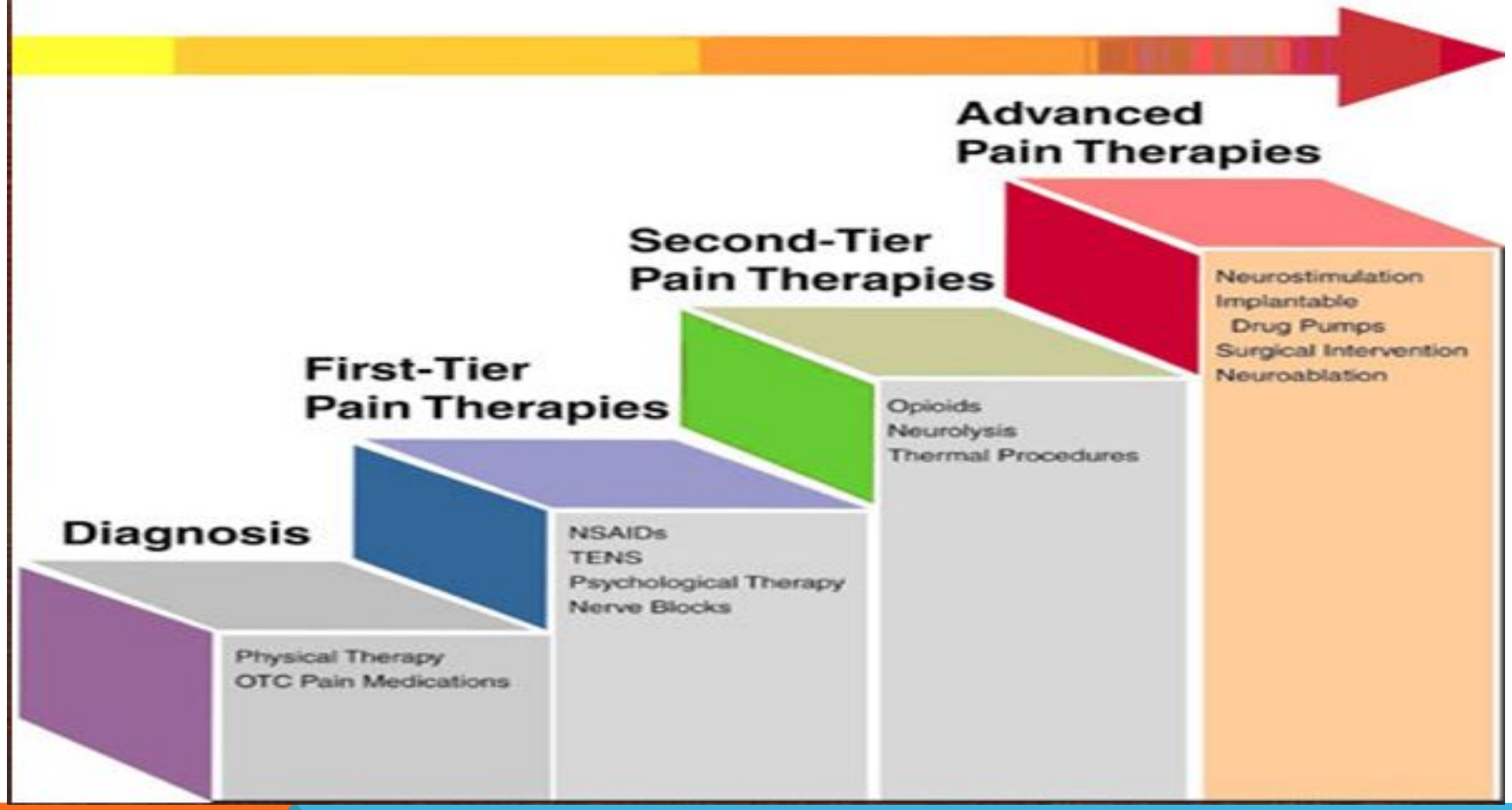
DR. RANDALL DRYER

SPINAL CORD STIMULATION

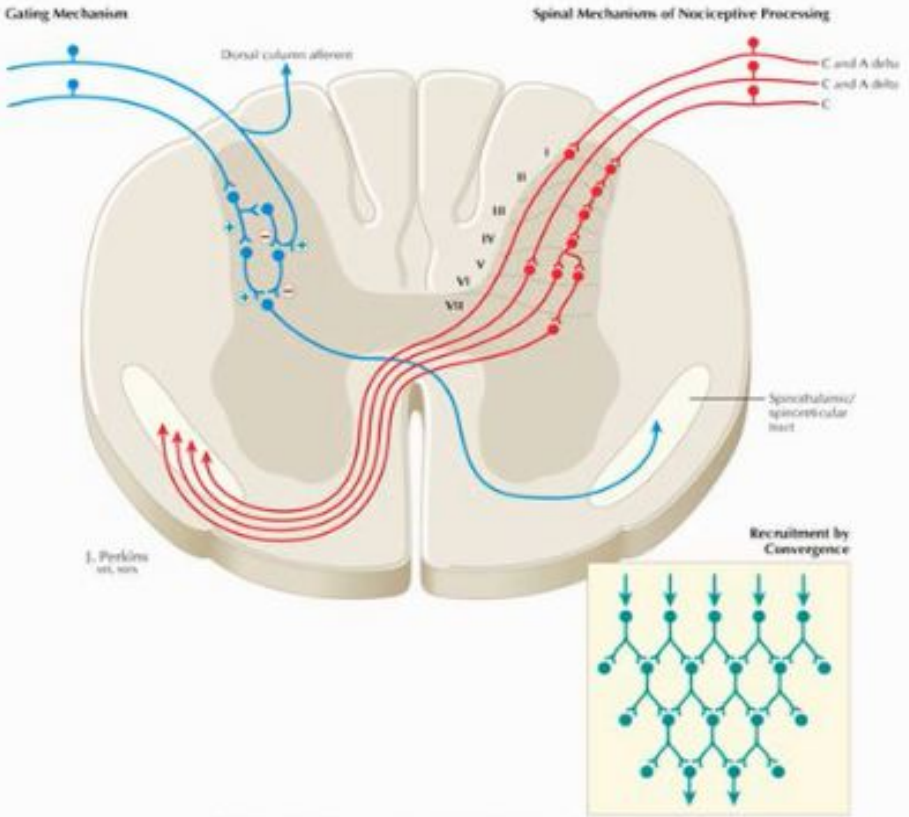
UTAH 2018

The Chronic Pain Treatment Continuum



Gate Control Theory of SCS

- Originally derived from gate control theory by Melzack and Wall
- Peripheral stimulation of Aβ fibers leads to activation of inhibitory interneurons and subsequent inhibition of second order nociceptive neurons in the dorsal horn
- Expanded to electrical stimulation of the dorsal column with production of paresthesia

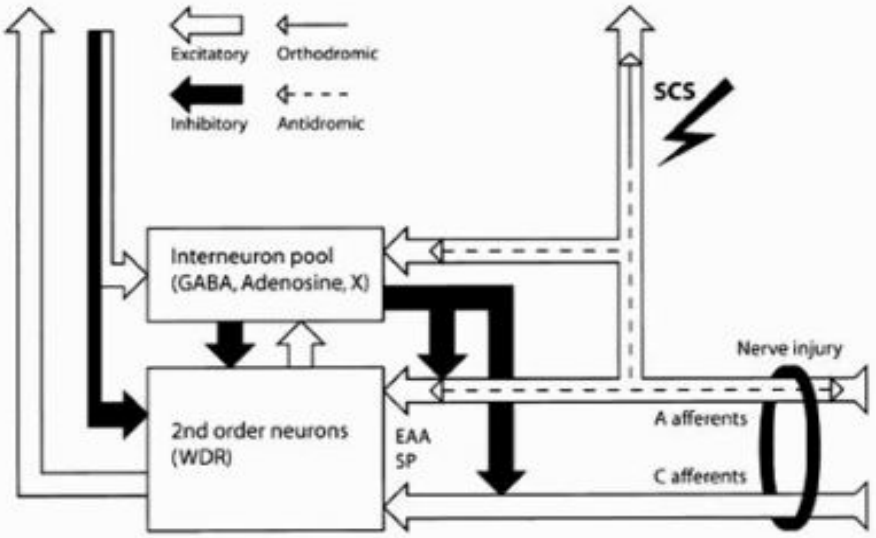


HISTORY OF SPINAL CORD STIMULATION

- **Melzaclk and Wall proposed the Gate Control Theory in 1965. The theory proposed that nerves carrying painful peripheral stimuli and nerves carrying touch and vibratory sensation both terminate in the Dorsal Horn.**
- **Shealy is credited with the first ever Dorsal Column stimulator implant in 1967. He used a single cathode electrode in a terminal lung cancer patient. The patient died three days after implantation due to endocarditis with cerebral embolism that resulted in paraparesis and death.**
- **Due to the short duration of the implant it could not be deemed a complete success. However, it generated much more interest in the procedure due to the reported reduction in pain.**

Neurophysiologic Mechanisms of SCS

- SCS increases dorsal horn inhibitory neurotransmitter $GABA_B$, while decreasing excitatory amino acids Glutamate and Aspartate
- Activation of descending somatosensory control pathways through release of Serotonin, Norepinephrine, Adenosine
- Suppression of sympathetic activation by modulation of α-adrenoreceptors and antidromic release of calcitonin gene-related peptide (CGRP) and Substance P
- Modulation of WDR neurons



Meyerson et al, *Journal of Pain and Symptom Management*, April 2006, Vol 31, No 4S

SCS TIMELINE

- **1965-Melzack and Wall**
- **1967-Shealy**
- **1978- Medtronic introduces a percutaneously inserted epidural electrode for permanent use**
- **1978-1998– Medtronic only real player in SCS**
- **1998- Advanced Neuromodulation System (ANS) formerly Quest Medical hits the scene**
- **2004- Advanced Bionics introduces the first rechargeable IPG**
- **2005- St. Jude Medical acquires ANS**
- **2006- Boston Scientific acquires Advanced Bionics**
- **20015- Nevro receives FDA approval for 10khz therapy**

EARLY DIFFICULTIES

- **Not many contacts to work with on the leads**
- **Percutaneous lead placement from the trial is very difficult to replicate exactly for the permanent implant**
- **Programming limitations---- relying on individuals to program patients manually without the use of computer algorithms led to diminished effectiveness**
- **No MRI conditionality**
- **Diminished effective therapy over time due to single source voltage and current**

IMPROVED OUTCOMES

- **Up to 32 contacts can now be used**
- **More contacts and programming algorithms now allow for AXIAL LOW BACK coverage in addition to neuropathic pain symptoms.**
- ***Perm Trials (Paddle leads-open surgery) No longer have to try and replace linear leads in the exact same location. Can start with a paddle and leave it there with high rates of success.**
- **Wide range of MRI conditionality now exists**
- **Multiple Independent Current Control (Boston Scientific only) now allows for continued therapy over a much longer period of time.**

MAIN PLAYERS IN SCS TODAY

- **Boston Scientific**
- **Abbott Medical**
- **Medtronic**
- **Nevro**
- **Nuvectra**
- **Stimwave**
- **Saluda**

MRI COMPATIBLE?

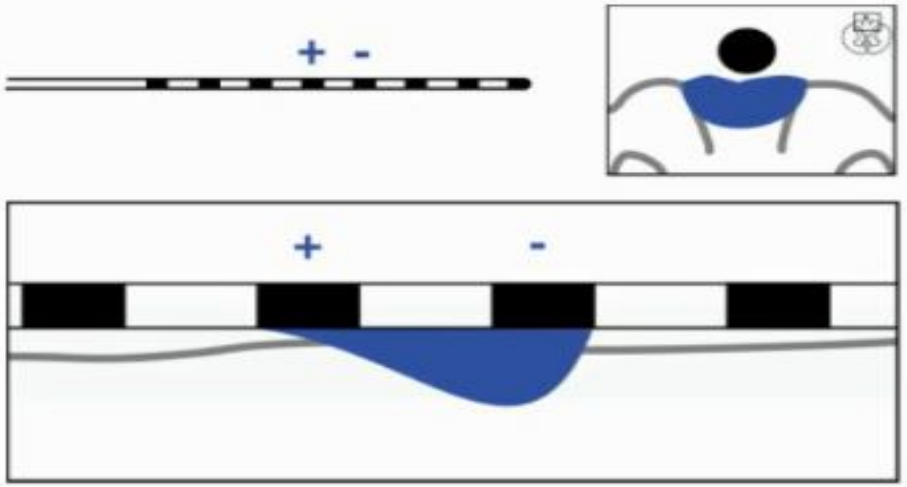
- **YES! GAME CHANGER**
- **Older technologies were not MRI safe**
- **Now through innovation the four main SCS companies: Boston Scientific, Abbott, Medtronic, and Nevro all have full body MRI capabilities**
- **This allows physicians the ability to provide their patients with great pain relief perhaps at a younger age**
- **Further work up and surgery can be done if SCS fails**

THERAPY OPTIONS I.E. WAVEFORMS

- **Waveforms are the patterns of electrical impulses that are delivered to the nerves that provide the patients with pain relief**
- **Paresthesia- has always been the gold standard. It blocks the pain signals to the brain and replaces them with a "tingling" or "vibrating" sensation**
- **Sub-Paresthesia- much newer waveform for pain relief. It provides pain relief without giving the patient any "tingling" or "vibrating" sensations**
- **Forms of Sub-Paresthesia: High Frequency, Burst DR, Micro-Burst**

Electrophysiologic Mechanisms of SCS

- Current flows from Cathode (-) to Anode (+) resulting in neuronal depolarization at Cathode (-) and hyperpolarization at Anode (+)
- Electrical parameters are adjusted during programming including electrode polarity, Frequency (Hz), Amplitude (V or ma), and Pulse Width (µs)
- Potential segmental conductance blockade of spinothalamic tracts



FBSS

- Chronic Pain
- DDD
- Post Laminectomy Syndrome
- Sciatica
- Neuropathy
- Arachnoiditis

NEUROSURGERY

THE REGISTER OF THE NEUROSURGICAL MEME

Spinal Cord Stimulation versus Repeated Lumbosacral Spine Surgery for Chronic Pain: A Randomized, Controlled Trial

Richard B. North, M.D. ✉, David H. Kidd, M.A., Farrokh Farrokhi, M.D., Steven A. Piantadosi, M.D., Ph.D.

Neurosurgery, Volume 56, Issue 1, 1 January 2005, Pages 98–107,

SCS Indications

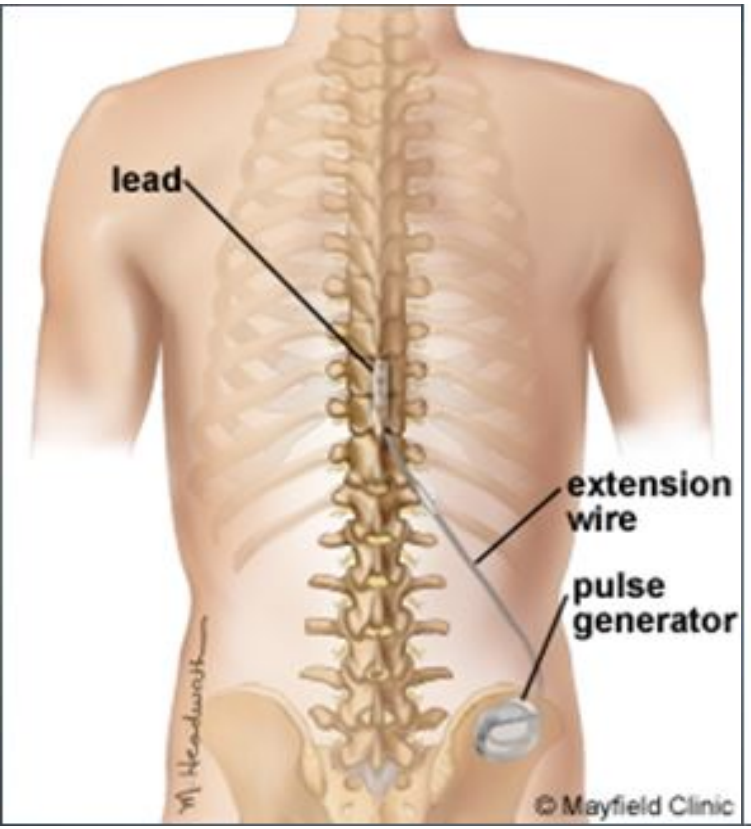
- Indicated for the management of chronic and intractable pain of the trunk or extremities
- Patients have failed adequate trial of conservative and conventional therapies
- Patients have passed psychological screening
- Common conditions include
  - Failed Back Surgery Syndrome/Post-Laminectomy Syndrome
  - Complex Regional Pain Syndrome (CRPS)
  - Arachnoiditis
  - Chronic Radiculopathy
  - Epidural Scarring or Fibrosis
  - Chronic Neuropathy or Neuralgia
  - Post-Thoracotomy Pain

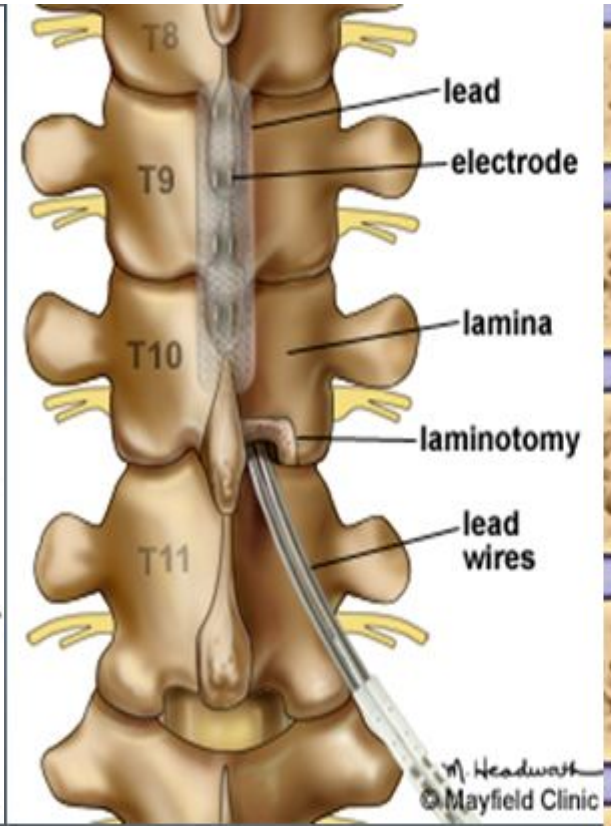
WHAT DID IT FIND?

- **SCS was less expensive and more effective than reoperation in selected failed back-surgery syndrome patients, and should be the initial therapy of choice. SCS is most cost-effective when patients forego repeat operations. Should SCS fail, reoperation is unlikely to succeed.**

PARADIGM SHIFT???

- **Has SCS become a better chronic pain treatment than a reoperation?**
- **MRI Capabilities**
- **Axial Low Back and Radicular pain relief**
- **No Bridges burned if trial not successful**


lead
extension wire
pulse generator
© Mayfield Clinic


T8
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lead
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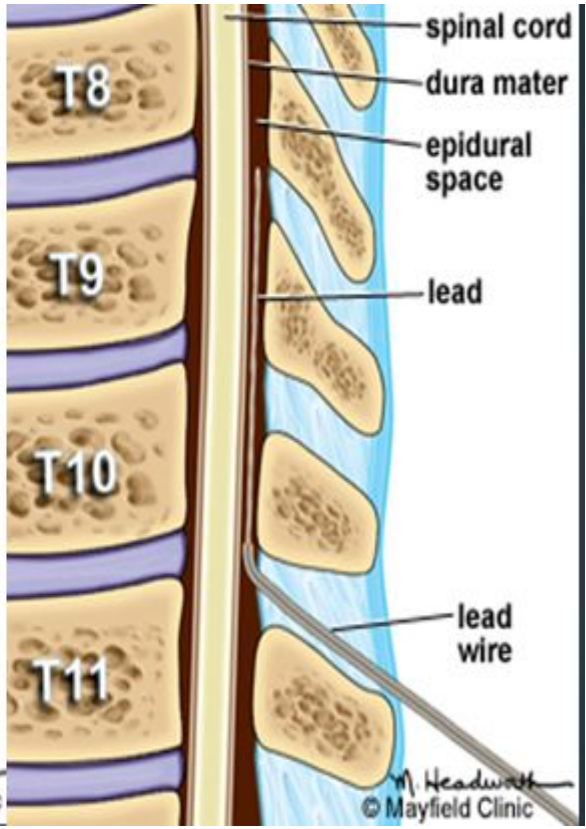
lead wires
© Mayfield Clinic

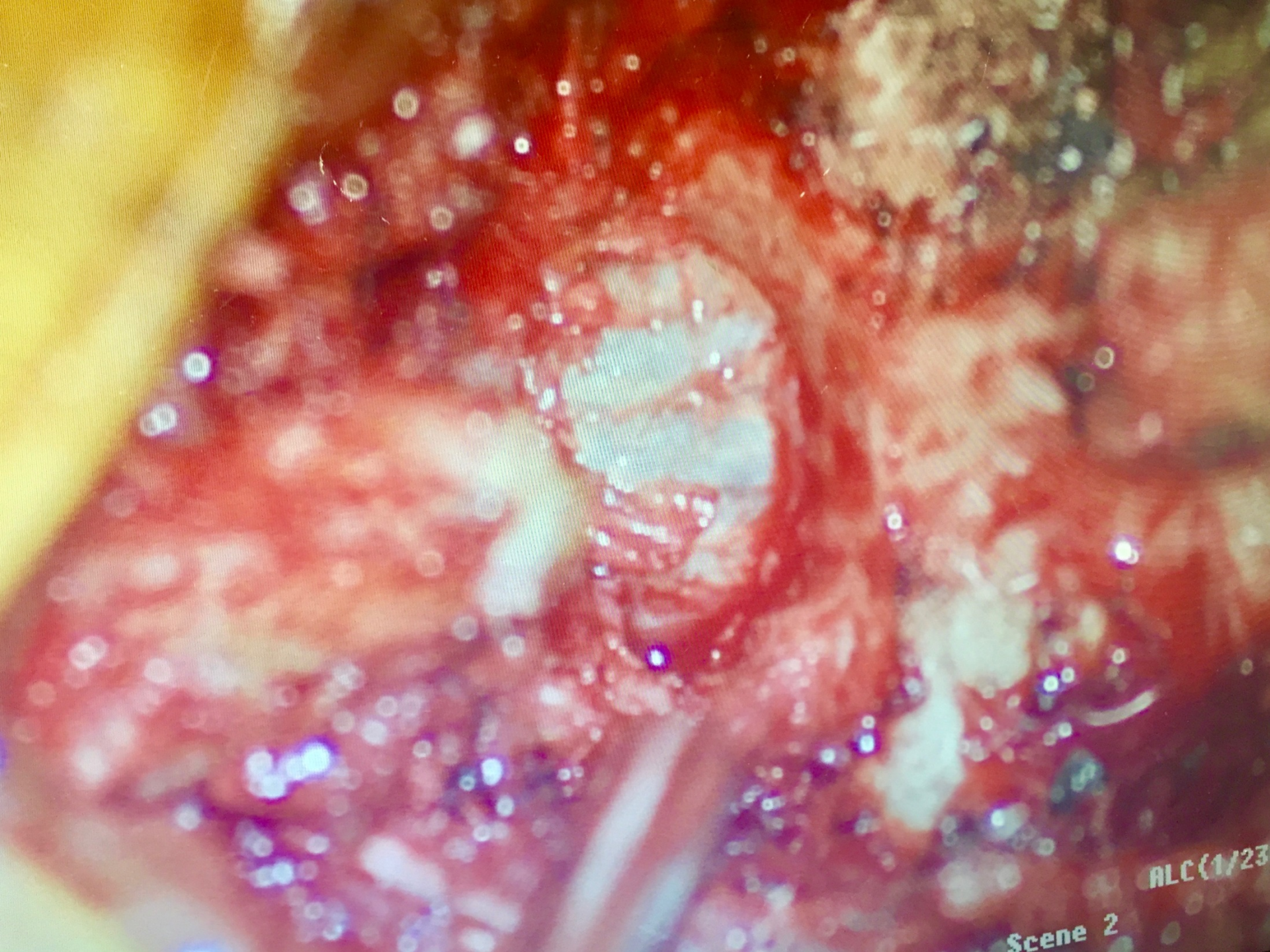

T8
T9
T10
T11
spinal cord
dura mater
epidural space
lead
lead wire
© Mayfield Clinic

SURGICAL TECHNIQUE: FIRST STAGE

1. **Perm Trial : Open placement of paddle leads**
2. **Count Levels and mark skin using flouroscopy**
3. **Make midline incision ;T9-10**
4. **Laminotomy**
5. **Insert Paddle; top of paddle at mid to upper T7 vertebral body**
6. **Test Impedances and Paresthesia by connecting to temporary connection**
7. **Suture leads to bony lamina**
8. **Pocket incision in the sub- Q over the flank**
9. **Tunnel from pocket incision to the thoracic incision and pass leads**
10. **Connect Extensions then tunnel to a stab incision and bring extension leads out through skin**
11. **Connect cables**
12. **Close and large dressing**

TRIAL PERIOD: IF SUCCESSFUL, PLACE BATTERY

1. **One Week Duration**
2. **Will be sore at incision sites. Manage Expectations**
3. **Rep Follow Up Daily**
4. **Mid Trial reprogramming→ Decide whether or not to move forward at this point**
5. **Bring them back to the hospital to place battery IPG at the end of the week long trial and remove temporary extension leads**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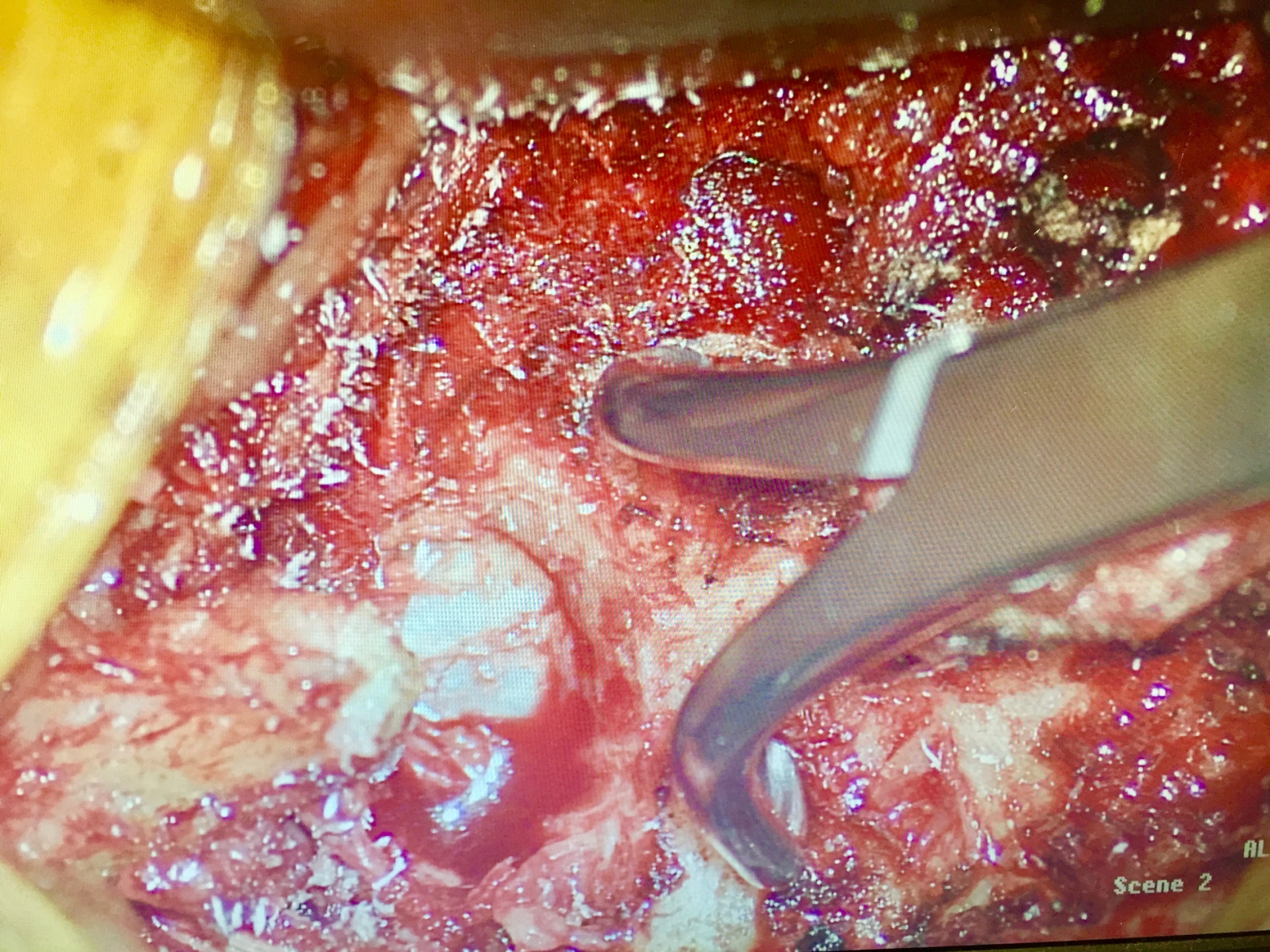
Scene 2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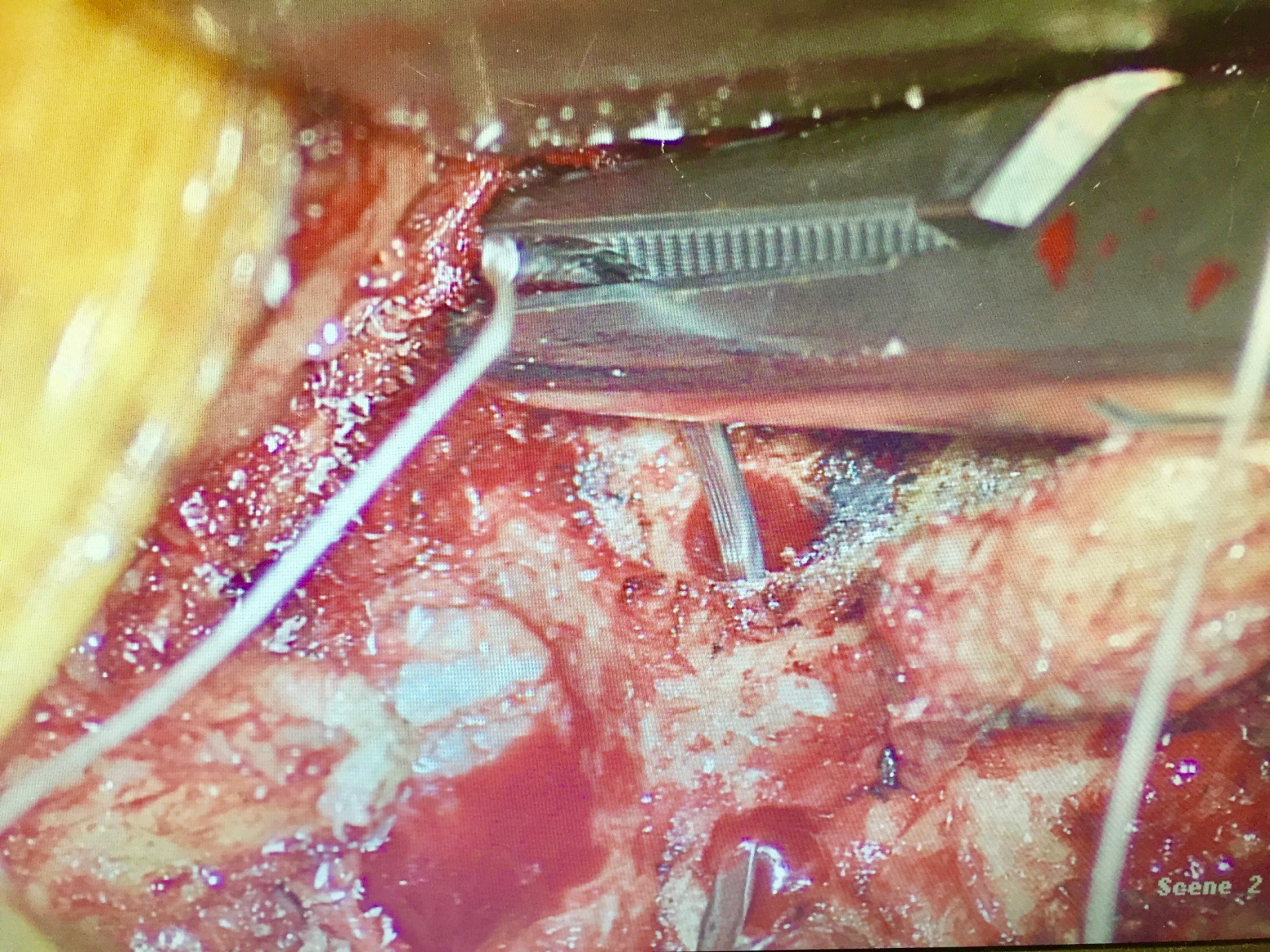
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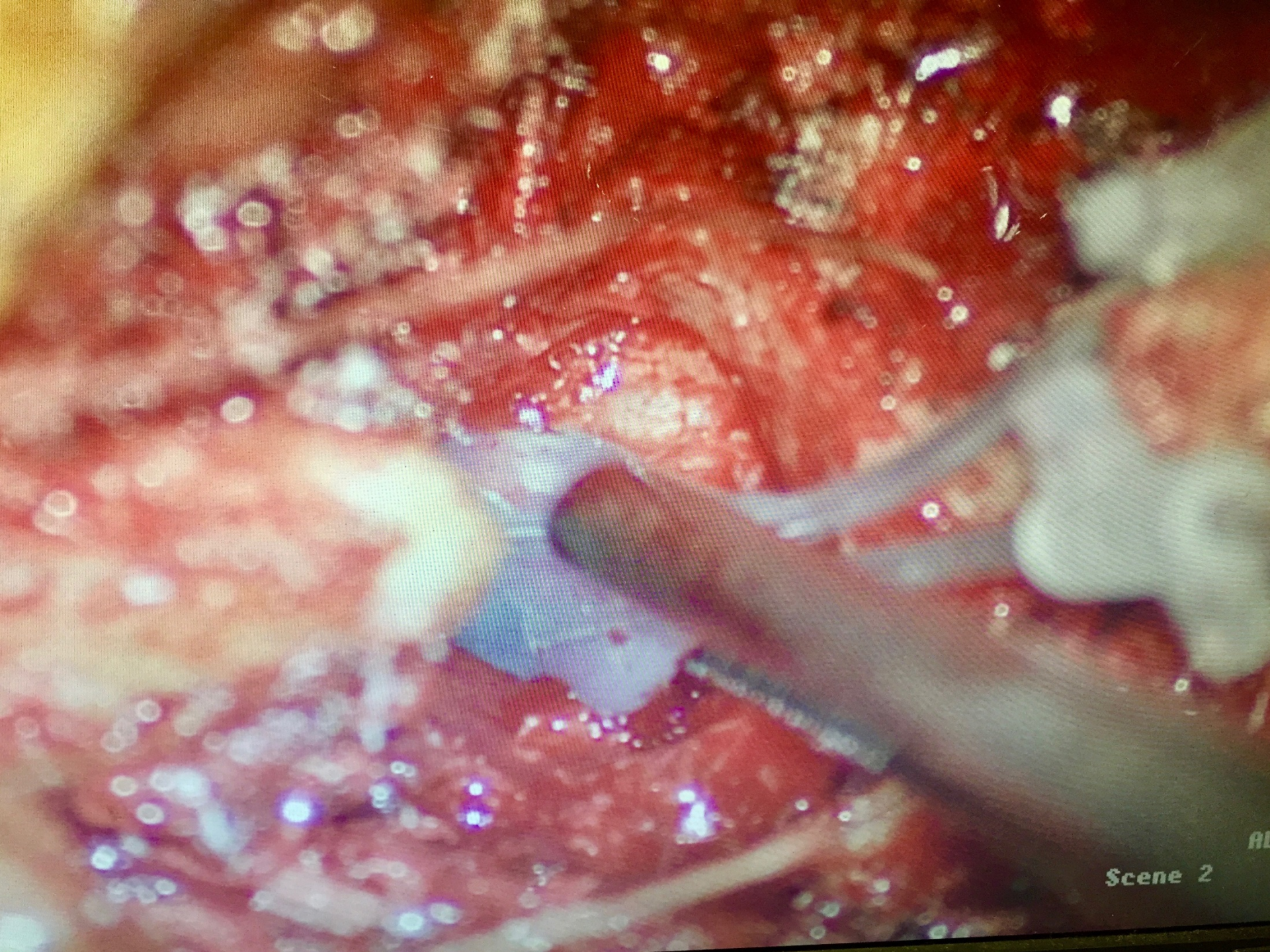
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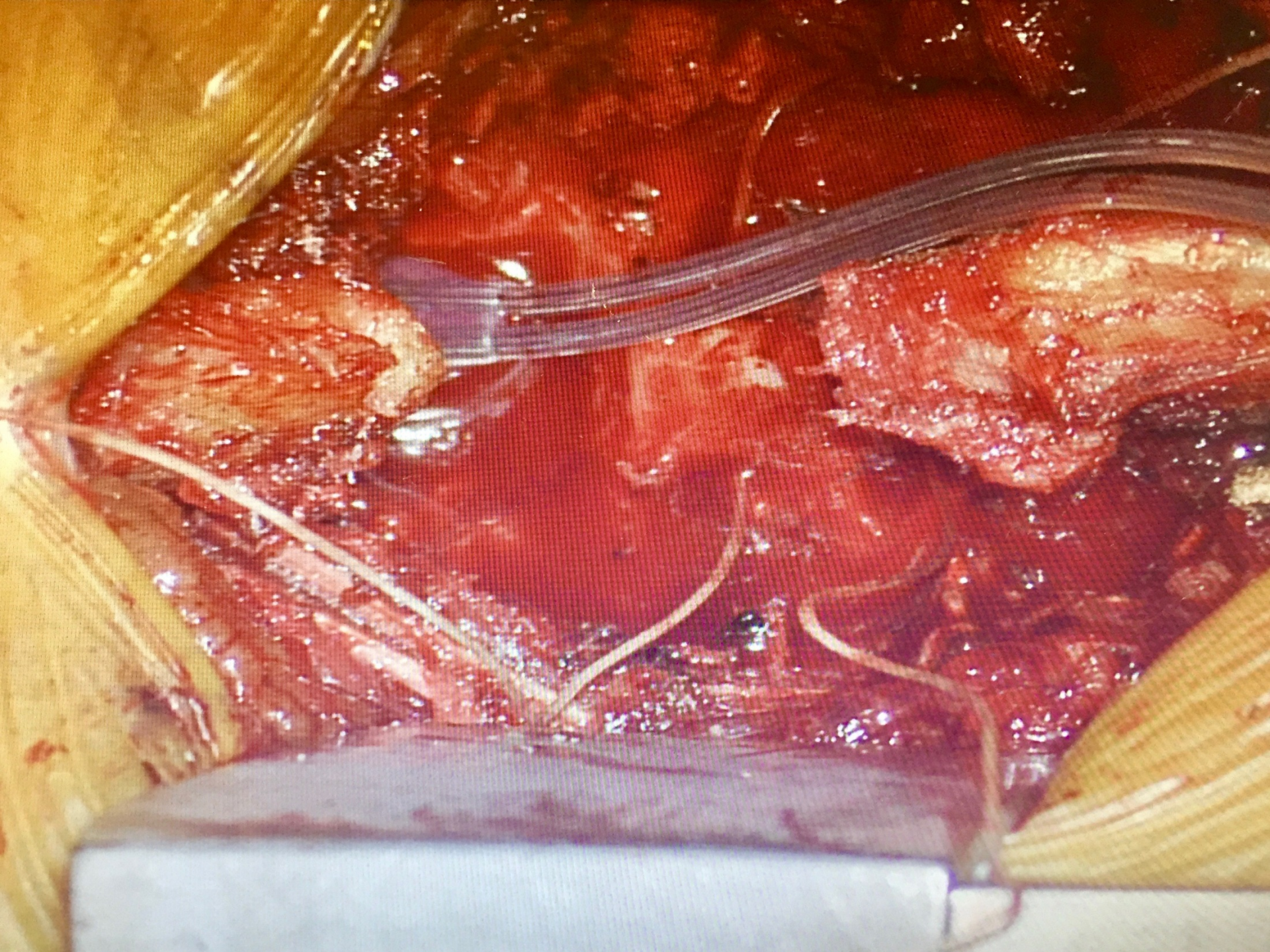

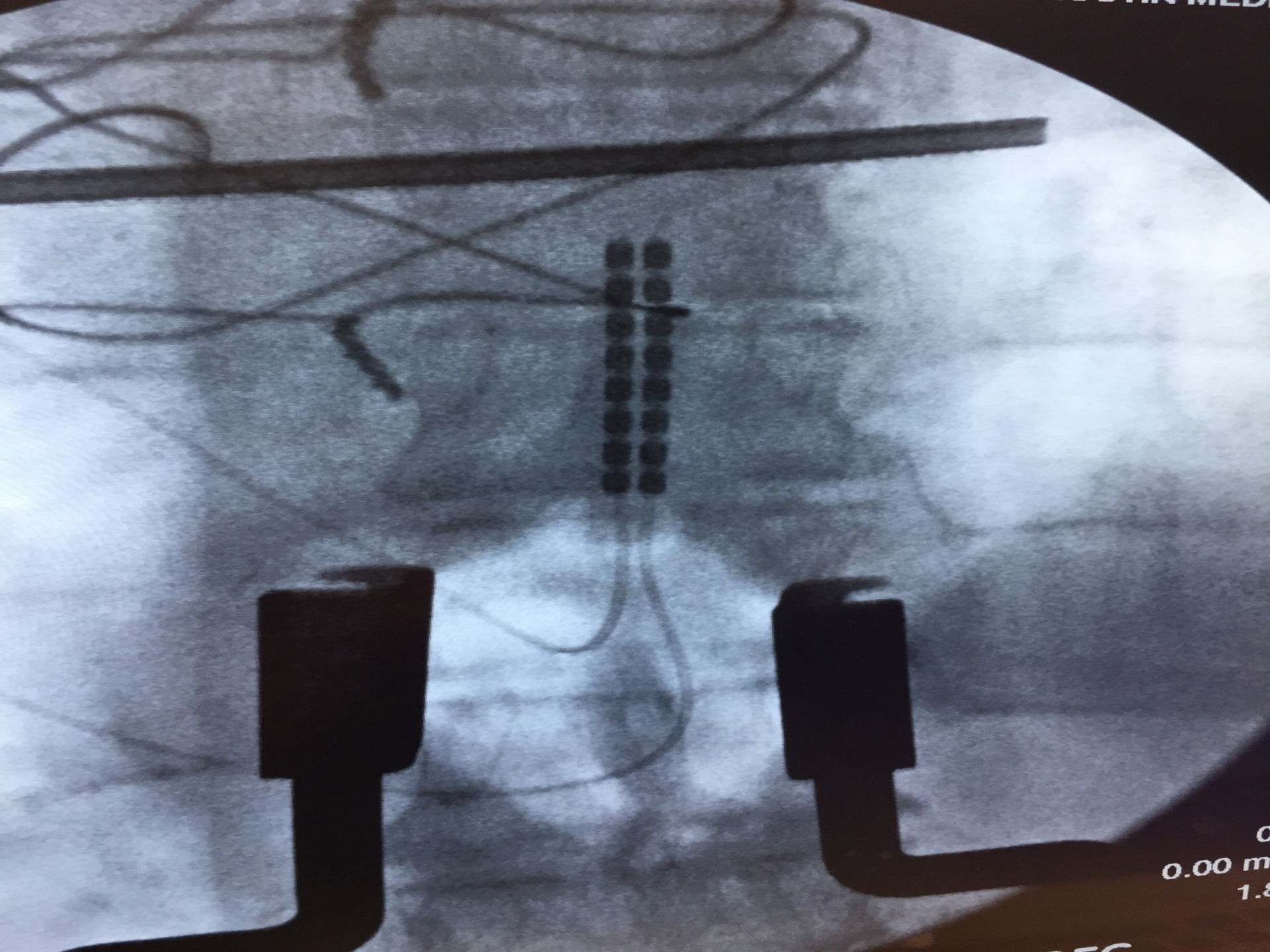

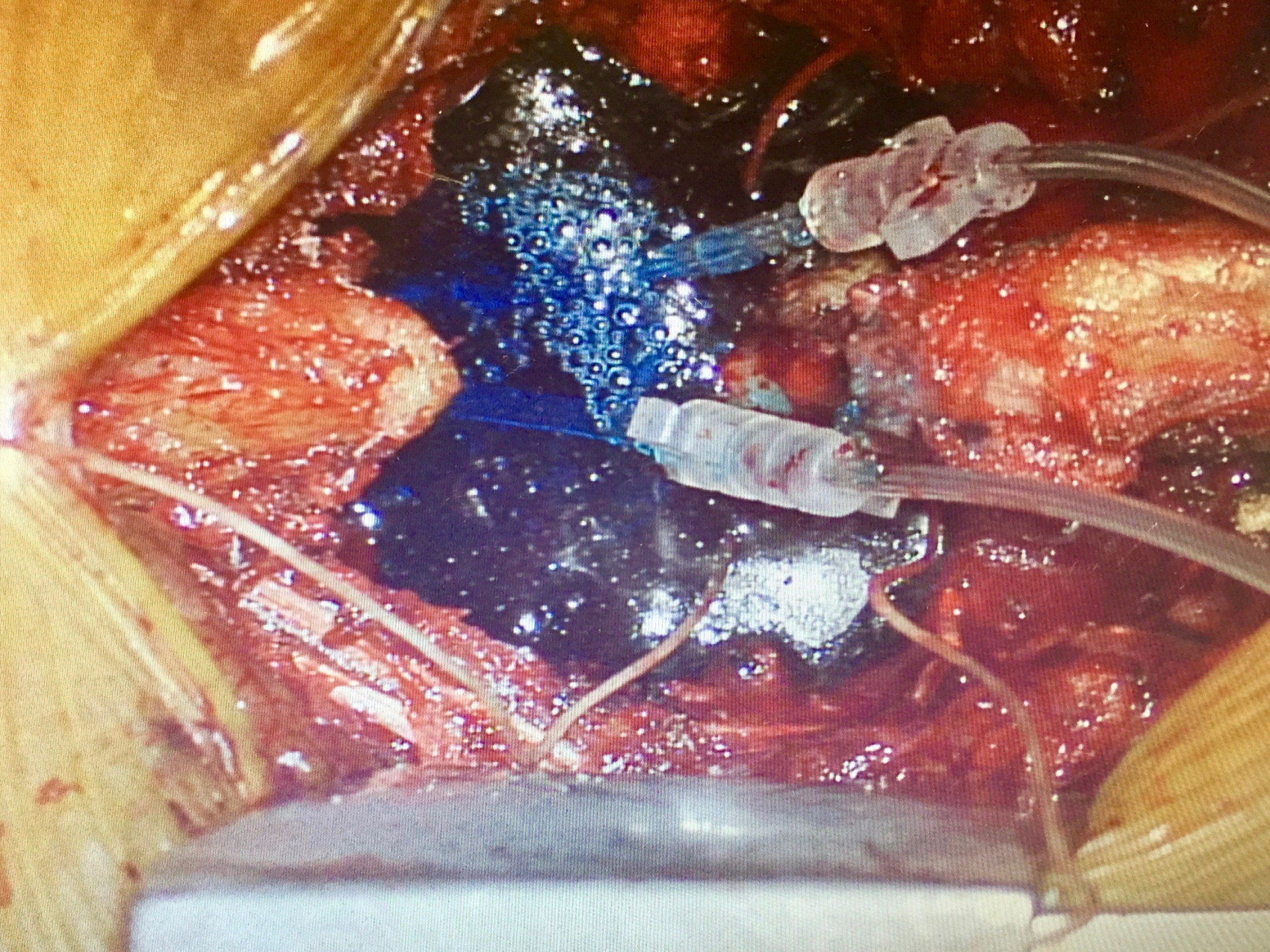

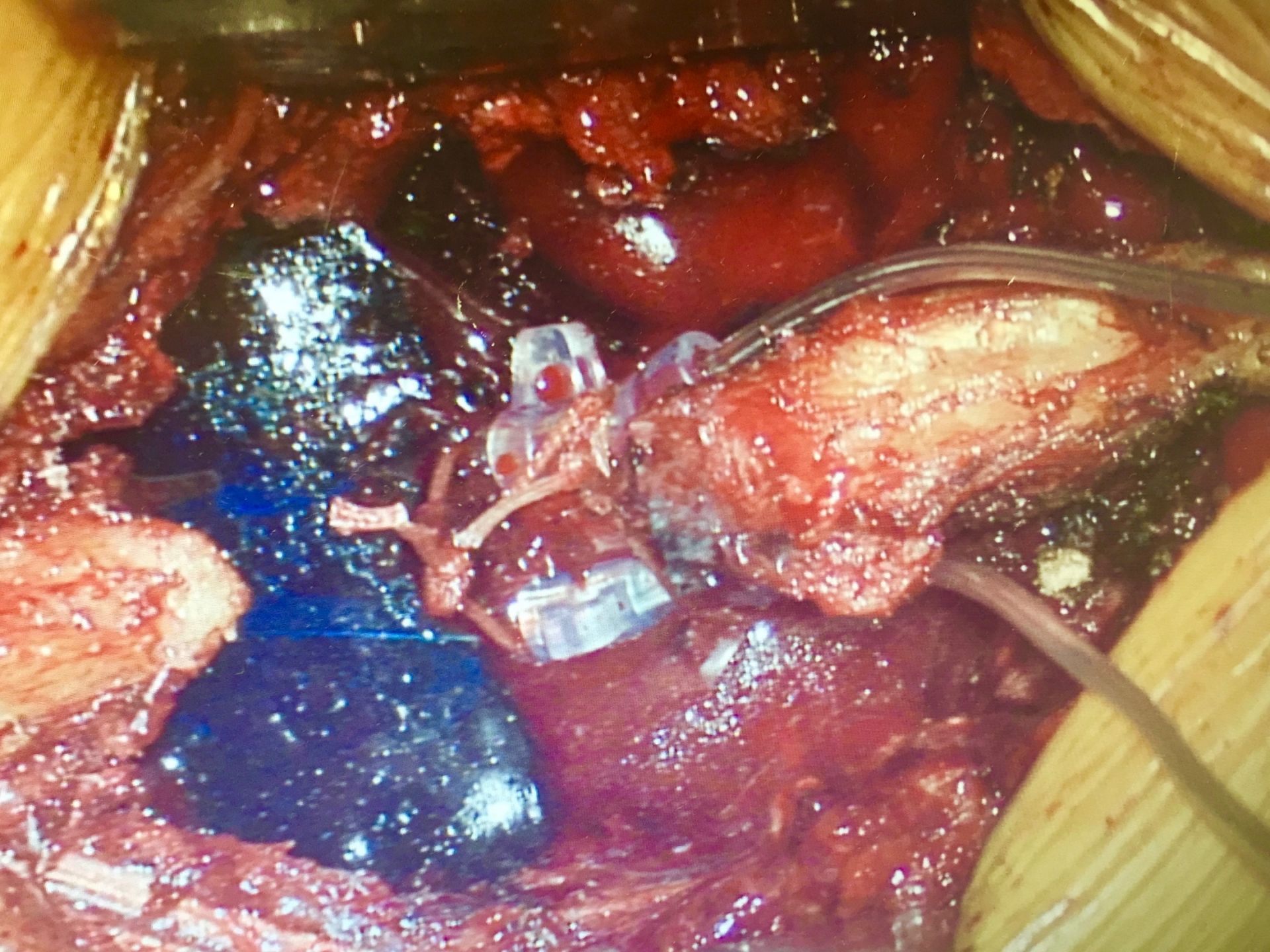

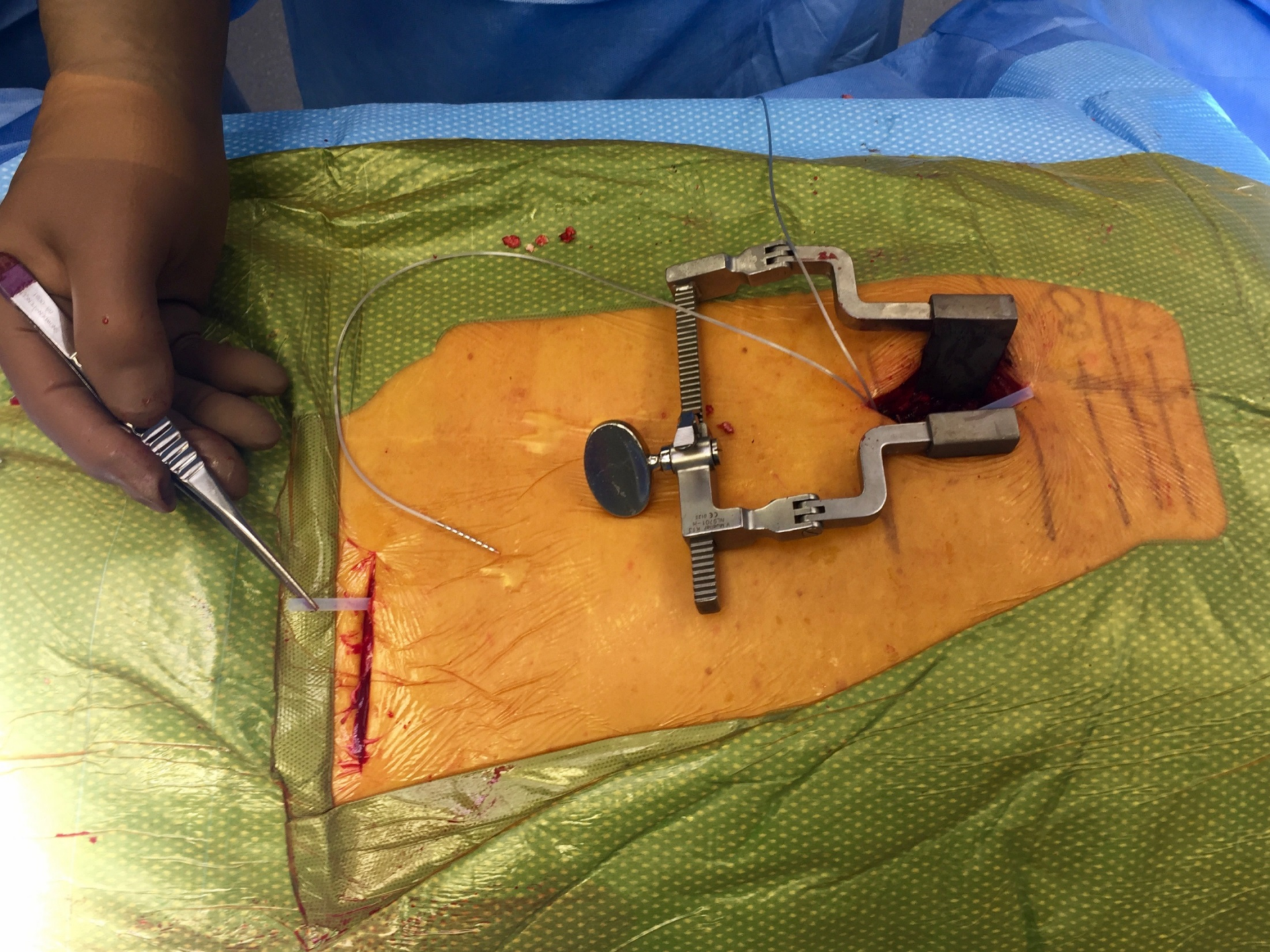

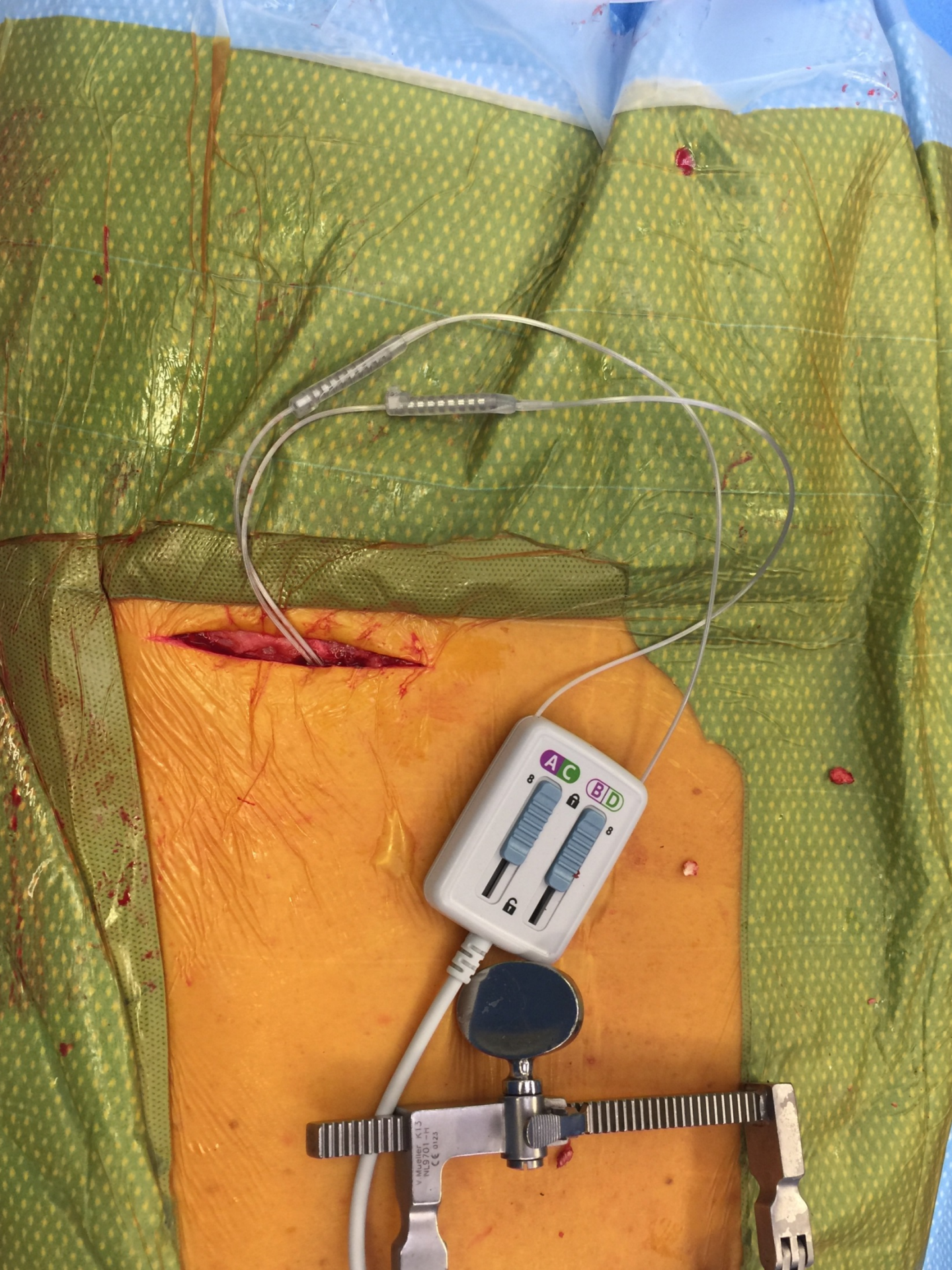
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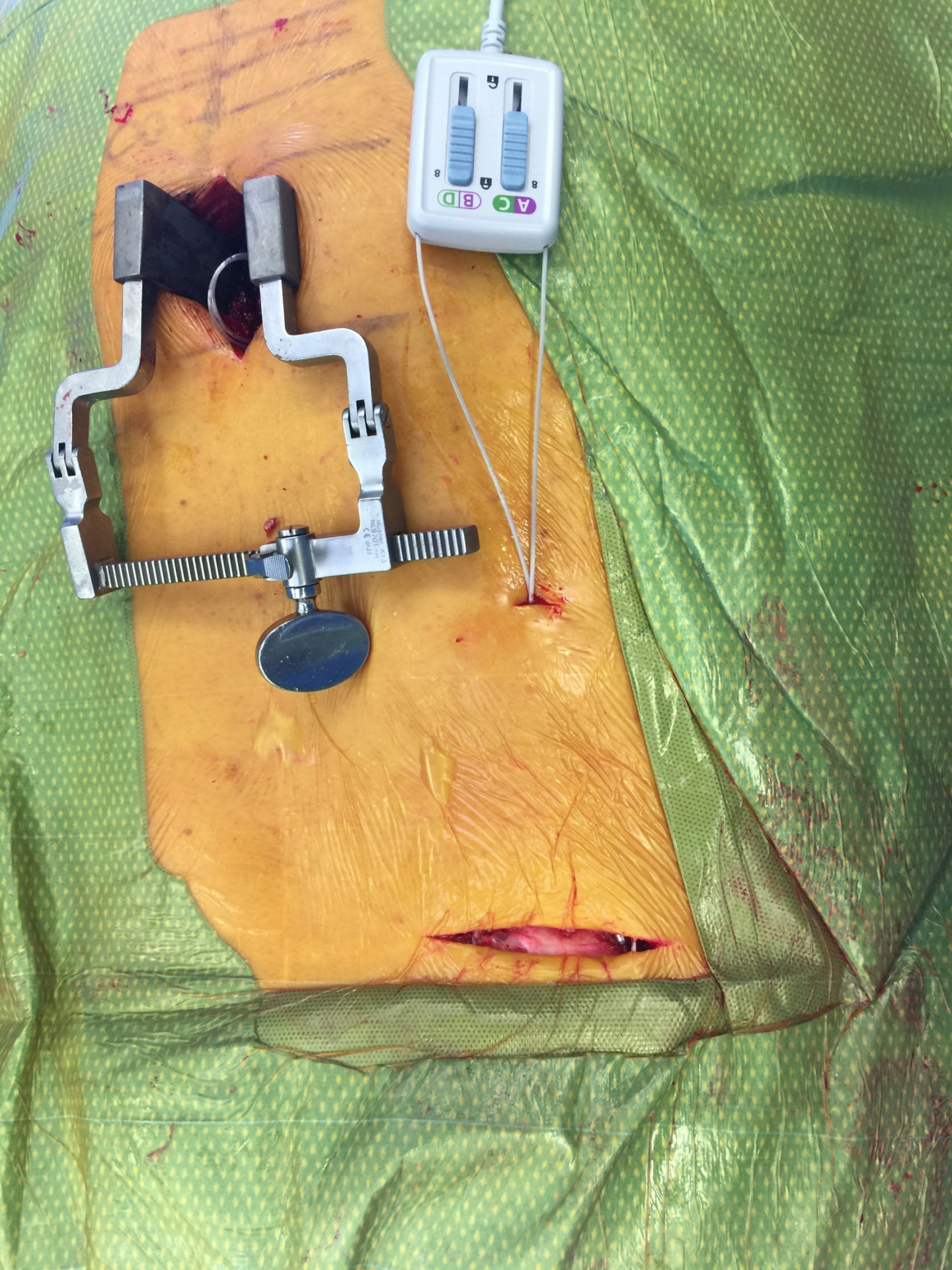
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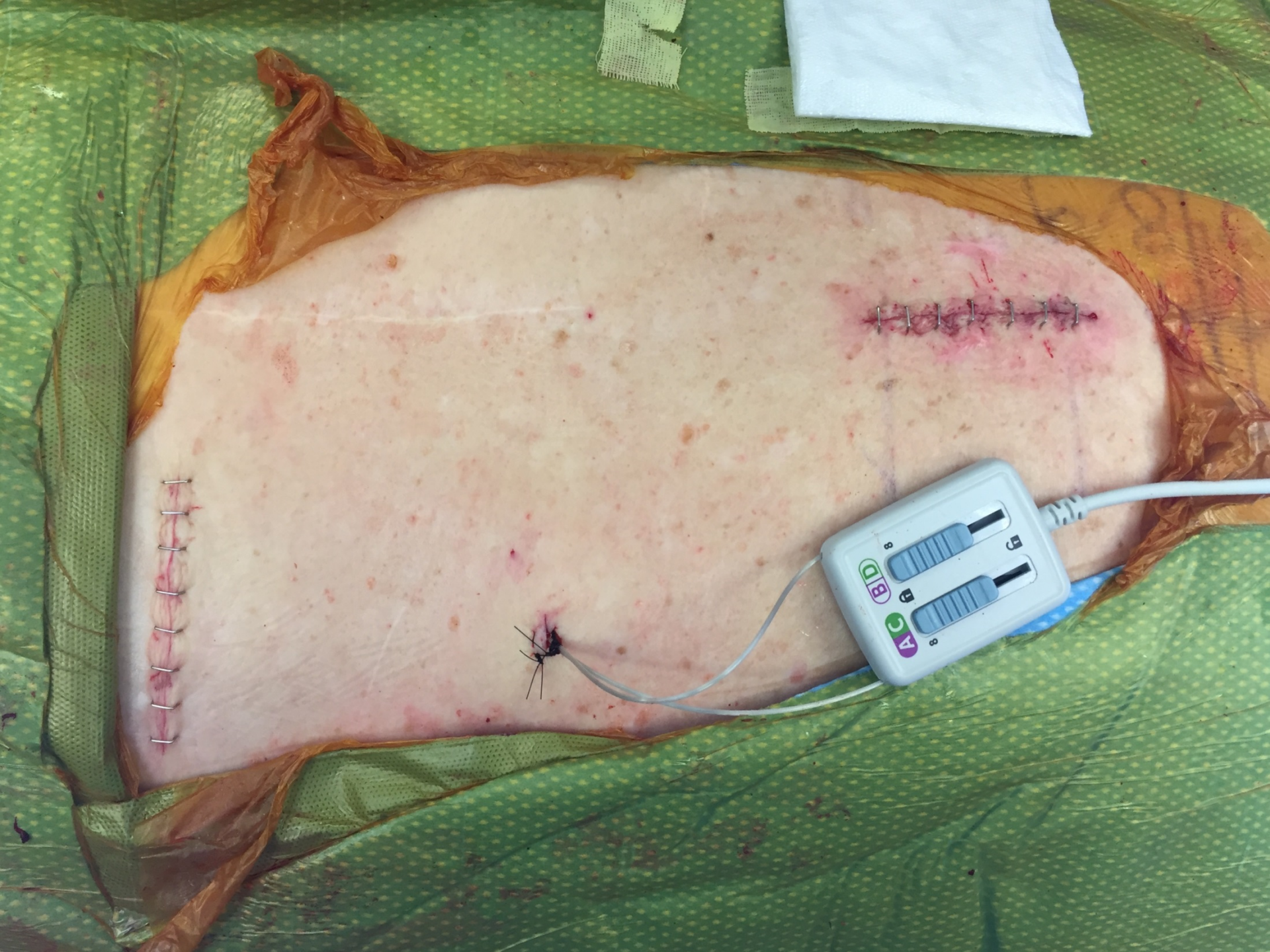
BD
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PERMANENT IMPLANT: SECOND PROCEEDURE

1. **Open Pocket Incision**
2. **Cut Extensions in the IPG pocket and then pull through smaller stab incision**
3. **Connect IPG to the paddle**
4. **Test Impedances through the remote**
5. **Close**

PATIENT OUTCOMES : DRYER SERIES 12 MO.

Patients: 49

Male: 22

Female:27

Median Age: 65

Age Range: 41-80

Patients with previous spine surgery: 31

Pre SCS VAS average: 9

Pre SCS ODI average: 68

Post SCS VAS average: 2

Post SCS ODI average:26

CONCLUSION

1. **SCS works for axial low back and radicular pain**
2. **It is more cost effective than reoperation with greater success rates, for select patients**
3. **Trial period allows patient to try the stimulator before committing to the final procedure**
4. **No Bridges Burned if not successful**
5. **MRI compatibility allows use in younger patients**
6. **Less morbidity and mortality, easier and quicker recovery**
7. **Possible paradigm shift for young patients with multilevel degenerative disc disease who would not be candidates for fusion; Can we buy them some time??**

- 45 Year old man
- Axial Low Back Pain
- No Leg Pain
- Failed all conservative treatments
- What do you do moving forward?