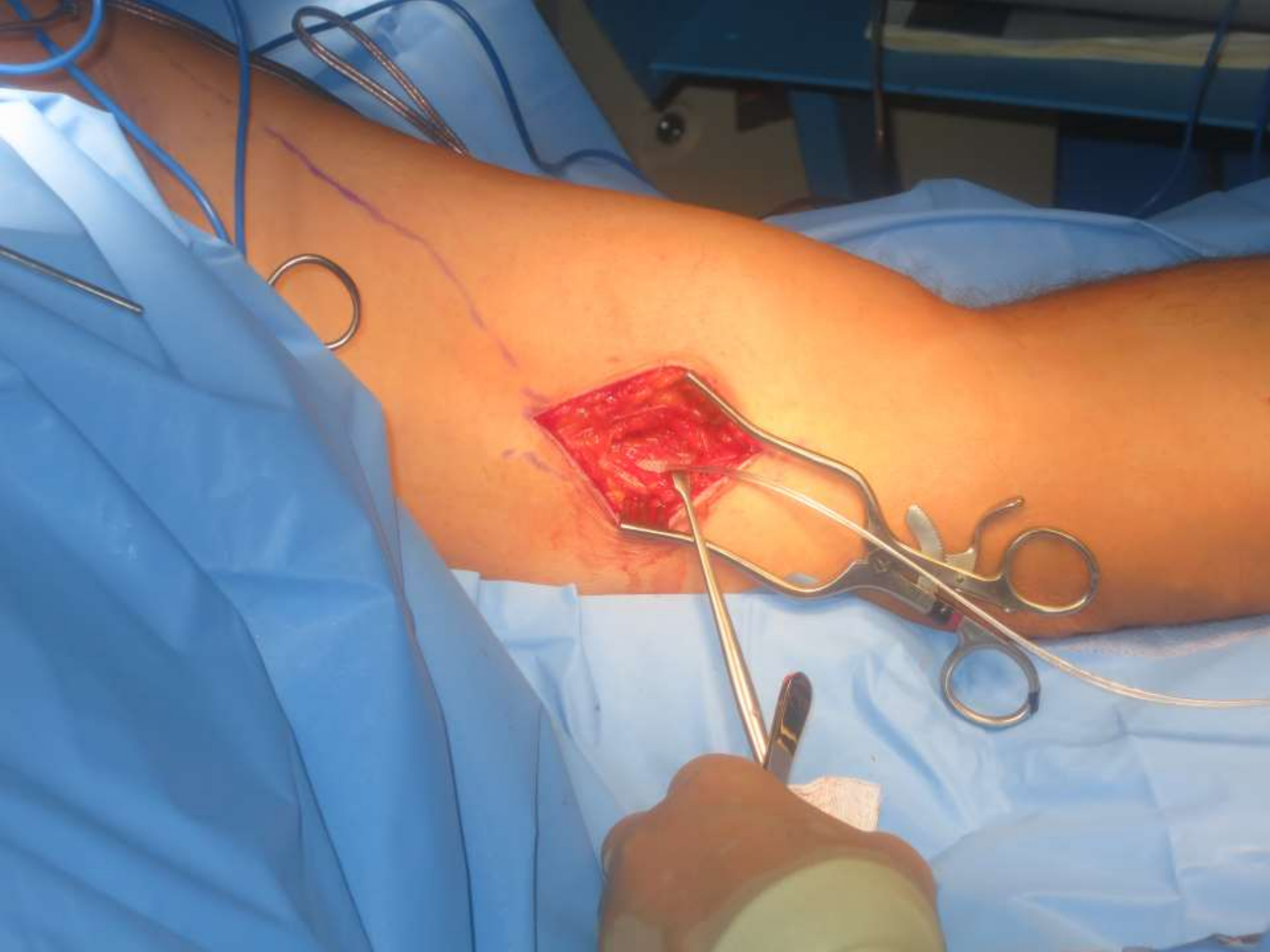




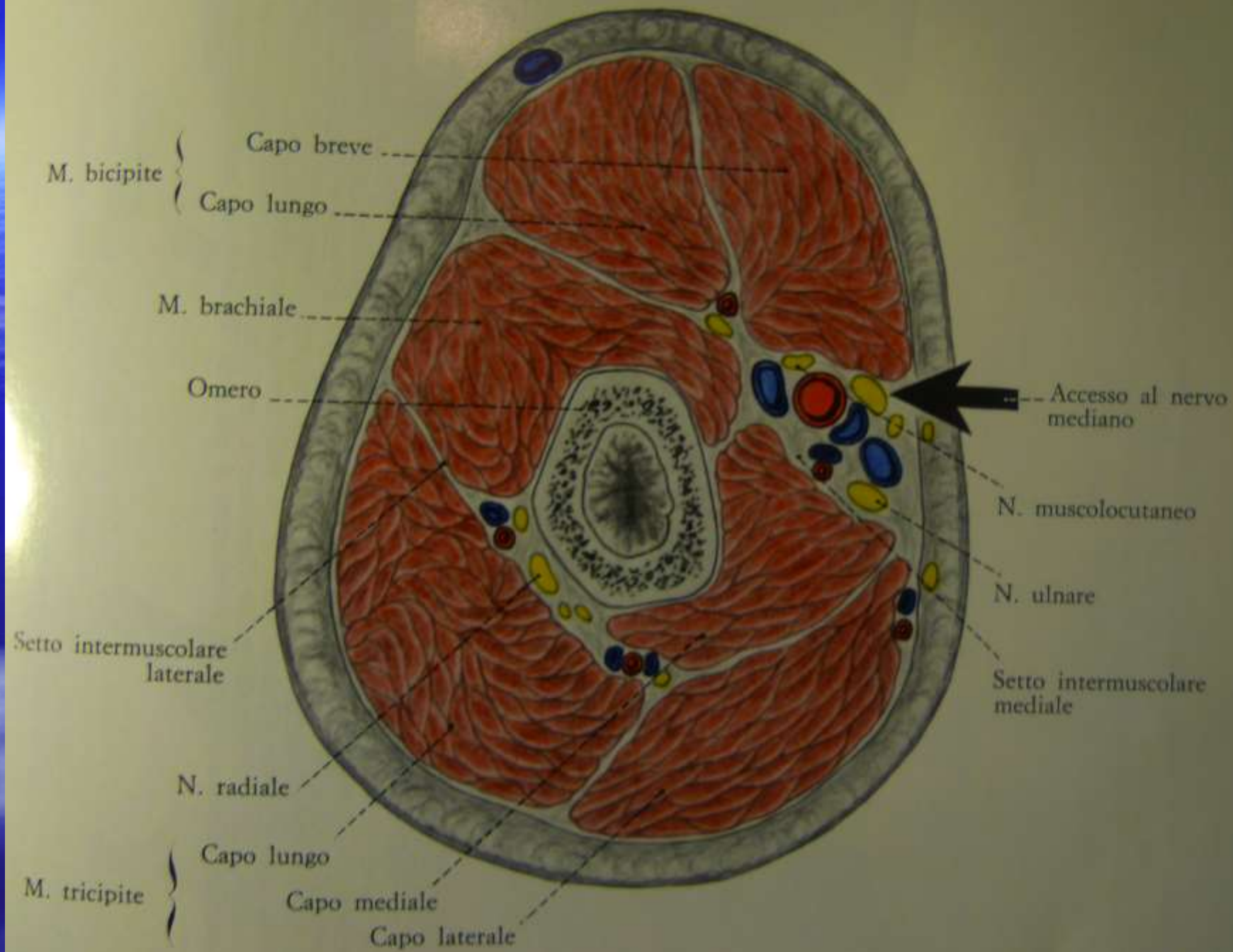


Median Nerve





Combined Stimulation of Median and Ulnar nerve





Electrode on Median Nerve



RT



12/5/2017
12:01:07 PM

EI : 188
Elt : 200

RT



12/5/2017
12:02:07 PM

EI : 168
Elt : 200

Superficial Radial Nerve



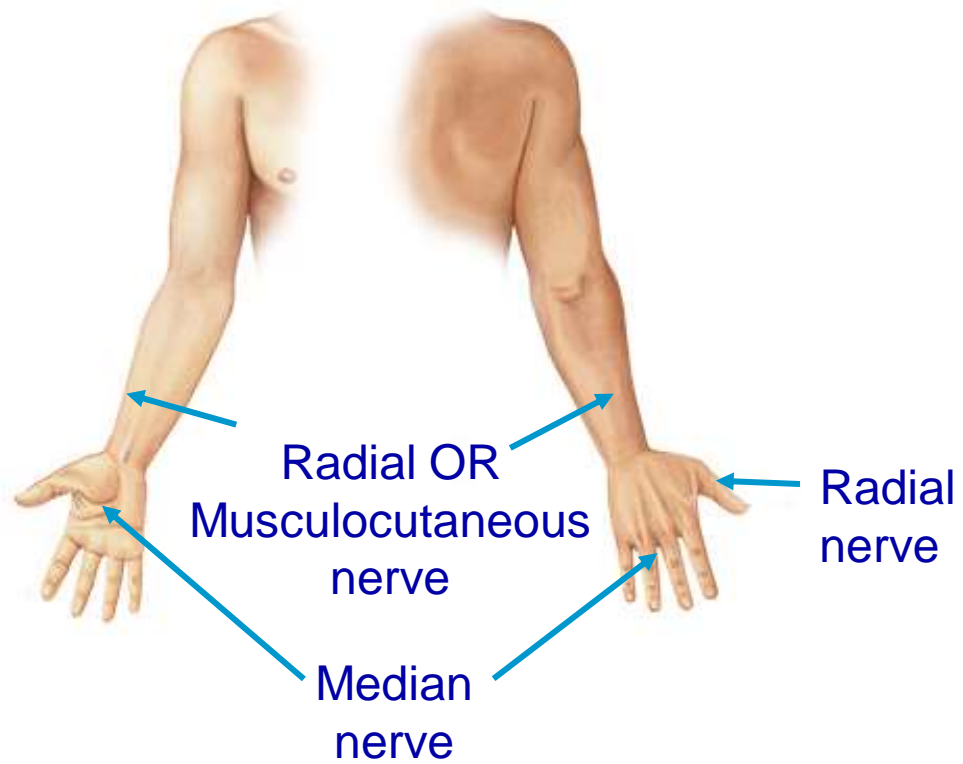




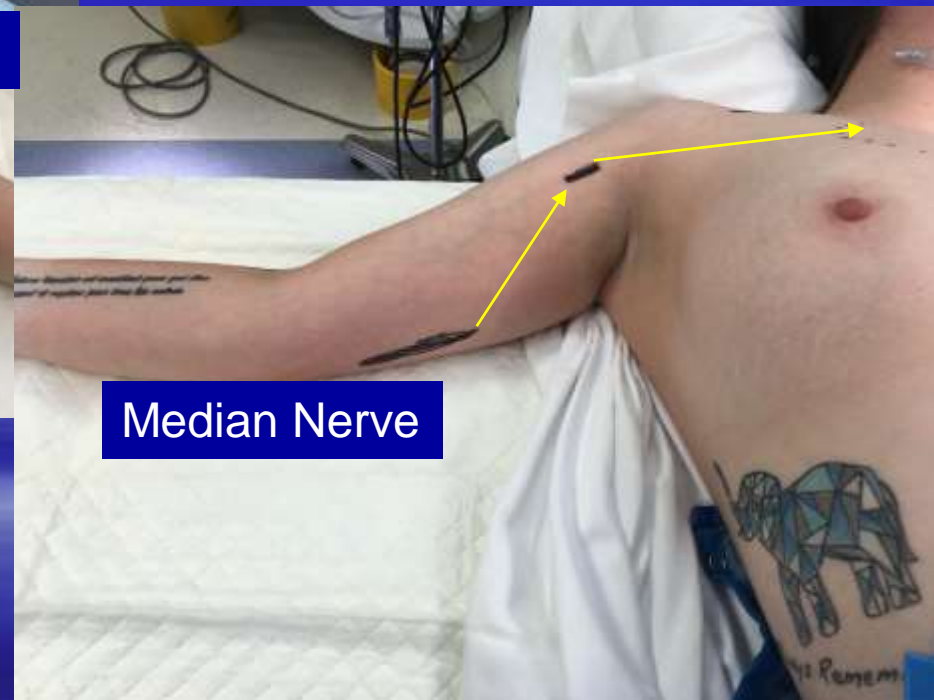
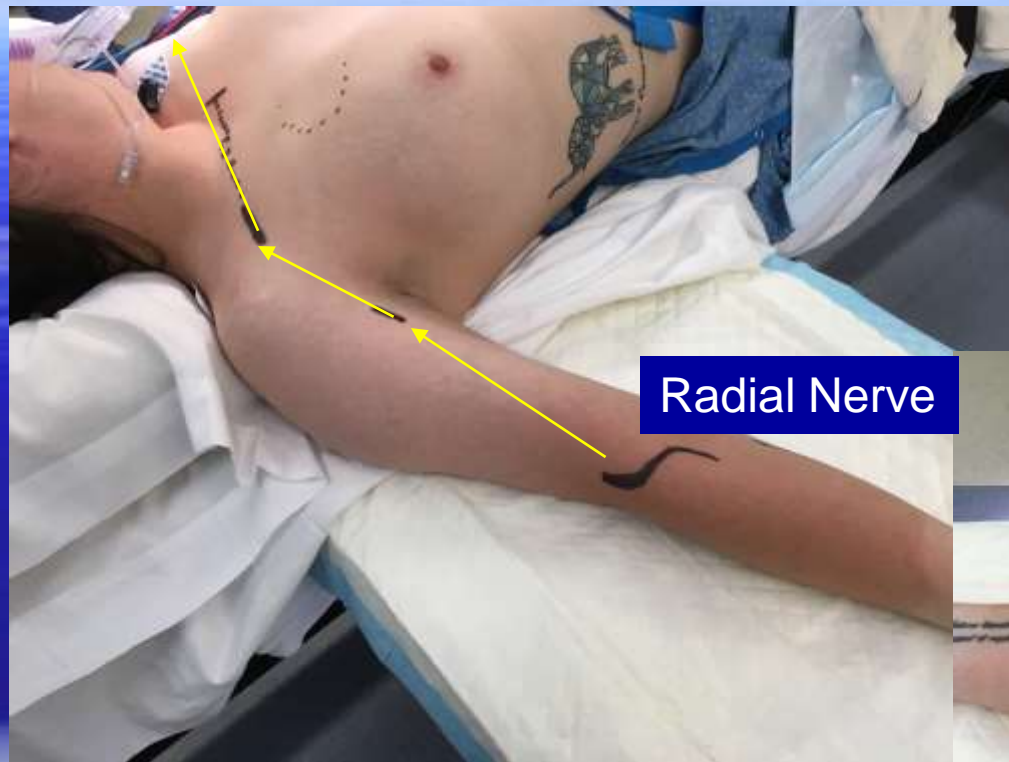


- ❖ 29 Y/O white female with severe CRPS 1 of the Right Upper Extremity
- ❖ Failed all treatments
- ❖ Excellent candidate for neurostimulation
- ❖ Does NOT want to have cervical epidural leads !!!!!





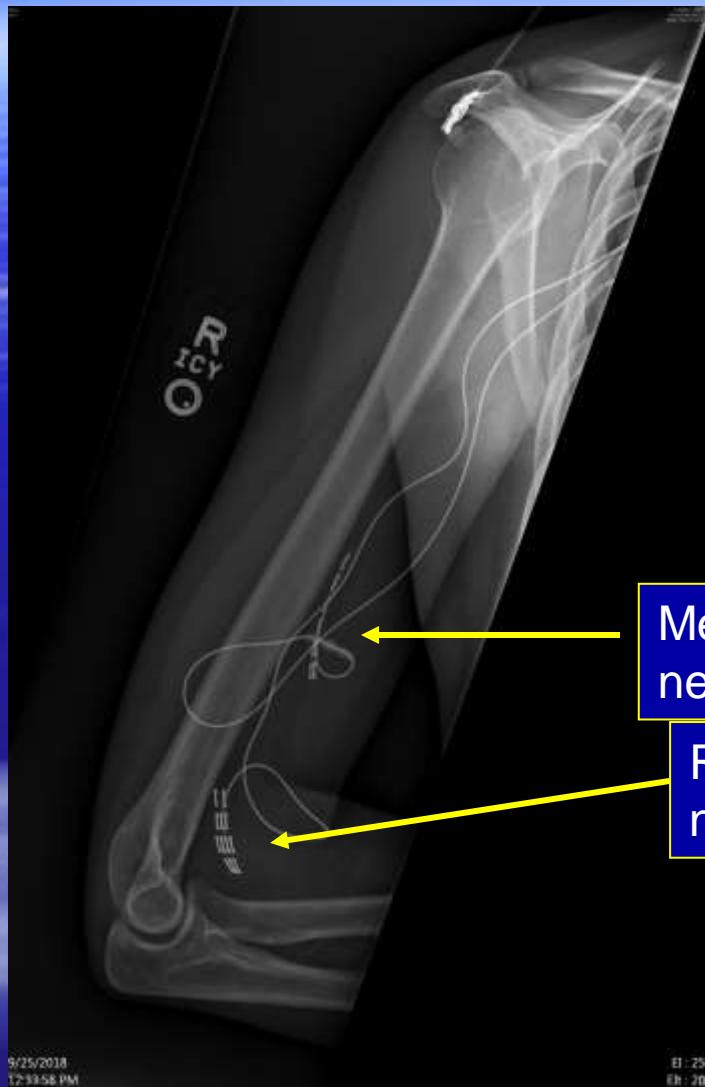










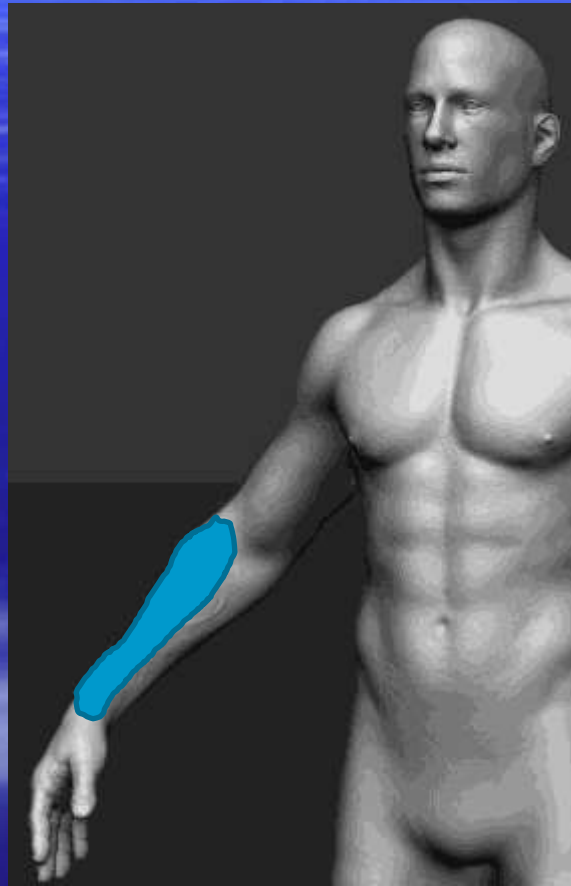


Median
nerve

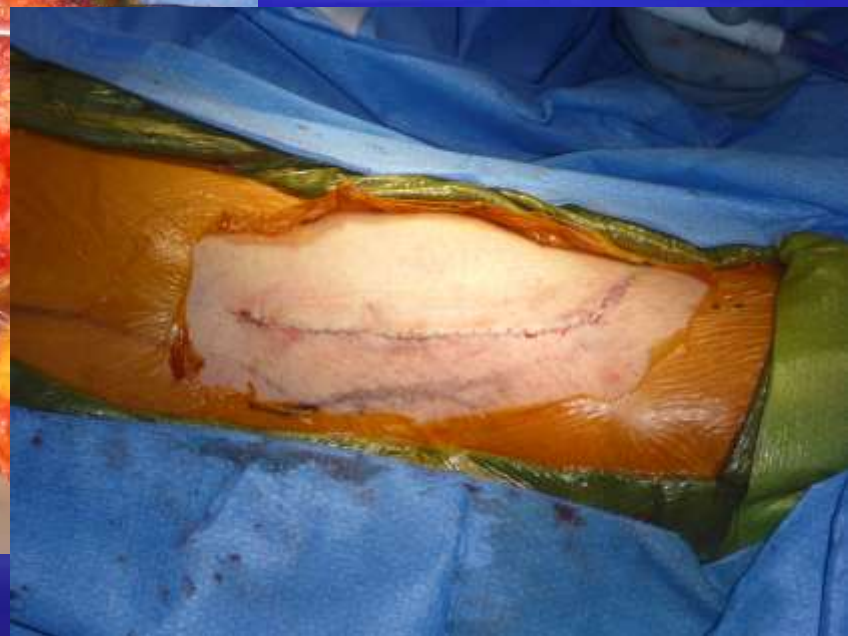
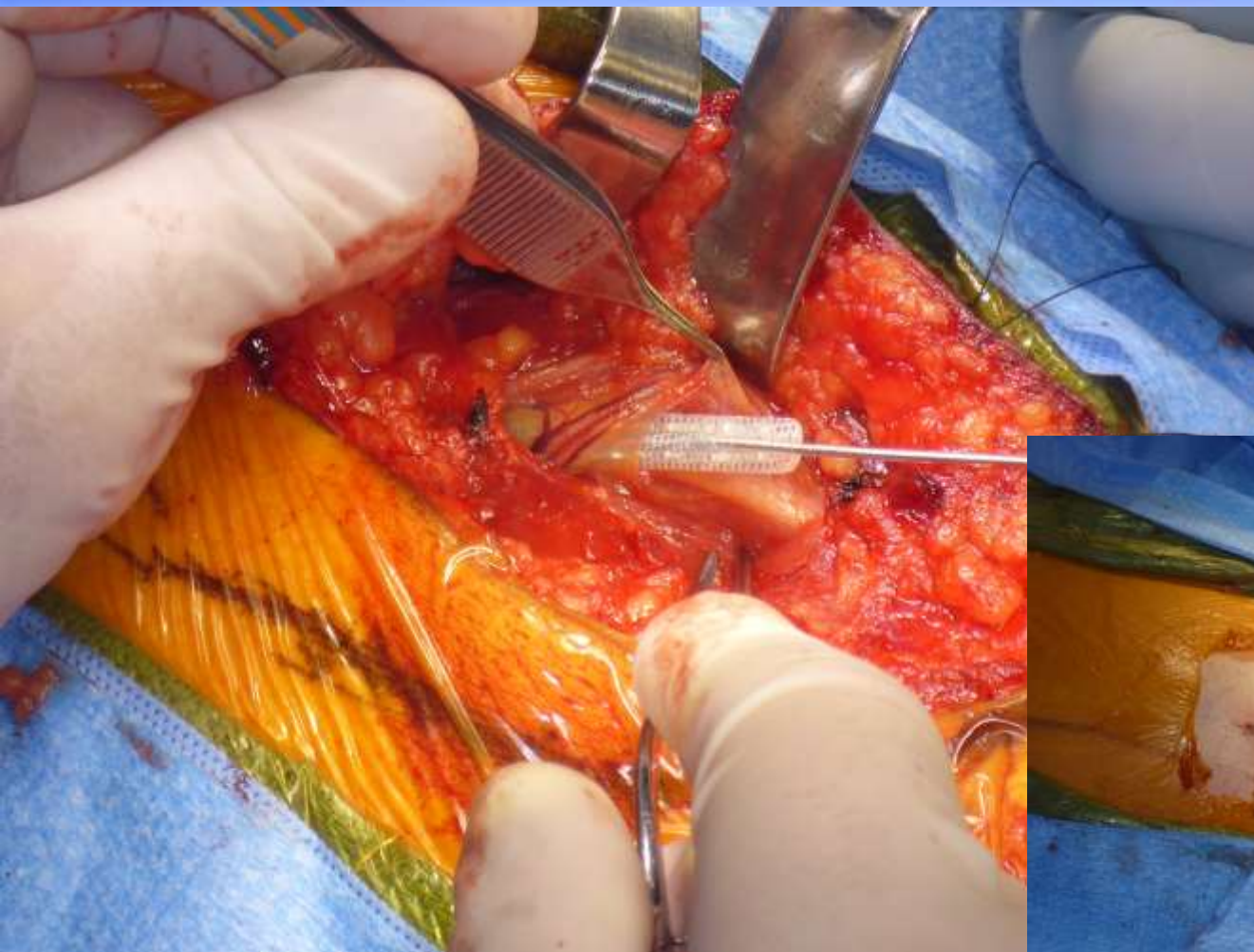
Radial
nerve



Pain in Musculo-Cutaneous Nerve Distribution



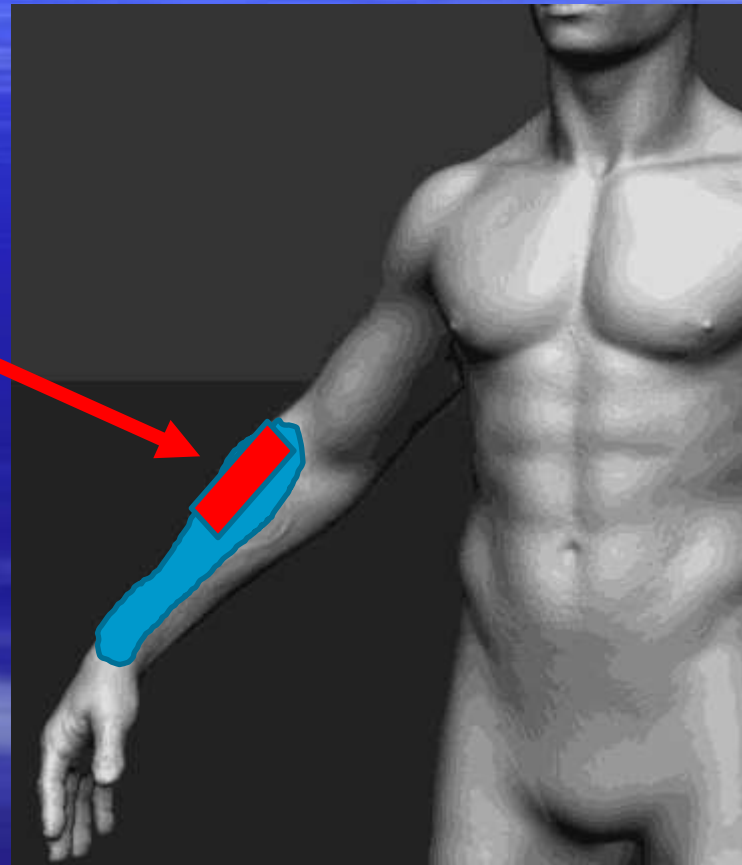


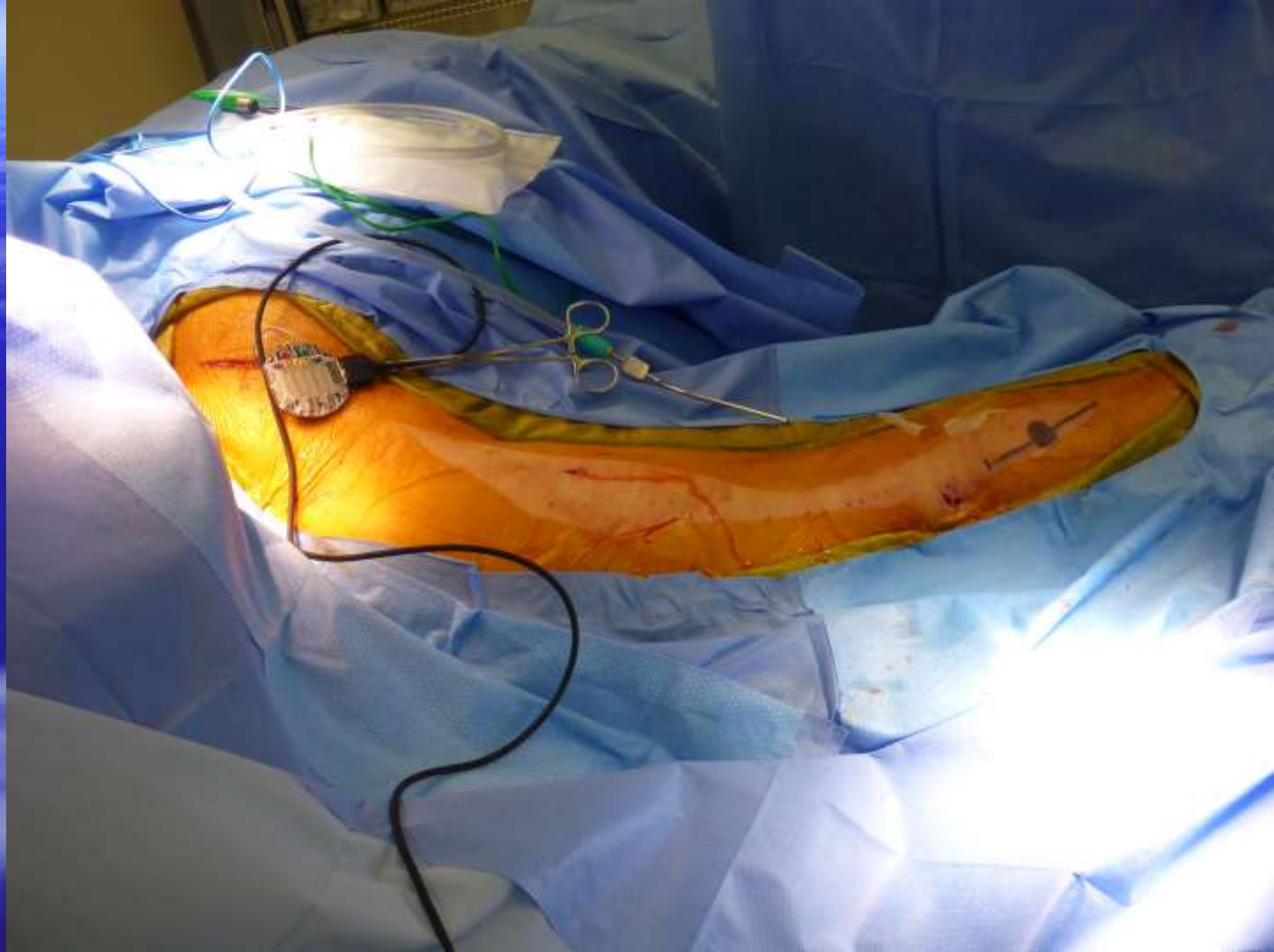


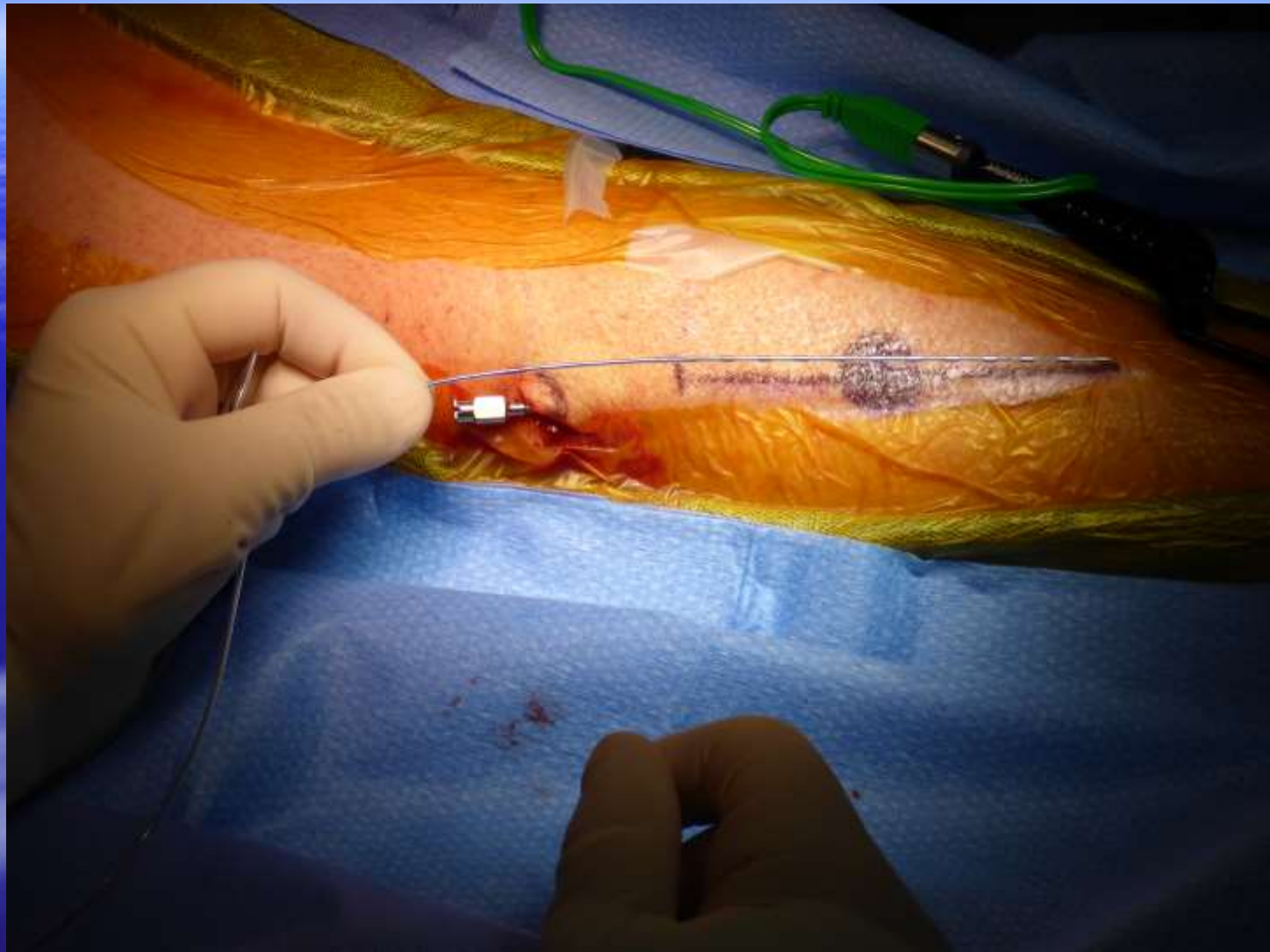


Pain in Musculo-Cutaneous Nerve Distribution

Nerve stimulation
was missing this
area

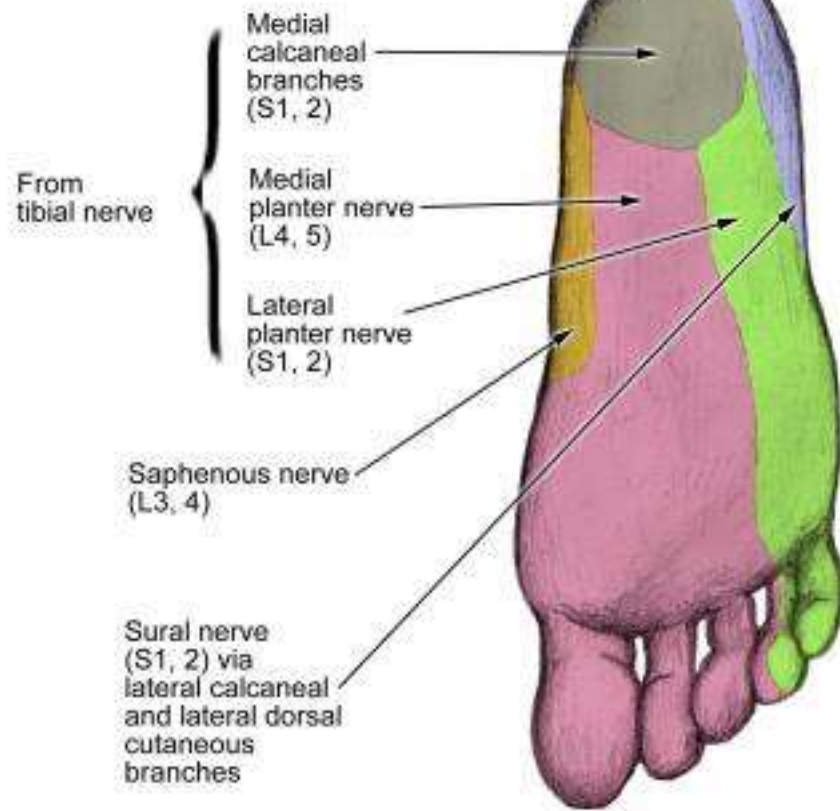








Posterior Tibial Nerve



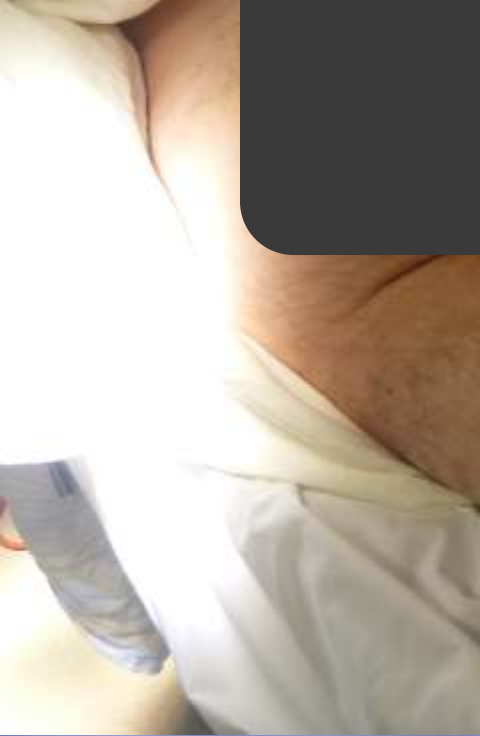


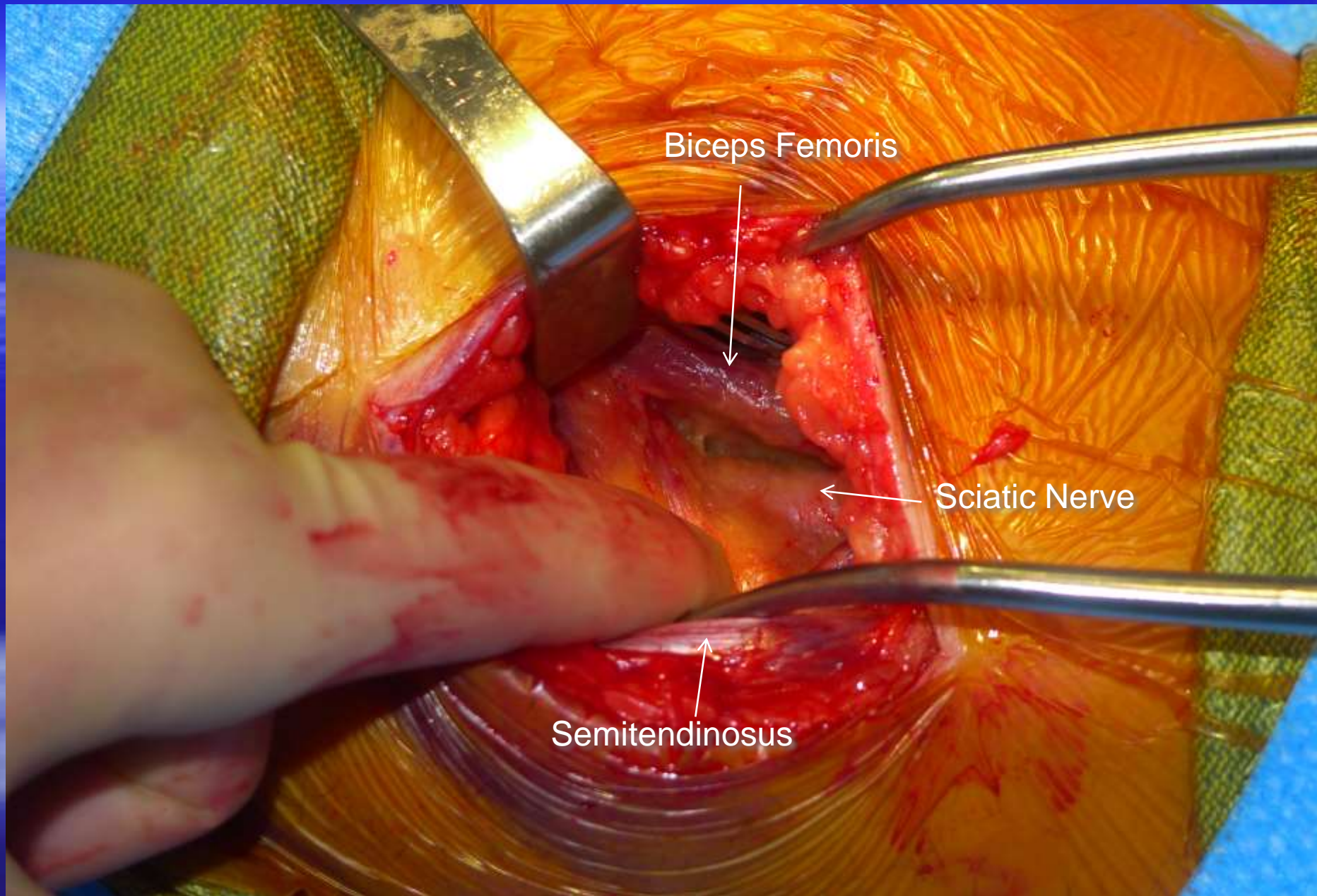
Sciatic Nerve



**Pain in L5 S1
Distribution
Below the
Knee**



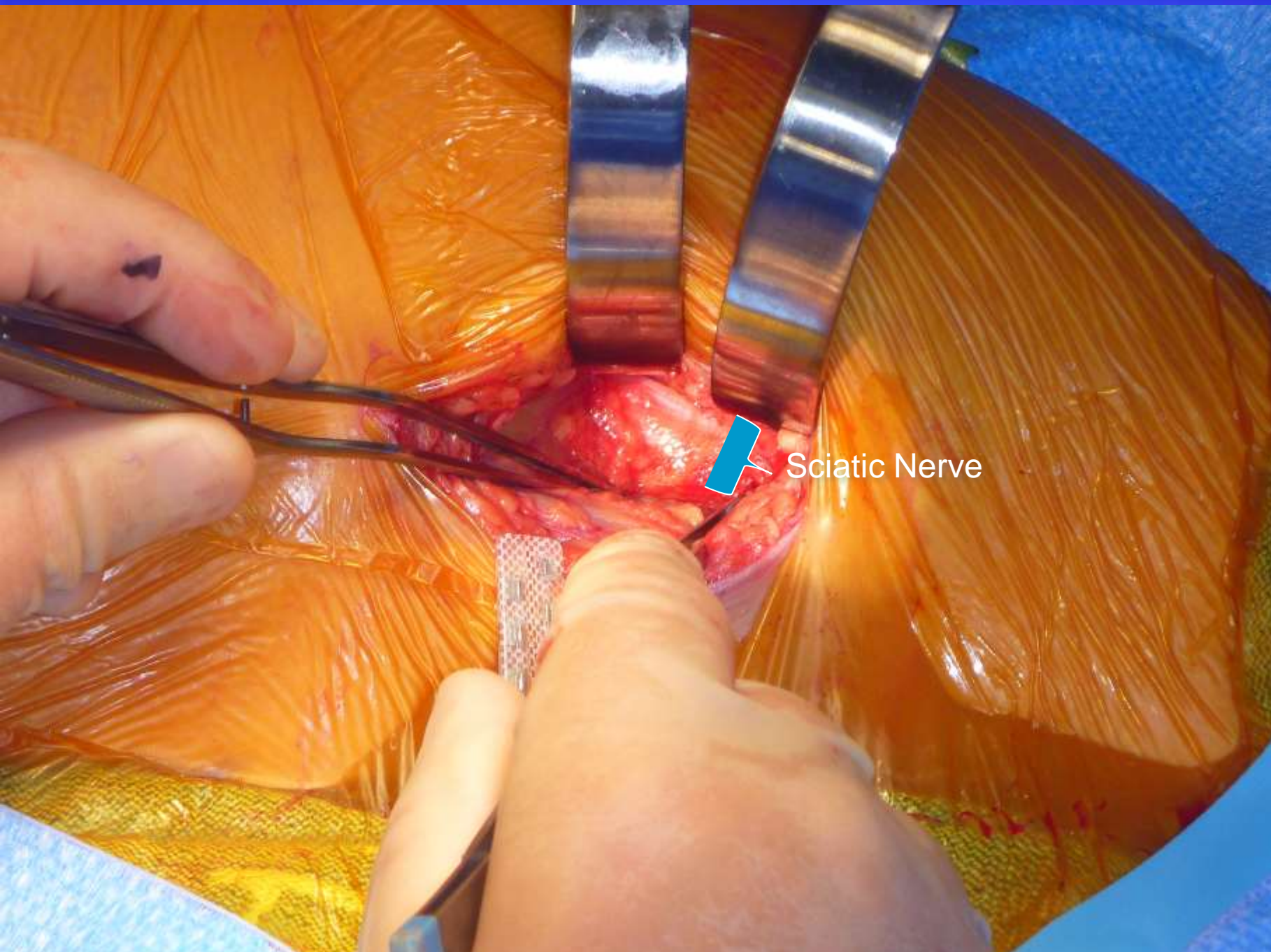




Biceps Femoris

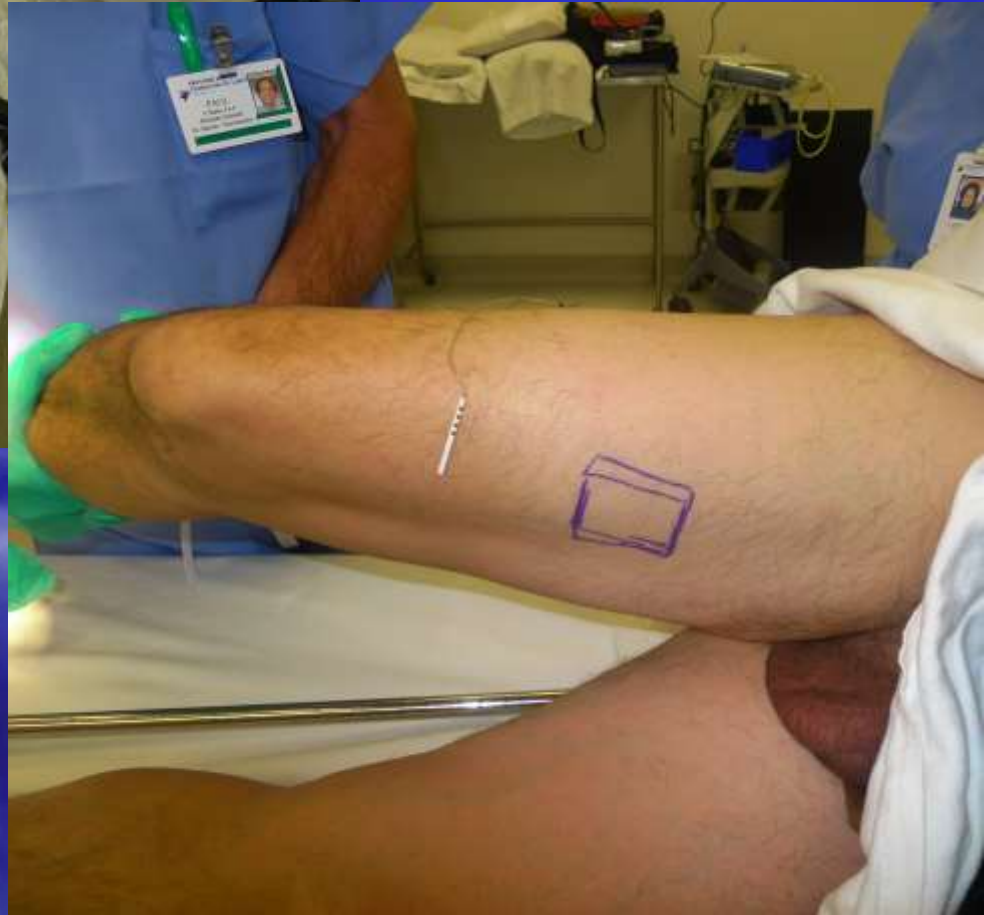
Sciatic Nerve

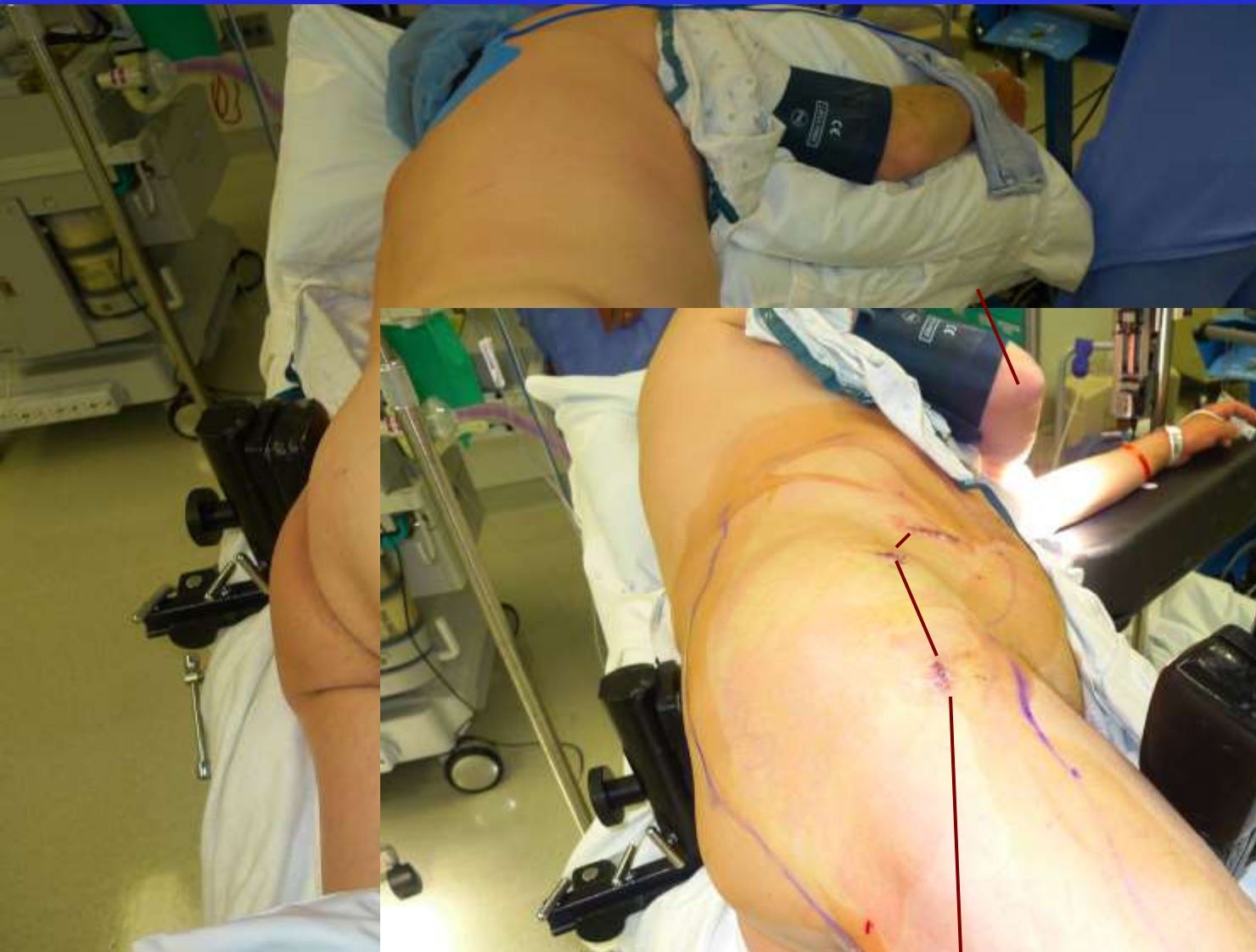
Semitendinosus

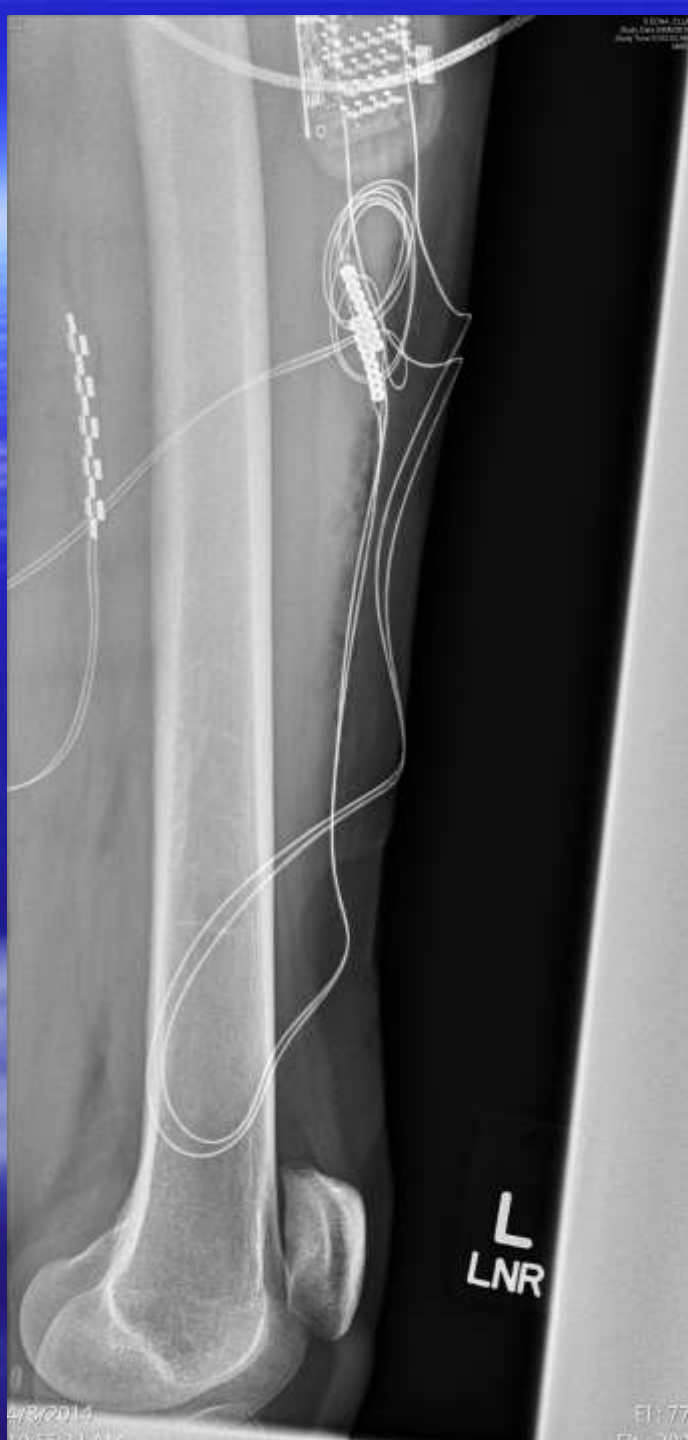


Sciatic Nerve





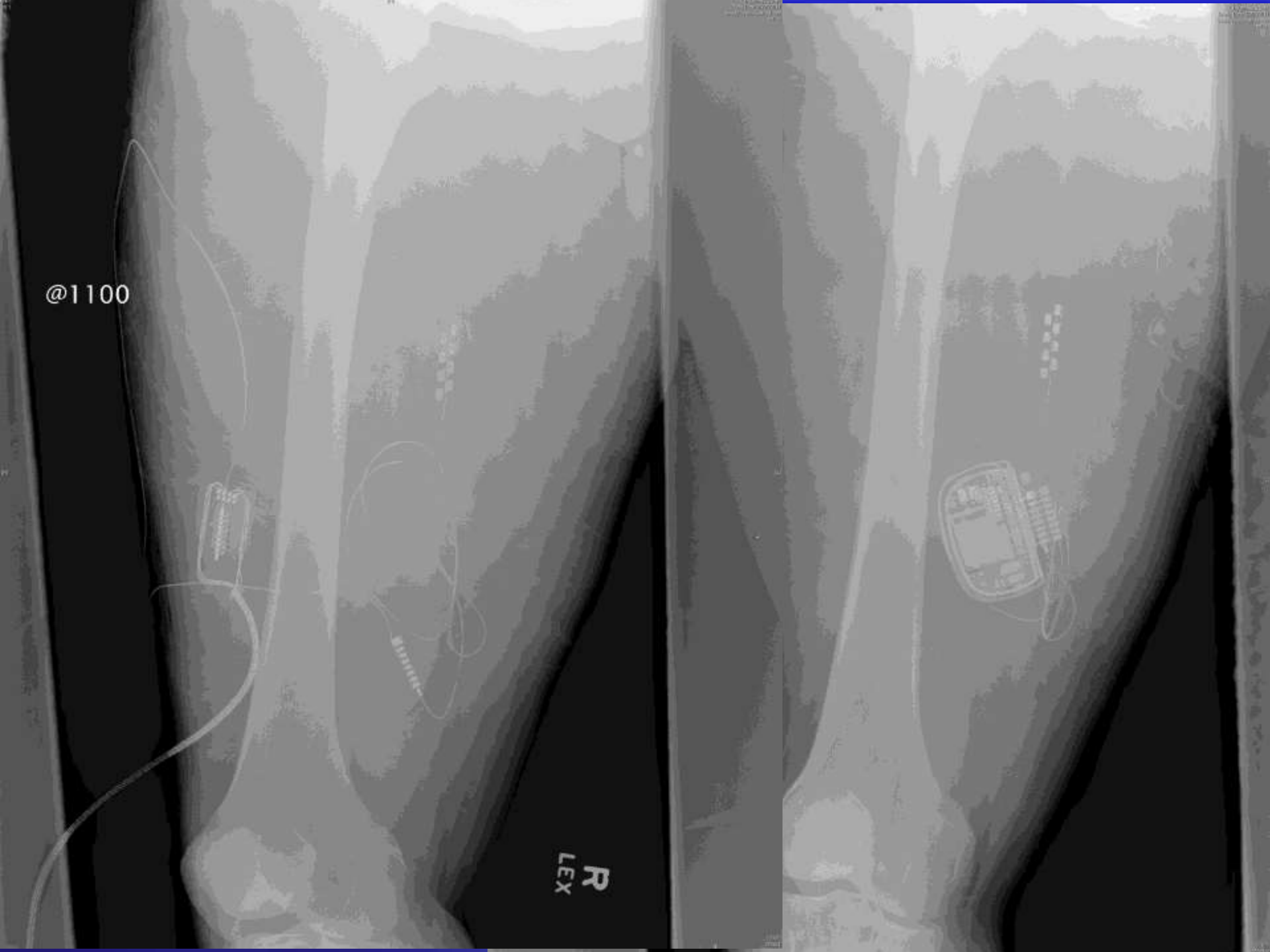






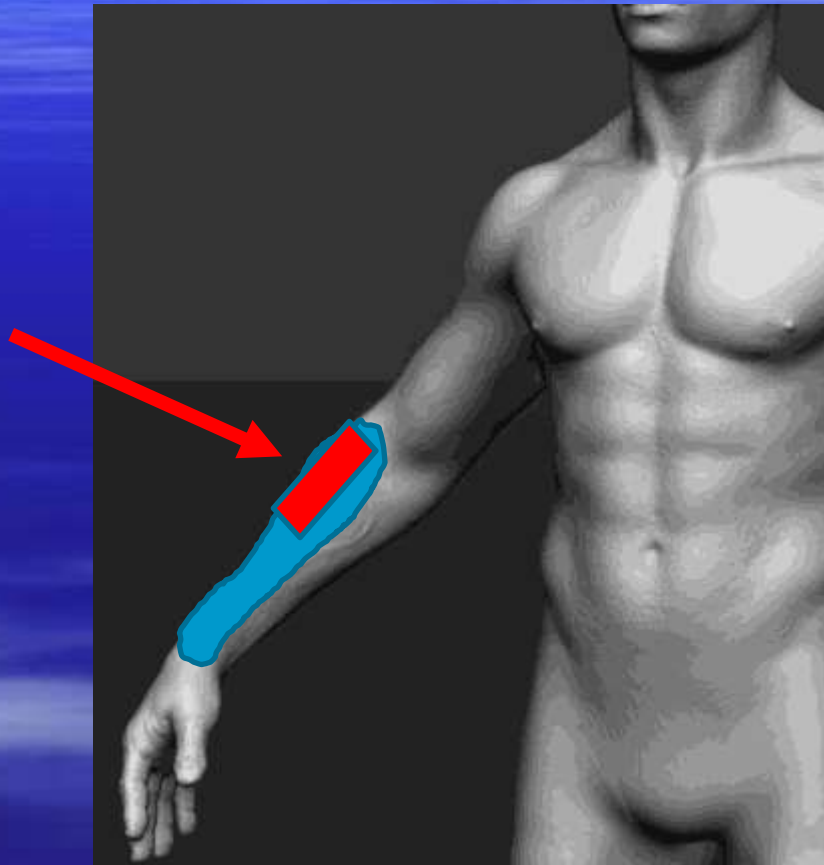
@1100

R
LEX



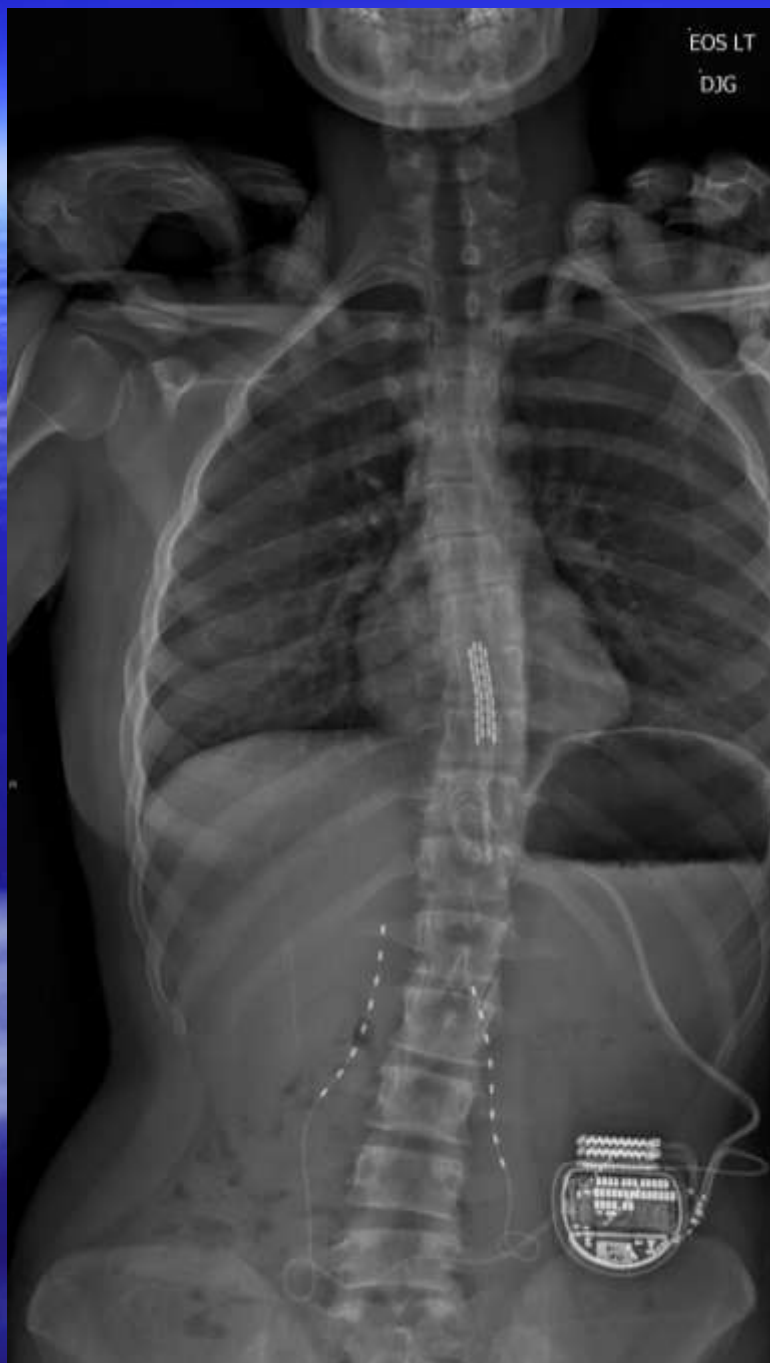
Pain in Musculo-Cutaneous Nerve Distribution

Nerve stimulation
was missing this
area



Combined SCS and PNfS

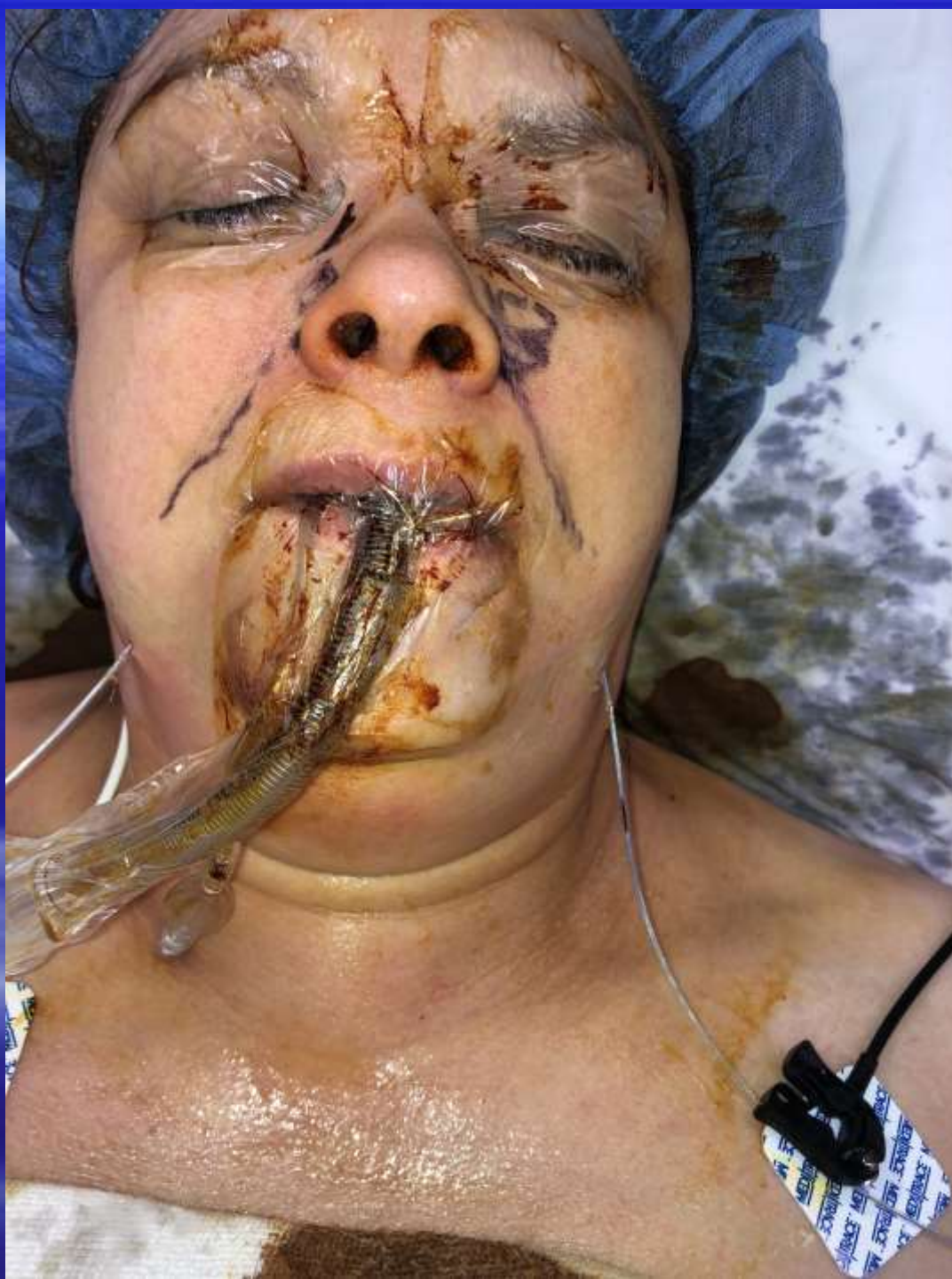
- 22 y/o
- Multi-level thoracic and lumbar spine degenerative disease
- Intractable pain in the lower/mid/upper lumbar area and both lower extremities



FACIAL PAIN
SECONDARY TO
MANY SINUS
SURGERIES









TESTICULAR PAIN



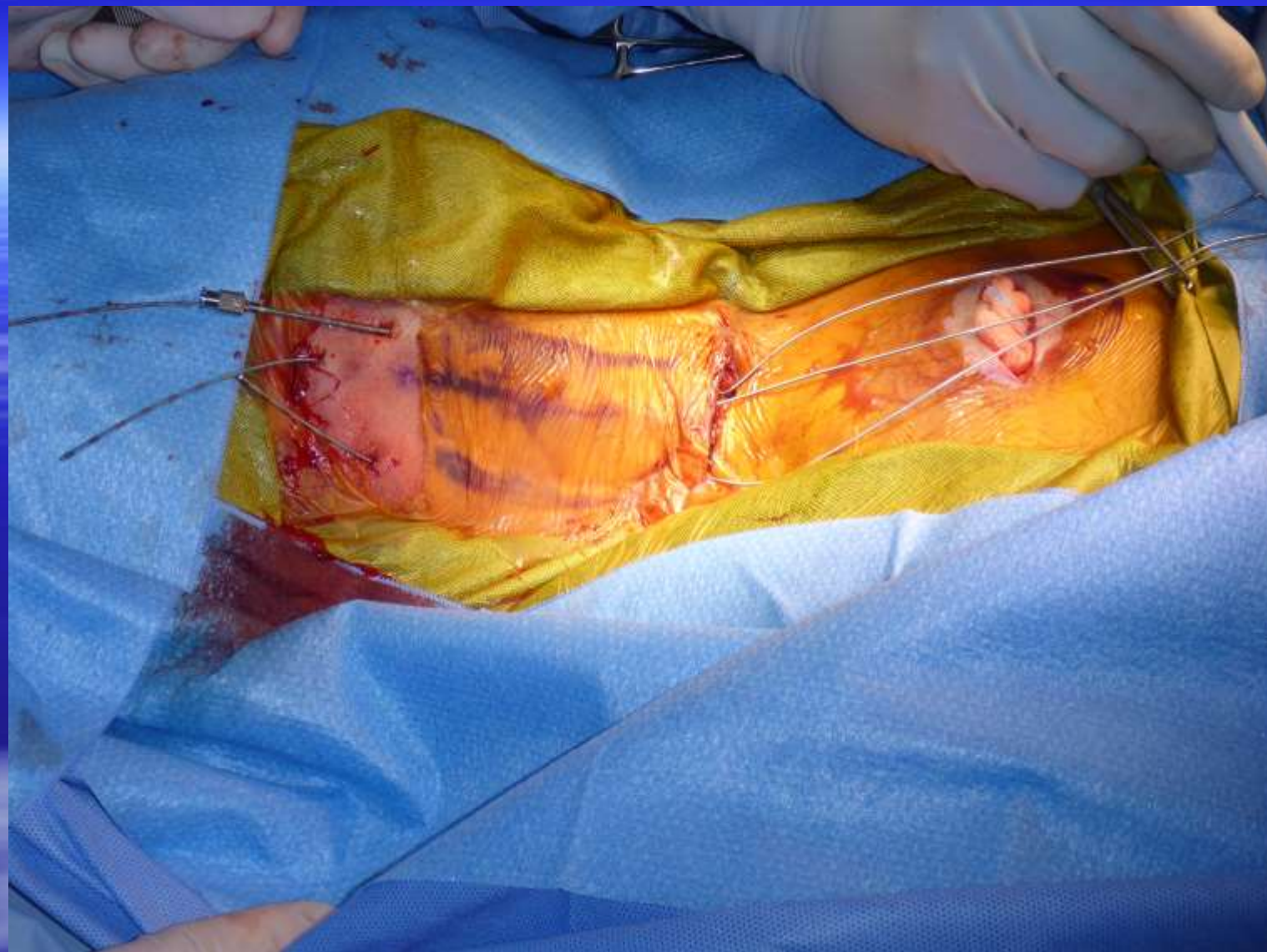






INTRACTABLE NECK PAIN
FOLLOWING
RADICAL NECK DISSECTION
FOR THYROID CANCER



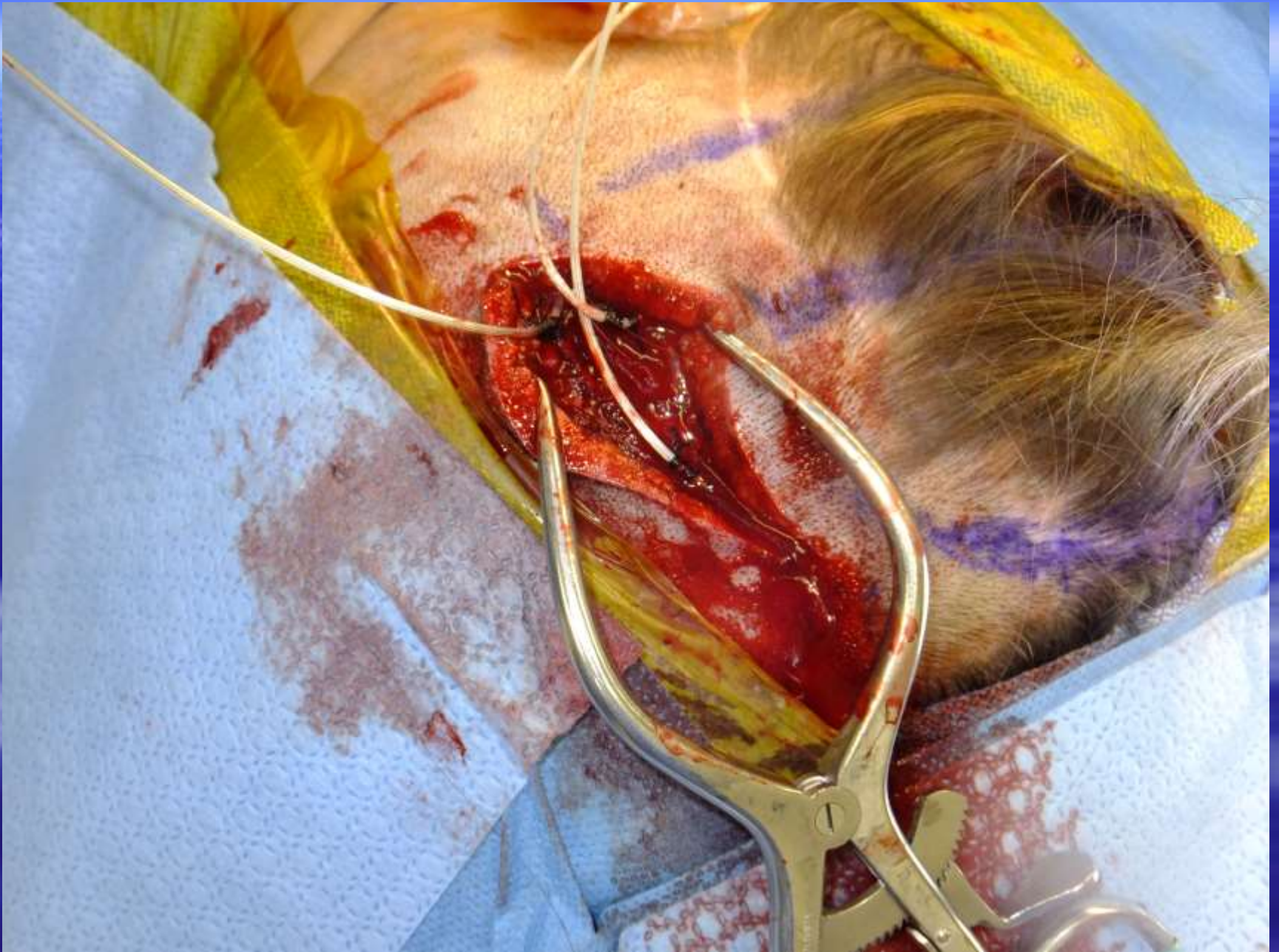


SEVERE POST
FRONTAL
CRANIOTOMY
PAIN

Severe Post- Frontal Craniotomy Pain



Severe Post- Frontal Craniotomy Pain



Severe Post- Frontal Craniotomy Pain



1050

PORT @ 1050 X-TABLE



**What is the
Biggest
Challenge
with PNS?**

REIMBOURSEMENT

THANK YOU

Gbarolat@gmail.com