



European Society of  
Regional Anaesthesia  
& Pain Therapy  
**ESRA ITALIA**

**ESRA** *Cè*

# XXIX

## CONGRESSO NAZIONALE

ESRA Italian Chapter  
CESENA, Cesena fiere

Presidente del congresso  
**Vanni Agnoletti**  
**Domenico Pietro Santonastaso**  
**Andrea Tognù**

7-9  
*Novembre*  
2024



 **MZ**  
EVENTS



# Ruolo dell'ecografia nelle tecniche di neuromodulazione e neurostimolazione periferica

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«NEUROMODULATION is the alteration of nerve activity through targeted delivery of a stimulus, electrical stimulation or chemical (or physical agents), to specific neurological sites in the body»

*The International Neuromodulation Society*

Electrically or chemically or physically

- Inhibition
- Stimulation
- Modification
- Regulation
- Therapeutic alteration

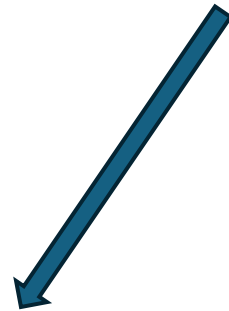


Activity in the central,  
peripheral or  
autonomic nervous  
system



# Electrical and thermal neuromodulation

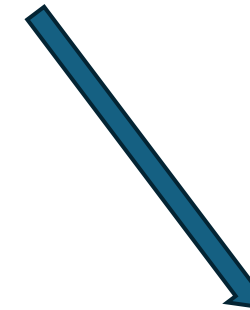
## Extra-axial Neuromodulation



Peripheral Nerve



Subcutaneous tissue (PFNS)



pFR/RF/Cryo




## Neuromodulation

Continuous	Pulsed	Cryo
Since 1965	Since 1996	Since 1976
Continuous administration of high frequency electrical current	Short electrical pulses with high voltage followed by a silent period : heat is washed out	The ice crystals create vascular damage to the vasonervorum, which produces severe endoneural edema. Cryoanalgesia disrupts the nerve structure and creates wallerian degeneration, but leaves the myelin sheath and endoneurium intact
Production of heat	No guaranteed success even if well performed procedures	complete block, like local anesthetics
Motor and sensory loss ??	No motor and sensory loss	Motor and sensory loss
Last 6+ months	Last 1-12 months	Last 6 months
Possible neuroma formation	No neuroma formation	No neuroma formation



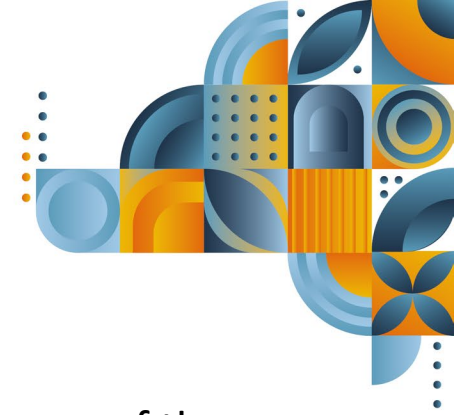


- 1. Anatomy visualization**
- 2. Pathology visualization**
- 3. Target visualization**
- 4. Avoid risks**
- 5. A guide**

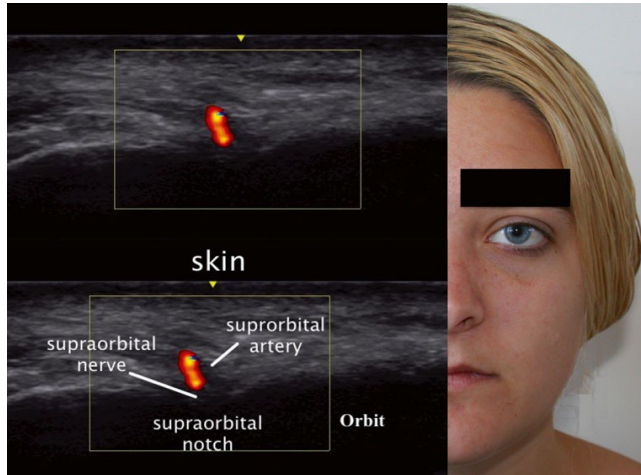
A dark puzzle piece is centered in a field of white puzzle pieces. The text "Anatomy visualization" is written in red on the dark piece.

**Anatomy  
visualization**

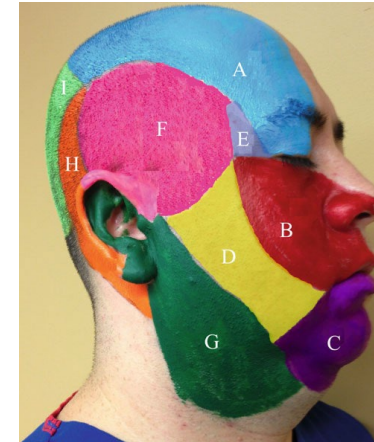




### Supraorbital nerve (V1)

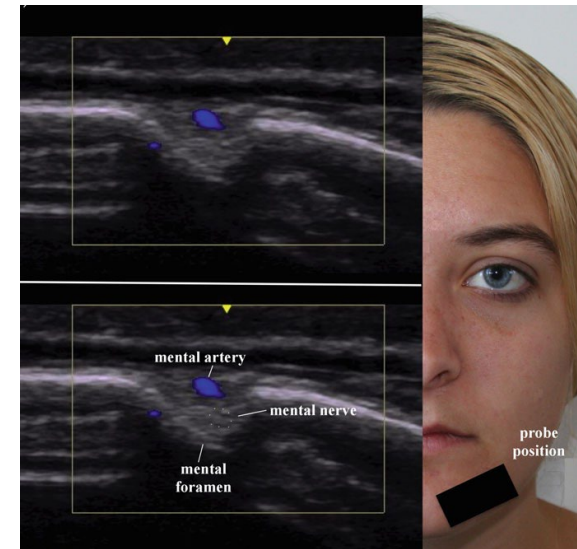
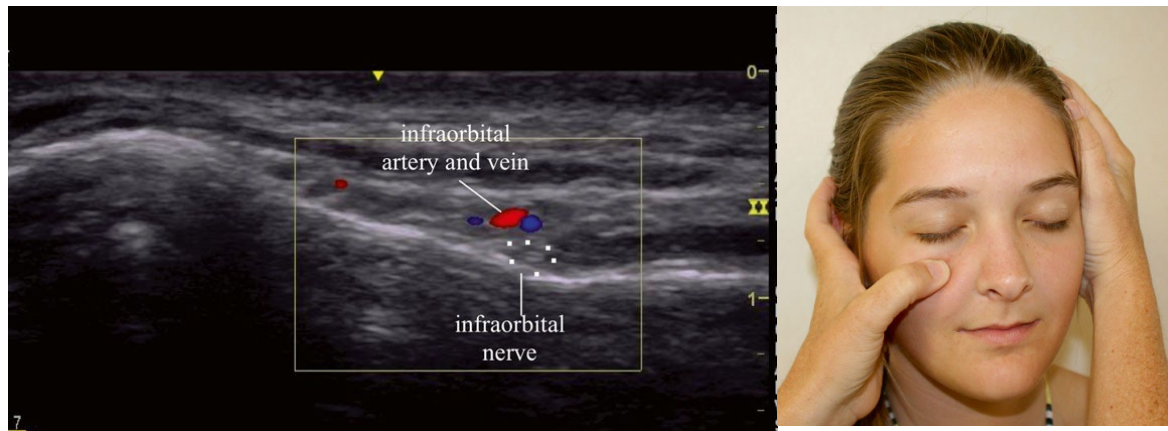


Trigeminal  
RFP  
(vascular  
structures)



Sensory areas of the  
trigeminal nerve  
branches:  
A supraorbital nerve  
B infraorbital nerve  
C mental nerve

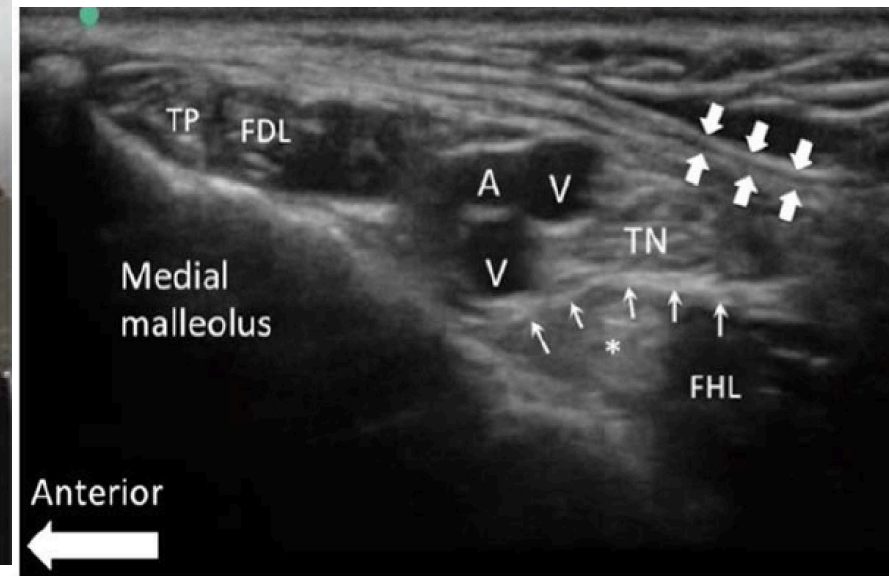
### Infraorbital nerve (V2)



Mental  
nerve (V3)



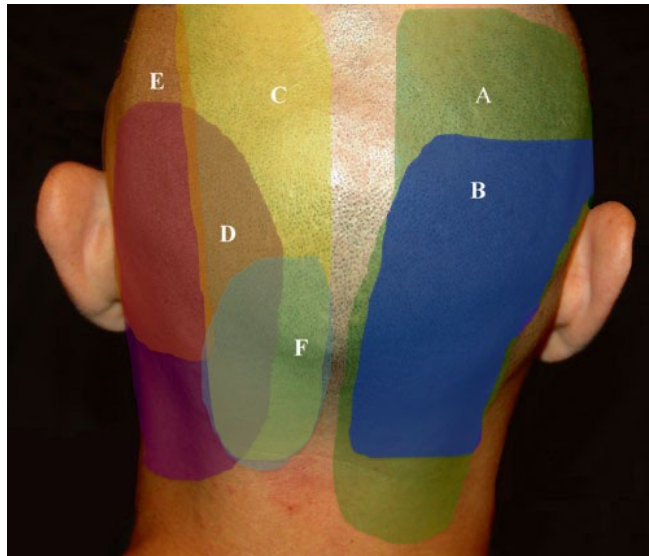
## Tibial nerve ( avoid FHL) (anatomy differentiation)



**FIGURE 15.** Sonoanatomy of the tarsal tunnel. The flexor retinaculum (bold arrows) classically appears as a 3-layer structure (hypoechoic layer sandwiched between 2 hyperechoic layers). Note the neurovascular bundle typically "rests" on the fascial layer (line arrows) overlying the FHL muscle and tendon (\*). The TN can be differentiated from FHL tendon seen by extending and flexing the big toe. FDL indicates flexor digitorum longus; A and V, posterior tibial artery and vein. Reproduced with permission from Philip Peng Educational Series.



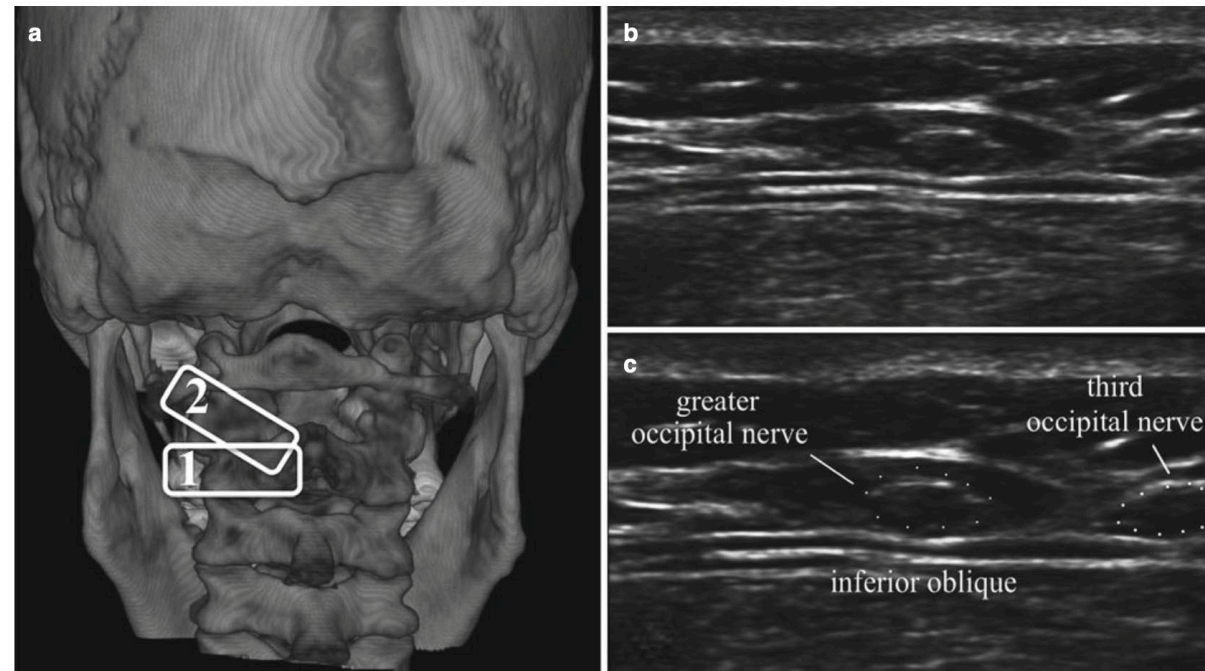
## GON vs TON (anatomy differentiation)



C: GON

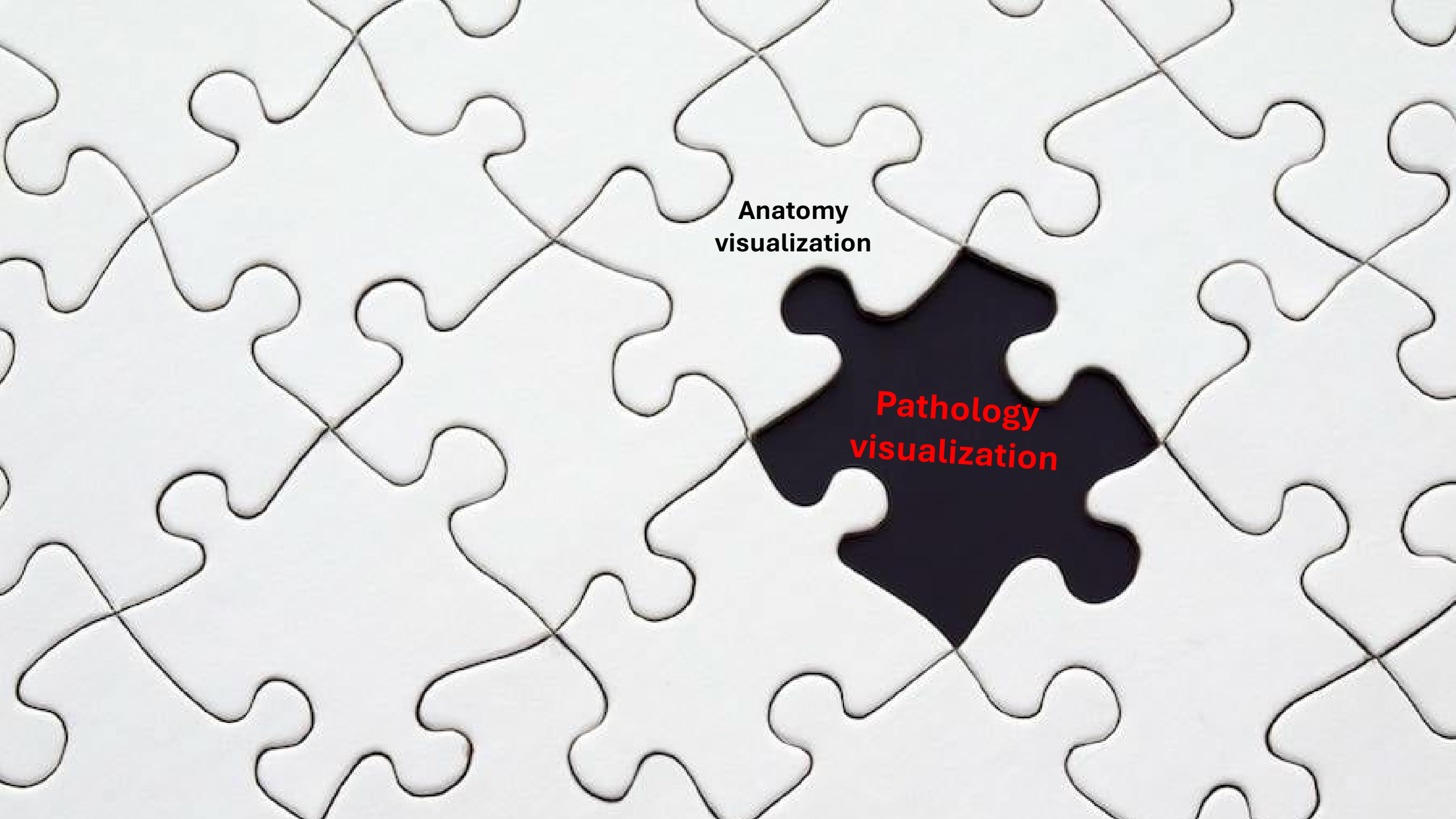
F: TON

(Image of Andrea Trescot)



**Fig. 19.14** US imaging of the third occipital nerve. (a) Location of ultrasound transducer: 1 = the initial probe placement; 2 = the final probe placement. (b) US image of the proximal third occipital nerve. (c)

Labeled US image (Image courtesy of Andrea Trescot, MD, modified from Greher et al. [21])

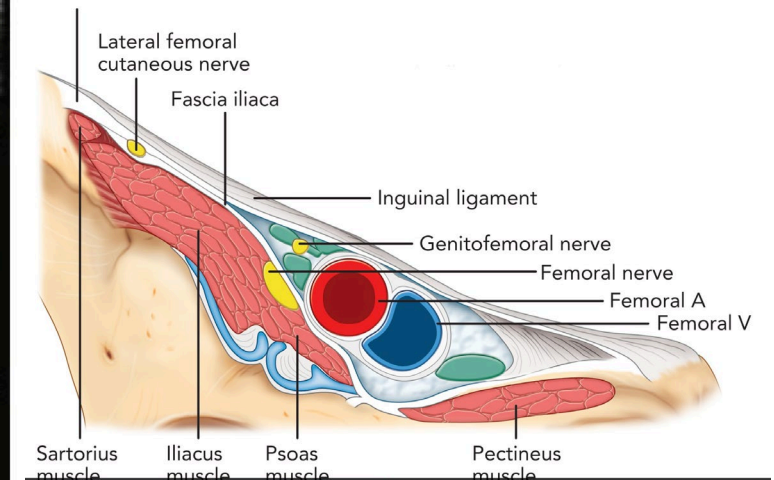
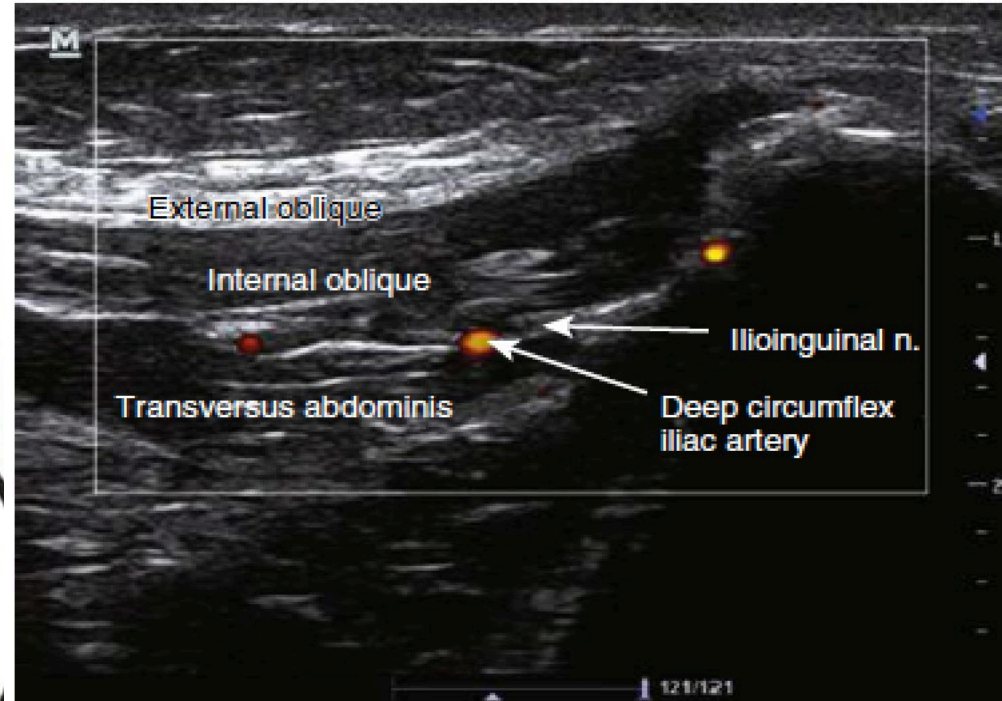
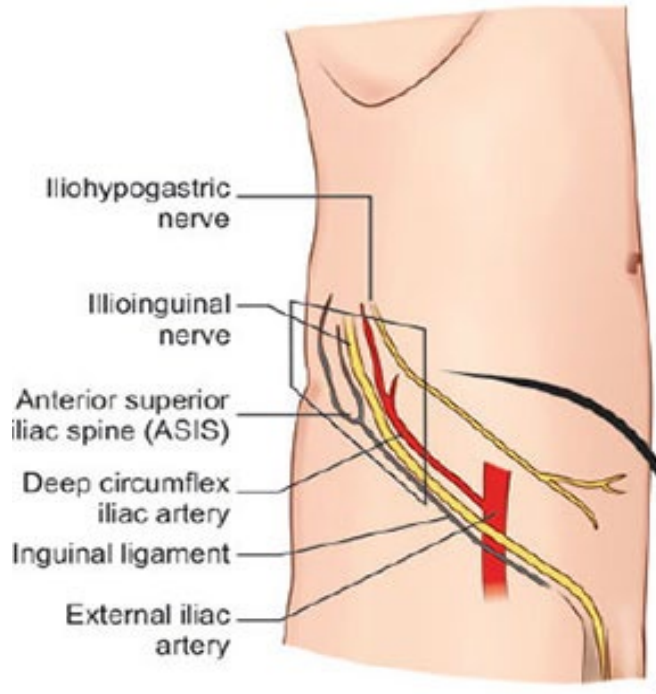
A white puzzle with one dark piece missing. The dark piece is in the center-right and contains the text 'Pathology visualization' in red. The text 'Anatomy visualization' is written in black above the dark piece.

**Anatomy  
visualization**

**Pathology  
visualization**

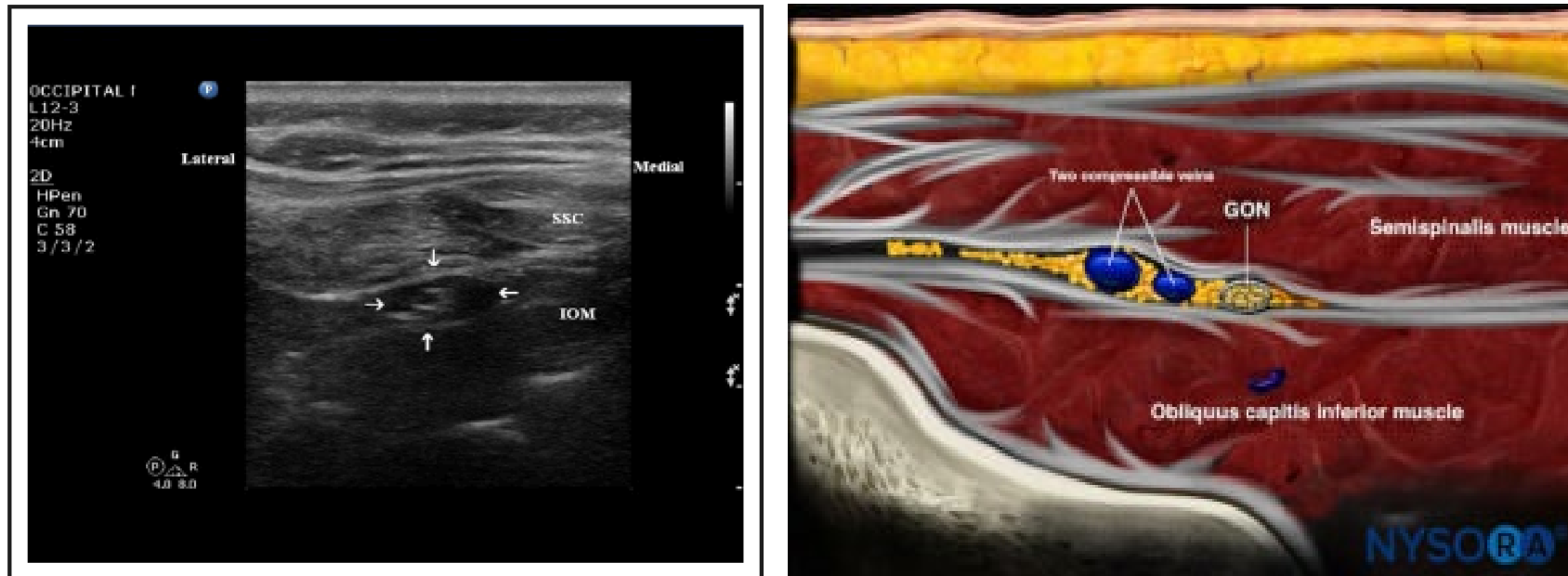


## IL-IHP (entrapment)





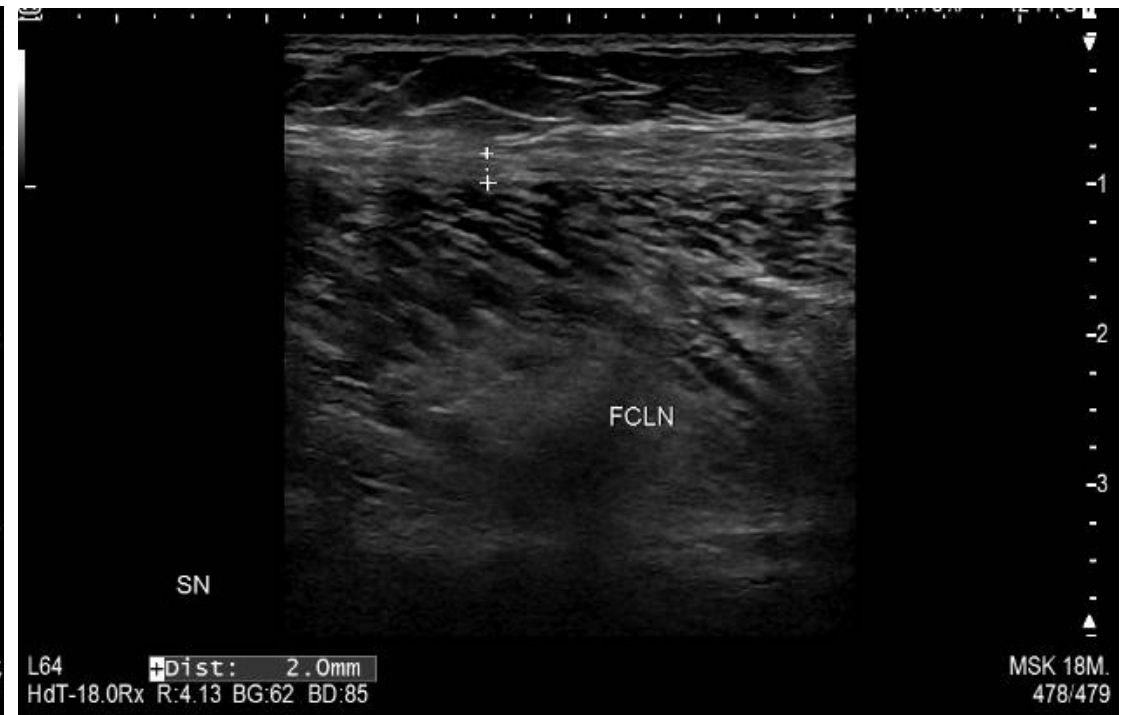
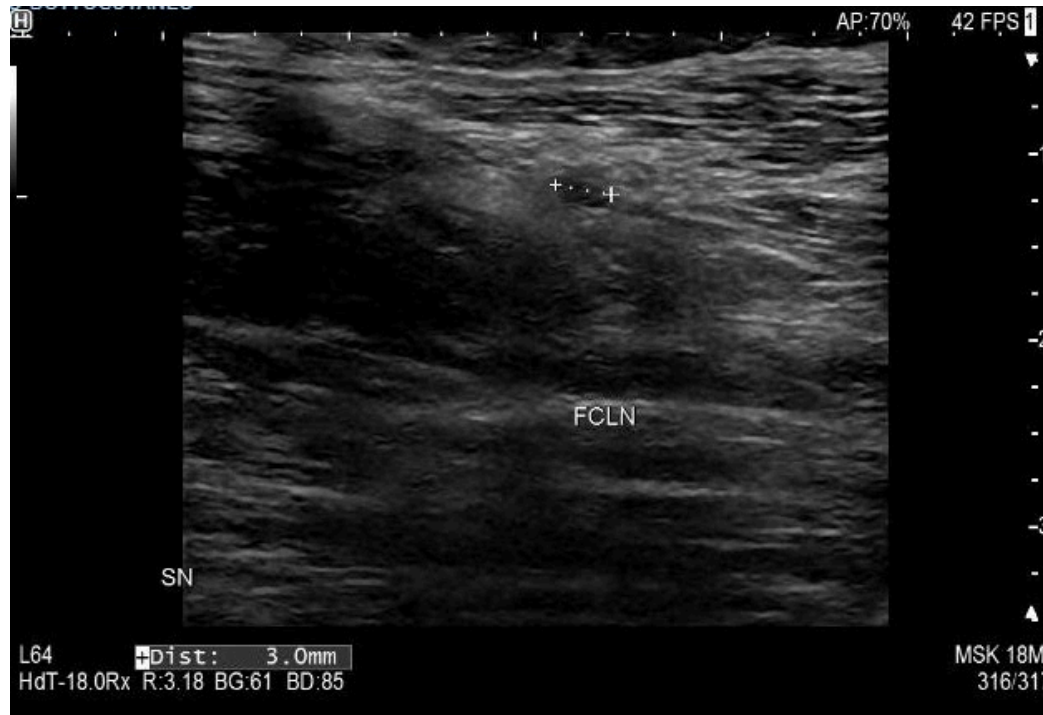
## GON ( edema surroundig the nerve)




**Fig. 3.—Short axis sonogram at C1-2 level showing a swollen greater occipital nerve with edema surrounding the nerve (arrows) as it runs between the inferior oblique muscle (IOM) and the semispinalis capitis (SSC).**



## Neuroma (3 mm) of FCLN





Anatomy  
Visualization

Pathology  
Visualization

**Target  
visualization**



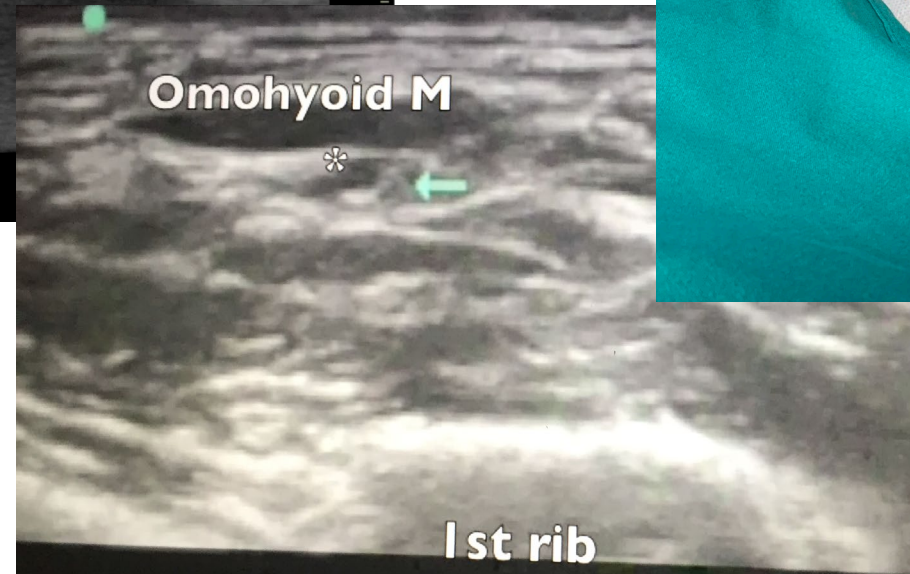
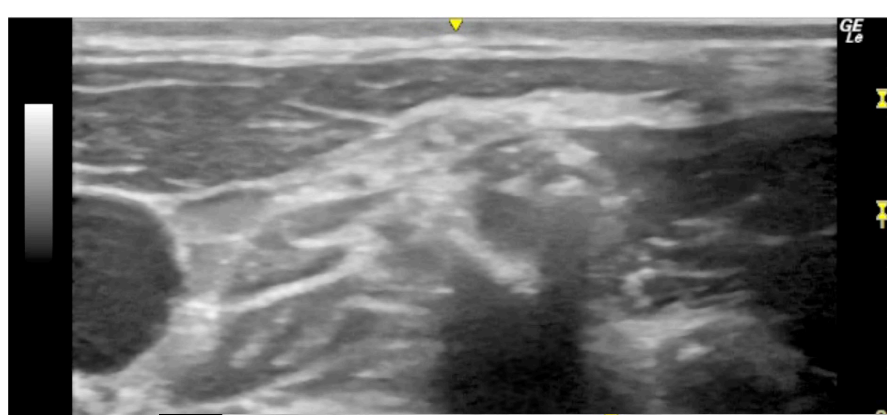
## SSC nerve: Anterior approach

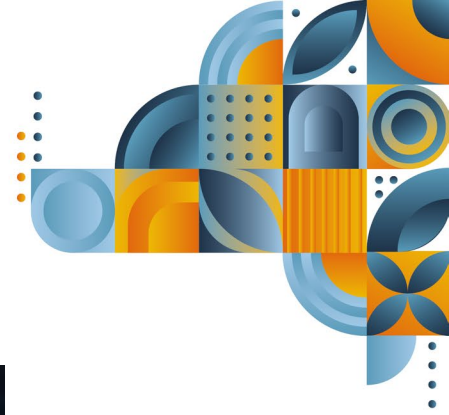
1. follow C5 e see  
that SSN derived  
from C5

2. Follow SSC nerve  
that crosses omoyoid  
muscle

3. SSN behind omoyoid muscle in  
the distal region

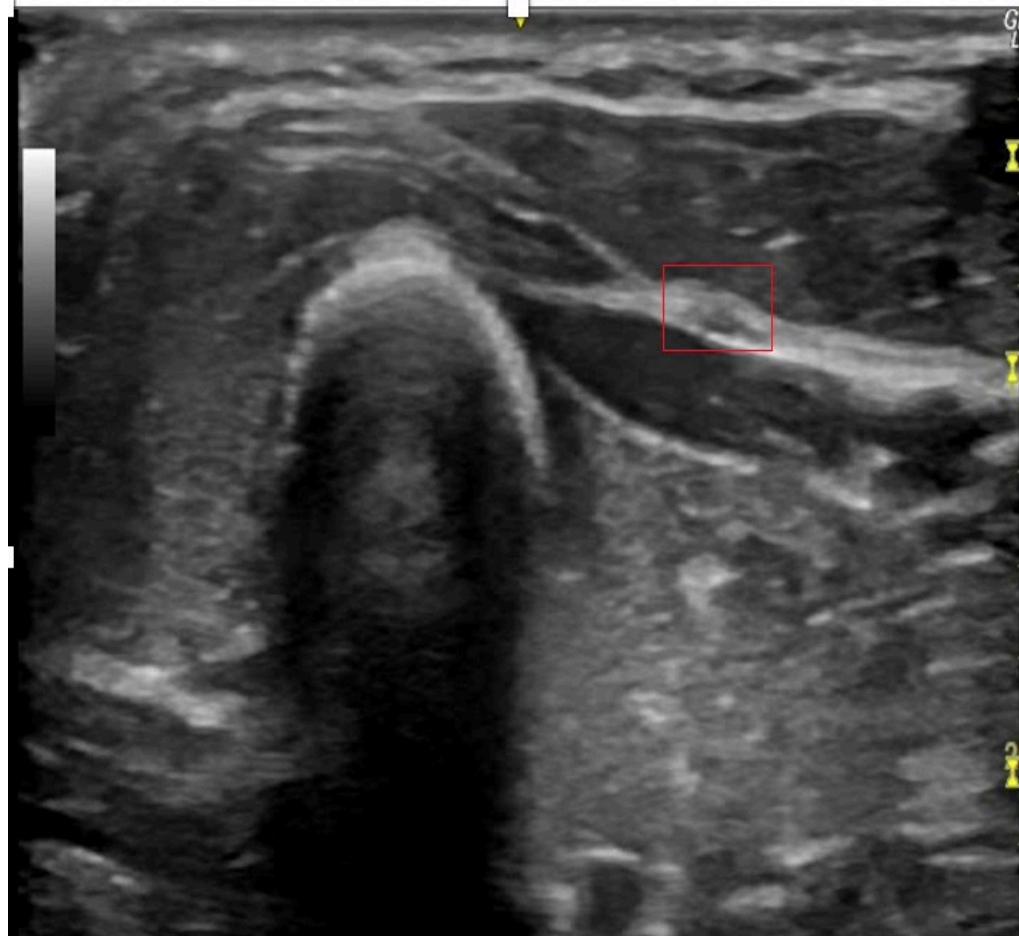
avoid the transverse cervical artery (TCA)

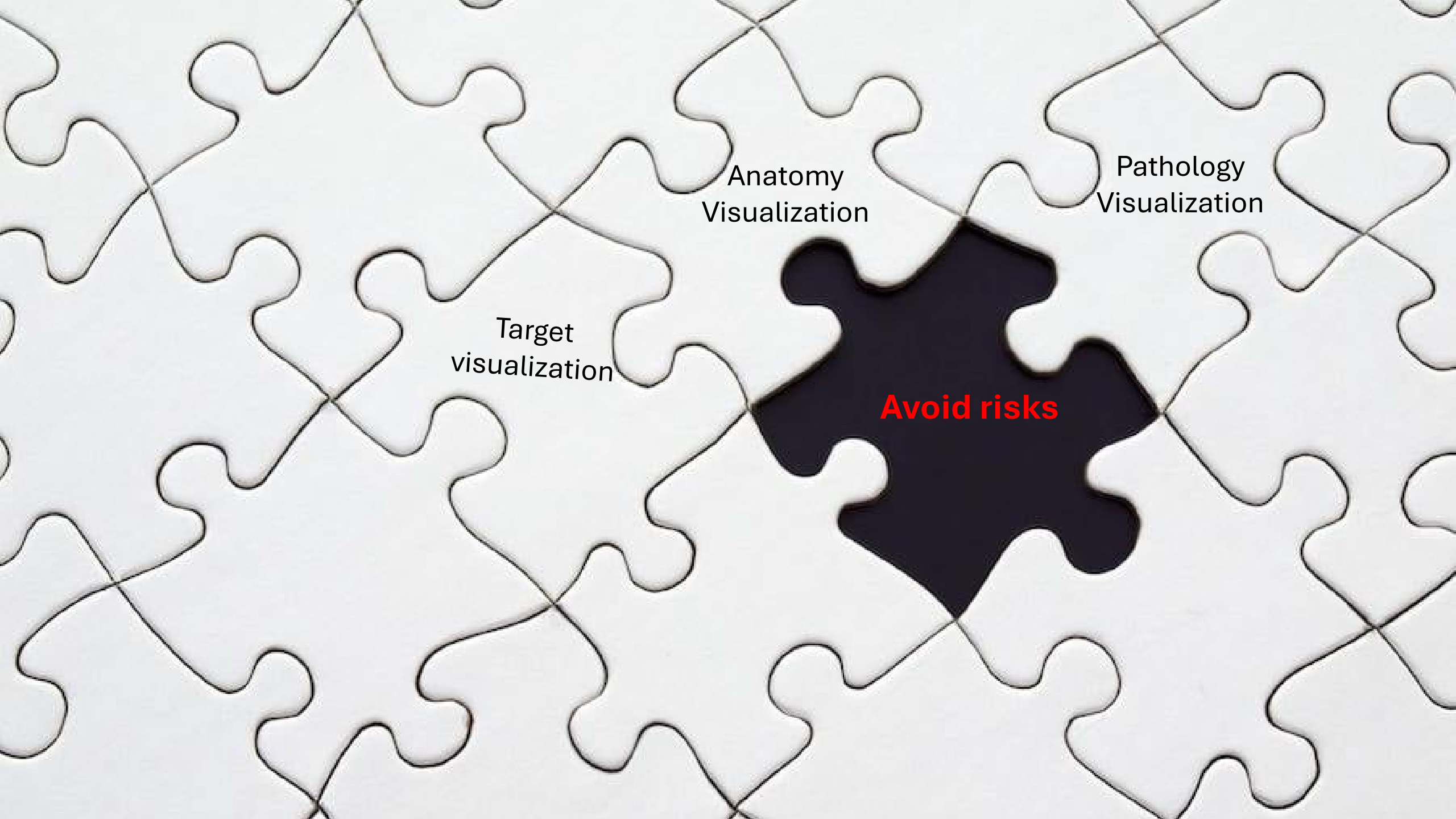




Radial nerve: from the  
elbow to the wrist

superficial  
radial nerve  
(sensitive)





Anatomy  
Visualization

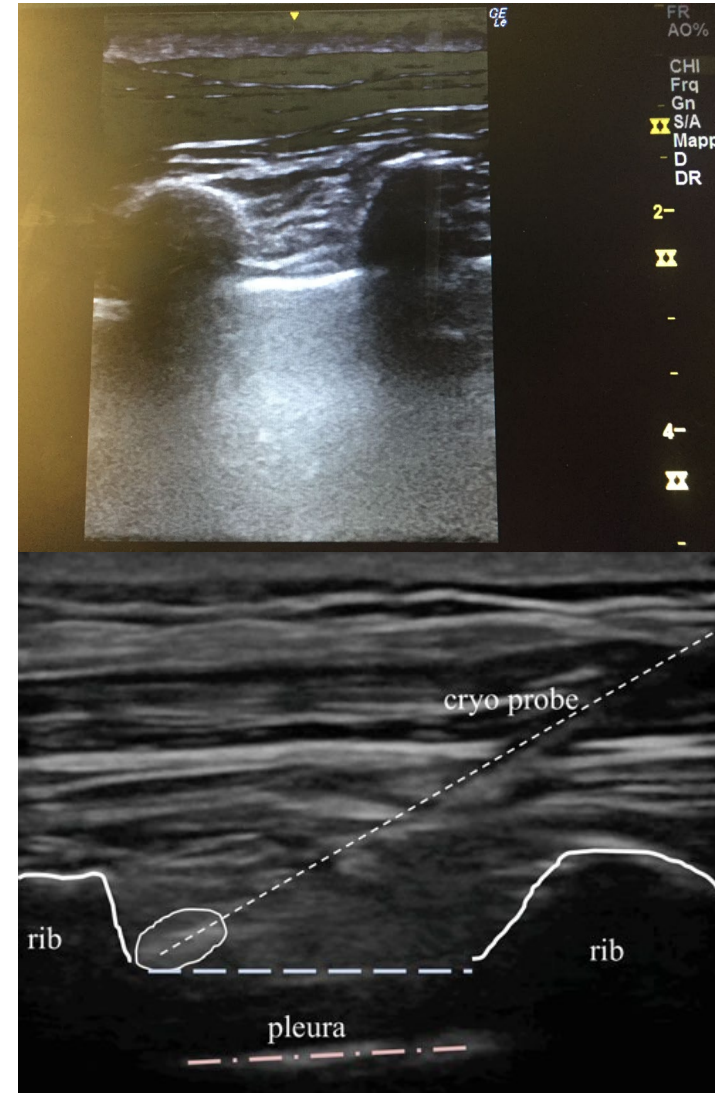
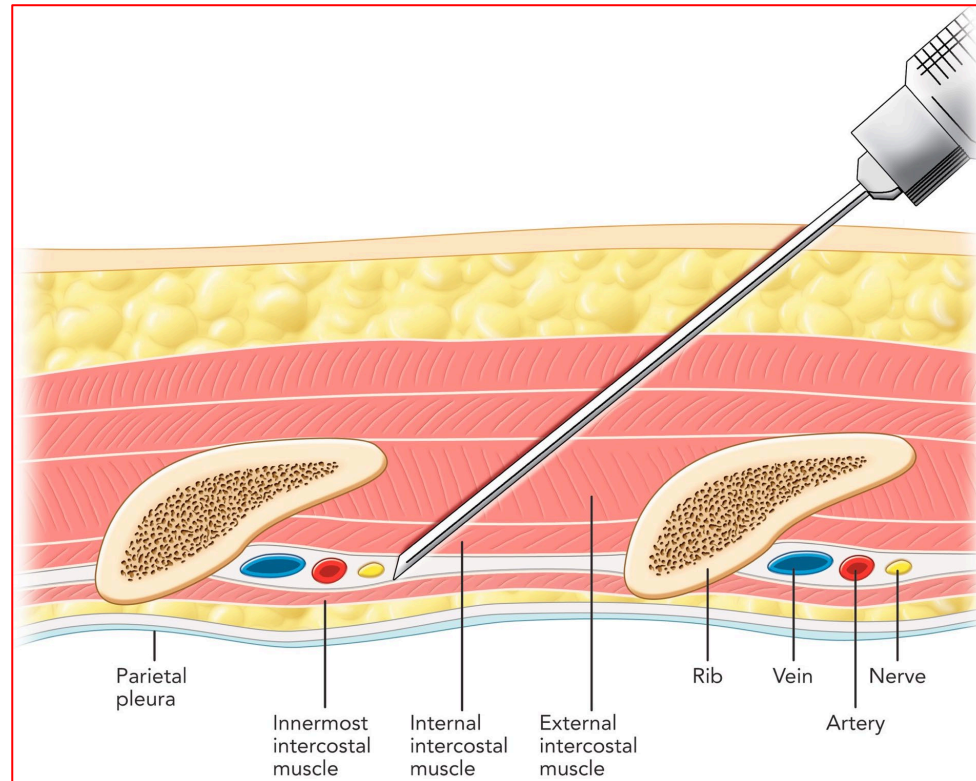
Pathology  
Visualization

Target  
visualization

**Avoid risks**

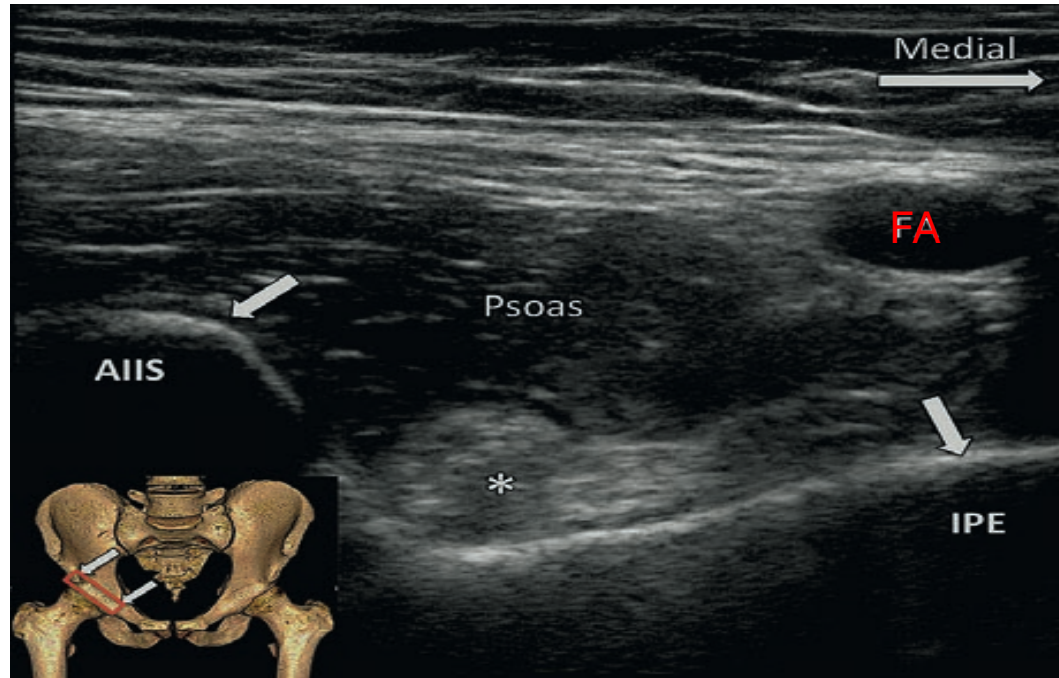


## Intercostal nerve (avoid pleura)



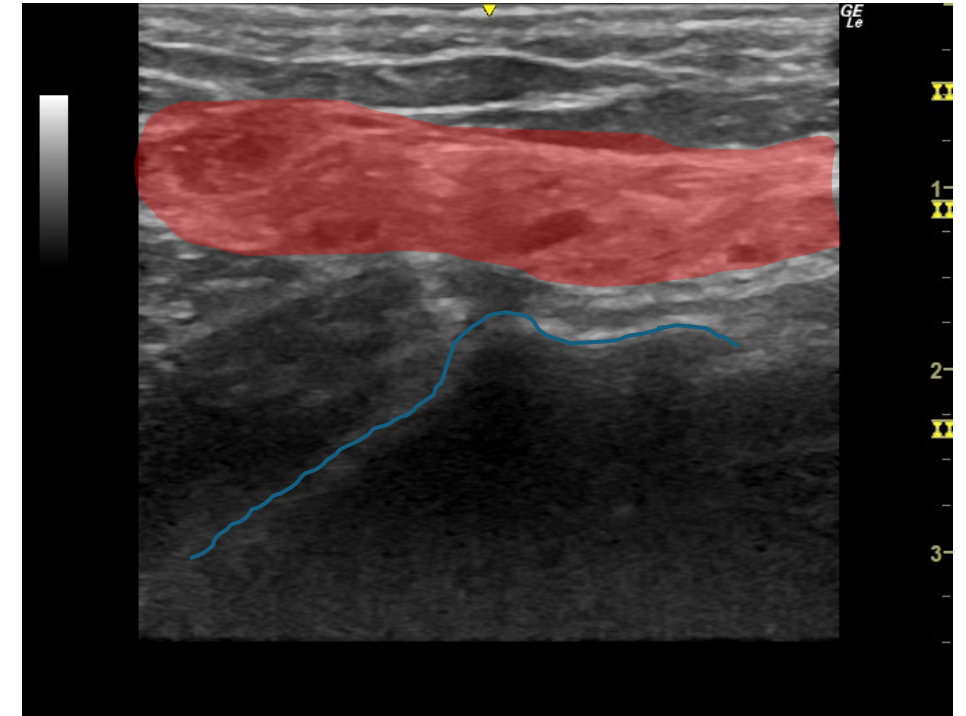
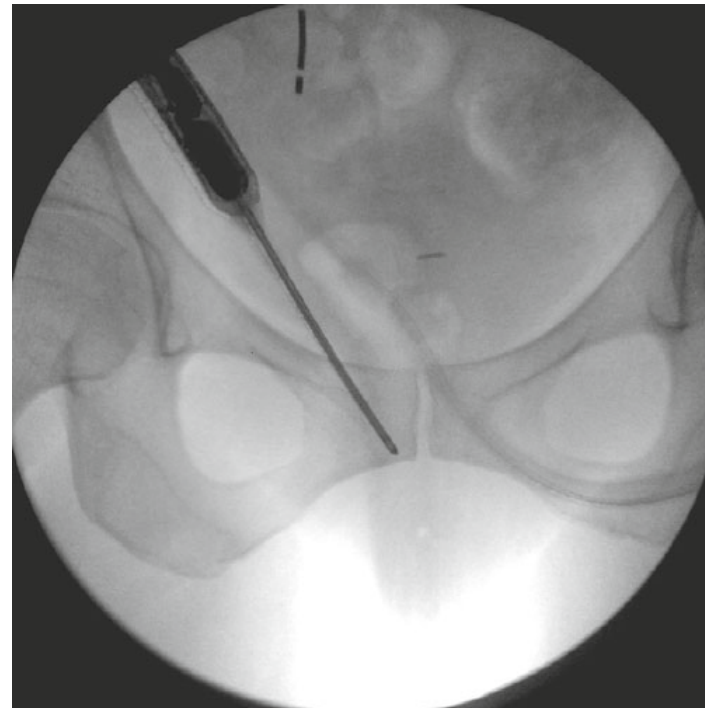
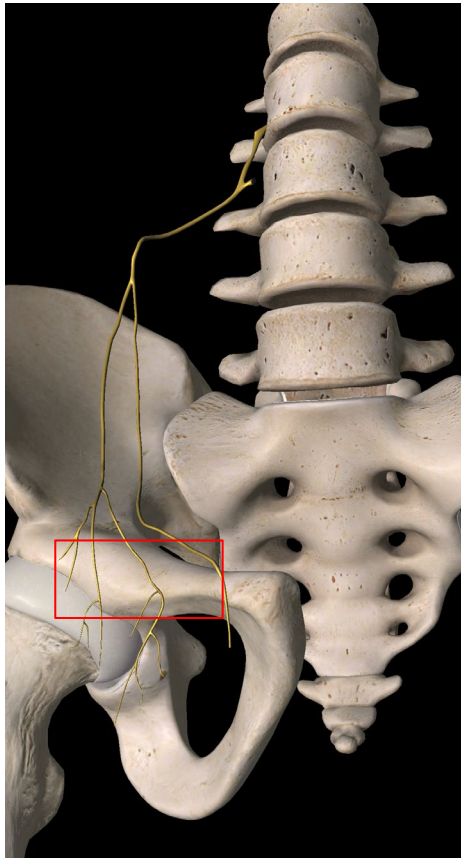


## HIP ( avoid artery)

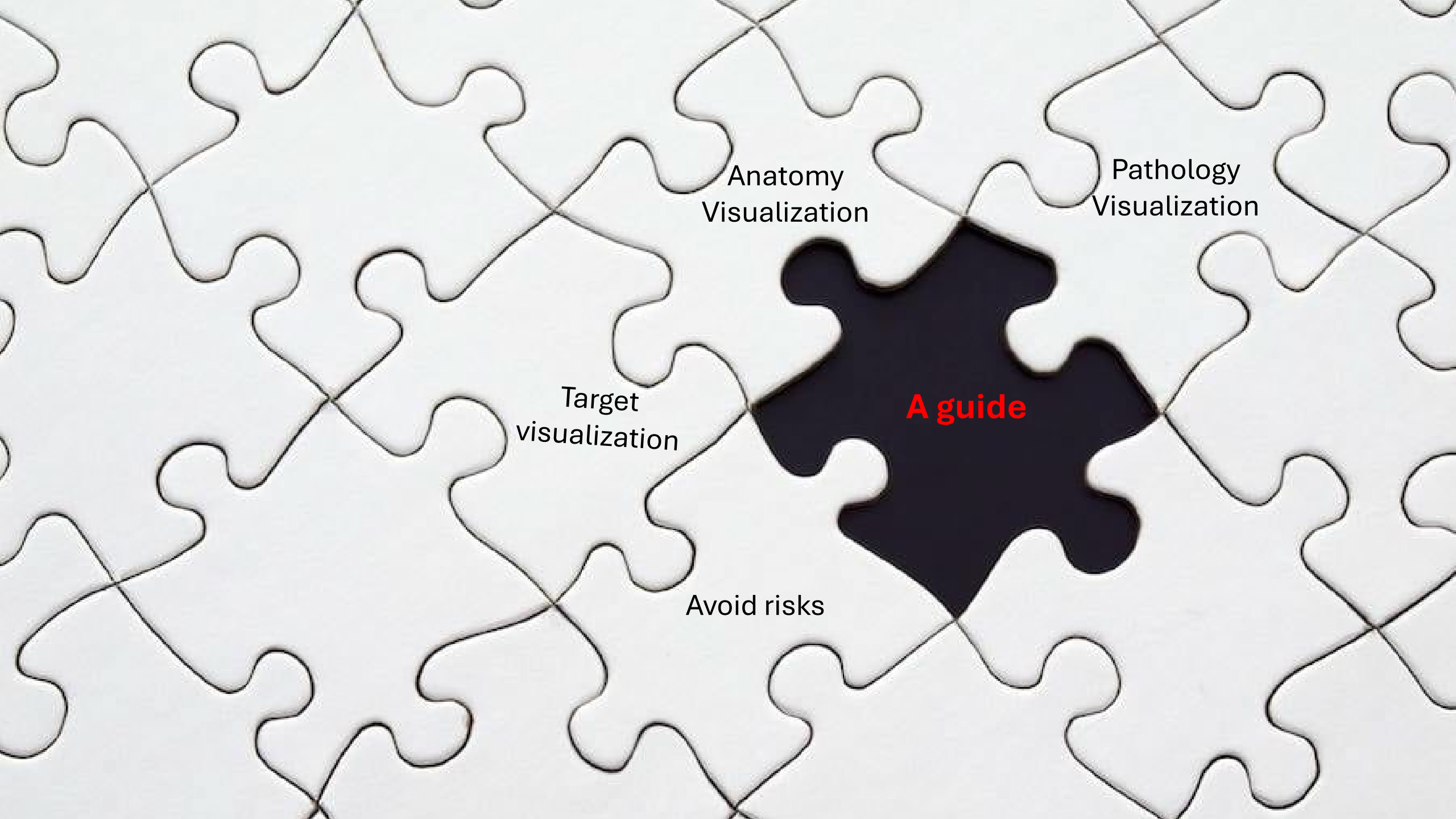




## Genitofemoral nerve ( avoid pubic tubercle)



- Pubic tubercle
- Spermatic cord



Anatomy  
Visualization

Pathology  
Visualization

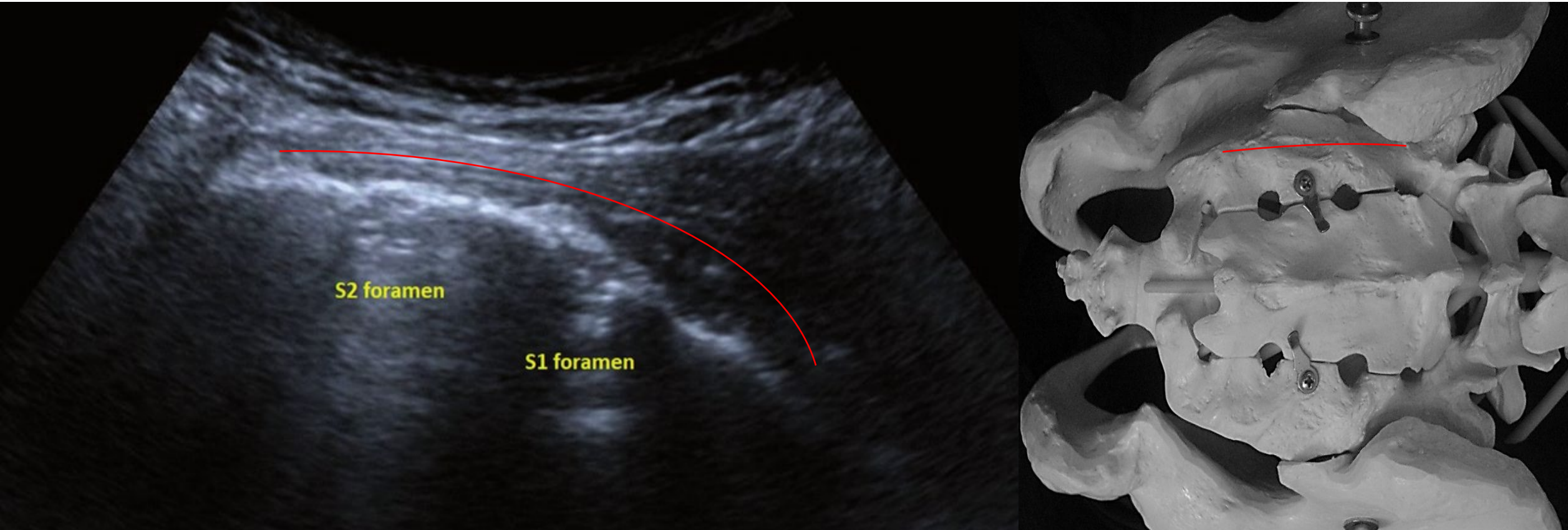
Target  
visualization

**A guide**

Avoid risks



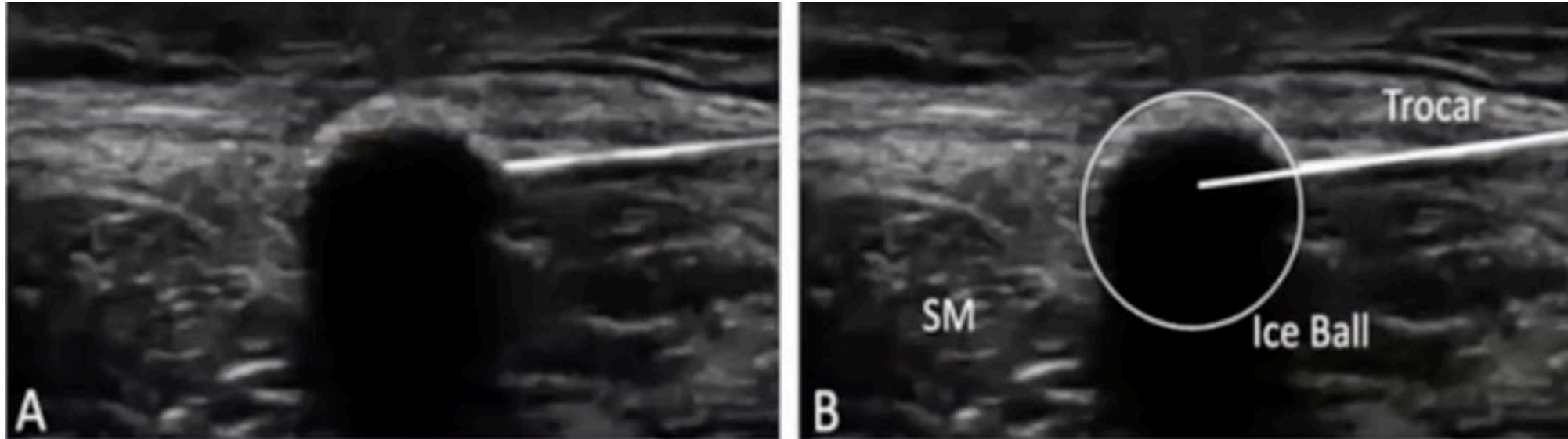
## SIJ cryo: Bone visualization to reduce ionic radiation





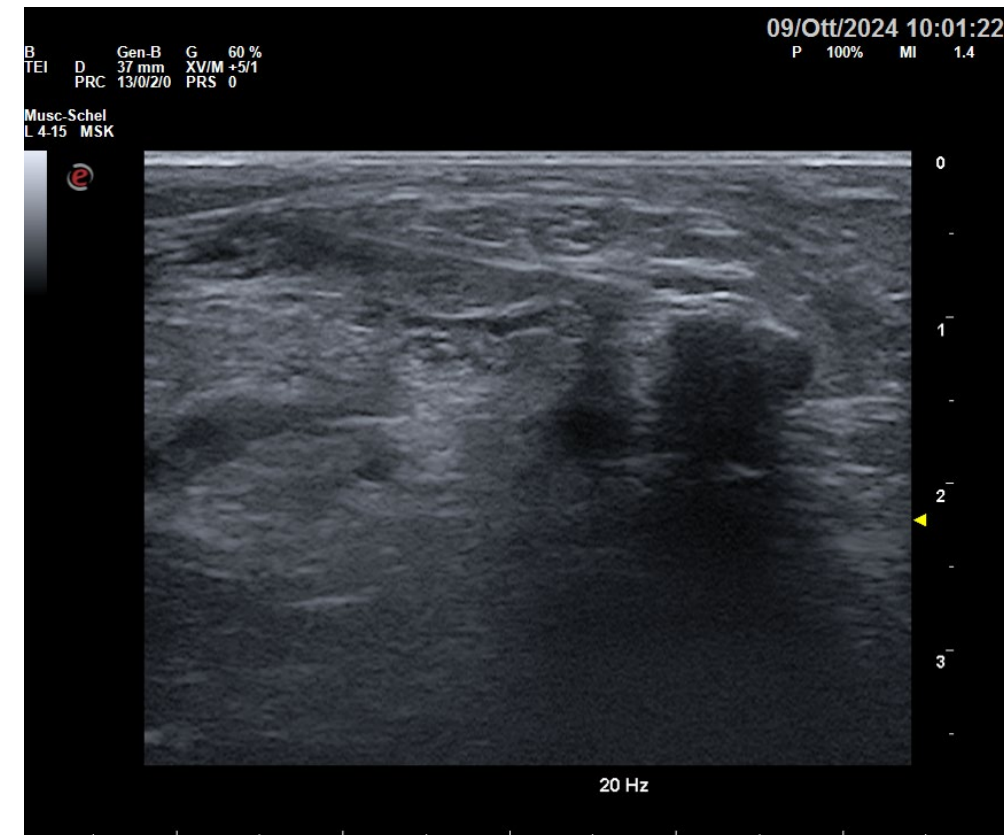
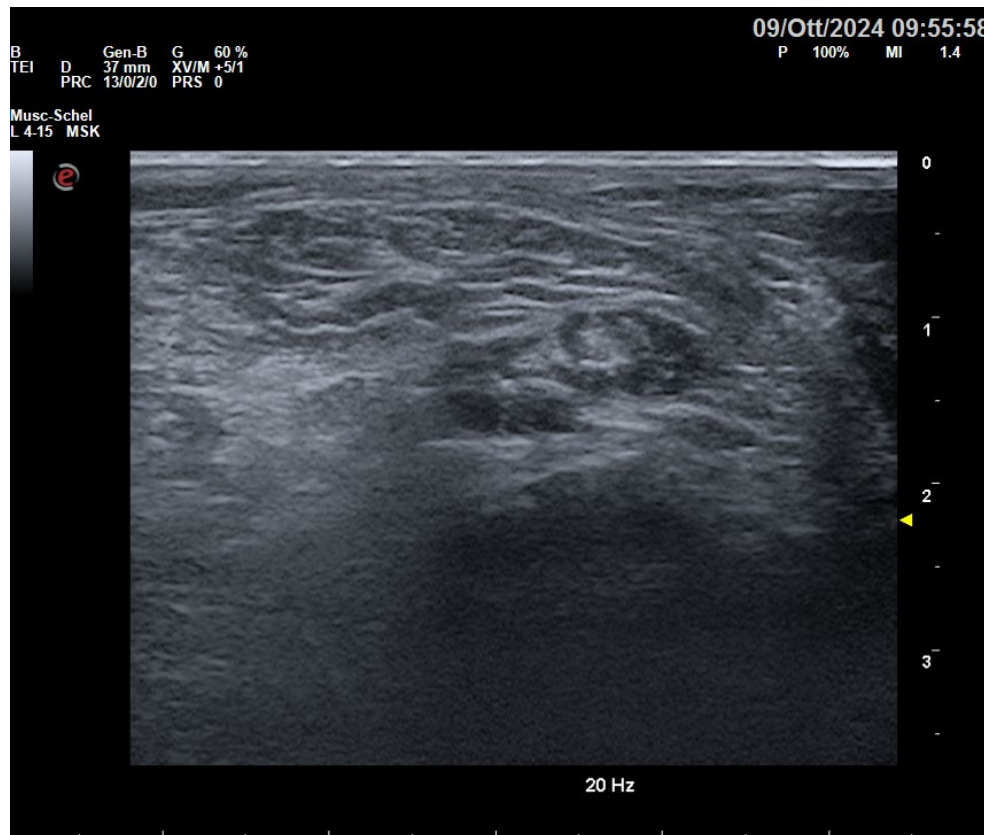


To see the iceball



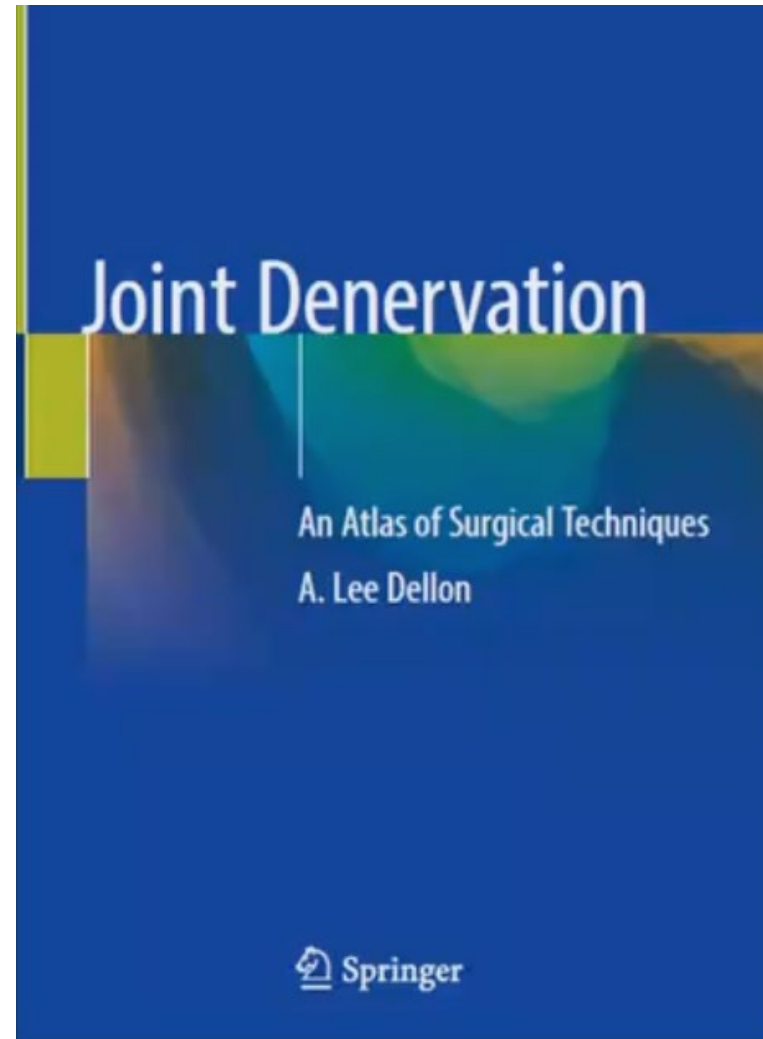


## Sciatic nerve and cryo



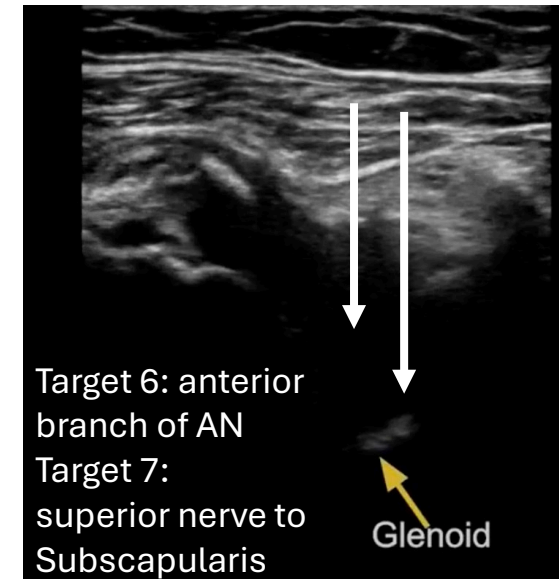
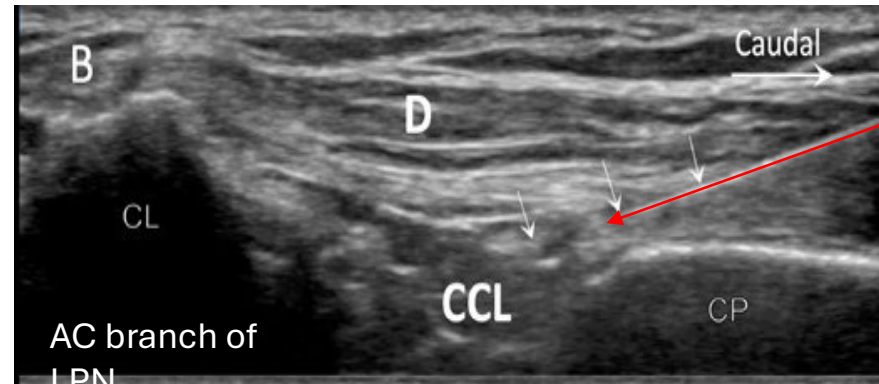
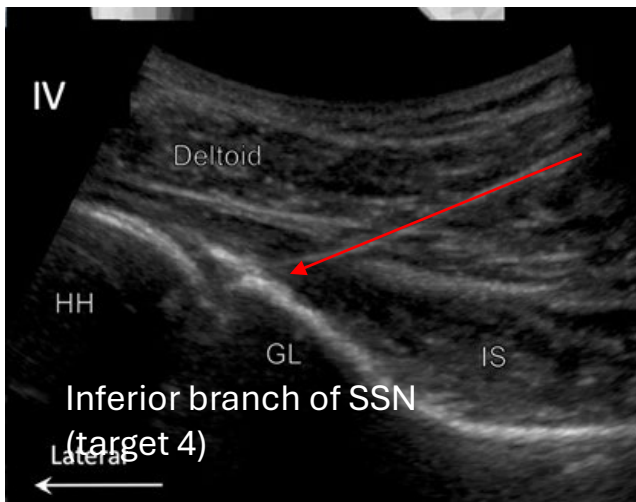
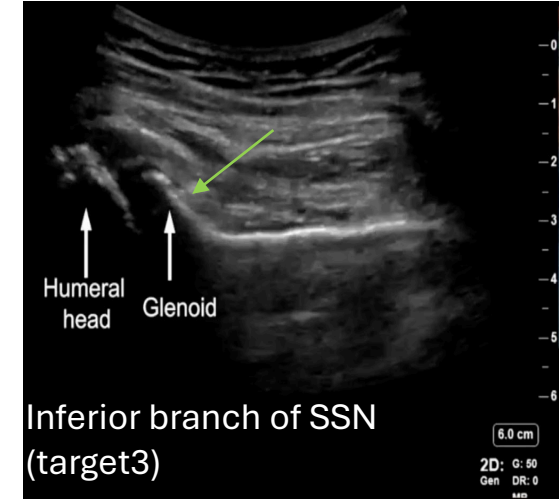
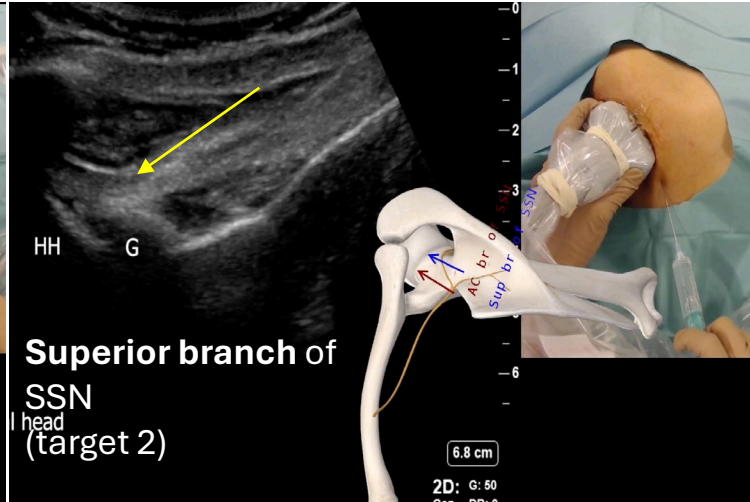
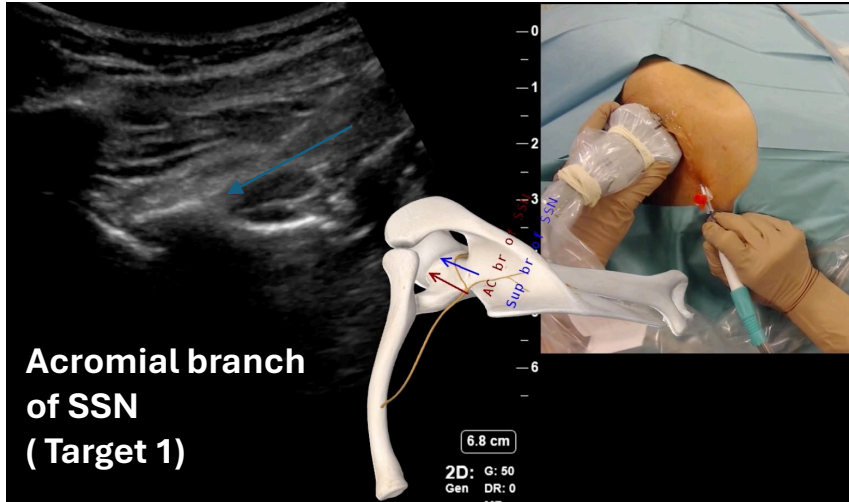


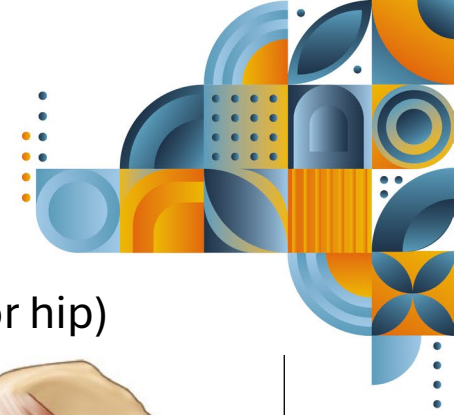
Motor  
sparing



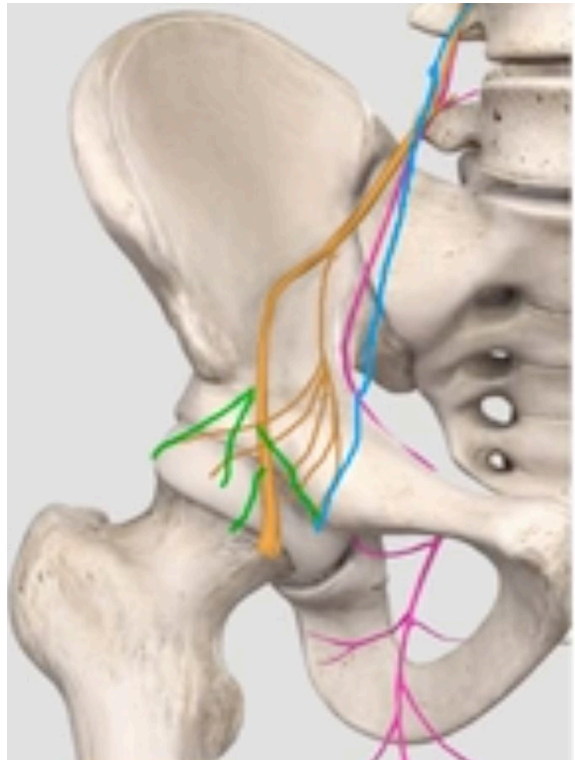


## Shoulder neuromodulation



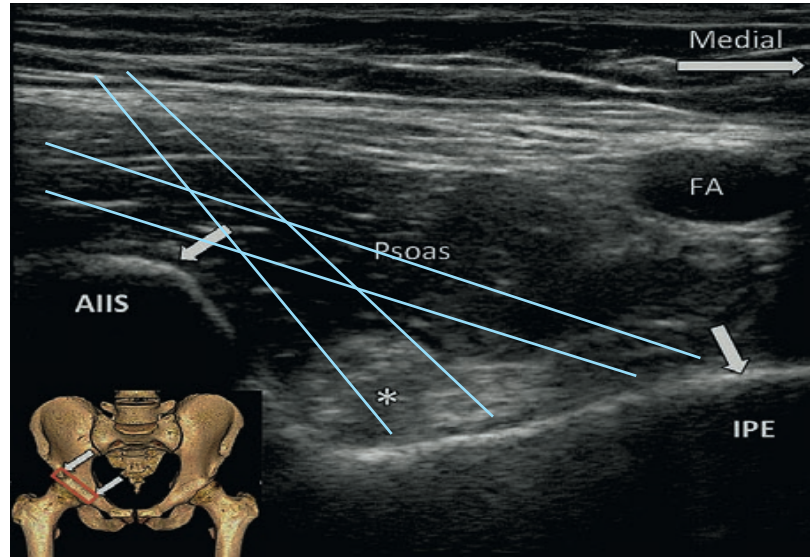


# HIP neuromodulation



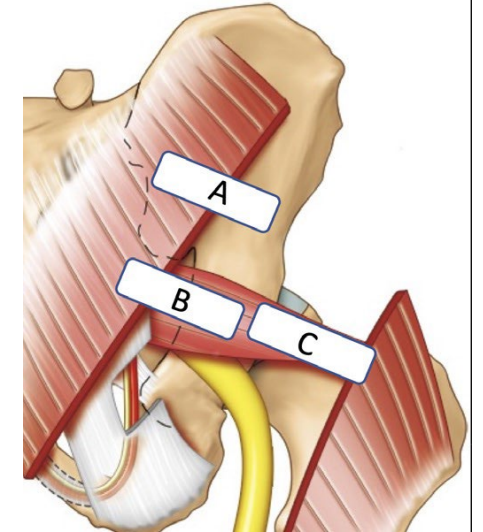
(Anterior hip)

**FN+ AON**

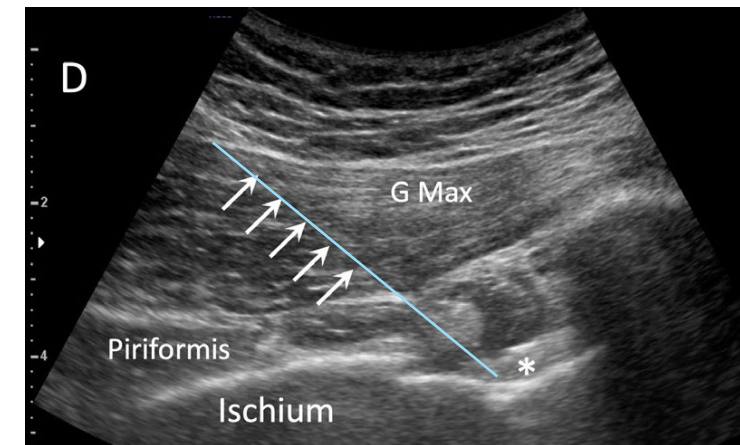


**ON**

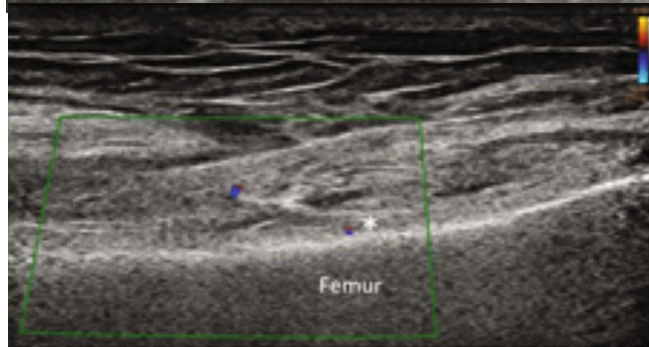
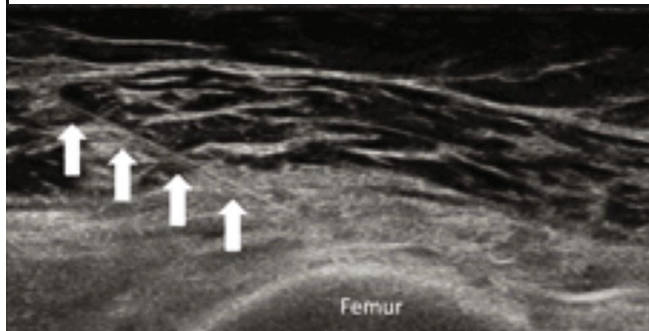
(Posterior hip)



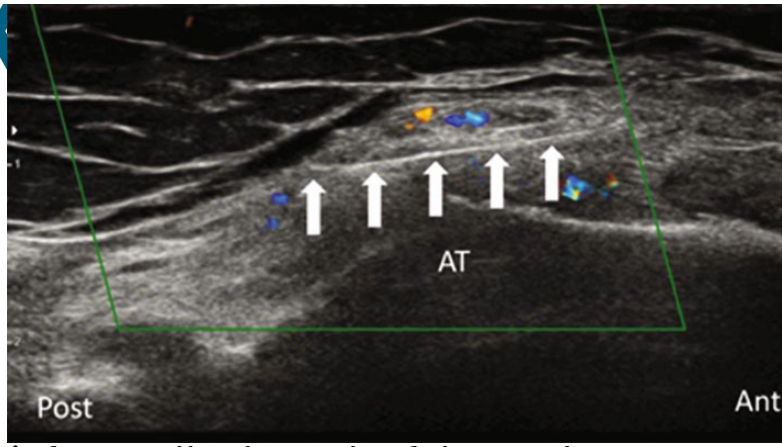
**Nerve to quadratus femoris (NQF)**



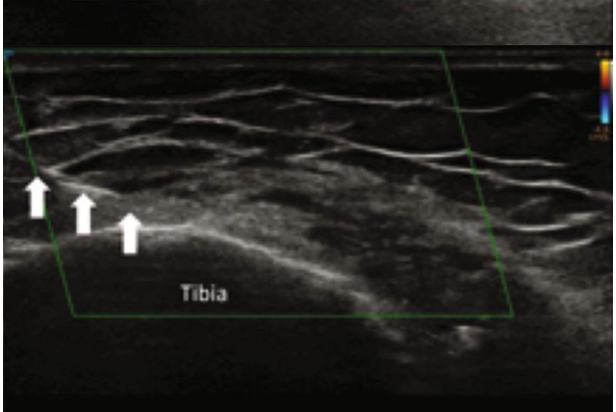
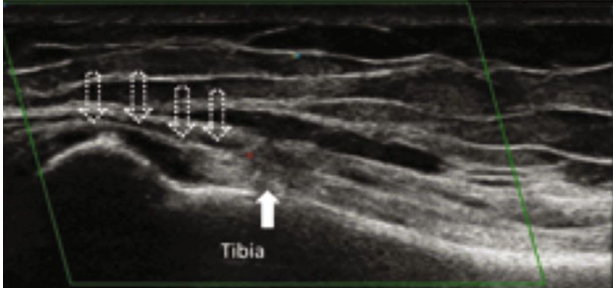
# KNEE neuromodulation



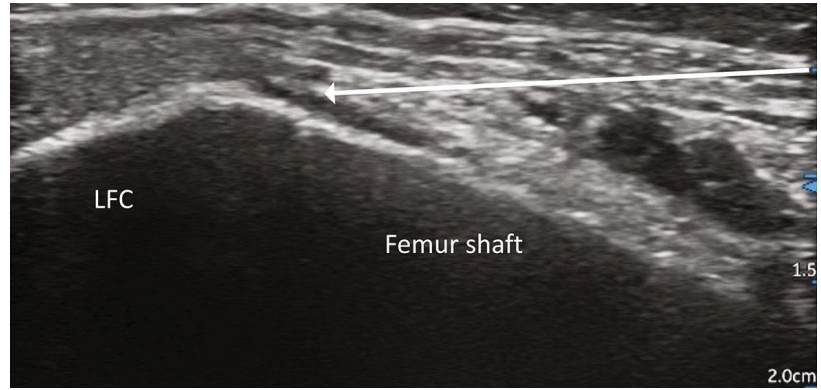
Nerve to vastus intermedius (NVI)  
medial and lateral



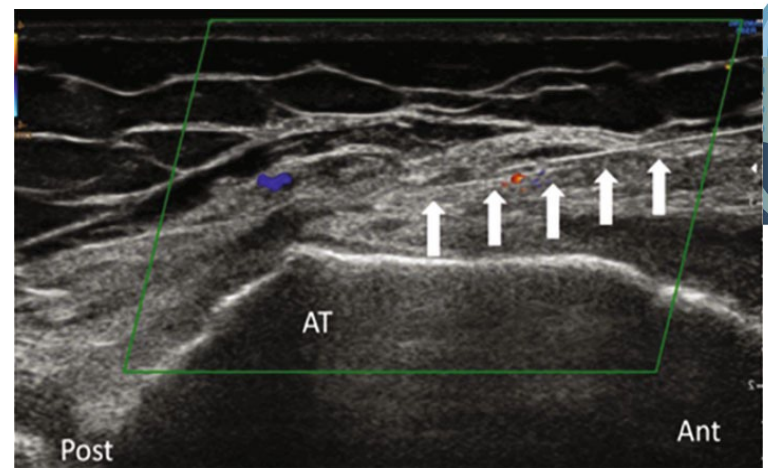
infrapatellar branch of the saphenous nerve (IPBSN)



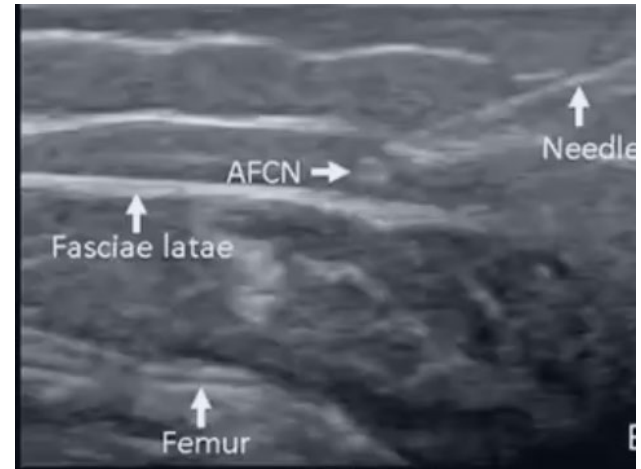
Inferomedial genicular nerve (IMGN)



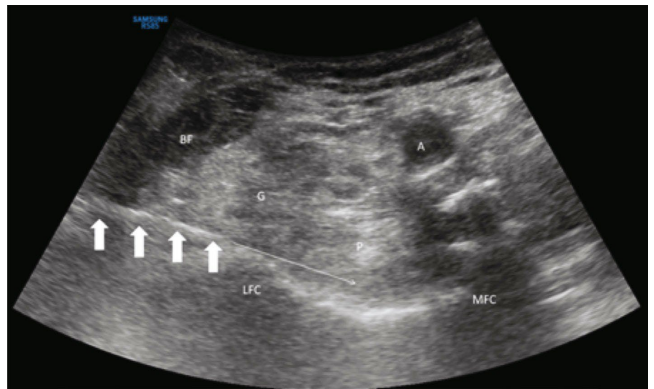
Superolateral genicular nerve (SLGN)



superomedial genicular nerve (SMGN)



AFCN



Popliteal nerve plexus

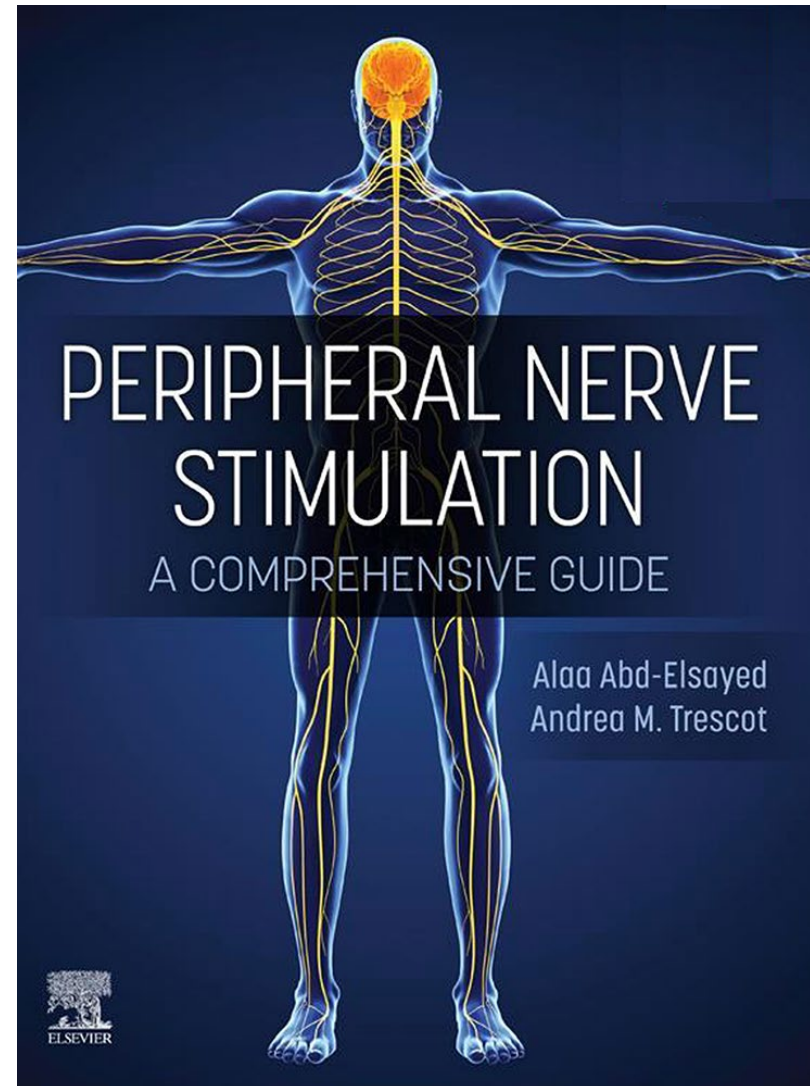




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**XXIX** CONGRESSO  
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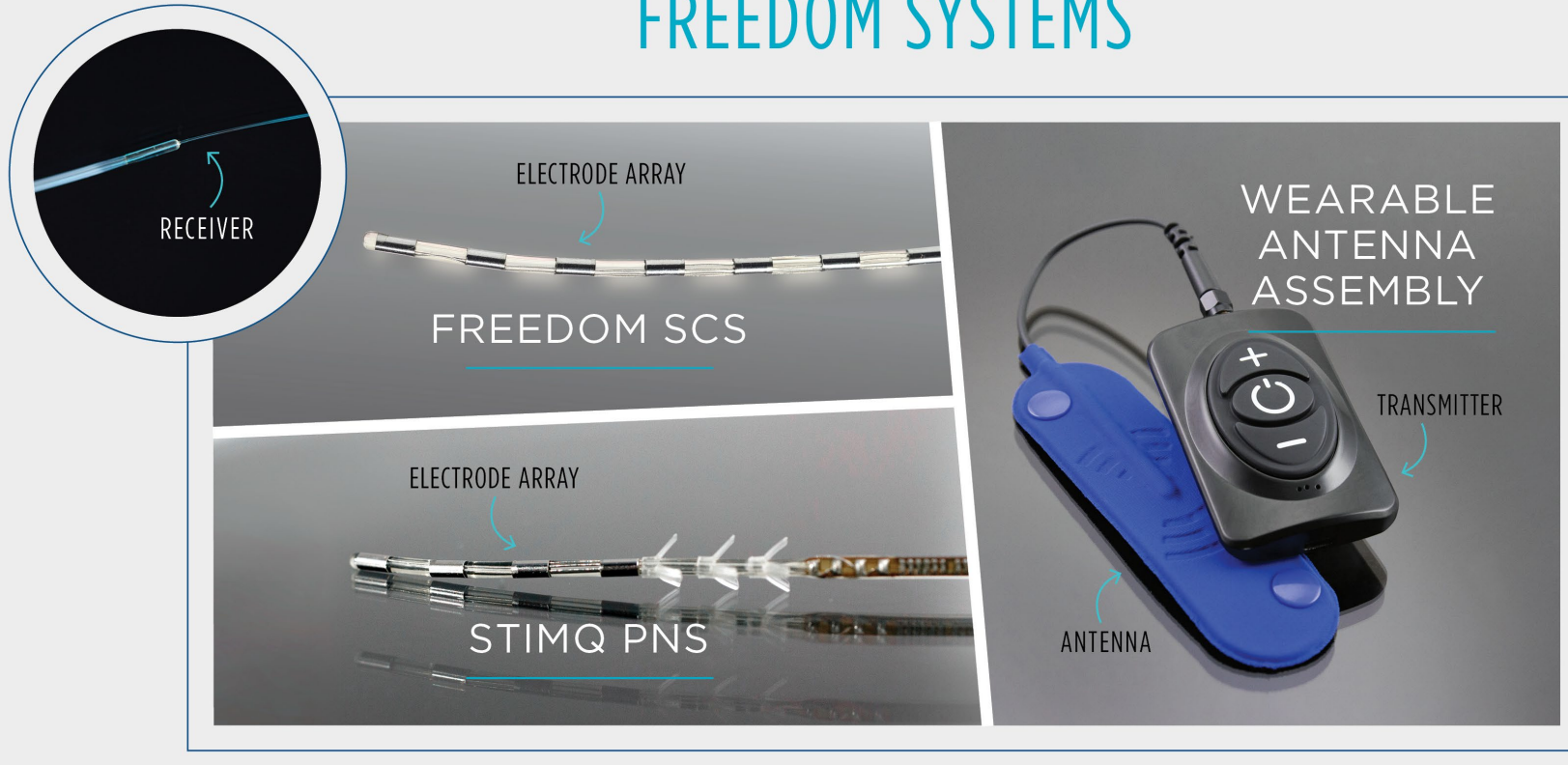
*7-9 Novembre 2024*

CESENA, Cesena fiere





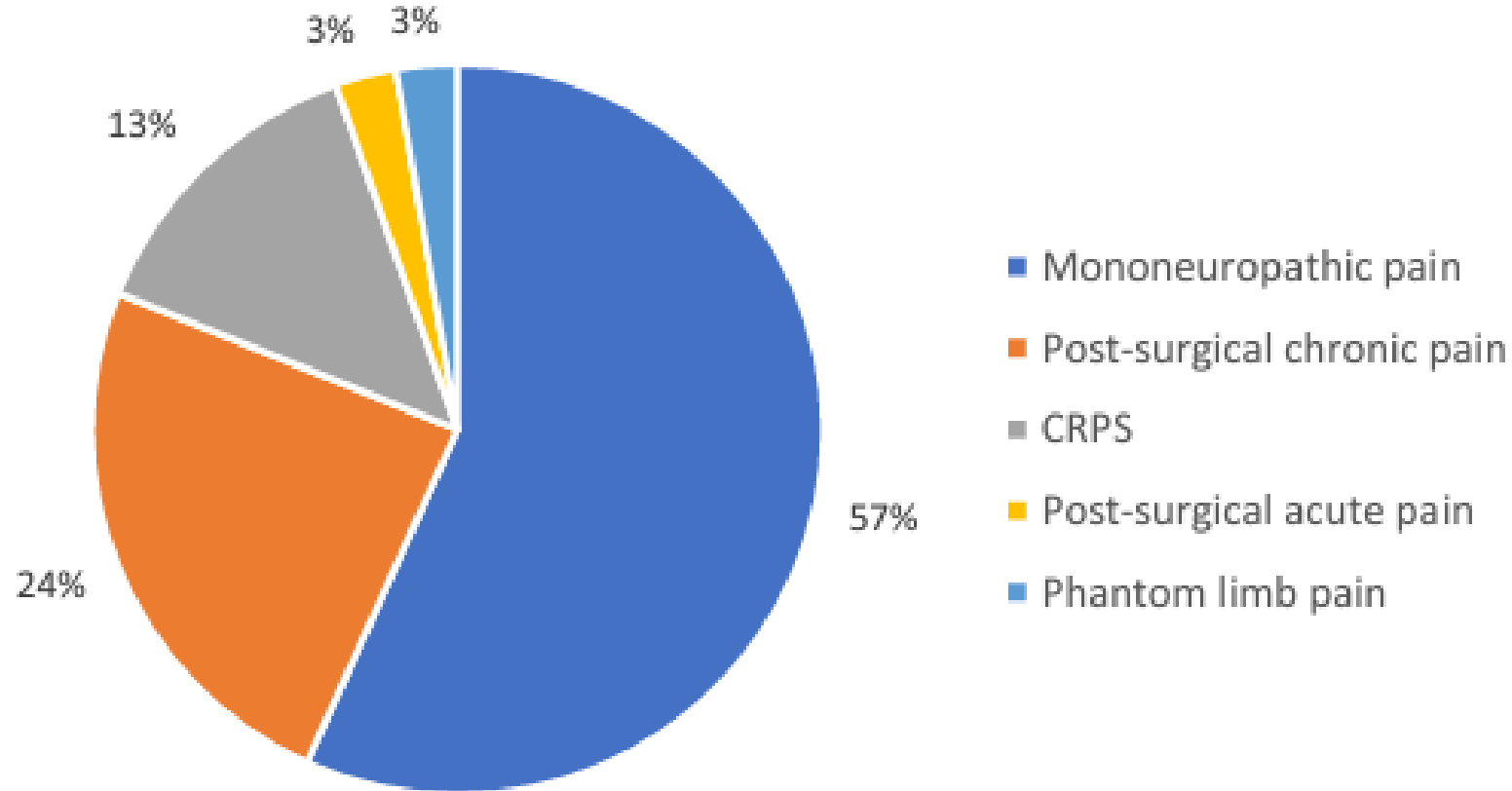
## FREEDOM SYSTEMS



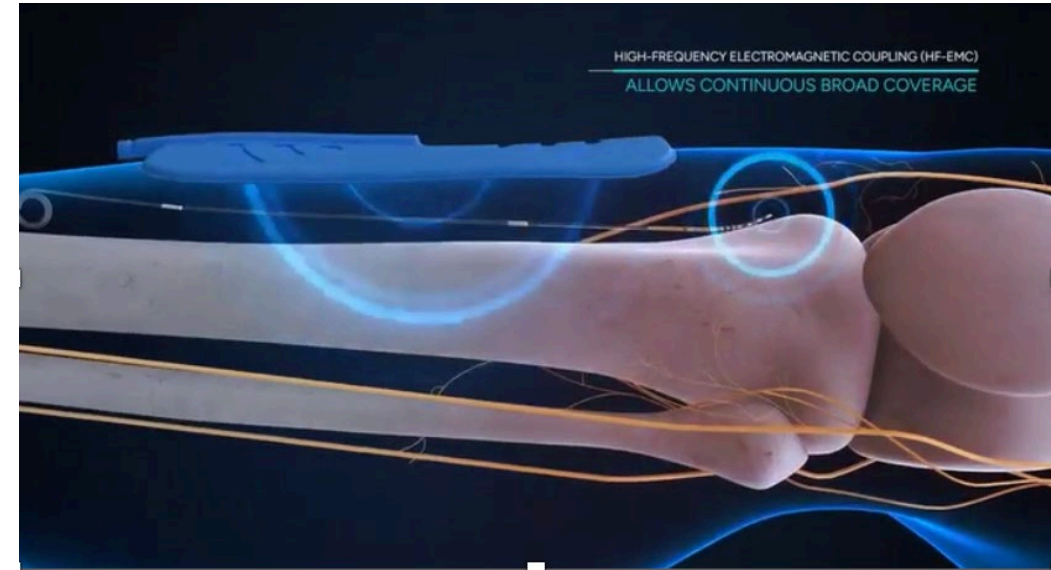
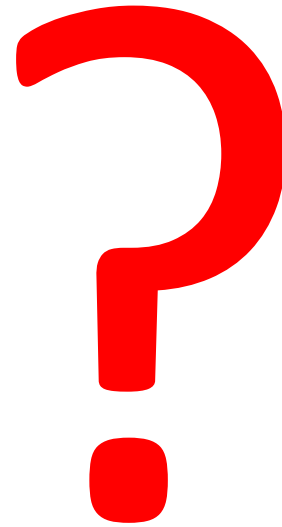
SISTEMA IMPIANTABILE

SISTEMA INDOSSABILE






A H Li et al. Considerations in permanent implantation of peripheral nerve stimulation (PNS) for chronic neuropathic pain. An international cross-sectional survey of implanters. Pain Practice 2022





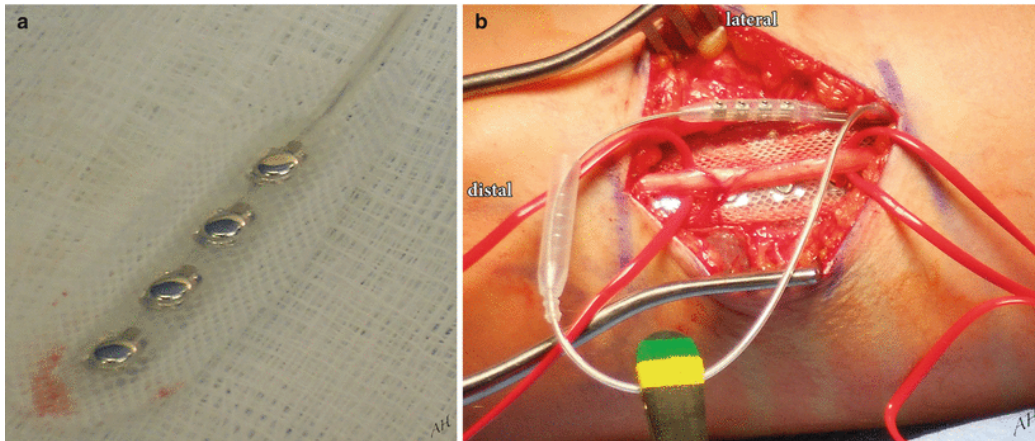
- 1. Anatomy visualization**
- 2. Pathology visualization**
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A dark puzzle piece is centered in a white puzzle background. The text "Anatomy visualization" is written in red on the dark piece.

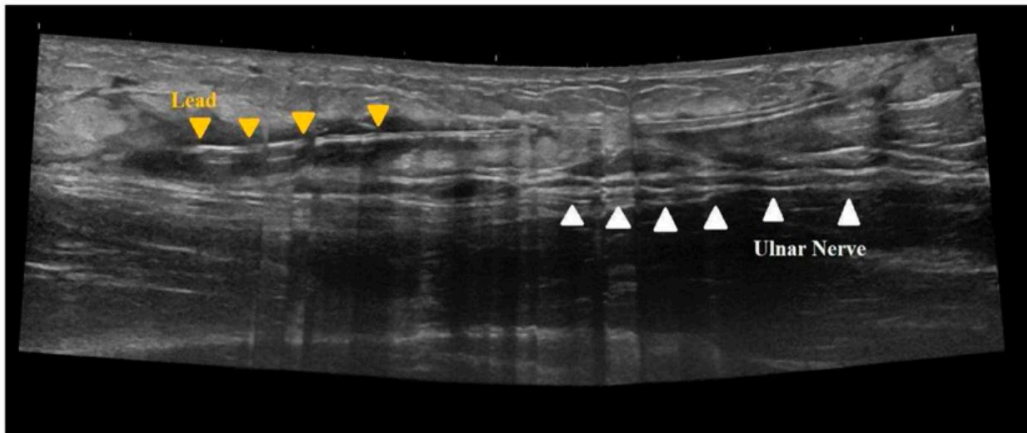
**Anatomy  
visualization**



### Open surgical placement of PNS of Ulnar nerve :



US guide



### - advantage:

- direct visualization of nerves and surrounding structures

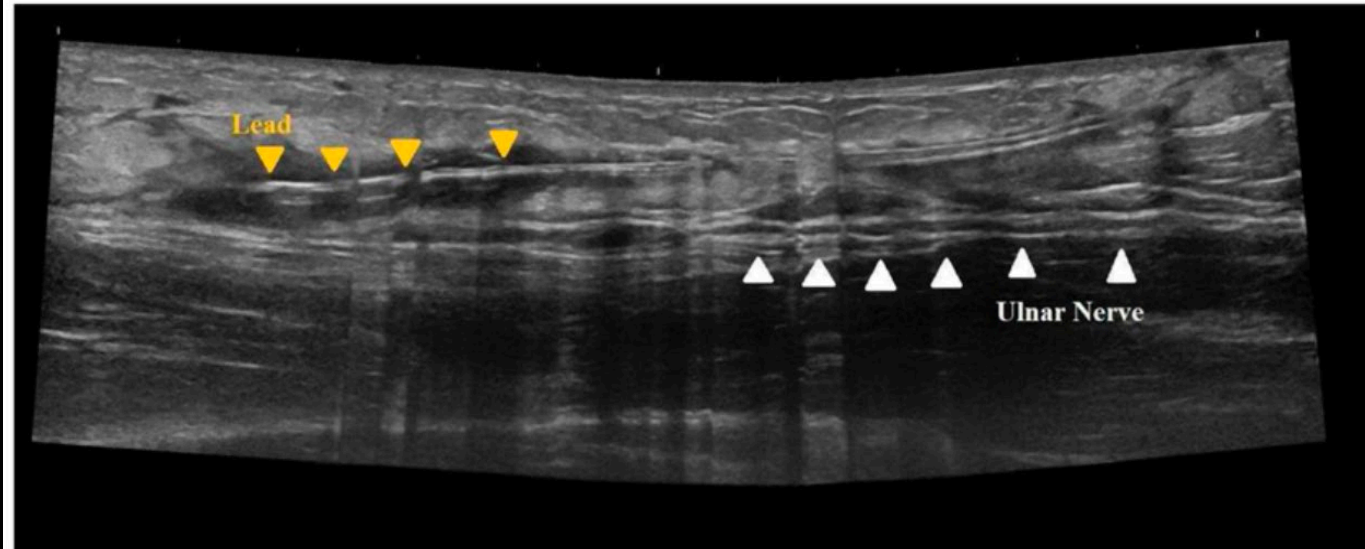
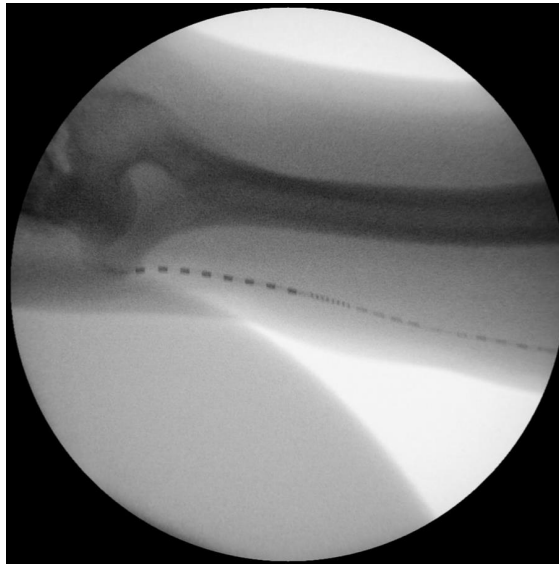
### -disadvantages:

- risk of damage to the nerve during dissection
- length of the operation and potential need for general anesthesia (which inhibits intraoperative testing)
- inability to trial the patient first

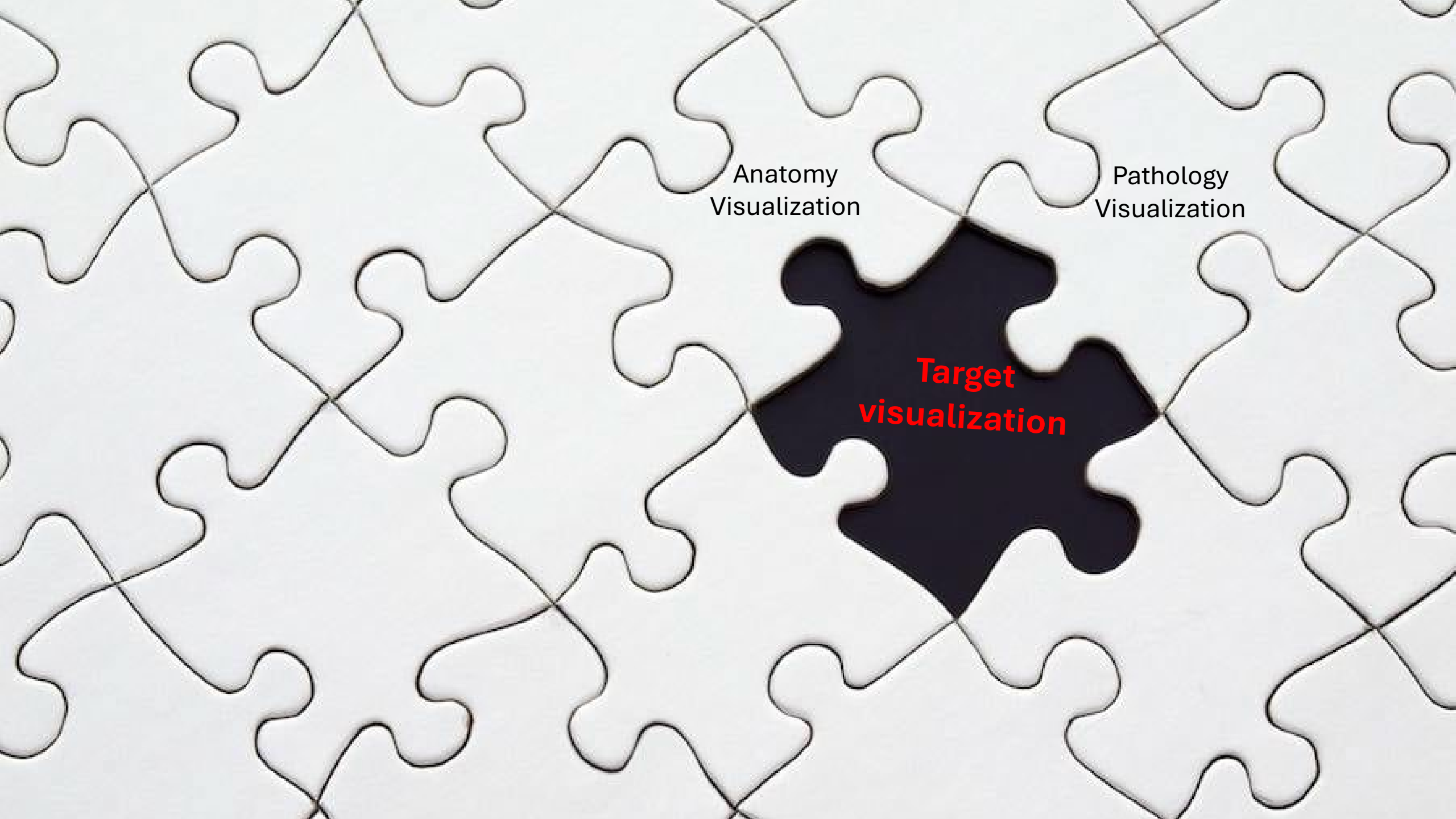
➤ Percutaneous approaches is safer and more accurate



Fluoroscopy guide vs US guide



- No radiation exposure (to both the patient and proceduralist)
- The ability to directly visualize muscle layers, surrounding vascular structures and targeted nerves
- It can reduce the painful muscle stimulation, dysesthesias, and inefficient electrical coverage and decrease the complications (trauma to arterial, muscular, and fascial structures)
- It requires less personnel to operate and is less expensive



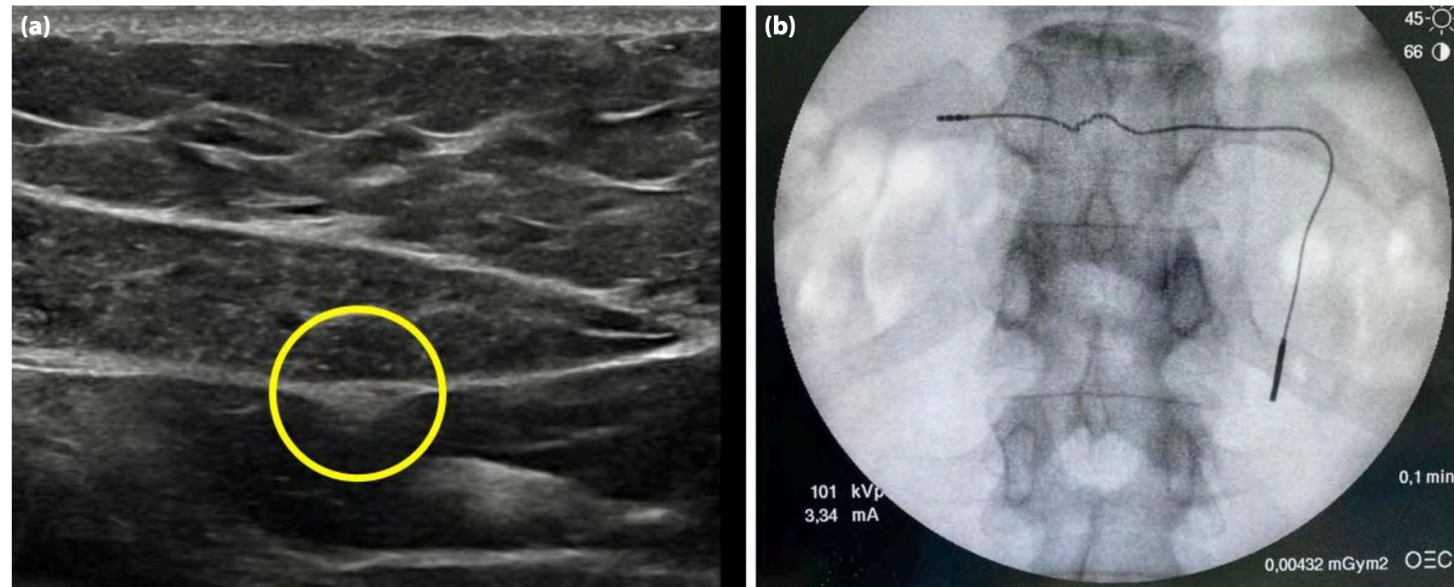
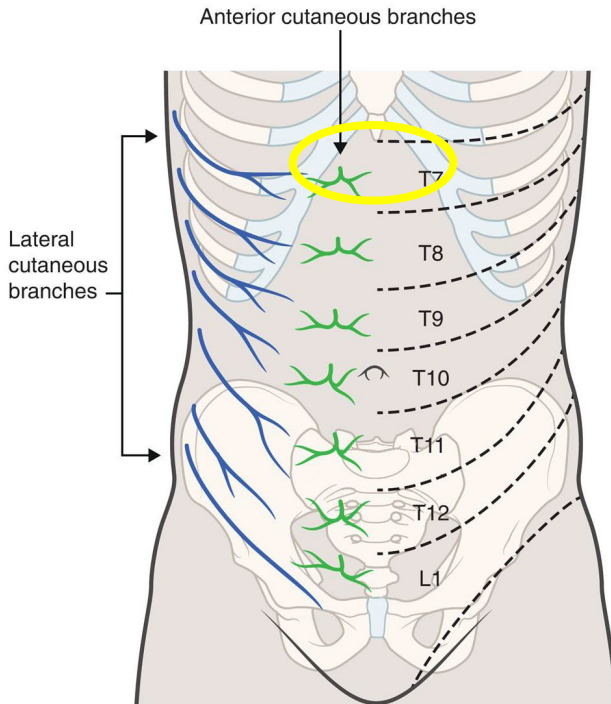
Anatomy  
Visualization

Pathology  
Visualization

**Target  
visualization**



## ACNES syndrome (of the 8th intercostal nerve)



**Figure 1.** Ultrasound image of anterior cutaneous nerve and PNS implantation. **(a)** Ultrasound image of the anterior cutaneous nerve detection (yellow circle). **(b)** Fluoroscopic image of the catheter positioned with an "L" shape in order to enlarge and maximize the stimulation field.

Peripheral nerve stimulation (PNS): A valid and definitive therapeutical option for a case of anterior cutaneous nerve entrapment syndrome (ACNES). E AMORIZZO et al. Agri 2024





## Superior cluneal nerve and PNS

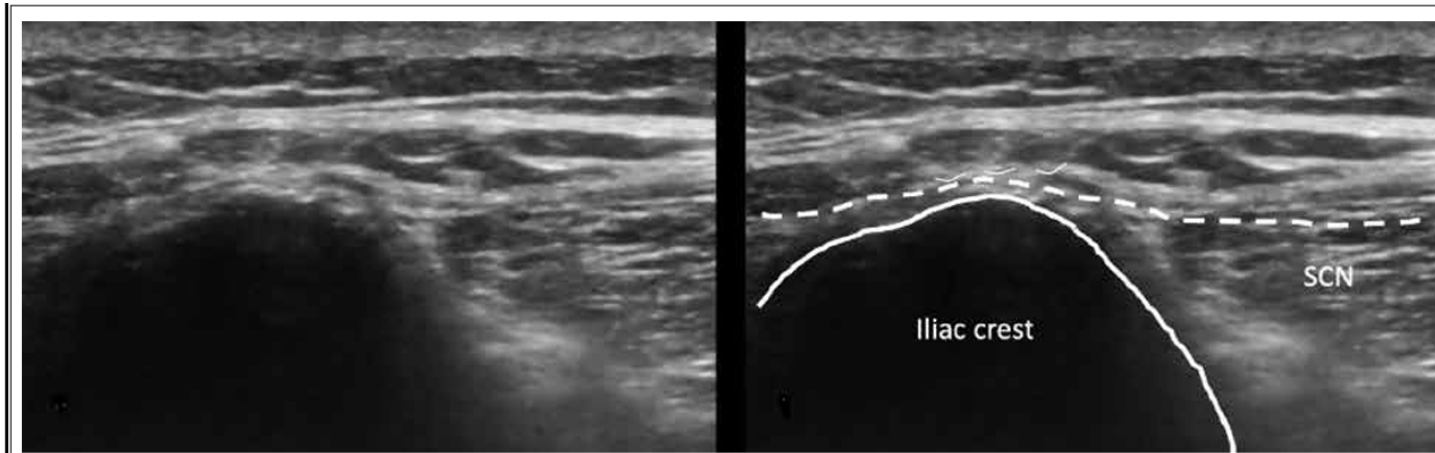
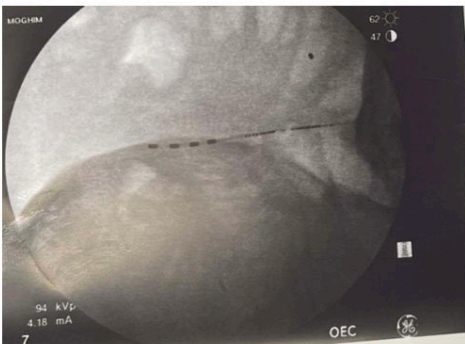
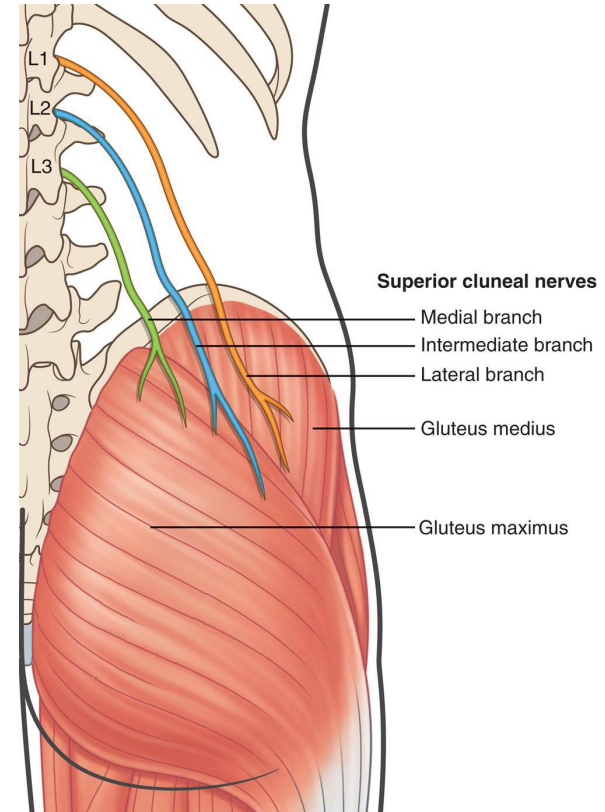


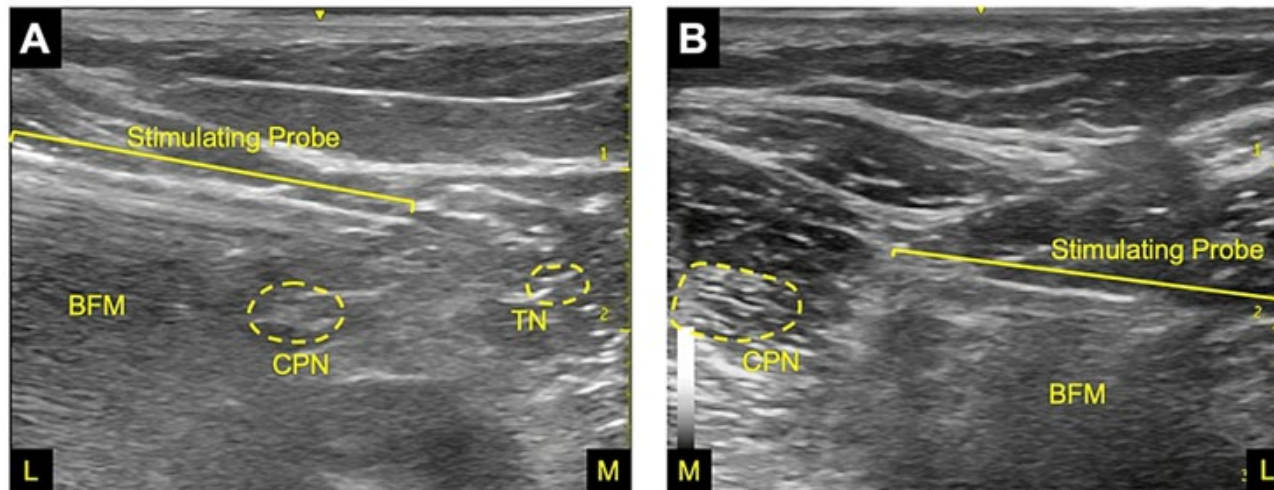
Fig. 12. *Ultrasound image of a superior cluneal nerve. The area to the left of the iliac crest is cephalad and to the right is caudad. (Image courtesy of Andrea Trescot, MD)*



HW Karl et al. Superior and Middle Cluneal Nerve Entrapment: A Cause of Low Back and Radicular Pain. Pain Physician 2022

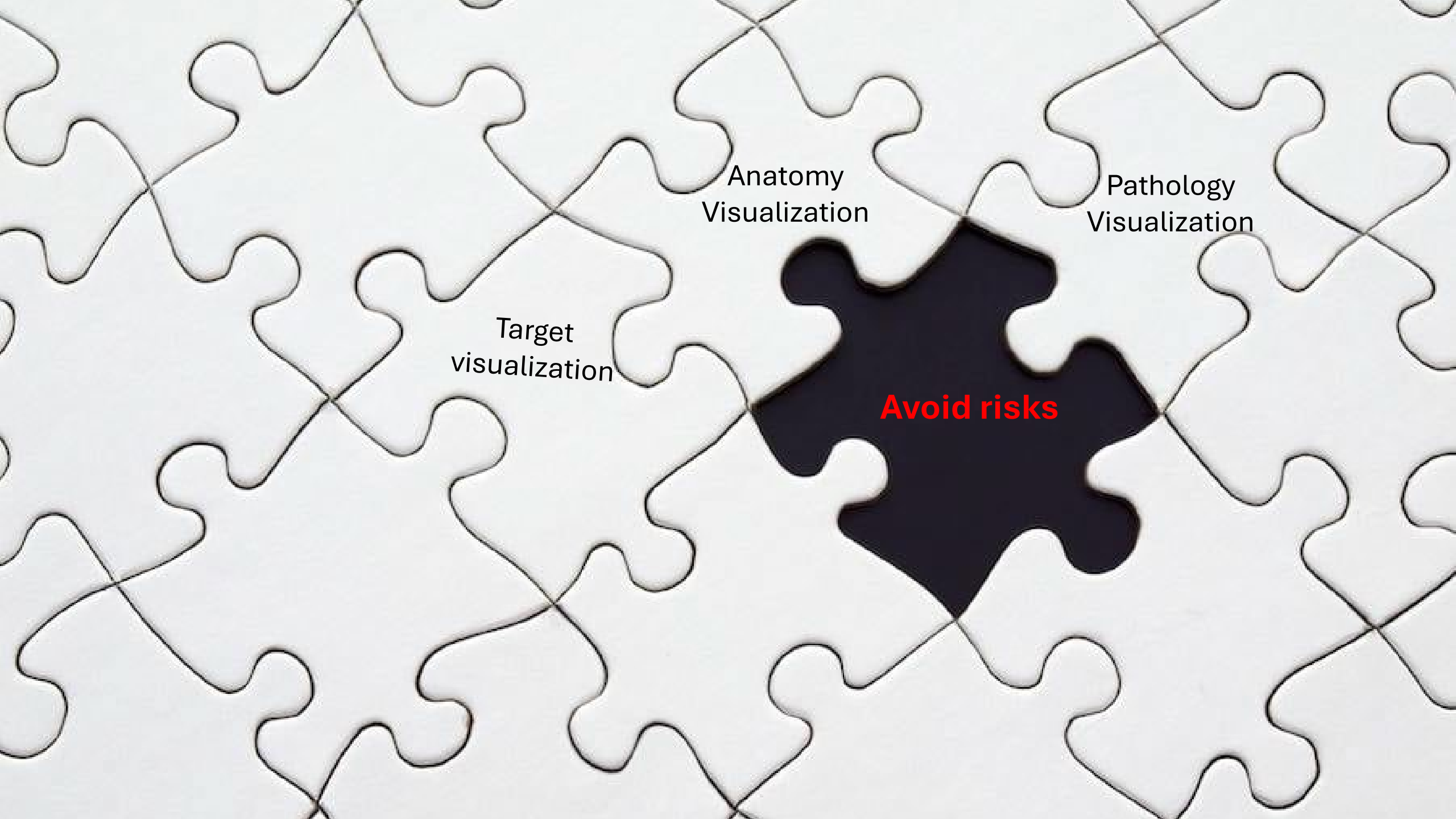


## CPRS of foot and PNS of common peroneal nerve and tibial nerve



**FIGURE 1:** In-procedure ultrasound images of the stimulating test probe for targeting the common peroneal nerve (CPN) near the biceps femoris muscle (BFM) for Case 1 (A) and Case 2 (B). The tibial nerve (TN) was targeted separately with an additional lead for each patient. In both cases, the probe approached the nerve in a lateral (L) to medial (M) direction.





Anatomy  
Visualization

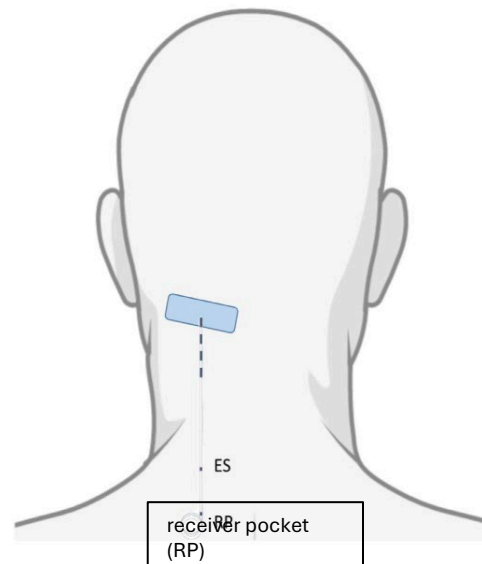
Pathology  
Visualization

Target  
visualization

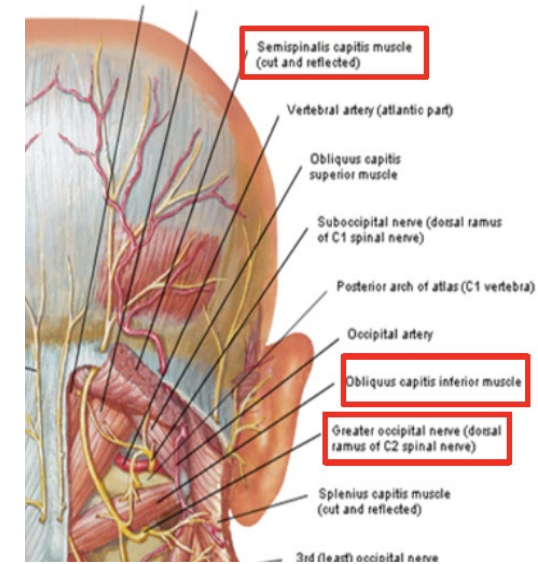
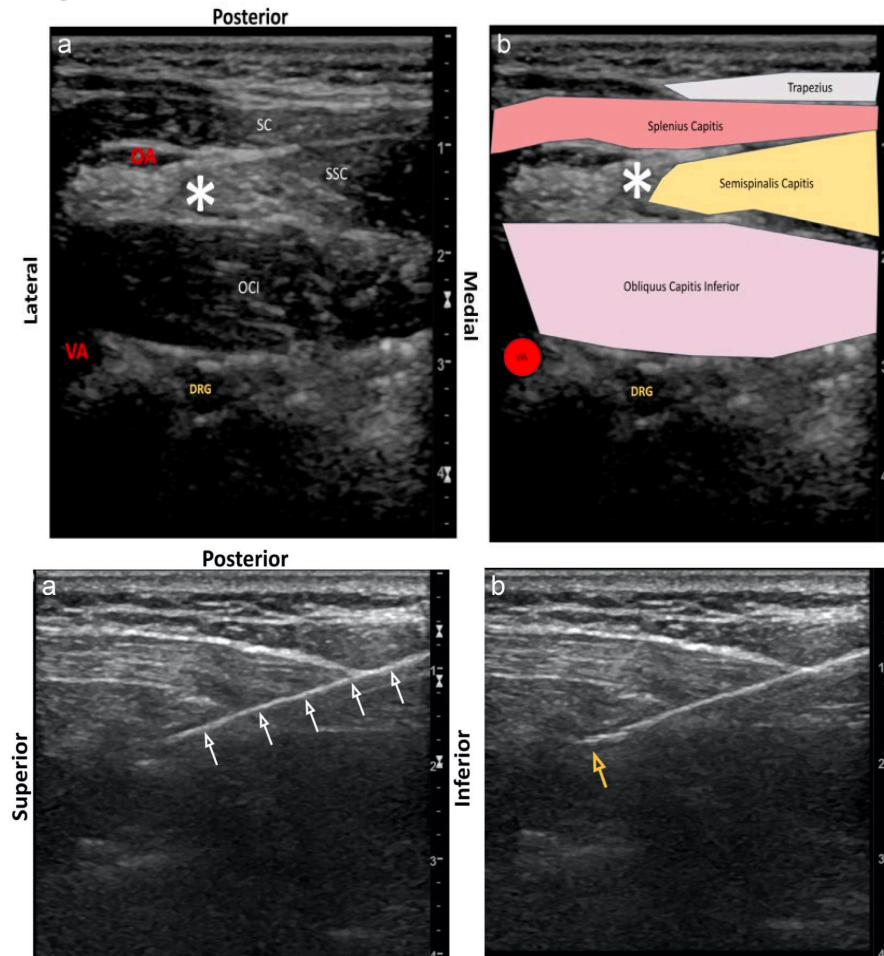
**Avoid risks**



## C2 DRG stimulation using an IPG-free PNS system for the management of chronic refractory atypical facial pain



**Figure 4.** Orientation of entry point (EP) and array placement. Ultrasound probe (blue rectangle). [Color figure can be viewed at [www.neuromodulationjournal.org](http://www.neuromodulationjournal.org)]



Ultrasonographic longitudinal view of electrode array placement.

a. Introducer assembly (white arrows) in position above the C2 DRG.

b. Electrode array (yellow arrow) projecting out of tip of the introducer sheath.



## ONS

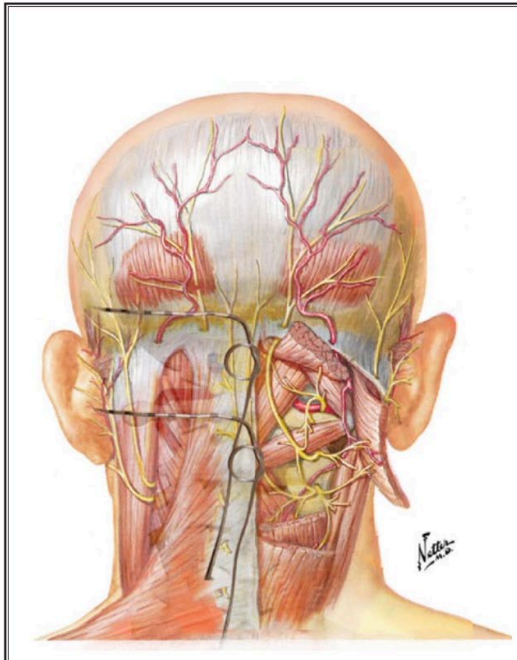


Fig. 9. Schematic depiction of the relationship of percutaneous occipital neurostimulator leads to the greater occipital nerve. The rostral lead is placed over the nuchal ridge and the caudal lead at the level of C1. Netter medical illustration used with permission of Elsevier. All rights reserved.

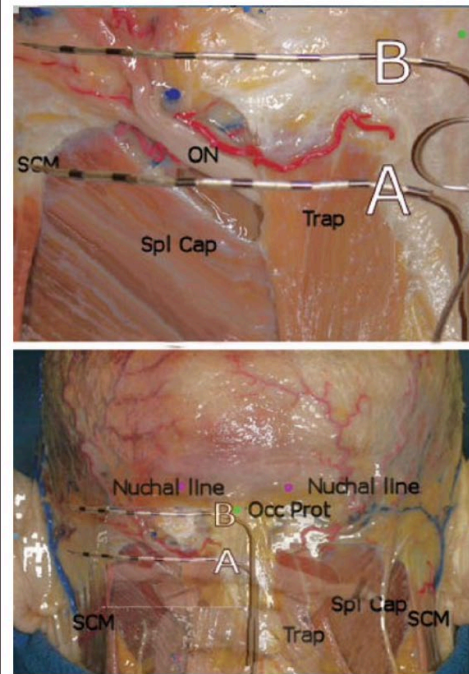
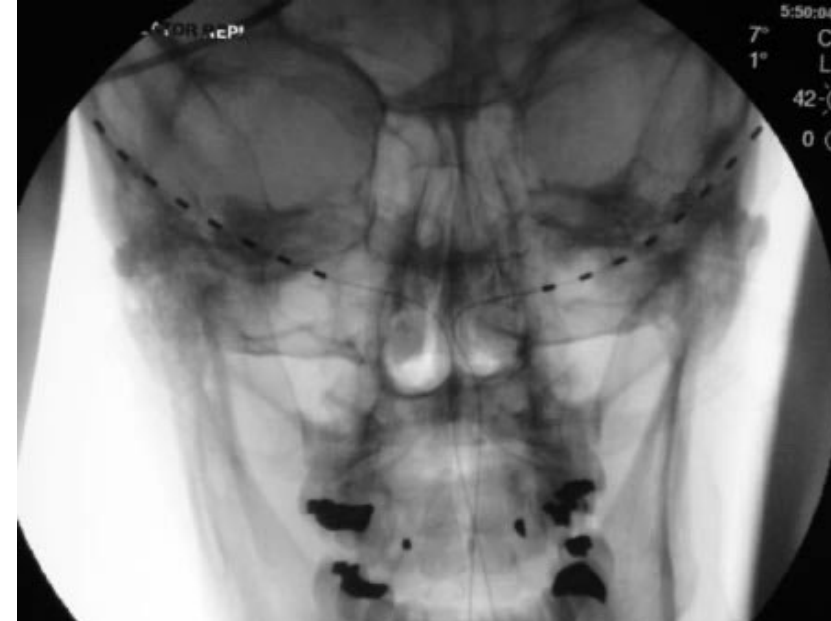


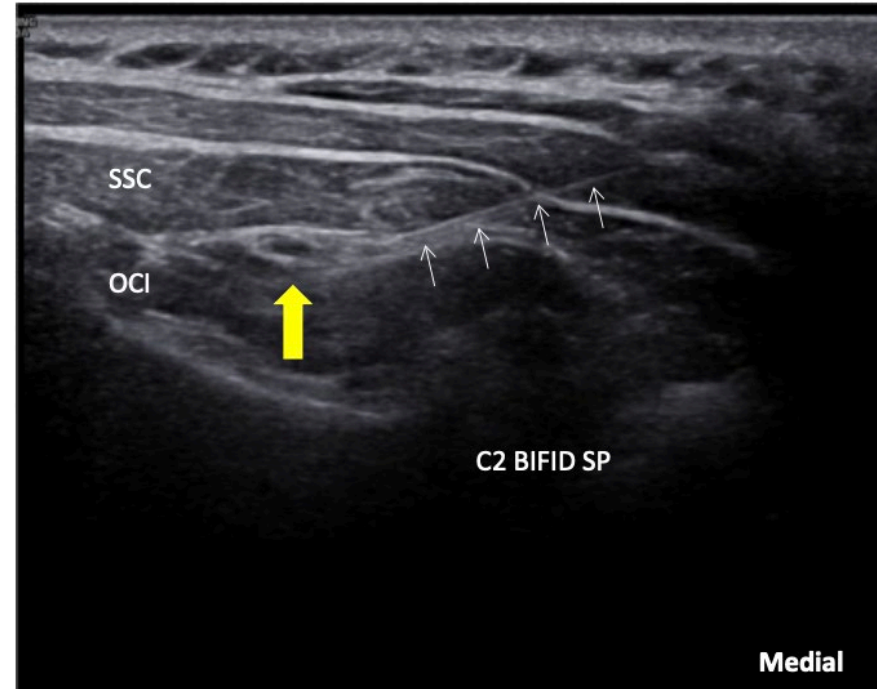
Fig. 10. Depiction of occipital neurostimulator leads obtained by overlaying lead images onto the anatomic dissection discussed in Fig. 5. Shimizu et al (34) medical illustrations used with the permission of Lippincott Williams & Wilkins (LWW).

Placement of peripheral neurostimulator leads at or above the nuchal line in these 5 cases provided good paresthesiae without causing neck muscle spasm.



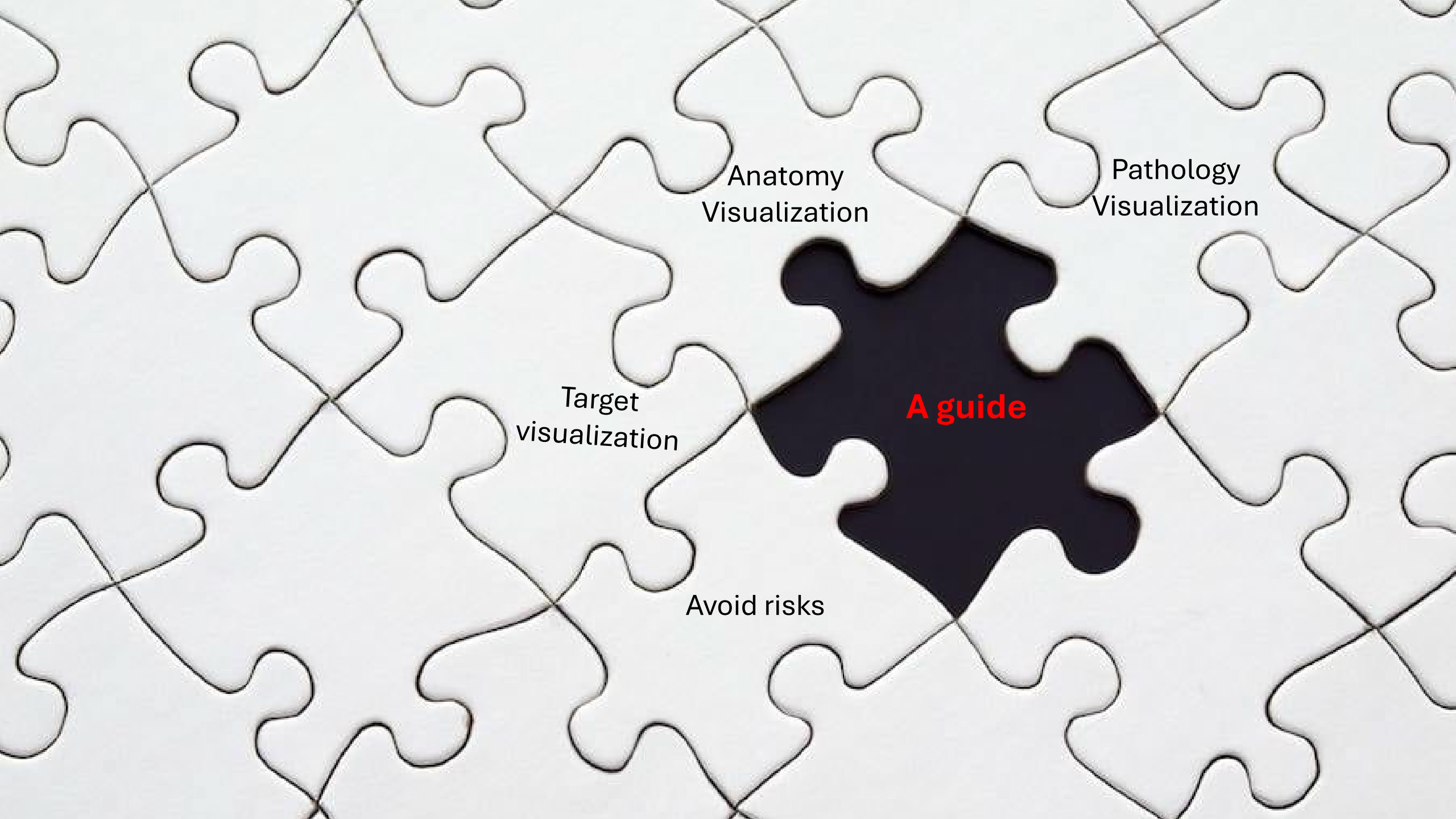


## Peripheral Nerve Stimulation for Occipital Neuralgia



GON (large arrow) lying in the fascial plane between the semispinalis capitis (SSC) and obliquus capitis inferior muscle (OCI). The shadow of the C2 bifid SP (spinous process) is also depicted to show the level of needle entry.

The needle (skinny arrows) is inserted from medial to lateral toward the left GON (large arrow).

A white puzzle with one dark grey piece in the center. The dark piece contains the text 'A guide' in red. Surrounding pieces contain the text 'Anatomy Visualization', 'Pathology Visualization', 'Target visualization', and 'Avoid risks'.

Anatomy  
Visualization

Pathology  
Visualization

Target  
visualization

**A guide**

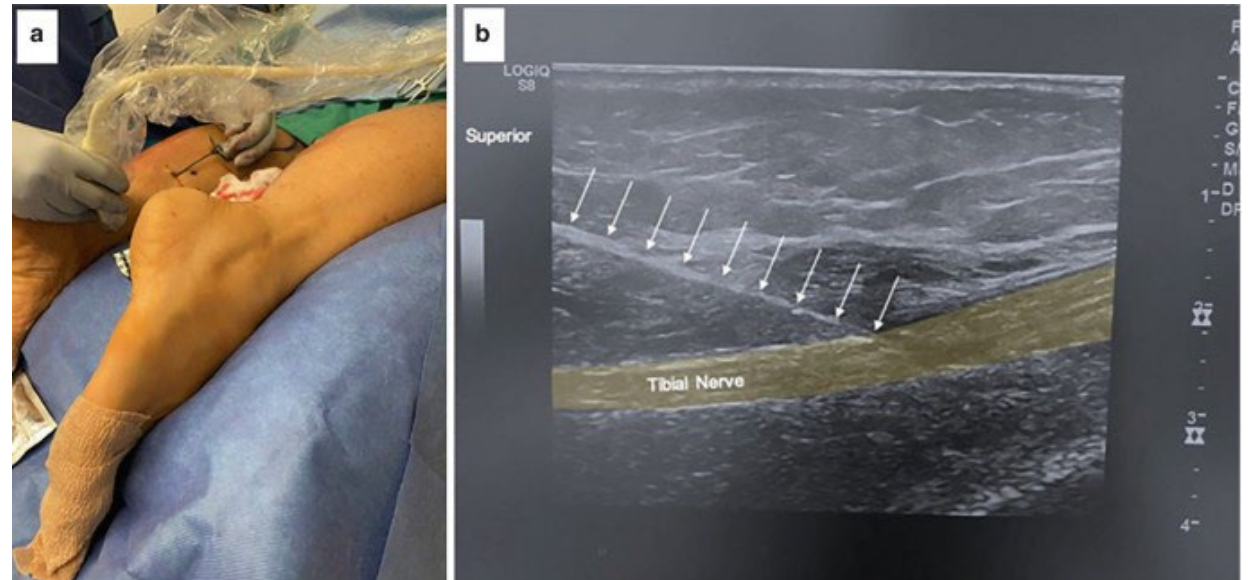
Avoid risks



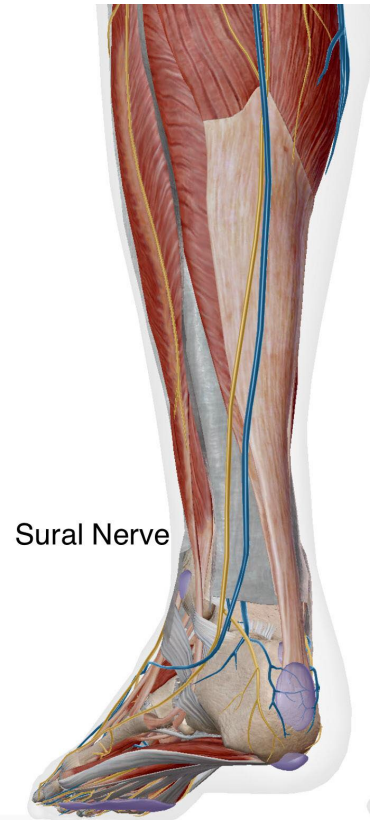
PNS systems with US guidance has unlocked the potential for varying waveform effects on a peripheral nerve.

- The thresholds were lowest when the nerves and electrodes were parallel
- it may be relevant to investigate the overall position of the target nerve fibers prior to electrode placement

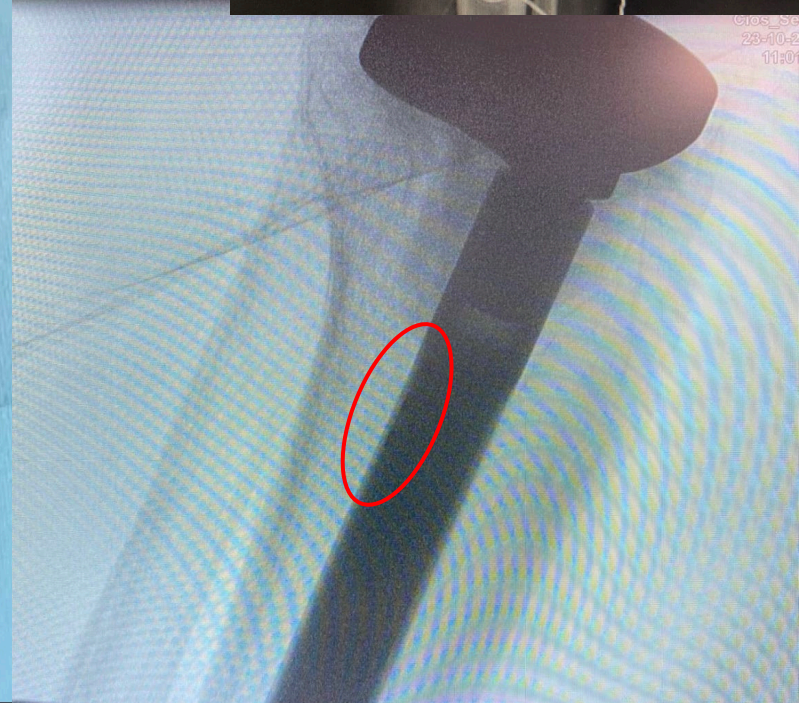
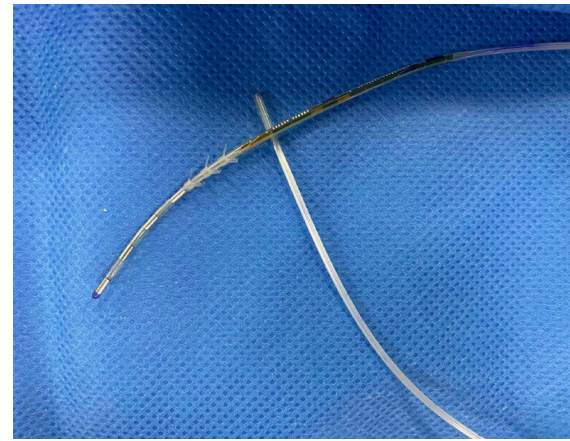
A Resurgence of Peripheral Nerve Stimulation with Innovation in Device Technologies.  
E Sivanesan, A. Gulati. Reg Anesth Pain Med. 2019





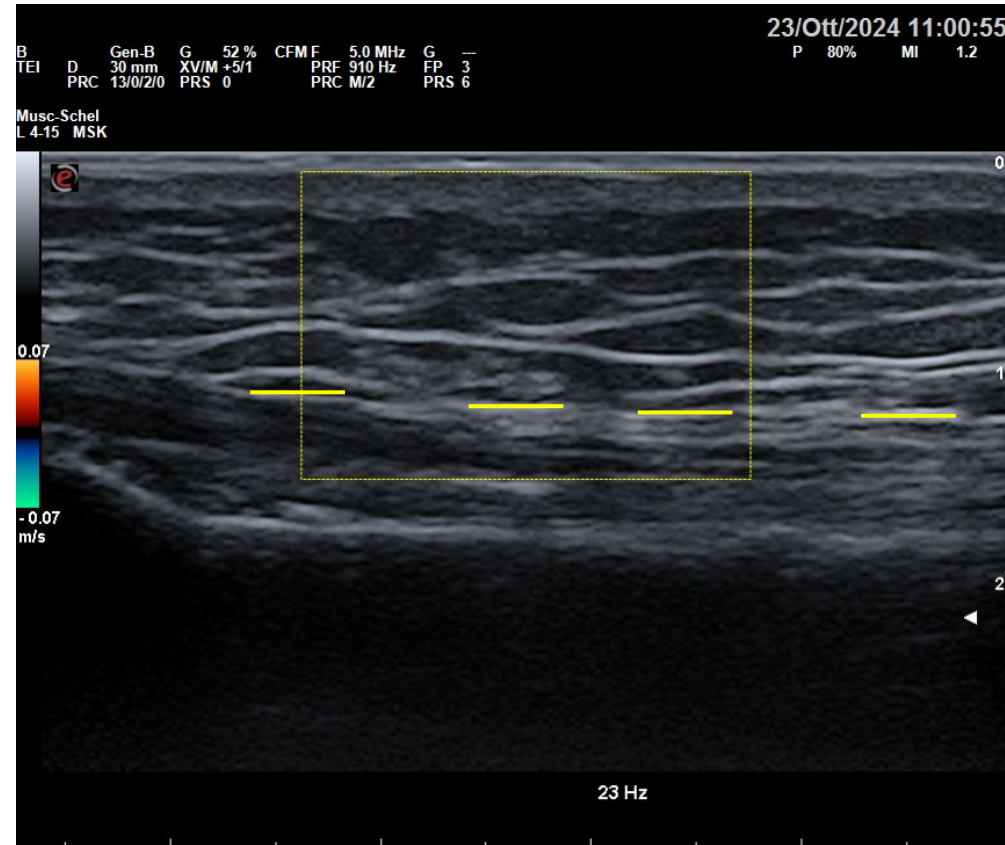
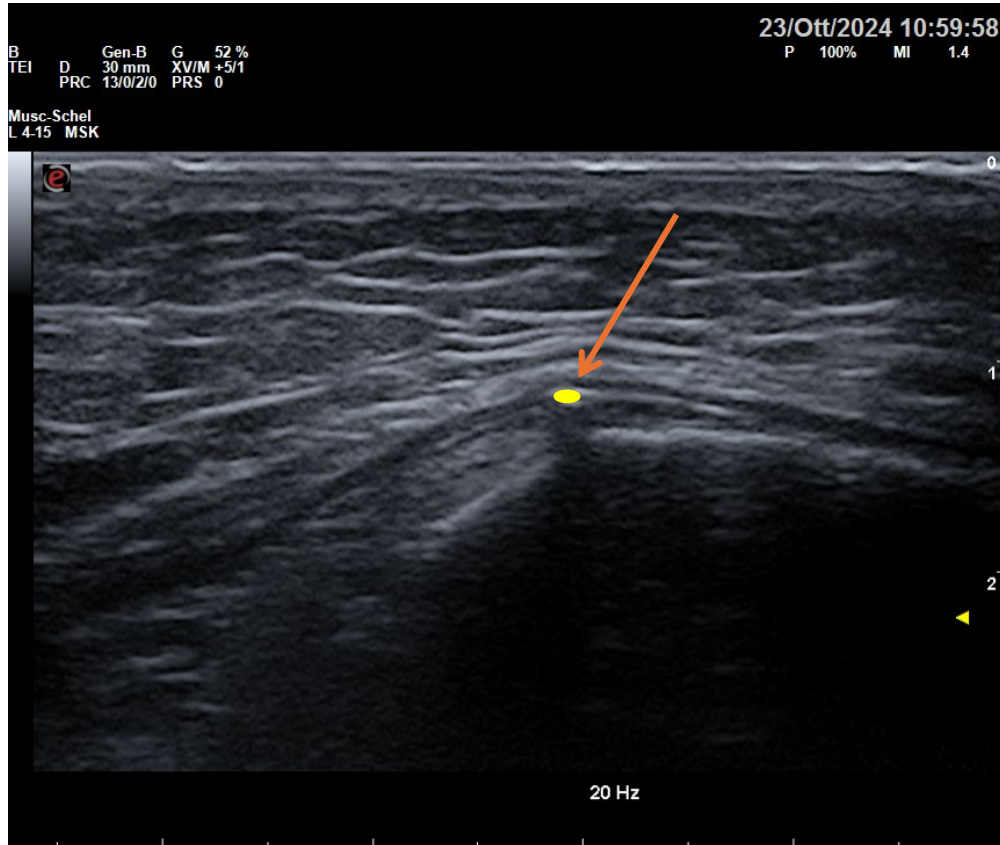
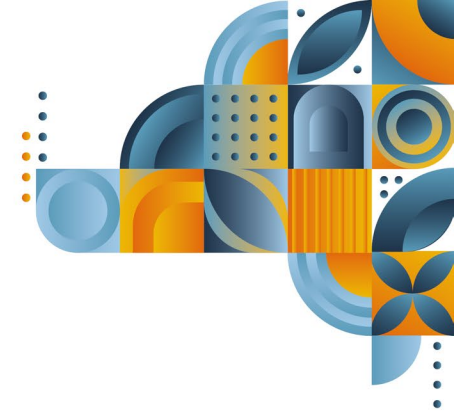
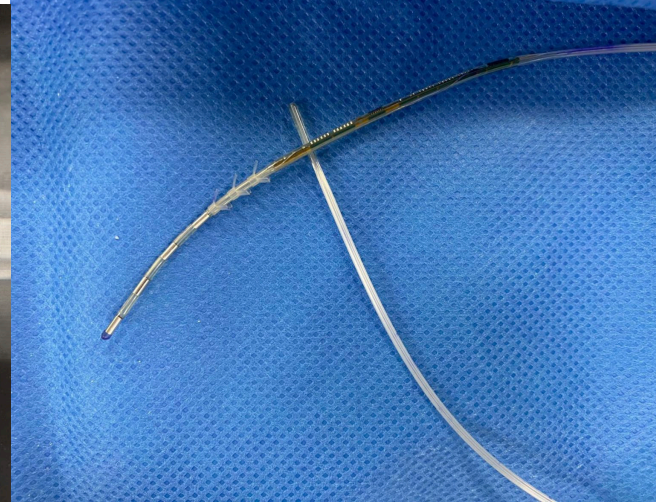
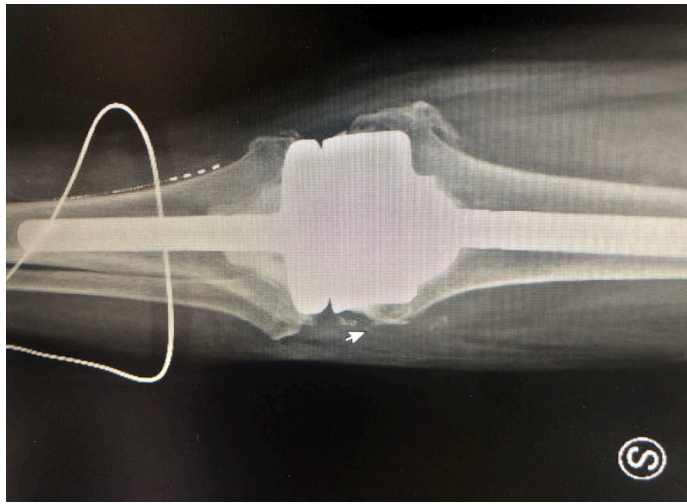


Painful Knee arthroplasty



Cros\_Sc  
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11:01

Painful Knee  
arthroplasty

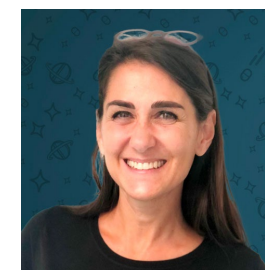
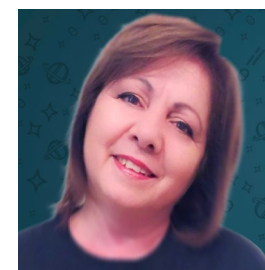
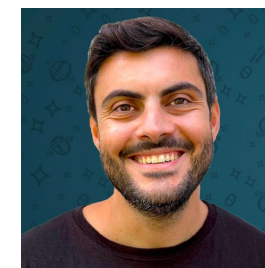
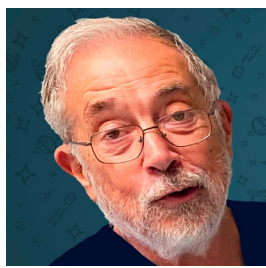
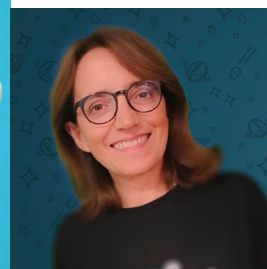
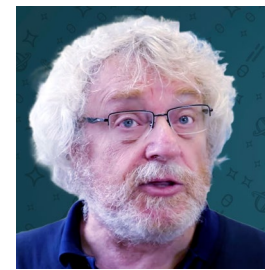




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