Cooled Radiofrequency Ablation for Joint Pain (Hip, Knee, ?Shoulder)

Maxim S. Eckmann, MD

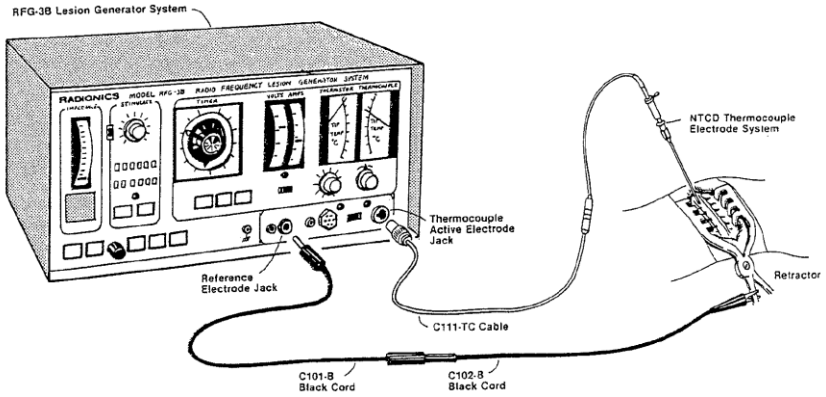
Associate Professor/Clinical, Department of Anesthesiology

University of Texas Health Science Center at San Antonio

Disclosures

- Neuromodulation Fellowship Education Support Grants from Abbot, Boston Scientific, and Medtronic.

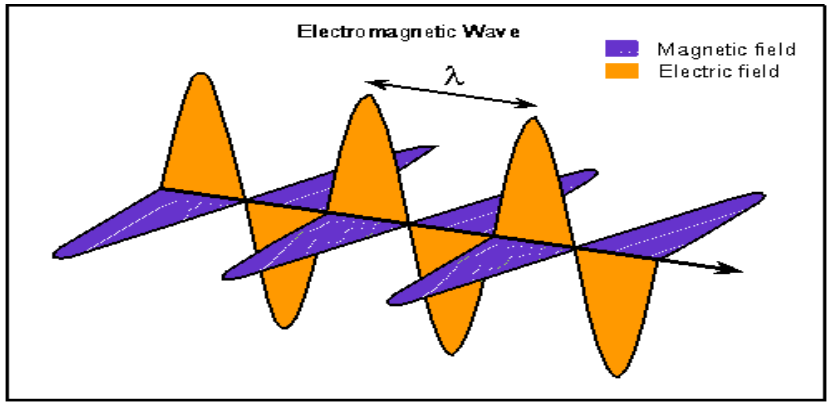
Objectives

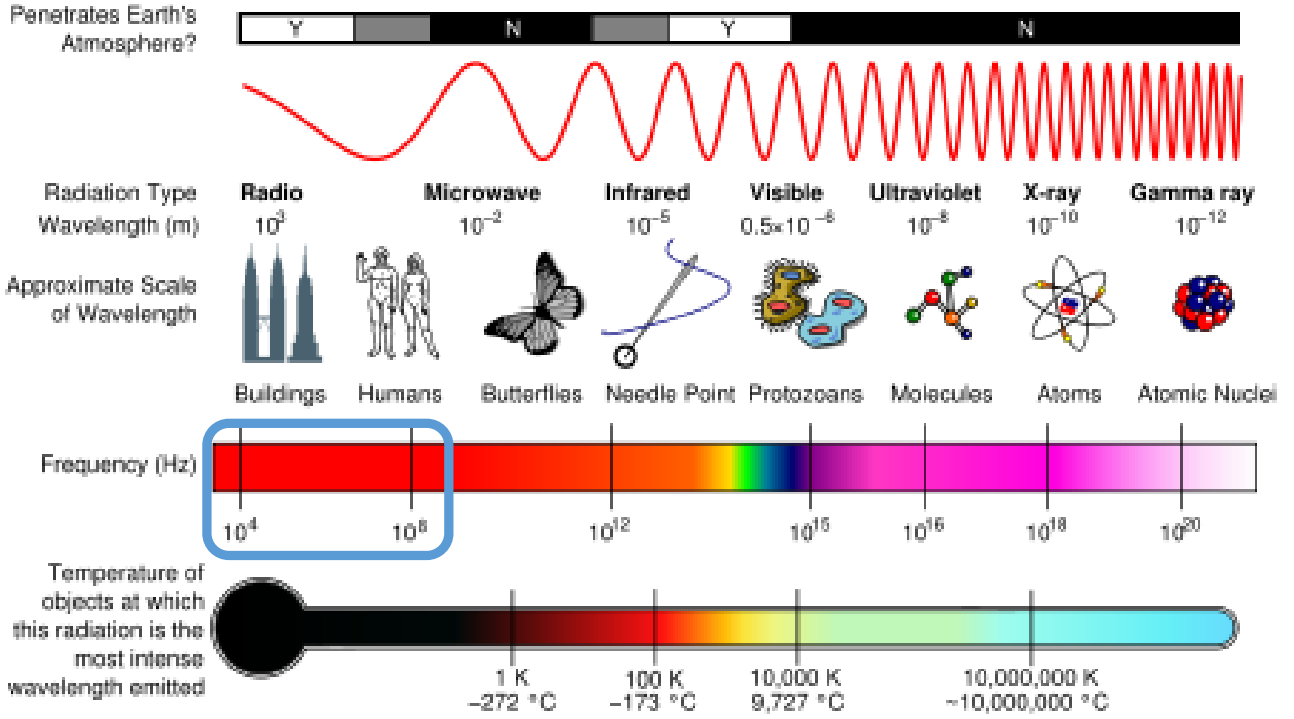


- Elucidate scientific principles governing Radiofrequency Ablation (RFA) and Cooled RFA.
- Understand ablation targets for innervation of major joints.
- Apply current technological concepts to understand relevant advantages, limitations, and complications.

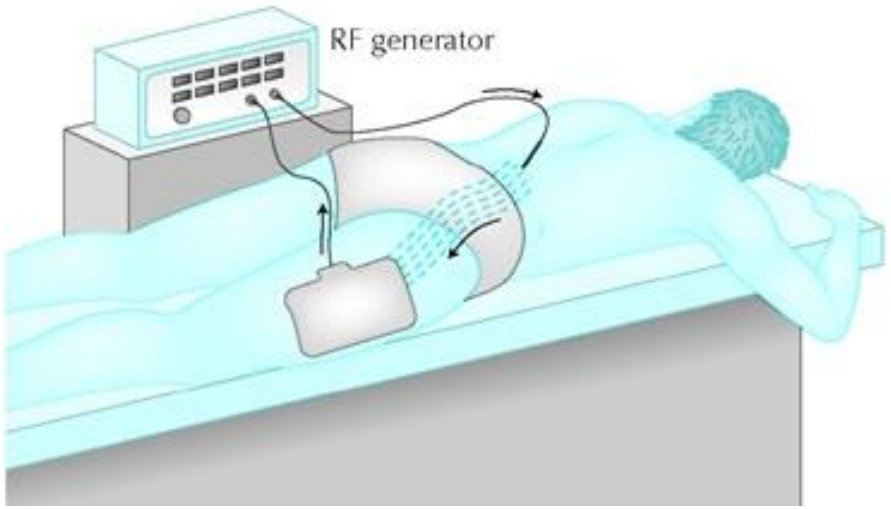
Radiofrequency: What is it?

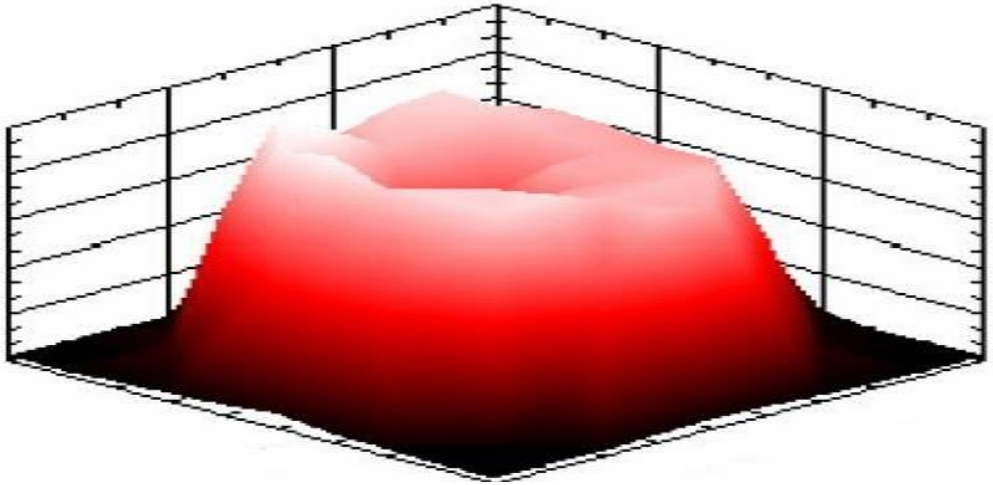
- Electromagnetic Energy Spectrum
- Typically: **400-500 kHz**
- Low inferference with human electrical conduction systems (e.g. cardiac).
- Able to produce ionic frictional heating



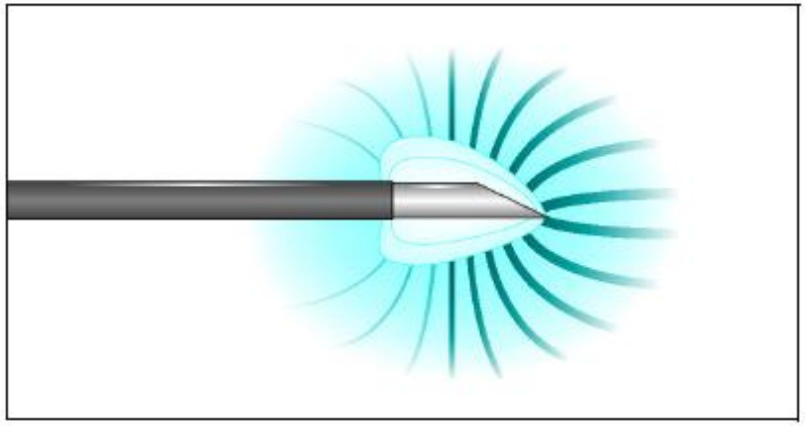


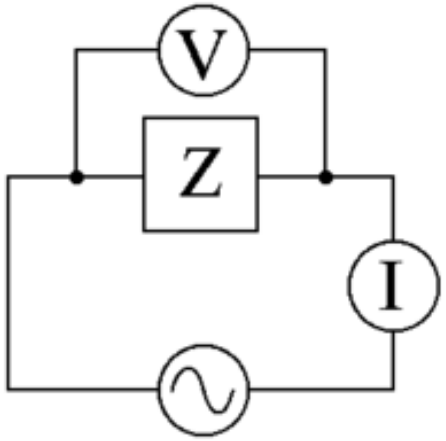
Conventional Radiofrequency Ablation (RFA)

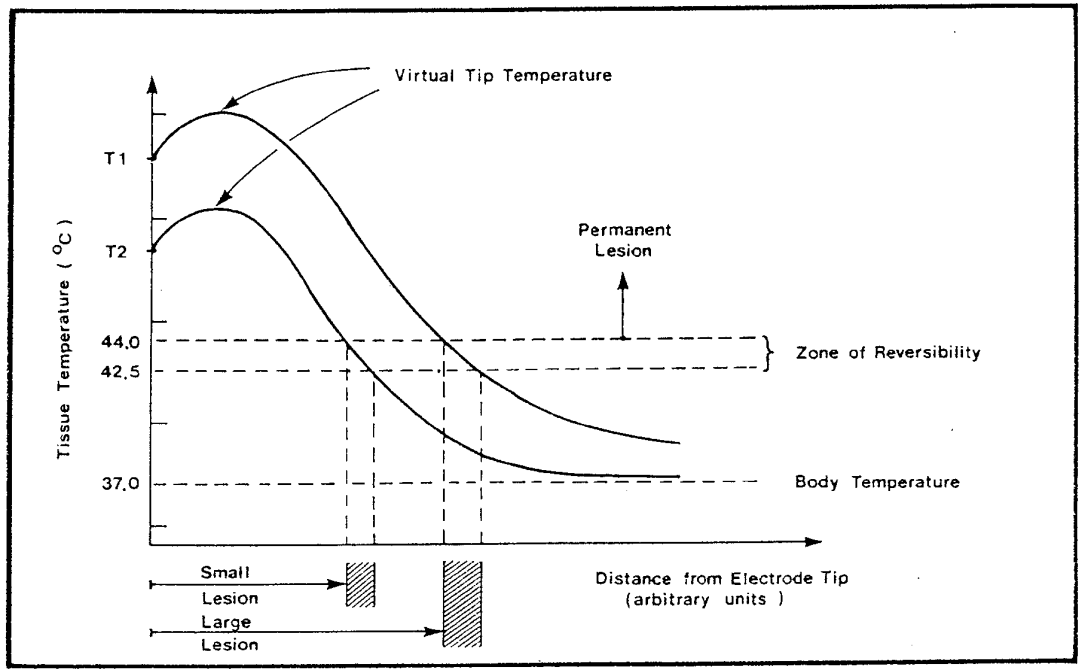




TISSUE TEMPERATURE VS. DISTANCE FROM ELECTRODE







Cosman ER. Neurosurgery 1984;15(6): 945-950
Ahadian FM. Current Pain and Headache Reports 2004;8:34-40

Creating Lesions in Tissue

$$\frac{dQ}{dt} = \kappa \nabla^2 T + \frac{1}{\sigma} j^2 - \frac{dQ_c}{dt}$$

Heat change
Per volume
Per time

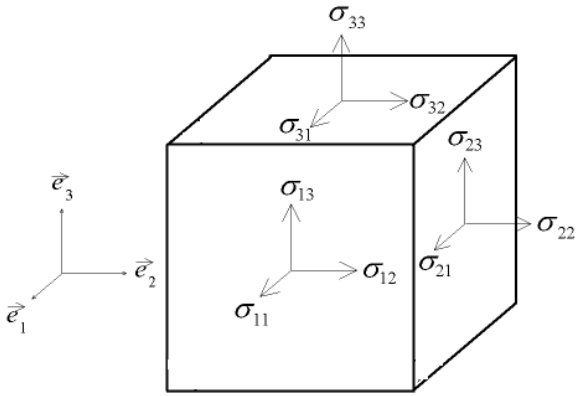
Thermal
Conductivity

Tissue
Temp

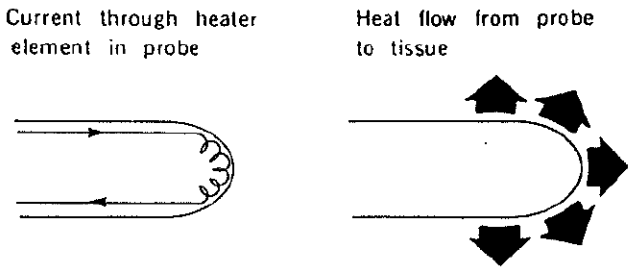
Electrical
Conductivity

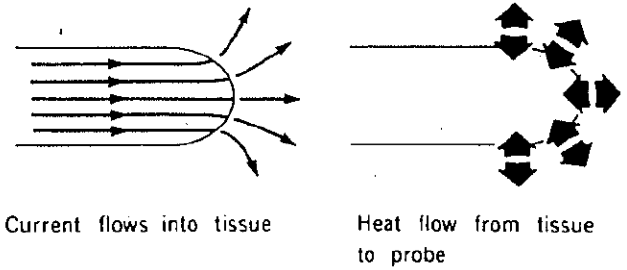
Current
Density^2

Heat loss
To circulation



(Direct Heating)





RF Heating (indirect)

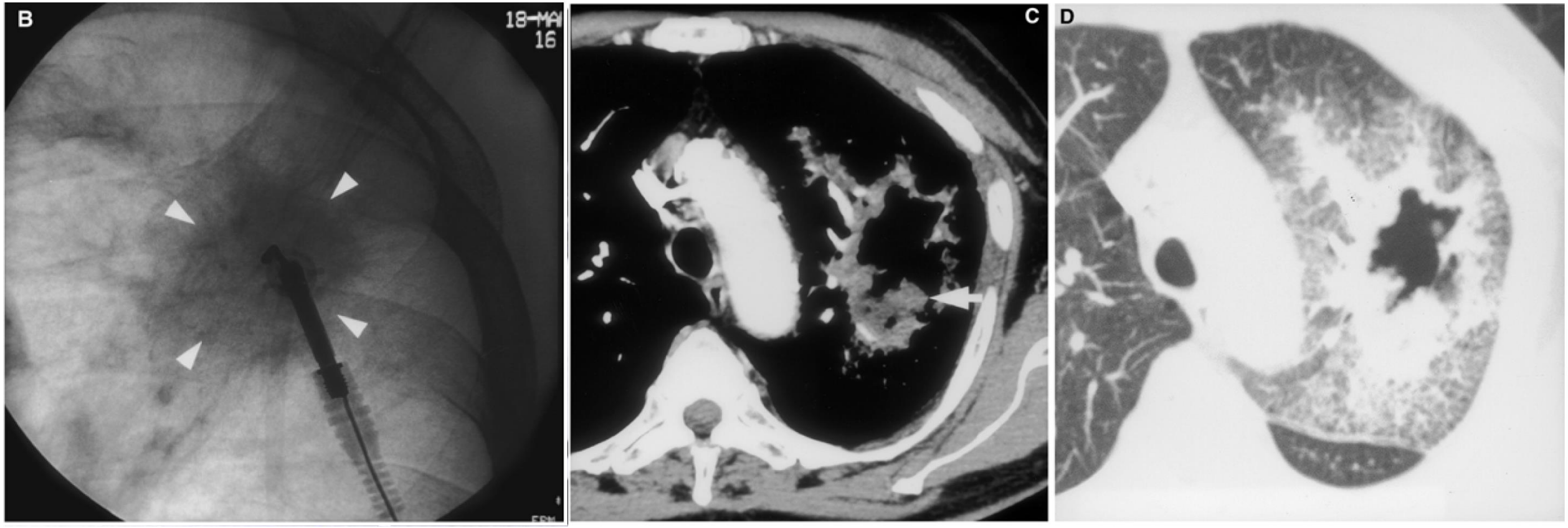
Organ LW. Applied Neurophysiology 1976/77;39:69-76
Cosman ER. Neurosurgery 1984;15(6): 945-950

More is Better? Quest for Larger Lesions

- Larger Gauge, Longer Active Tip
- Ionic Fluid Pre-Injection
- Palisading Monopolar Lesions
- Bipolar Lesions, Palisading Bipolar
- Cooled RFA
- Multi-tined RFA
- Multipolar RFA

Excessive Hyperthermic Necrosis of a Pulmonary Lobe after Hypertonic Saline-Enhanced Monopolar Radiofrequency Ablation

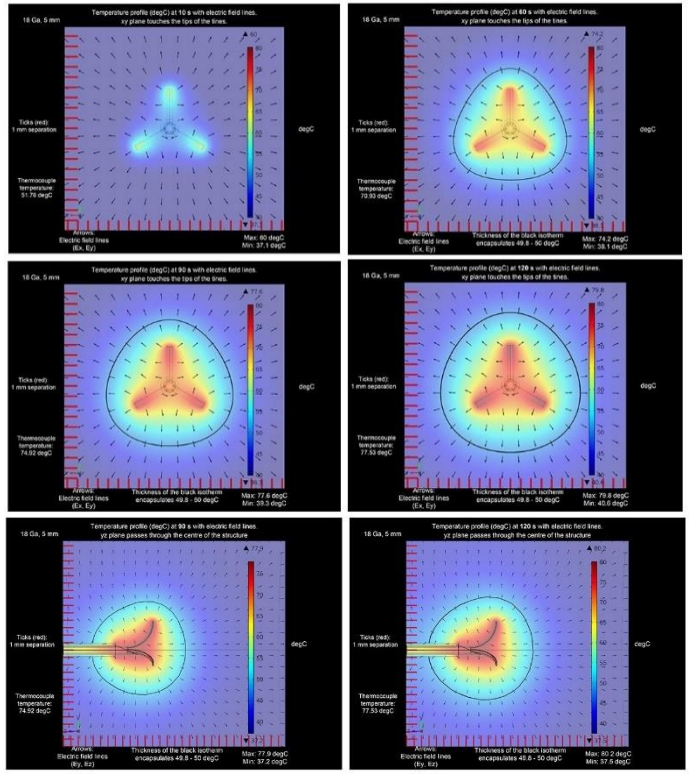
Tae Sung Kim,[1] Hyo K. Lim,[1] Hojoong Kim[2]

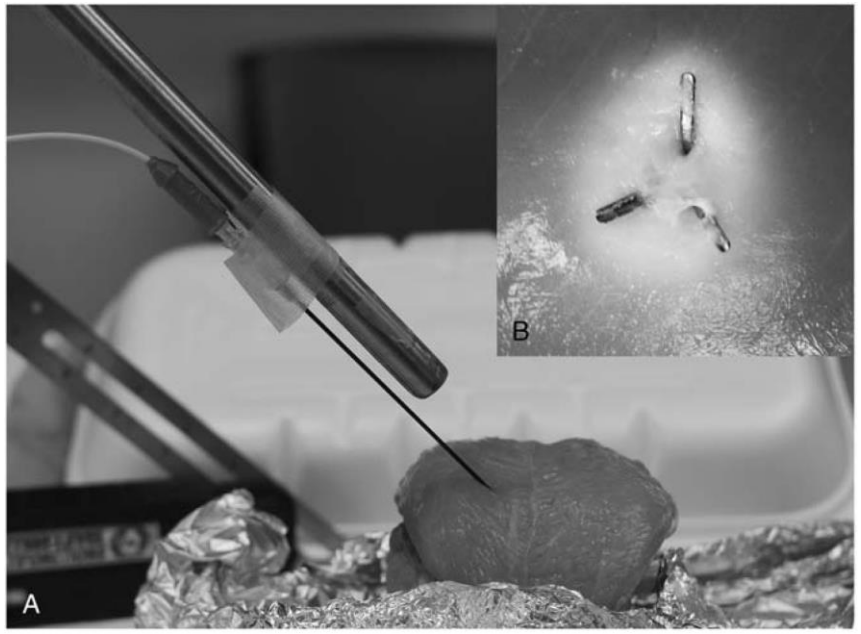


Livraghi T, et al. Radiology. 1997 Jan;202(1):205-10.
Provenzano DA, et. al. Reg Anesth Pain Med. 2015 Mar-Apr;40(2):112-24.

Example: Multi-tined Probes

- Monopolar Conventional RFA
- Functionally Larger Active Tip





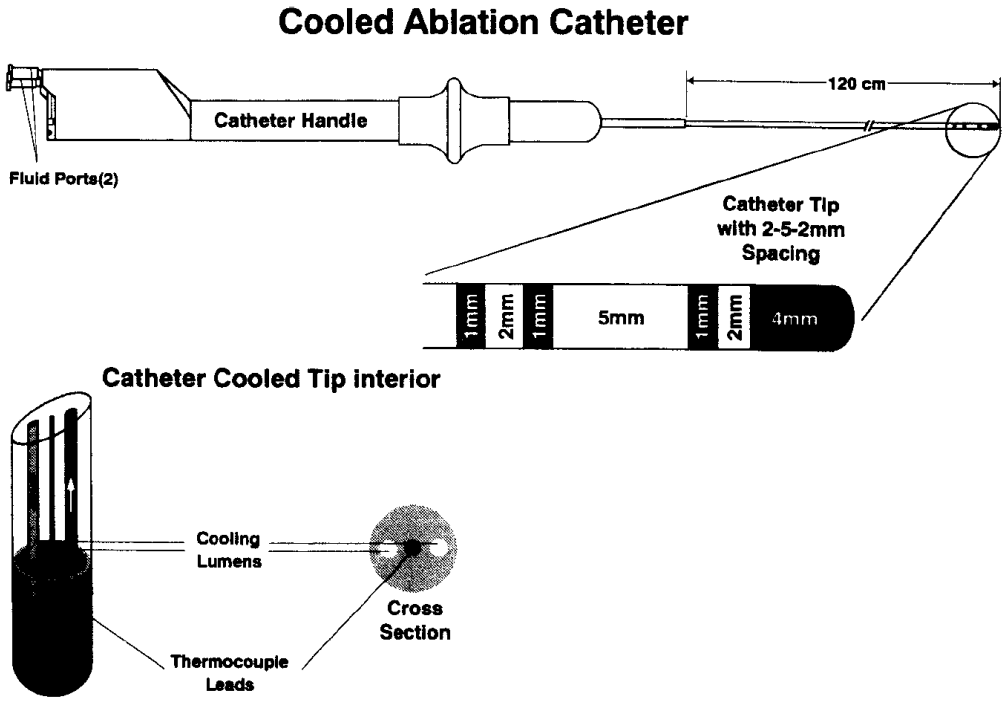
Finlayson RJ, et. al. Reg Anesth Pain Med. 2017 Jan/Feb;42(1):45-51.

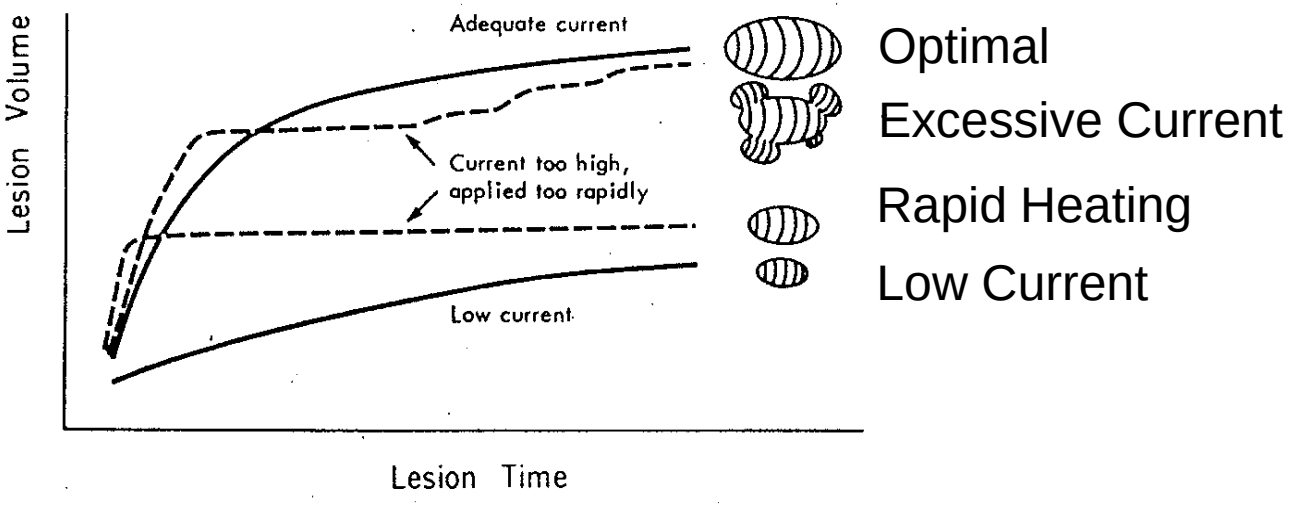
Cooled (not COLD!) Radiofrequency

Journal of Interventional Cardiac Electrophysiology 6, 9–16, 2002

Cooled-Tip Ablation Results in Increased Radiofrequency Power Delivery and Lesion Size in the Canine Heart: Importance of Catheter-Tip Temperature Monitoring for Prevention of Popping and Impedance Rise

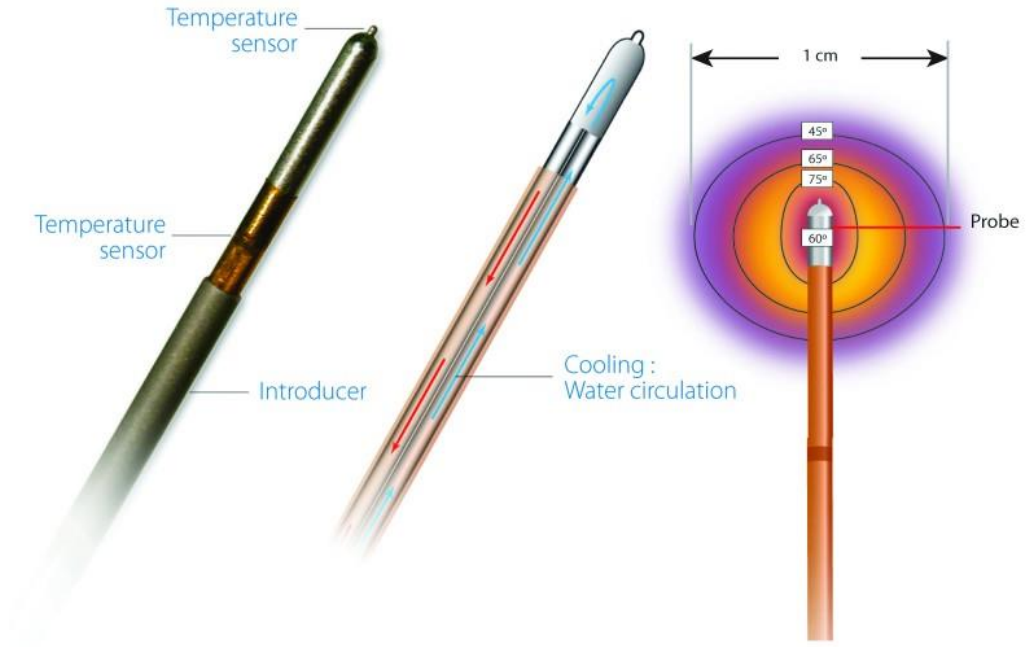
Ichiro Watanabe, Riko Masaki, Nuo Min, Naohiro Oshikawa, Kimie Okubo, Hidezou Sugimura, Toshiaki Kojima, Satoshi Saito, Yukio Ozawa, and Katsuo Kanmatsuse

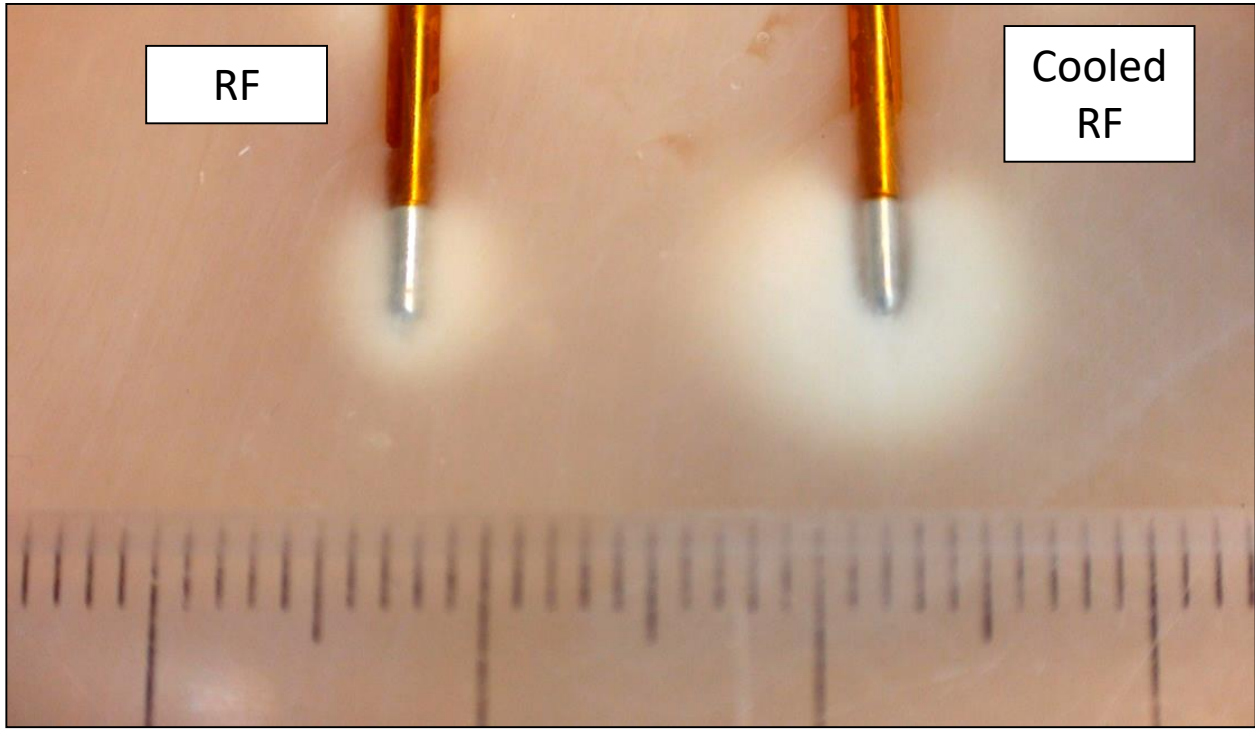




Cooled RF

- Cooled RF now applied to spine ablation
  - Has been used elsewhere for increasing size of solid organ lesions to 30-50mm.
- Applied to joint denervation for pain management.
- Fluid Pre-injection may not affect lesion size[1]

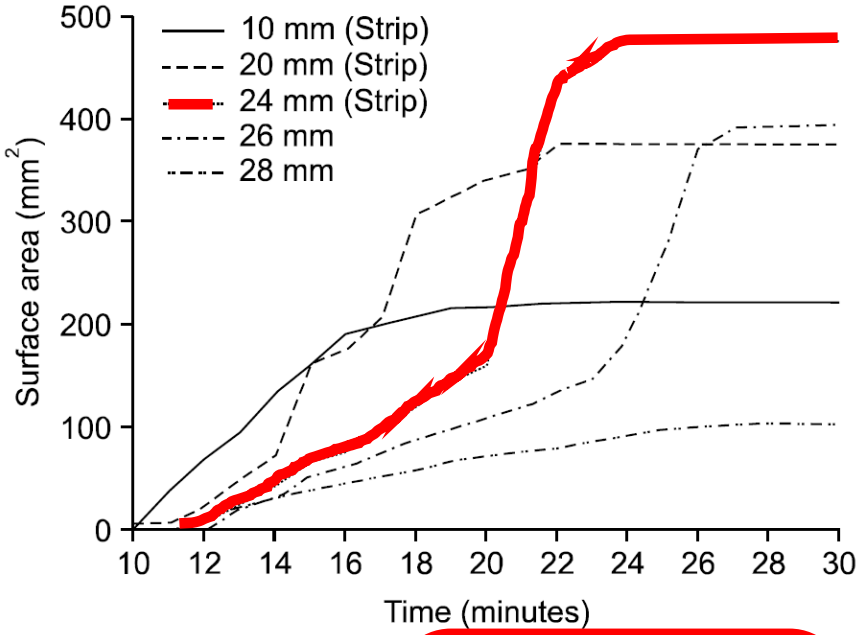


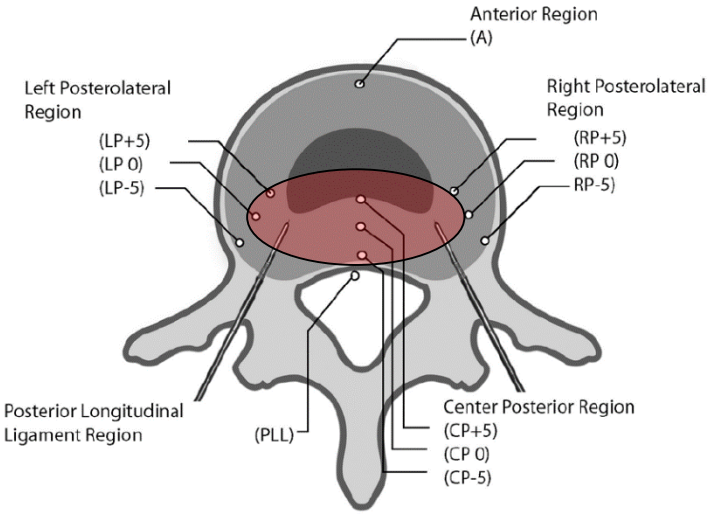


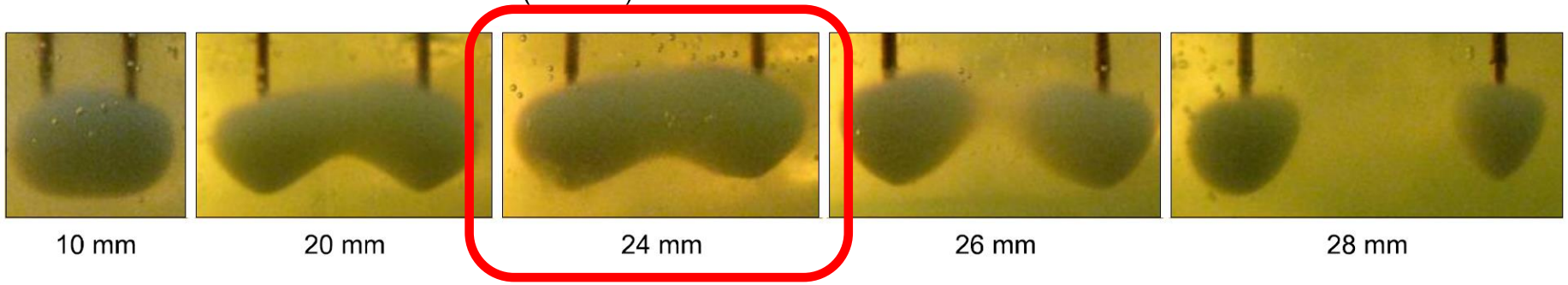
1. Wang H, et. al. Spine (Phila Pa 1976). 2016 Jun 15.

Bipolar Cooled RFA

- Large Strip Lesions
- Diminishing returns >24 mm



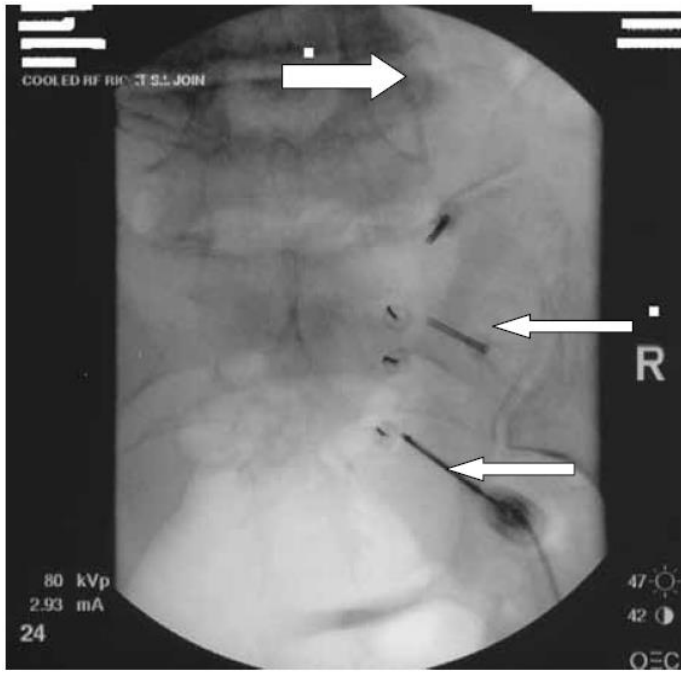


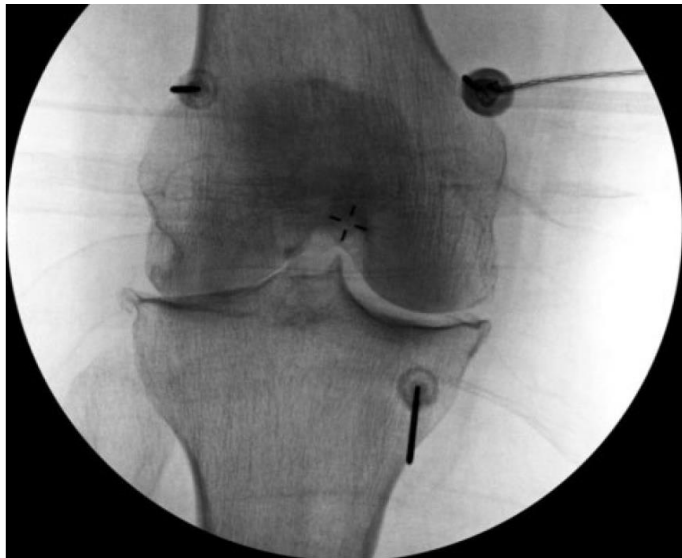


Kang SS, et. al. Korean J Pain. 2012 Jul;25(3):151-4.

Clinical Applications of Cooled RFA

- Disc Biacuplasty
  - Best quality evidence among Thermal/RF disc ablation
- Lateral Branch Ablation (SI joint)
  - Superior results to conventional
- Spine and Major Joints
  - Potentially better efficacy, more data emerging
- Spine Tumors

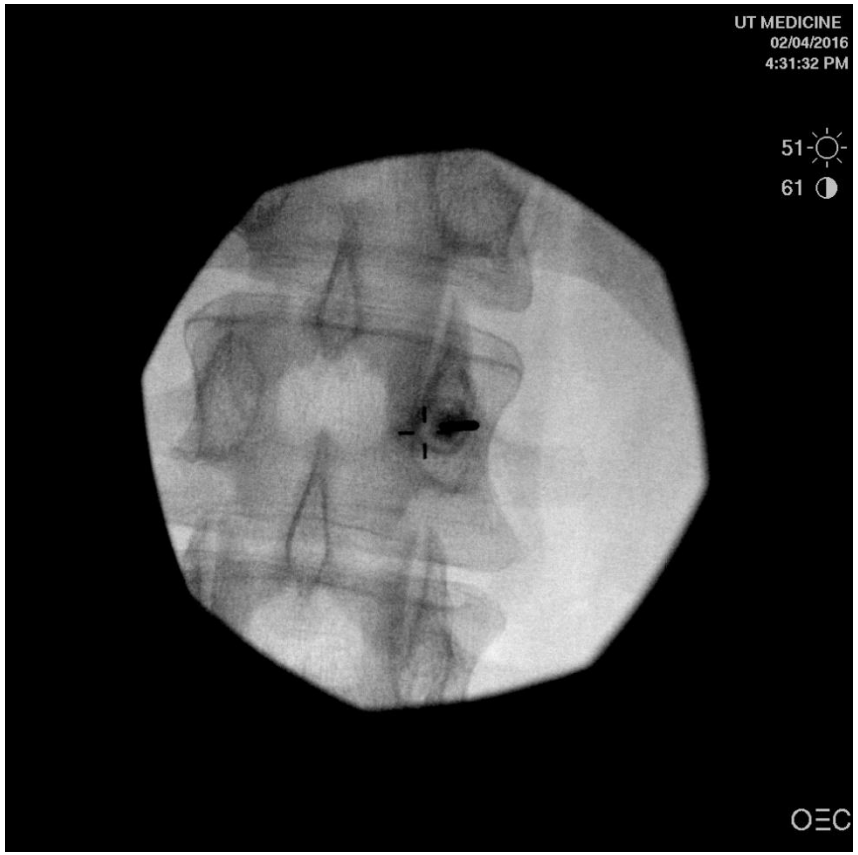




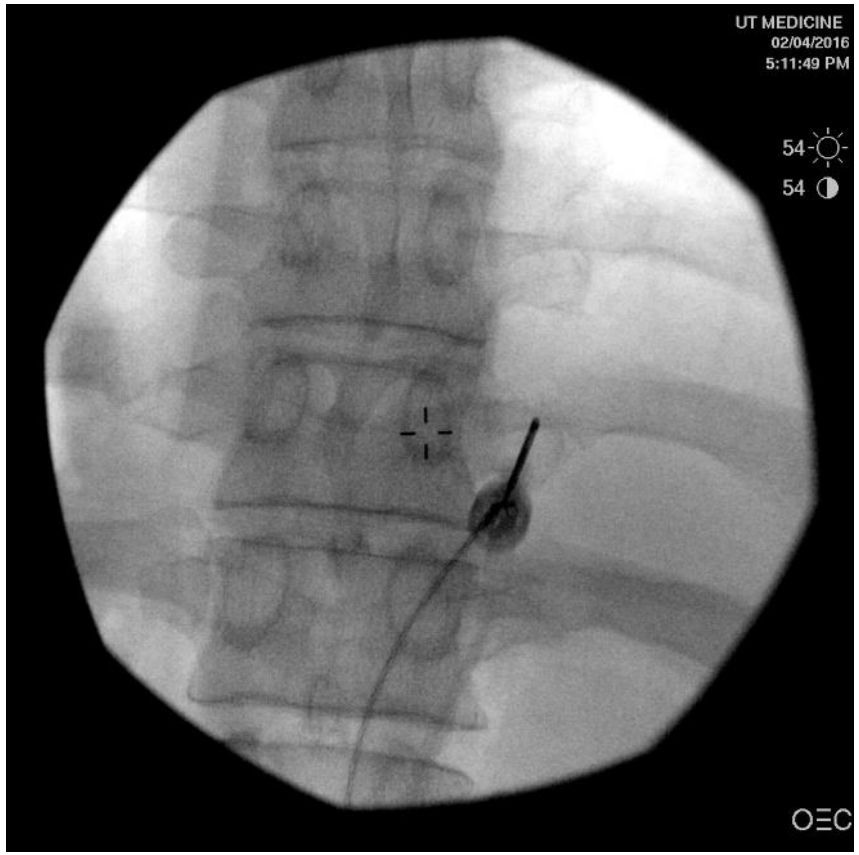
Pauza K. Pain Physician 2008 Nov-Dec;11(5):669-76. Patel N. Pain Med. 2012 Mar;13(3):383-98.
Kapural L, et. al. Pain Med. 2015 Mar;16(3):425-31. McCormick ZL, et. al. Pain Med. 2017 Apr 19.
Stelzer W, et al. J Pain Res. 2017 Jan 13;10:183-190.
McCormick ZL, et al. Pain Med. 2017 Apr 19.

Examples: Spine Cooled RFA

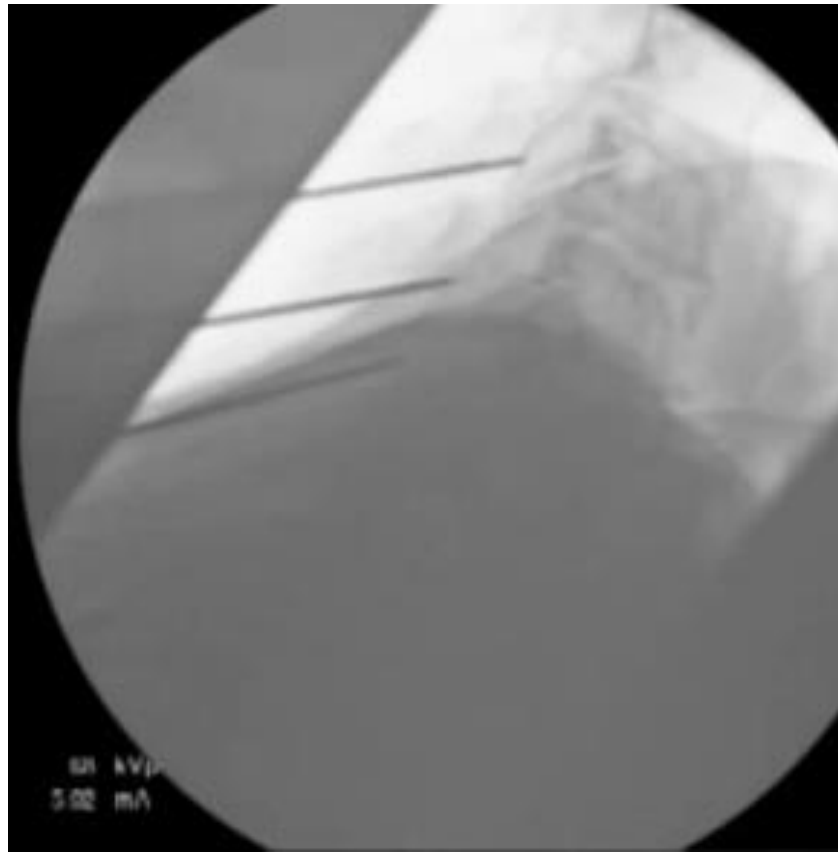
Lumbar Medial Branch



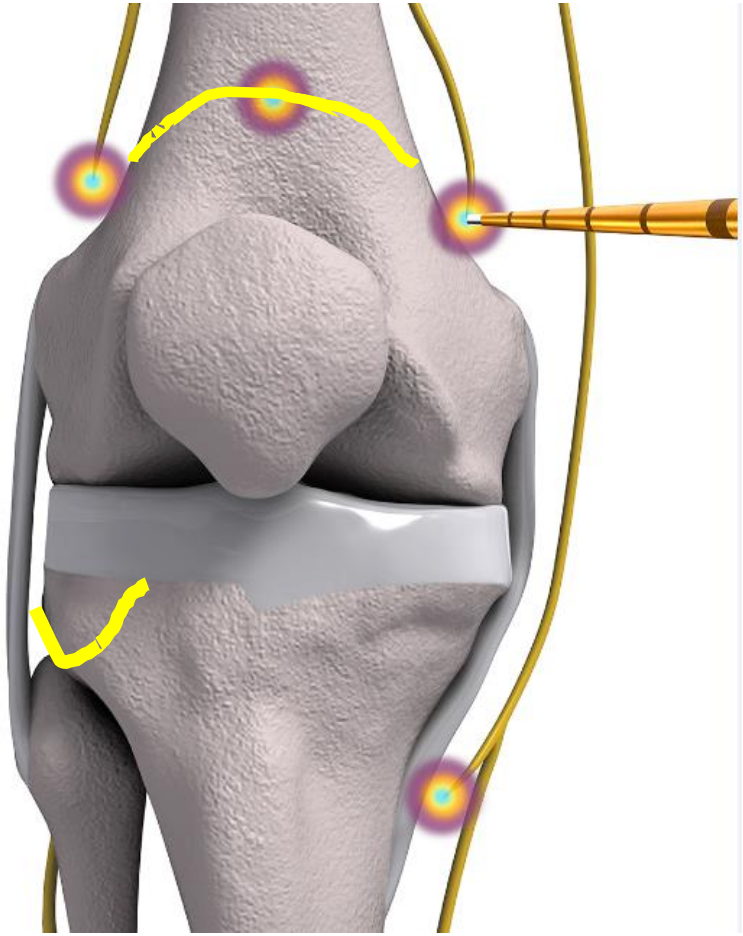
Thoracic Medial Branch



Cervical Medial Branch



Genicular Nerve Ablation



- ***Choi 2009 (RFA)***
- ***Ikeuchi 2009 (RFA)***
- ***Protzman 2013 (RFA post TKA)***
- ***Menzies 2015 (CRFA post TKA)***
- ***Franco 2015***
- ***Bellini 2015 (CRFA)***
- ***Shen 2016 (RFA)***

Genicular Nerves

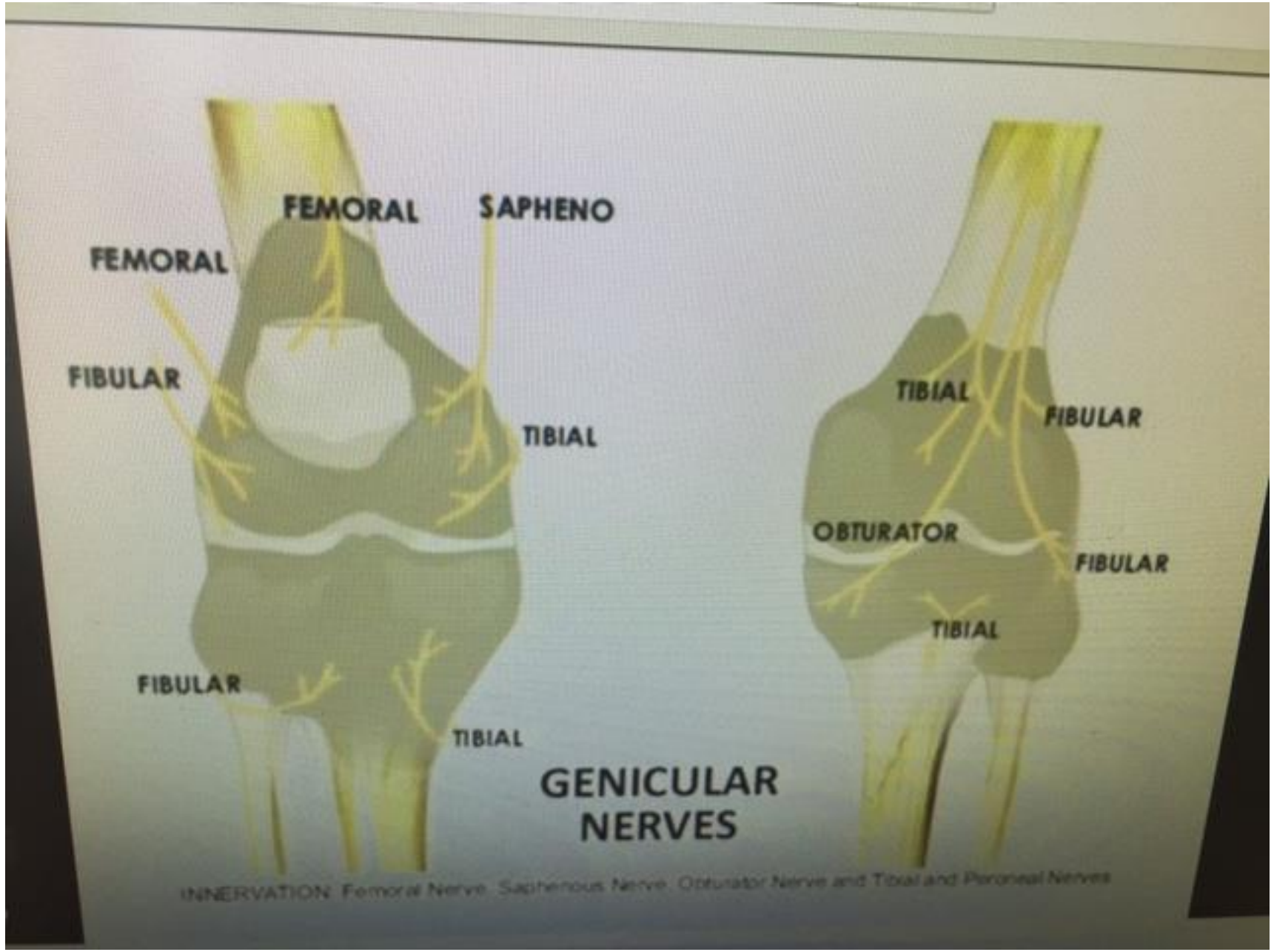
Sensory branches that provide innervation of knee joint and ligaments.

Many are of sciatic origin

Saphenous, and Nerve to Vastus Medialis probably contribute to a genicular nerve network, with a small amount from Obturator N.

Burckett-St Laurant D, Peng P, Girón Arango L, Niazi AU, Chan VW, Agur A, Perlas A. The Nerves of the Adductor Canal and the Innervation of the Knee: An Anatomic Study. Reg Anesth Pain Med. 2016 May-Jun;41(3):321-7.

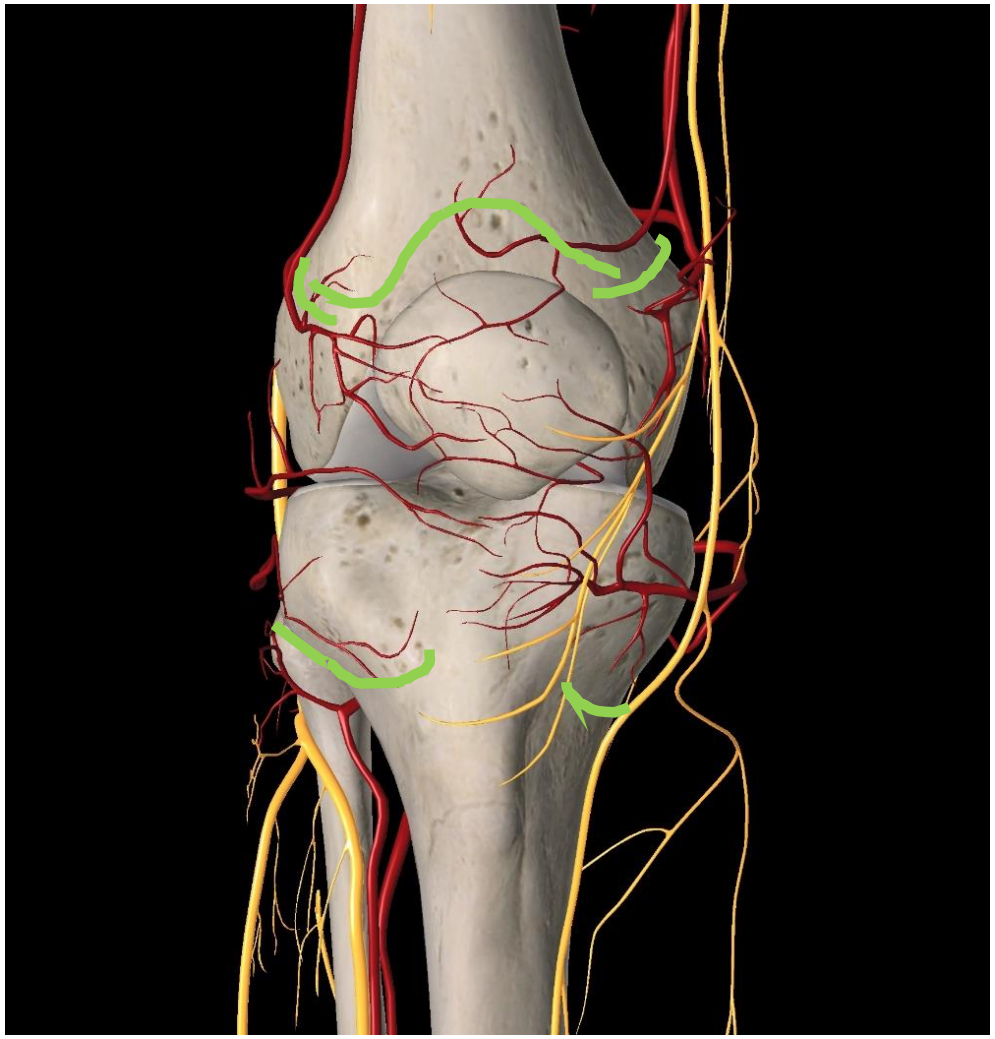
Tibial Nerve Origin	Common Peroneal Nerve Origin
-Superior medial genicular n -Inferomedial genicular n	-Superolateral genicular n -Inferolateral genicular n

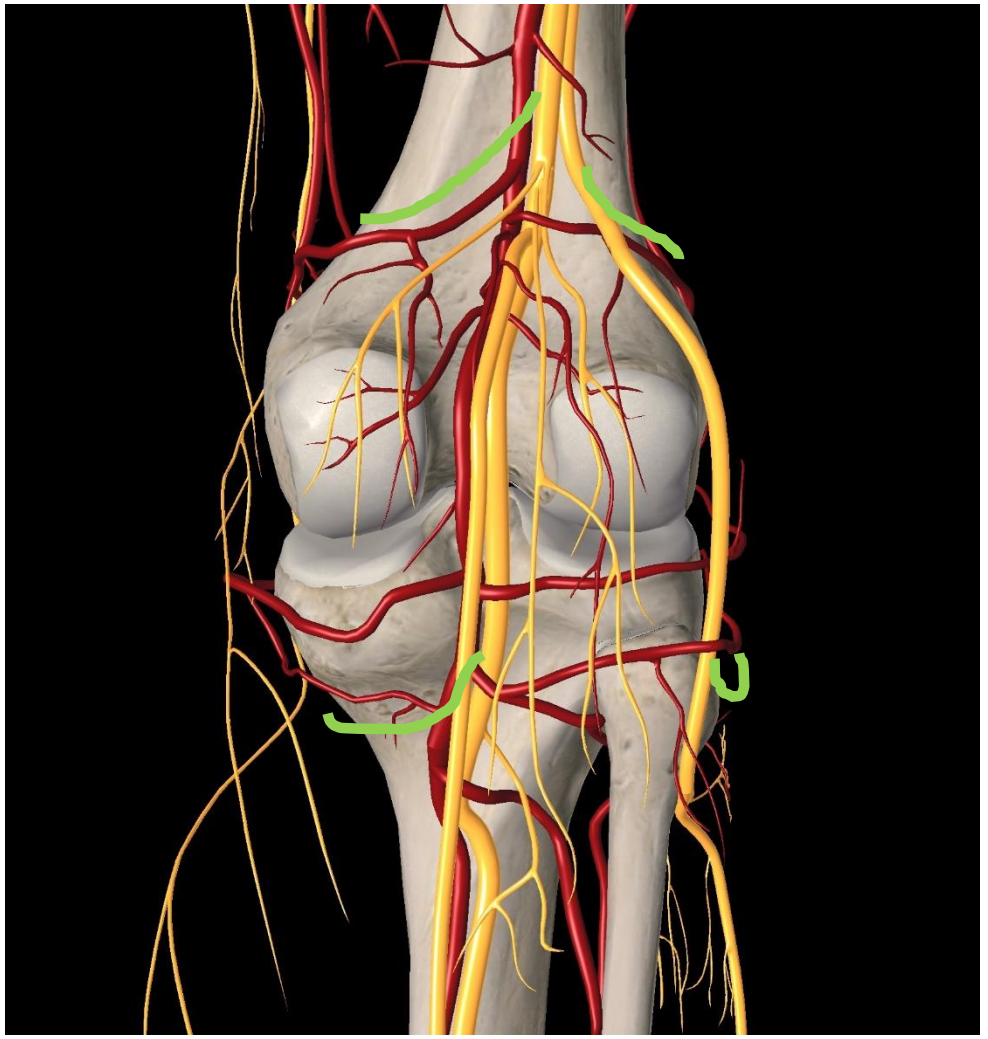

FEMORAL
SAPHENO
FEMORAL
FIBULAR
TIBIAL
FIBULAR
TIBIAL
TIBIAL
FIBULAR
OBTURATOR
FIBULAR
TIBIAL
GENICULAR NERVES
INNERVATION: Femoral Nerve, Saphenous Nerve, Obturator Nerve and Tibial and Peroneal Nerves

Genicular nerves of the Knee

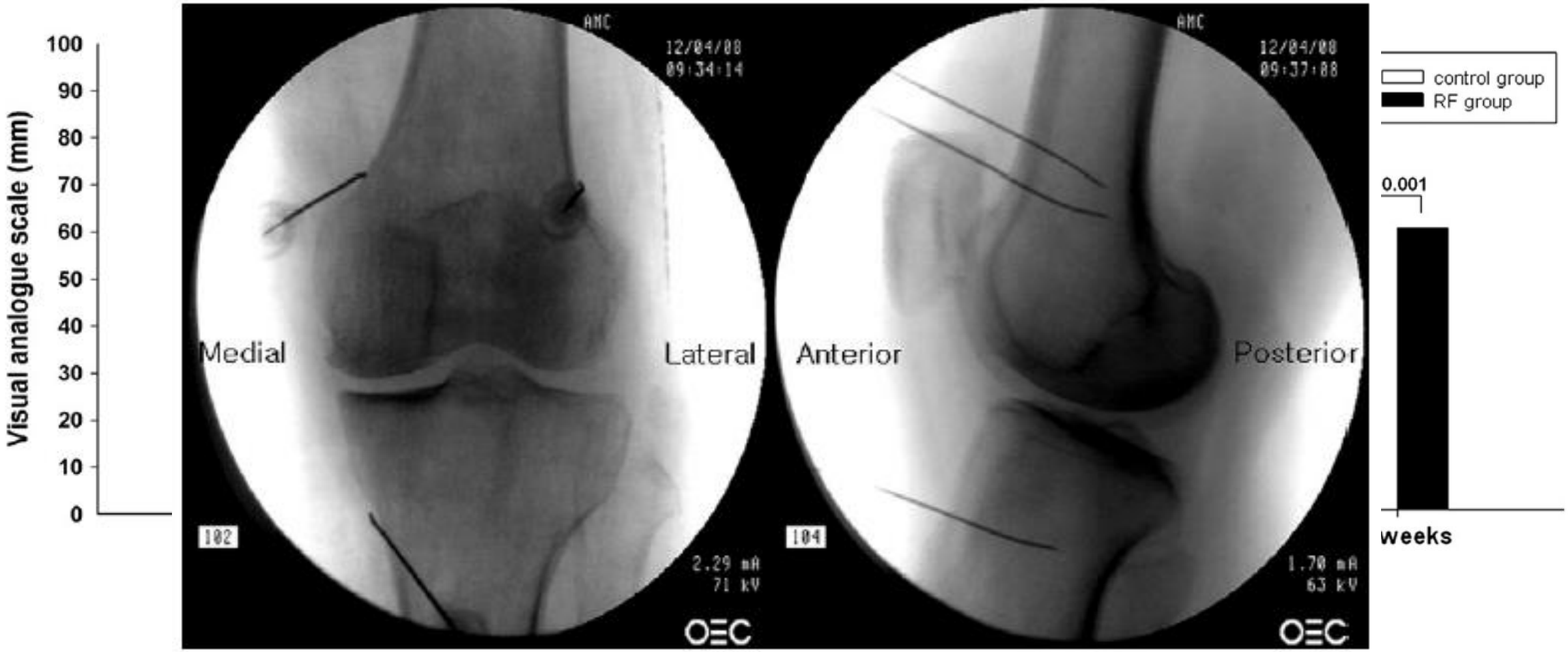
Franco CD, et. al. Reg Anesth Pain Med. 2015 Jul-Aug;40(4):363-8.

Genicular Nerves and Arteries





Genicular Conventional RFA



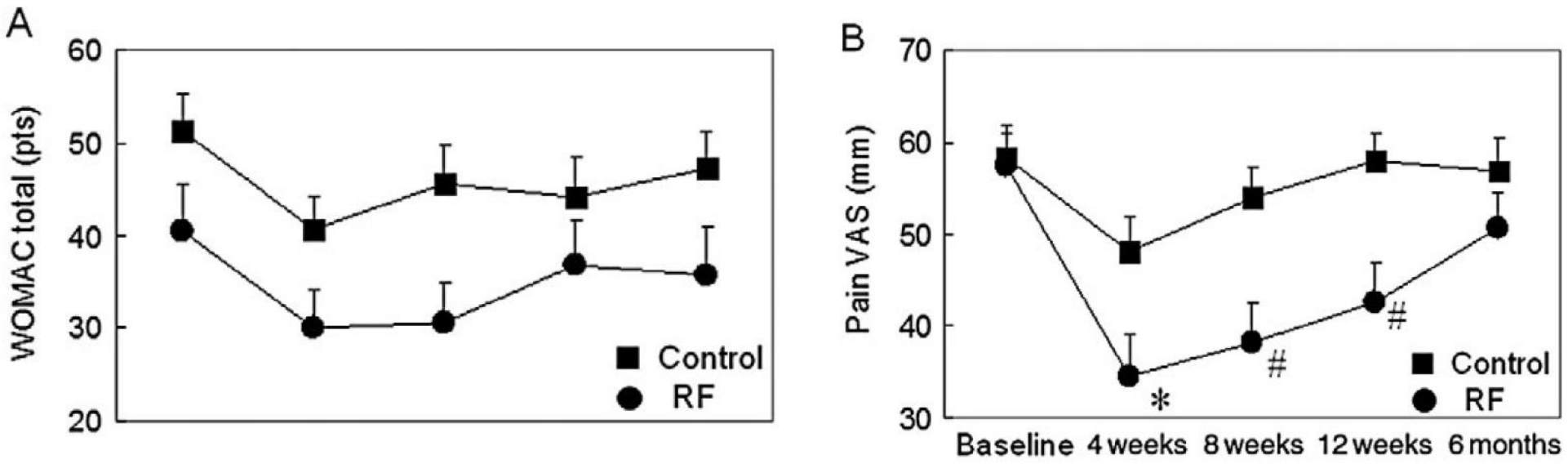
Choi WJ, et. al. Pain. 2011 Mar;152(3):481-7.

Genicular Conventional RFA

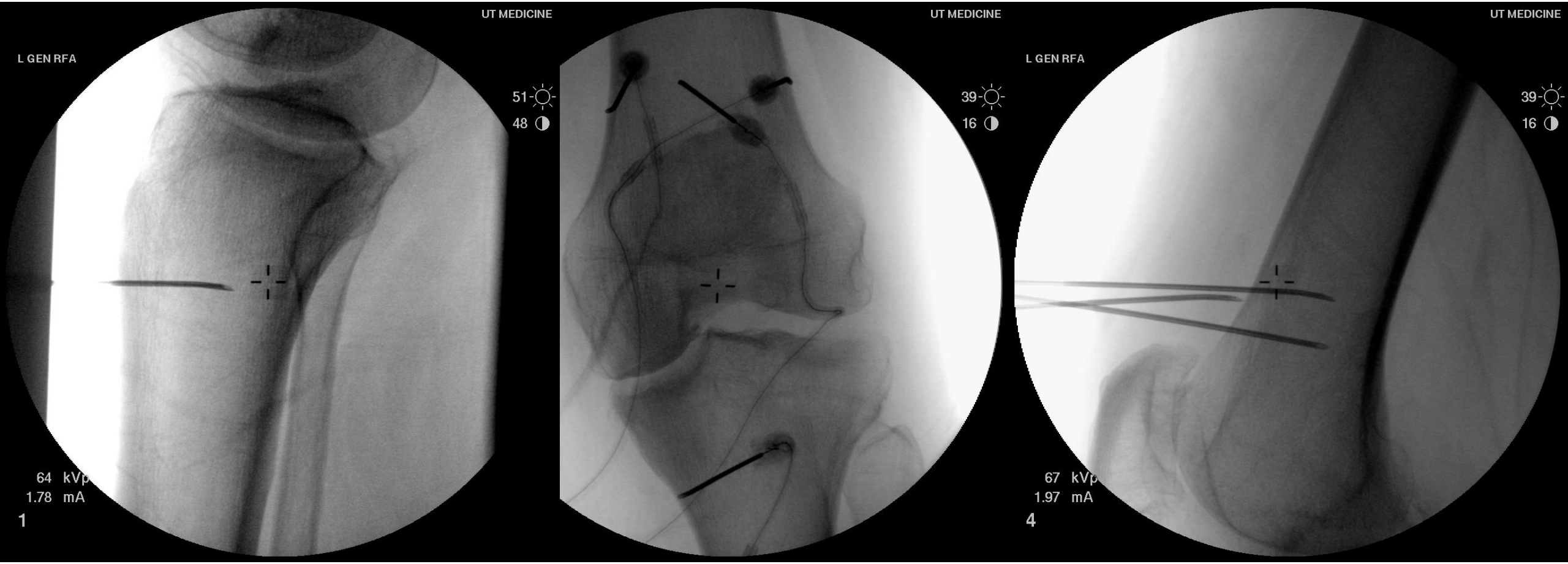
Pain Medicine 2011; 12: 546–551
Wiley Periodicals, Inc.

Percutaneous Radiofrequency Treatment for Refractory Anteromedial Pain of Osteoarthritic Knees

Masahiko Ikeuchi, MD, PhD,* Takahiro Ushida, MD, PhD,*† Masashi Izumi, MD,* and Toshikazu Tani, MD, PhD*



Genicular Radiofrequency Targets



Genicular Cooled RFA Case Series (n=9)

Cooled radiofrequency system relieves chronic knee osteoarthritis pain: the first case-series

Martina Bellini, Massimo Barbieri

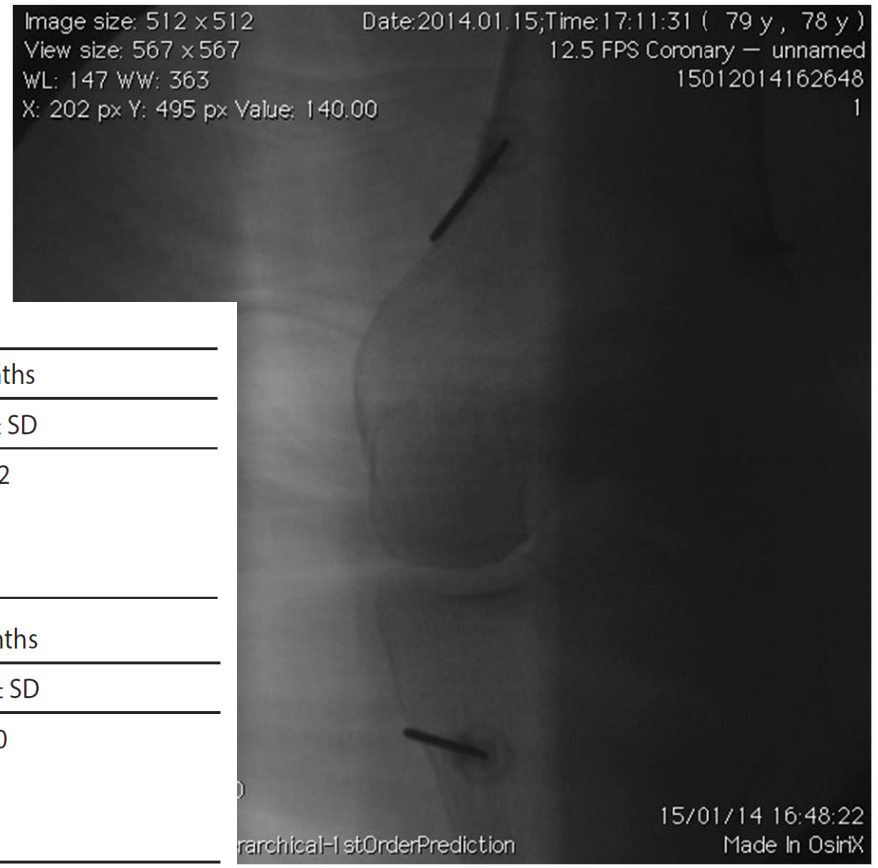


Table 2. WOMAC and VAS values

	1 month	3 months	6 months	12 months
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
VAS	2 ± 0.5	2.3 ± 0.7	2.1 ± 0.5	2.2 ± 0.2
P value				
Basal VS	< 0.01	< 0.01	< 0.01	< 0.01
	1 month	3 months	6 months	12 months
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
WOMAC	20 ± 2	22 ± 0.5	21 ± 1.7	20 ± 1.0
P value				
Basal VS	< 0.01	< 0.01	< 0.01	< 0.01

Basal value VAS 8 ± 1.5 and WOMAC 88 ± 1.9; VAS — visual analogue scale; WOMAC — Western Ontario McMaster Universities OA index

3 patients underwent TKA during this period

Anaesthesiology Intensive Therapy
2015, vol. 47, no 1, 30–33

Emerging Data for Genicular Cooled RFA

Table 5 Logistic regression model for clinical success† following genicular nerve block

	β	*P*	OR	95% CI
Body mass index, kg/m^2	0.16	0.025	1.17	1.02–1.35
Duration of pain at presentation, y		0.023		
>5	2.39	0.046	1	Reference
>2–≤5	4.35	0.007	10.54	0.67–168
≤2			13.05	1.30–131
Percent pain relief from diagnostic blocks*		0.071		
50–79%	2.35	0.096	1	Reference
80–99%	2.57	0.029	10.91	1.04–115
100%			77.34	3.43–1,778
Constant	–6.39	0.012		

Number of Patients (N = 33) Number of Treated Knees (N = 52)
66 (62–77)
10 (30)
23 (70)
31 (24–38)
10 (19)
24 (46)
18 (35)
2 (6)
1 (3)
13 (25)
19 (58)
14 (42)
8 (7–9)
6 (3–8)
12 (23)
6 (12)
34 (65)
19 (57)
8 (6–10)

The primary outcome, treatment success, was defined as a combination of 50% or greater reduction in NRS score and PGIC score consistent with "very much improved" or "improved," and no TKA. A secondary definition of treatment success was also defined based on improvement in NRS score equal to the minimal clinically important change for chronic pain: a two-point reduction [22,23]. MSQ III data were analyzed according

Conclusions. Genicular C-RFA demonstrated a success rate of 35% based on a robust combination of outcome measures, and 19% of procedures resulted in complete relief of pain at a minimum of six months of follow-up. Report of 80% or greater relief from diagnostic blocks and duration of pain of less than five years are associated with high accuracy in predicting treatment success. Further prospective study is needed to optimize the patient selection protocol and success rate of this procedure.

Importance of Prognostic Blocks

Cooled Radiofrequency Ablation of Genicular Nerves for Knee Osteoarthritis Pain: A Protocol for Patient Selection and Case Series

Baseline NRS (Right/Left, if applicable)	6	5/4	7/5	3
Baseline MQS3/MEq	32.1/64	8/0	4.8/10	4/0
Percent reduction in pain with test block	100	100/100	86/100	100
Percent reduction in pain 3 month post-RFA	100	90/90	80/50	90
Percent reduction in pain 6 months post-RFA	100	90/90	85/80	90
Percent reduction in pain 9 months post-RFA	90	80/80	N/A	N/A
Reduction in MQS3 score at 6 months post-RFA	-6.9[a]	8	4.8	4
Reduction in Morphine equivalent consumption at 6 months post-RFA	-8[a]	N/A	10	N/A

Complications

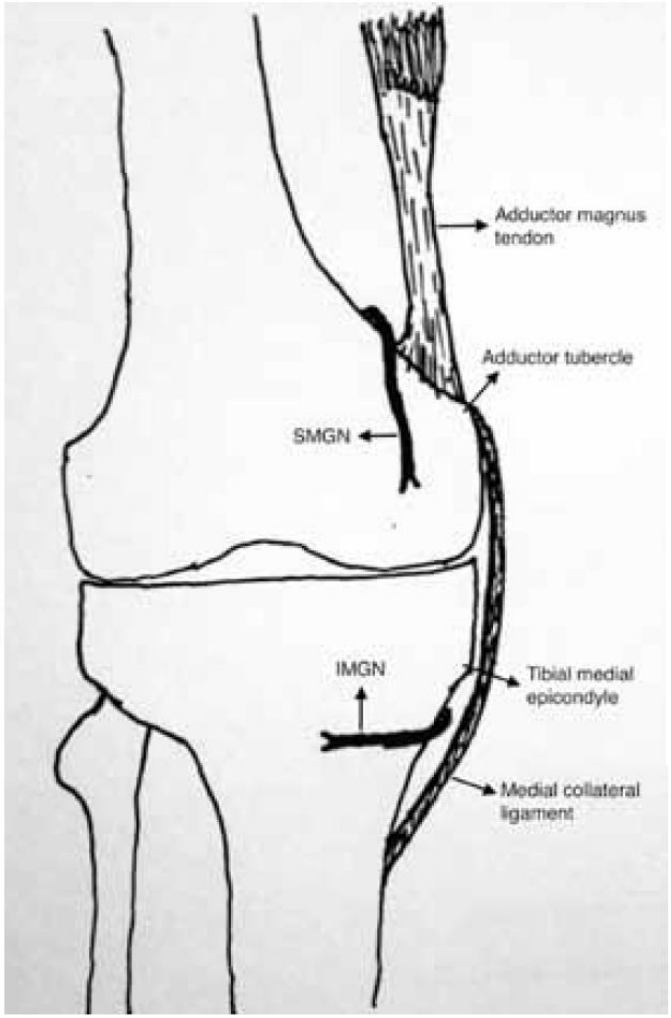
Is Genicular Nerve Radiofrequency Ablation Safe? A Literature Review and Anatomical Study *(Analysis of Reported Complications from Knee Surgery)*

Soo Yeon Kim, MD[1,2], Phuong Uyen Le, DO[1,2], Boleslav Kosharskyy, MD[1,2], Alan D. Kaye, MD, PhD[3], Naum Shaparin, MD[1,2], and Sherry A. Downie, PhD[2]

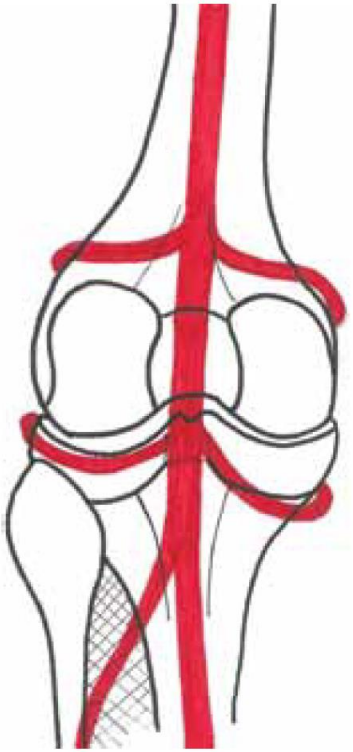
Of the 27 cases analyzed, 25.9% (7/27) involved the lateral superior genicular artery, 40.7% (11/27) involved the medial superior genicular artery, and 33.3% (9/27) involved the medial inferior genicular artery. Most often, these vascular injuries result in the formation of pseudoaneurysm, arteriovenous fistula (AVF), hemarthrosis, and/or osteonecrosis of the patella. Although rare, these complications carry significant morbidities. Based on the detailed dissections and review of the literature, our investigation suggests that vascular injury is a possible risk of genicular RFA. Lastly,

Pain Physician. 2016 Jul;19(5):E697-705

Genicular Branch (and Artery) Ultrasonography



Yasar E, et. al. Pain Physician. 2015 Sep-Oct;18(5):E899-904.



Kim SY, et. al. Pain Physician. 2016 Jul;19(5):E697-705.

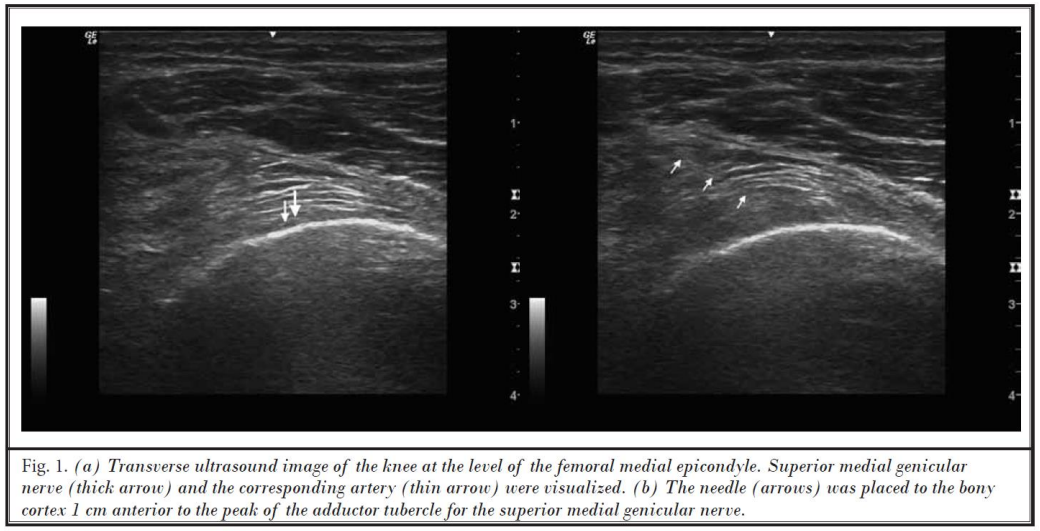


Fig. 1. *(a) Transverse ultrasound image of the knee at the level of the femoral medial epicondyle. Superior medial genicular nerve (thick arrow) and the corresponding artery (thin arrow) were visualized. (b) The needle (arrows) was placed to the bony cortex 1 cm anterior to the peak of the adductor tubercle for the superior medial genicular nerve.*

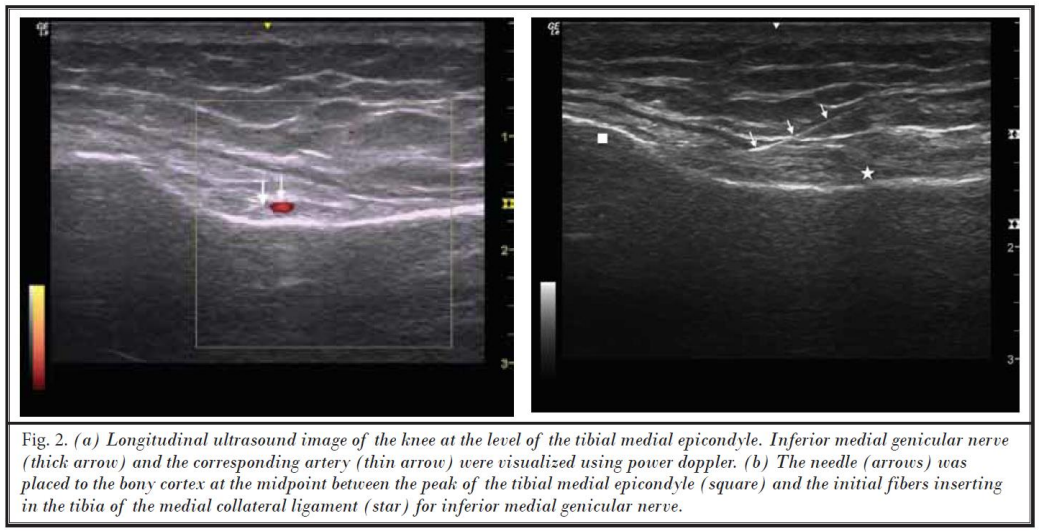


Fig. 2. *(a) Longitudinal ultrasound image of the knee at the level of the tibial medial epicondyle. Inferior medial genicular nerve (thick arrow) and the corresponding artery (thin arrow) were visualized using power doppler. (b) The needle (arrows) was placed to the bony cortex at the midpoint between the peak of the tibial medial epicondyle (square) and the initial fibers inserting in the tibia of the medial collateral ligament (star) for inferior medial genicular nerve.*

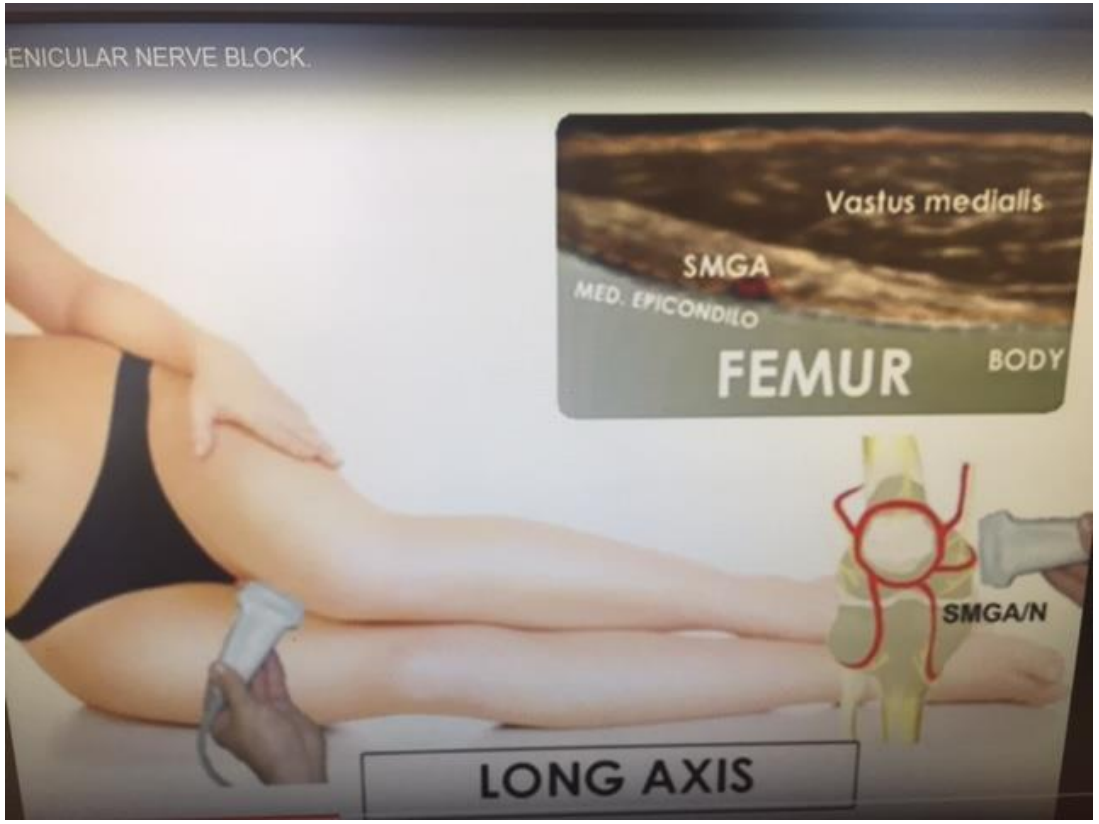
Kesikburun S, et. al. Pain Physician. 2016 Jul;19(5):E751-9.

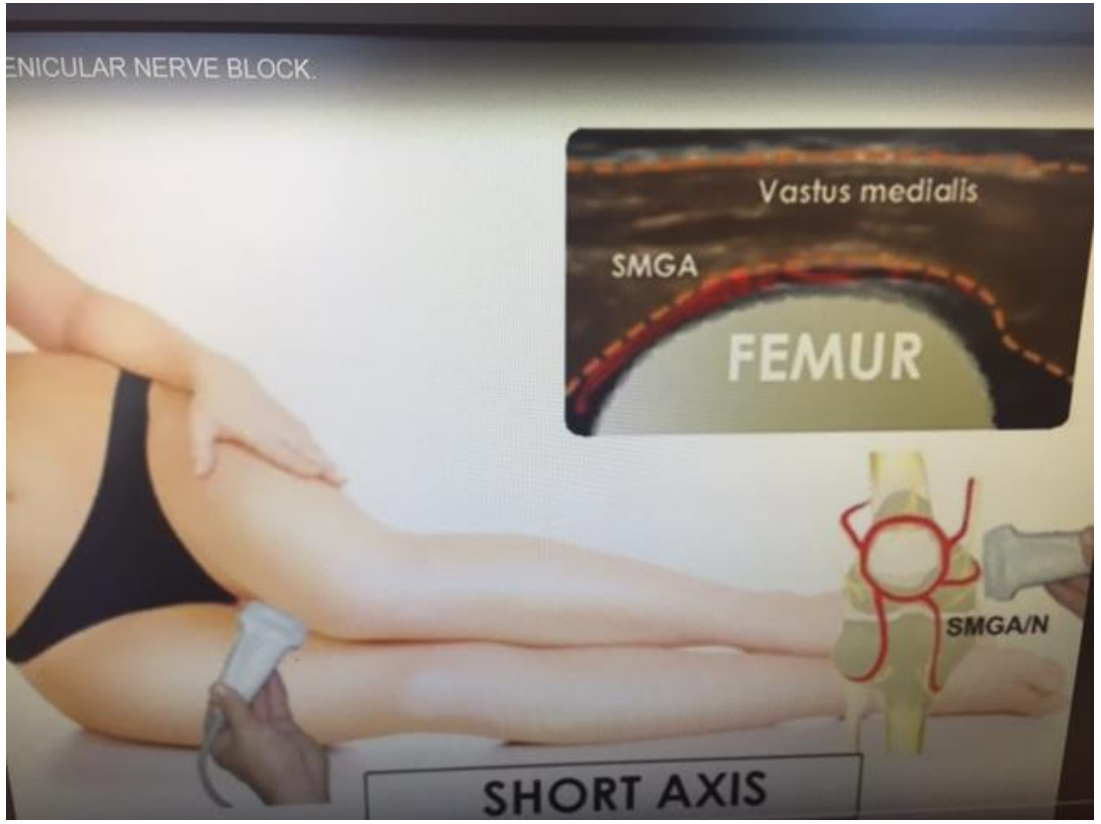
Genicular Block/RFA Ultrasound

Source:Dr.Vincente Roques
H.Universitario Virgen de la Arrixaca.Unidad de Dolor Quiron Murcia

Genicular Block/RFA Ultrasound

Source:Dr.Vincente Roques
H.Universitario Virgen de la Arrixaca.Unidad de Dolor Quiron Murcia





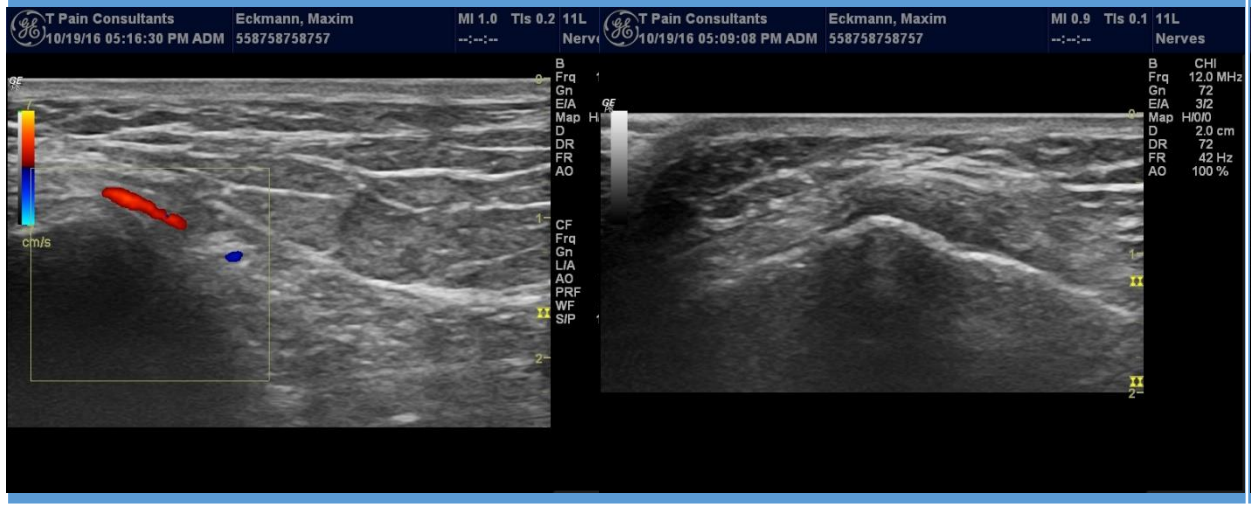
Genicular Block/RFA Ultrasound

Source:Dr.Vincente Roques
H.Universitario Virgen de la Arrixaca.Unidad de Dolor Quiron Murcia

Ultrasound Views for Genicular Block

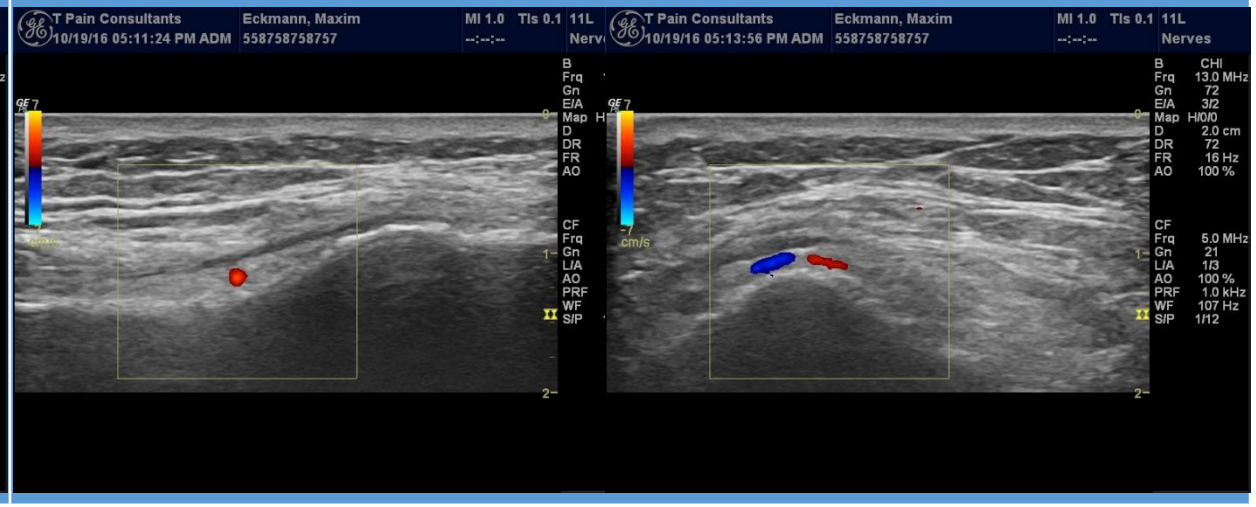
Superomedial

(Coronal/Longitudinal) (Transverse View)



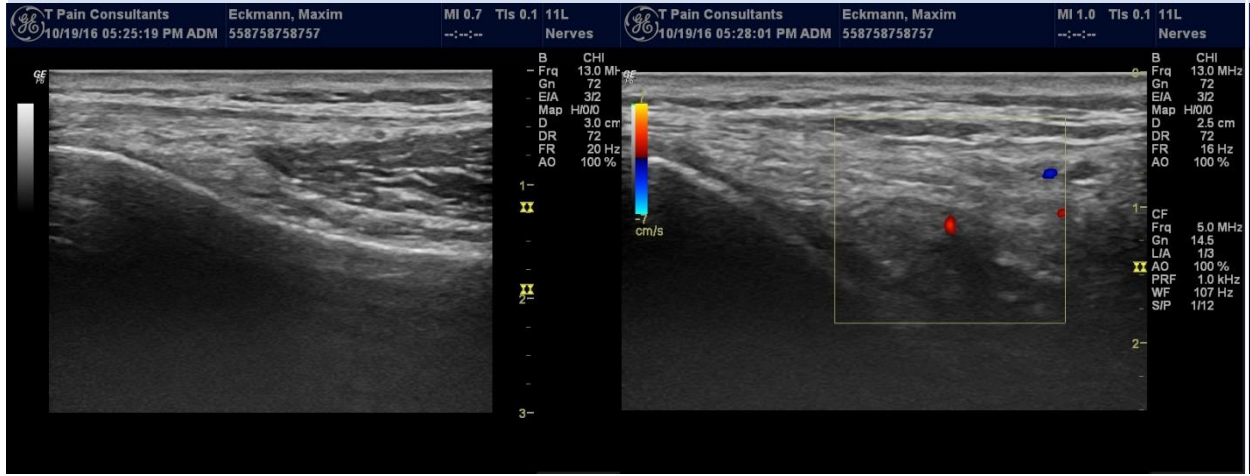
Inferomedial

(Coronal/Longitudinal) (Transverse View)

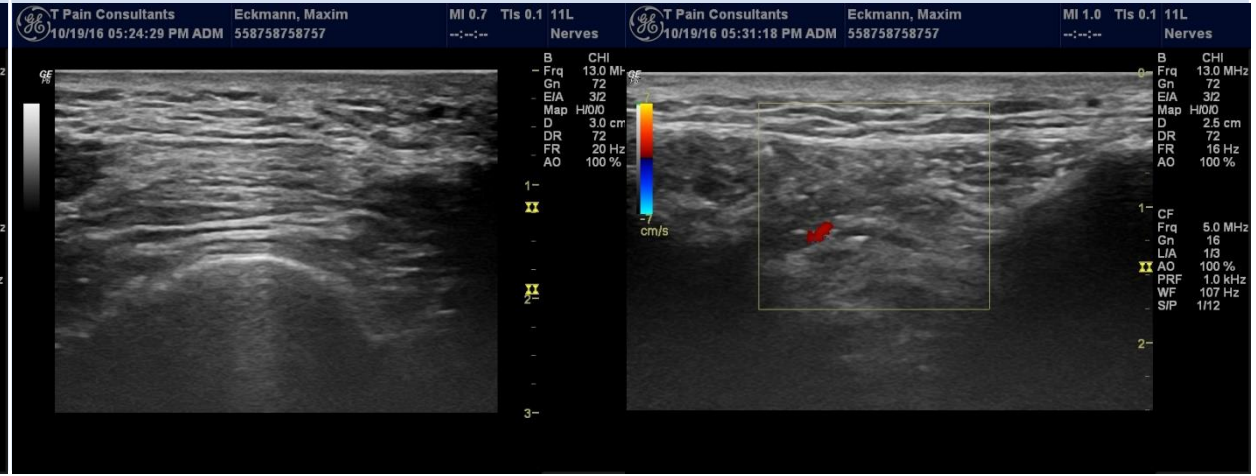


Superolateral

(Coronal/Longitudinal) (Transverse View)



Superior Mid-Femoral Inferolateral* (Caution)



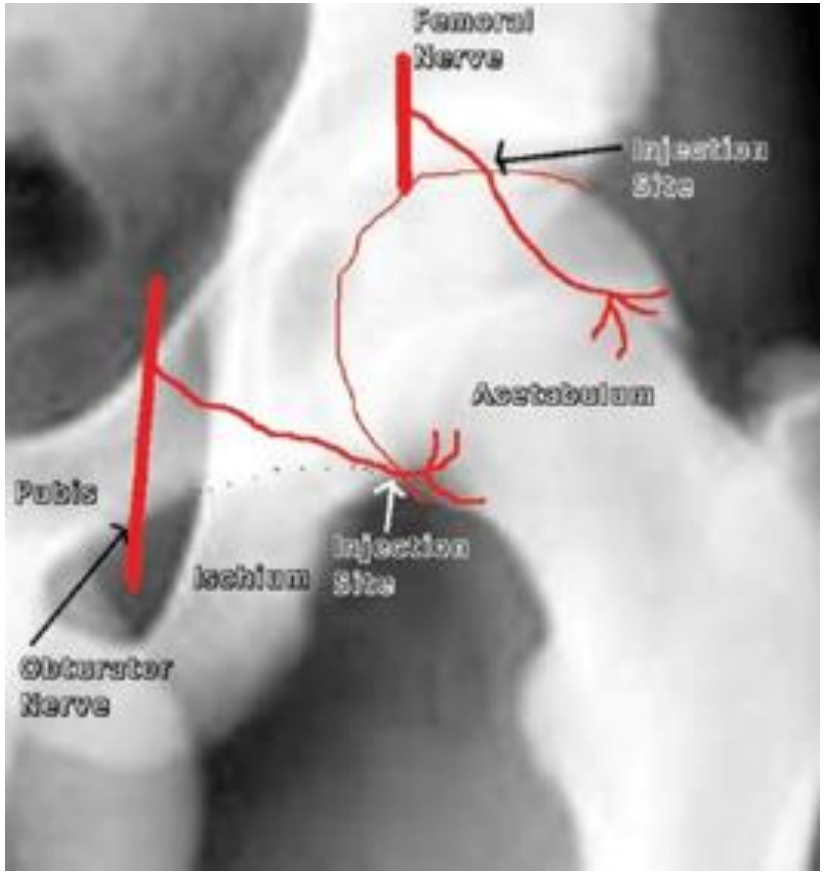
Obturator and Femoral Articular Nerve Ablation

The sensory innervation of the hip joint - An anatomical study

K. Birnbaum[1], A. Prescher[2], S. Heßler[1] and K.-D. Heller[1]

Surg Radiol Anat (1997) 19: 371-375

- Anteromedial joint: obturator nerve
- Anterolateral joint: femoral nerve
- Posterosuperior joint: sciatic nerve
- Posteroinferior joint: nerves to quadratus femoris muscle
- Posterolateral joint: superior gluteal nerve

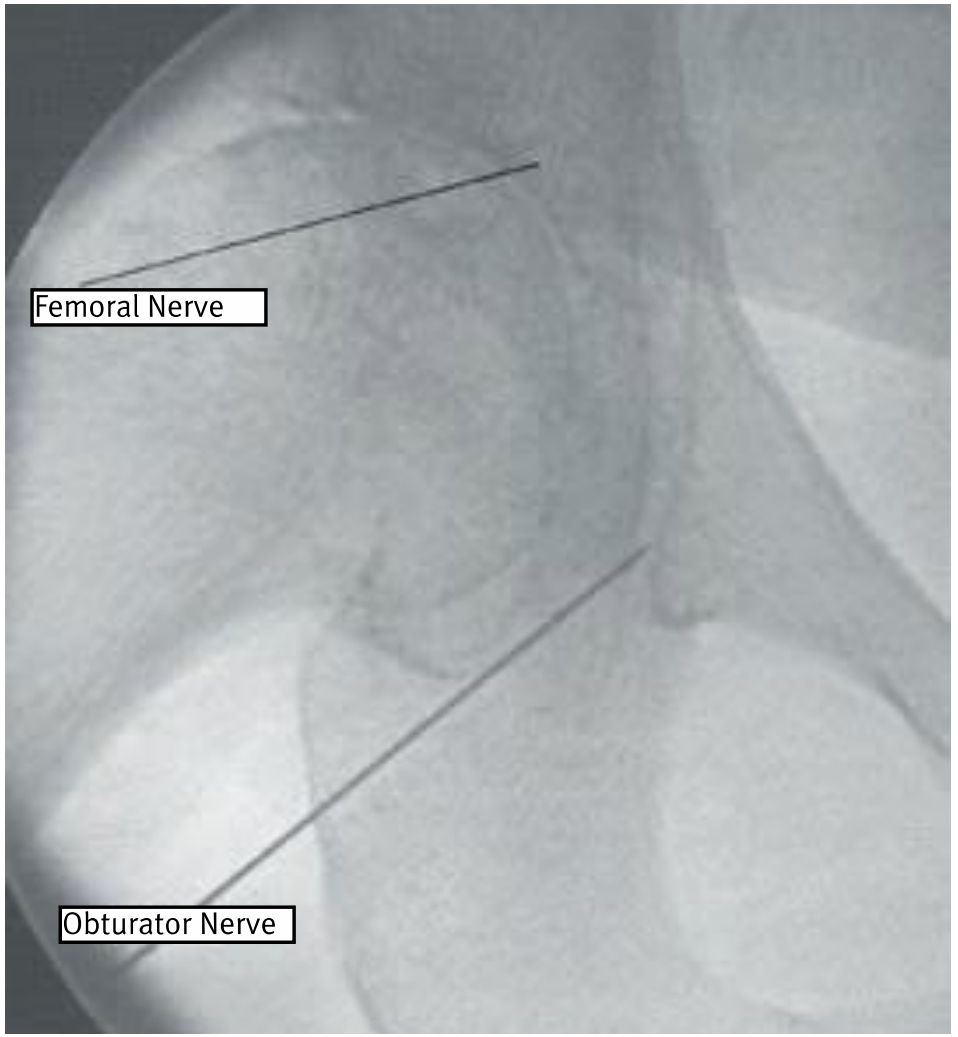


Percutaneous Radiofrequency Lesioning of Sensory Branches of the Obturator and Femoral Nerves for the Treatment of Non-Operable Hip Pain

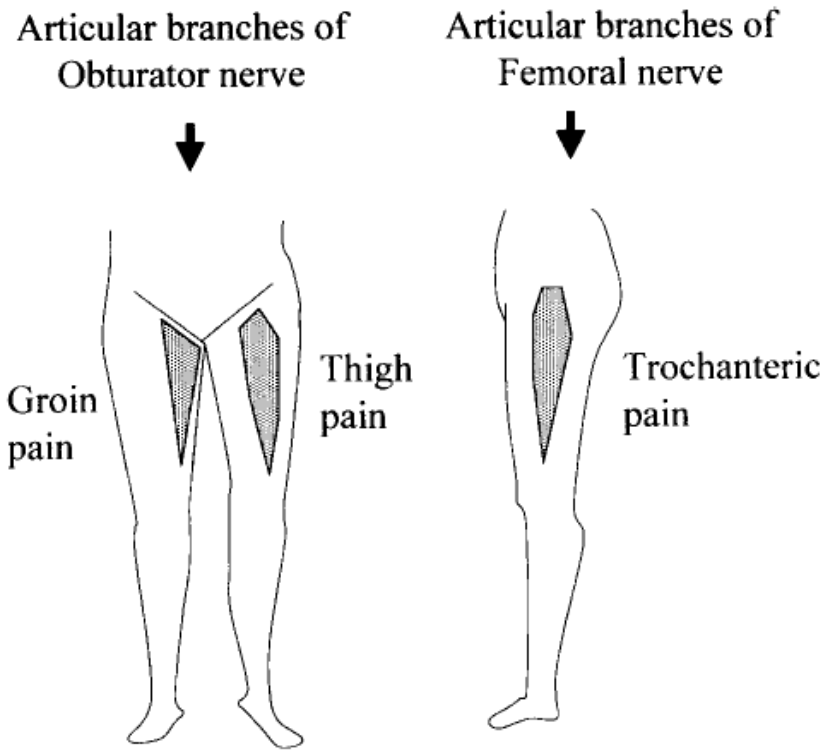
Atif Malik, MD, Thomas Simopolous, MD, Mohamed Elkersh, MD, Musa Aner, MD, and Zahid H. Bajwa, MD

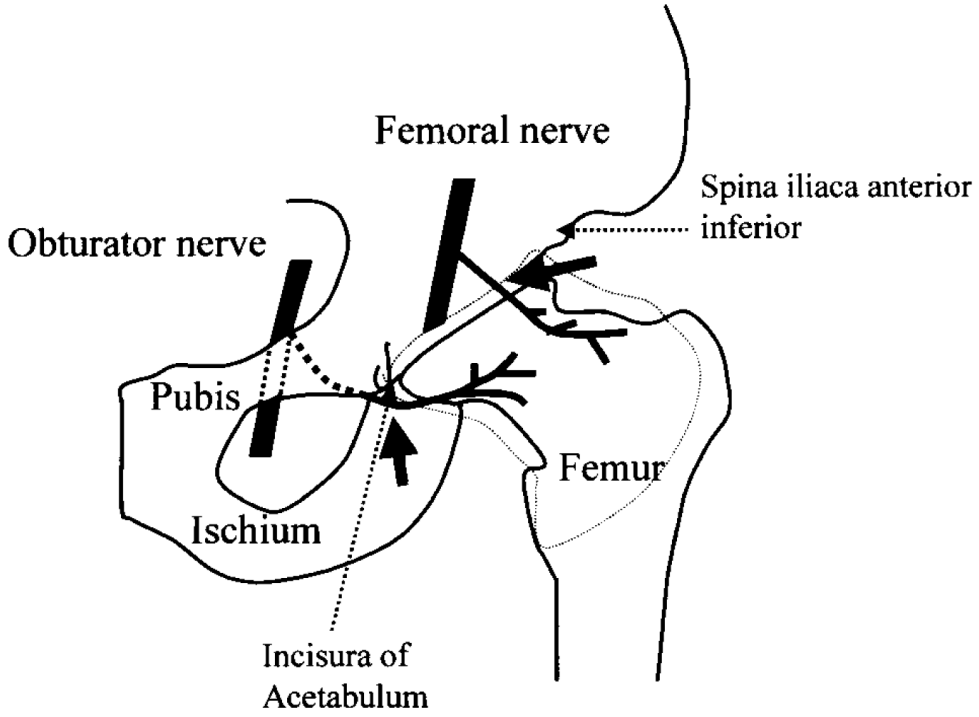
Pain Physician. 2003;6:499-502, ISSN 1533-3159

- Case series: 4 patients
- Single diagnostic nerve block: 1ml Marcaine 0.25%
- SRFA treatment
- All 4 had reduction in VAS
  - 3 had improved function
  - 2 had reduction in pain meds
- One patient reported numbness at the hip



Anterior Hip Articular Branches





Kawaguchi M, et. al. Reg Anesth Pain Med. 2001 Nov-Dec;26(6):576-81.
Malik A, et. al. Pain Physician. 2003 Oct;6(4):499-502.
Chye CL, et. al. Clin Interv Aging. 2015 Mar 16;10:569-74.
Wu H, Groner J. Pain Pract. 2007 Dec;7(4):341-4.

Percutaneous Radiofrequency Lesioning of Sensory Branches of the Obturator and Femoral Nerves for the Treatment of Hip Joint Pain

Masahiko Kawaguchi, M.D., Keiji Hashizume, M.D., Toshio Iwata, M.D., and Hitoshi Furuya, M.D.

Regional Anesthesia and Pain

- N: 14 patients
- Single diagnostic block: nerve/joint
- RF: obturator in 9, obturator and femoral in 5
- VAS: 6.8 to 2.7
- 86% had 50% relief for 1-11 months

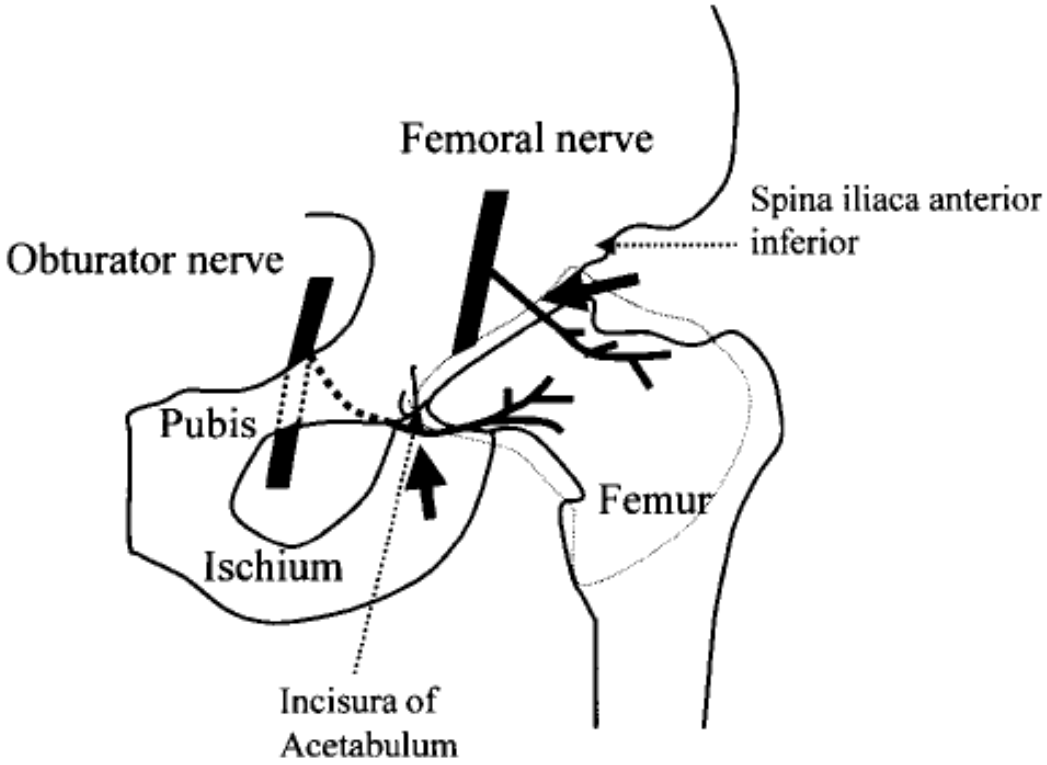


Fig 2. Anatomic drawing of the articular branches of obturator and femoral nerves. Arrows indicate the points directed by the needle for the radiofrequency lesioning of the articular branches of obturator and femoral nerve. The dotted area indicates the hip joint capsule.

Outcomes Continued

Orthopedics. 2012 Mar 7;35(3):e302-5.

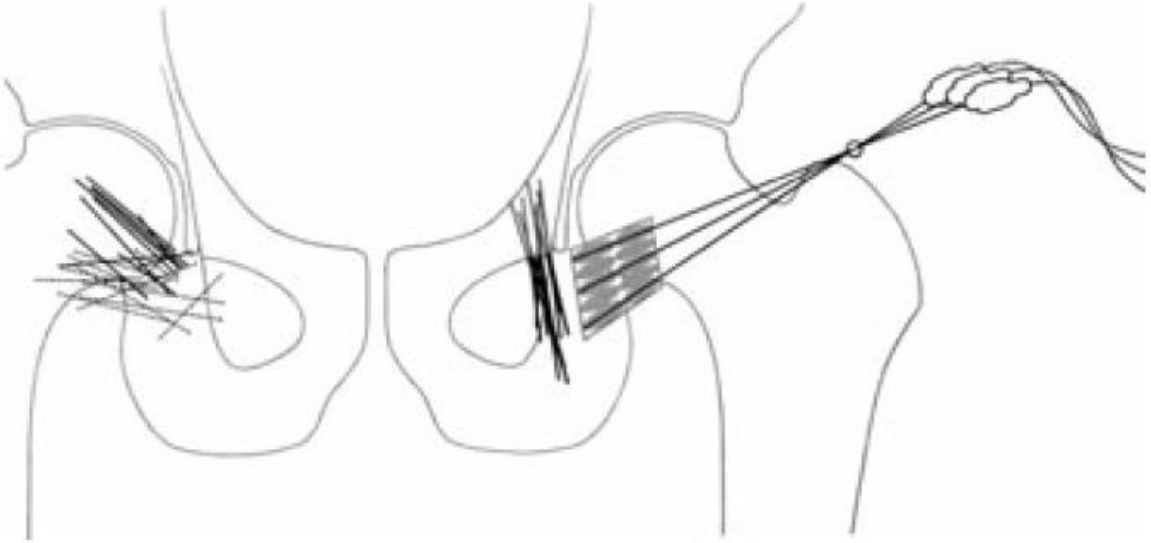
Percutaneous radiofrequency denervation in patients with contraindications for total hip arthroplasty.
Rivera F[1], et al.

- 16 pts
- 8 pts ≥ 50% pain relief at 6 months.
- Statistically improvement in WOMAC scores.

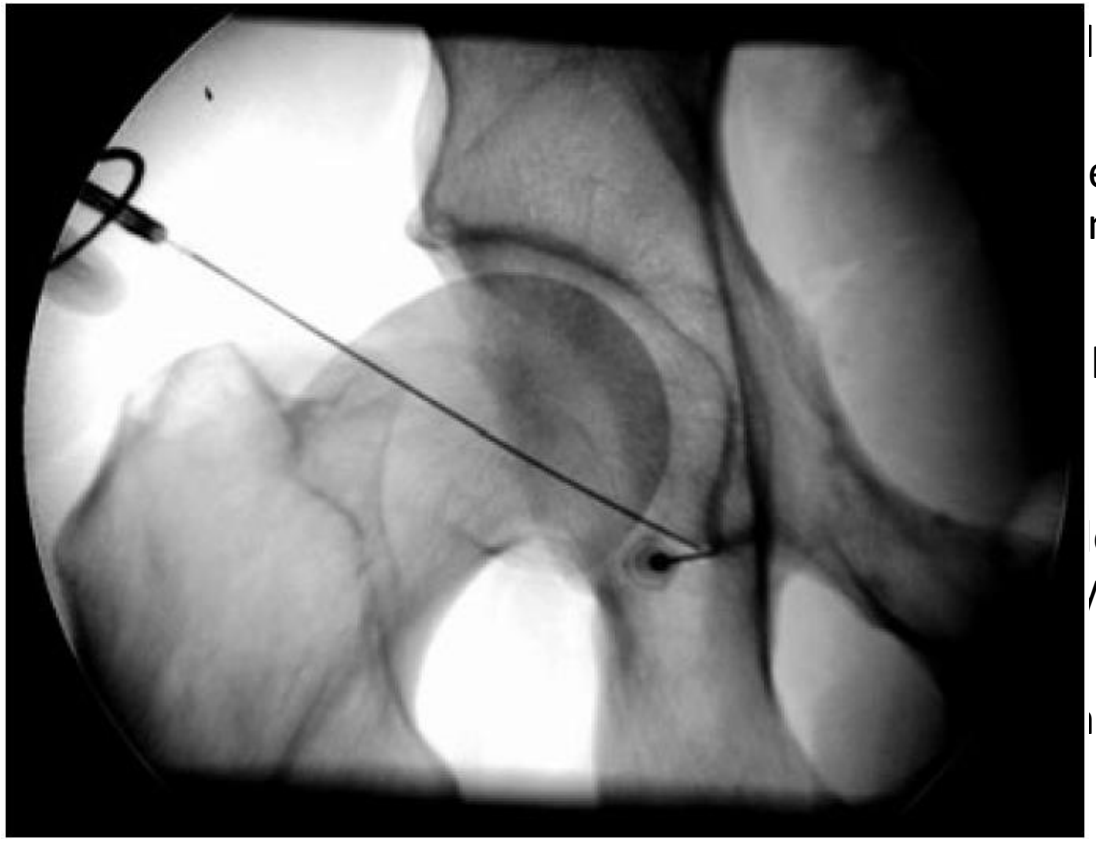
Radiological Anatomy of the Obturator Nerve and Its Articular Branches: Basis to Develop a Method of Radiofrequency Denervation for Hip Joint Pain

Stephan Locher, MD,* Helge Burmeister, MD,† Thomas Böhlen, MD,* Urs Eichenberger, MD,* Christophoros Stoupis, MD,‡ Bernhard Moriggl, MD, Prof,§ Klaus Siebenrock, MD, Prof,† and Michele Curatolo, MD, Prof*

- 10 cadavers, 4 bilateral
- The obturator nerve and its articular branches were marked by wires.
- Their radiological relationship to the bone structures on fluoroscopy was imaged and analyzed.
- A MRI on 20 patients to confirm soft tissue in pathway.



Results



location

ent, a
nimal

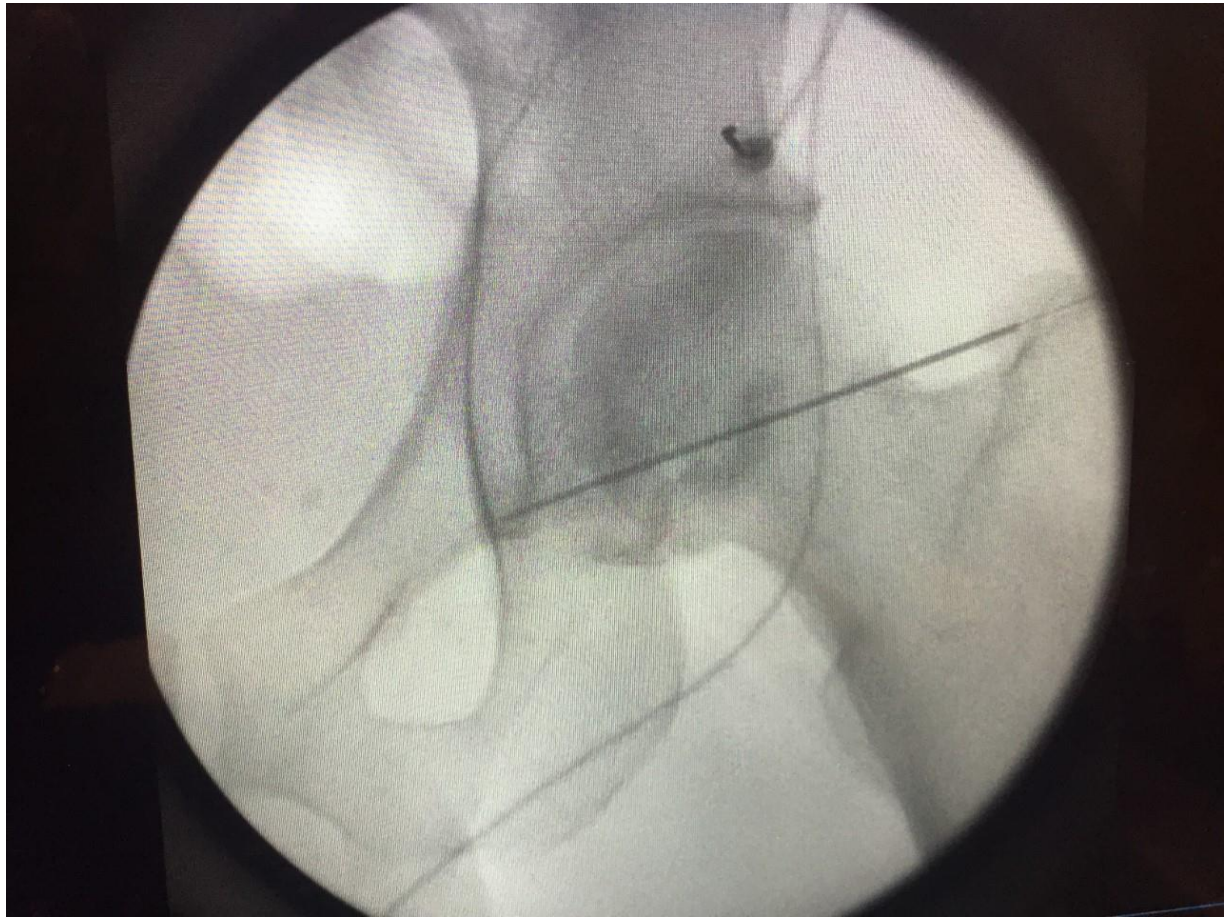
pproach

minimize
e and
/ the

nodate the

PAIN MEDICINE
Volume 9 • Number 3 • 2008

RFA Approach, Femoral and Obturator Branches



A Novel Technique for Obturator Articular Branch Block

John DiMuro, M.D.[†], Jeffrey D. Petersohn, M.D.[‡], Robert D. Menzies, M.D.[††], Carlo D. Franco, M.D.[‡‡*], Asokumar Buvanendran, M.D.[‡‡]

[†]SpineNevada ,Reno, NV, [†]PainCare,PC Linwood, NJ, Department of Anesthesiology and Perioperative Medicine Drexel University College of Medicine , Philadelphia, PA , [††]Southwest Sports and Spine, Ft. Worth, TX, [‡‡]Department of Anesthesiology and Pain Management, Rush University Medical Center, Chicago, IL , *Department of Anesthesiology and Pain Management, JHS Hospital of Cook County, C

ASRA 2015 (http://epostersonline.com/asrapain2015/node/307, poster 108)

- Anatomic study (n = 6)
- Purpose: Describe a novel approach to the obturator articular branch to reduce risk for neurovascular injury
- Method: Nerve branches identified, overlaid with steel wire, and correlated with radiographic landmarks
- Anatomy: Obturator branch traverses anterior ischia (Fig 1) and enters capsule 1-3 cm deep to femoral bundle, visible on true PA radiograph (Fig 2)
- Technique:
  - Patient supine
  - Abduction for true PA of femoral head, acetabulum, and incisura
  - Line drawn from incisura to ischial tuberosity – extended to medial thigh to mark needle entry
  - Needle steered to target site (Fig 3) following ischial surface.

Figure 1

Line drawn on skin from OAB target (•)to ischial tuberosity (•) is extended to medial thigh to define coronal plane needle trajectory. Needle is introduced at the point of the arrow on the medial thigh and directed posteriorly to contact the anterior aspect of the ischial tuberosity before "walking" along the anterior ischial surface to reach the OAB target.

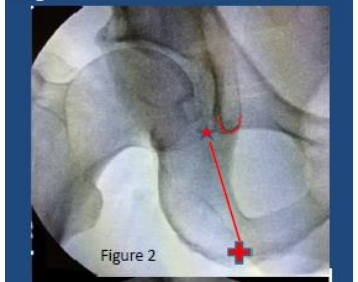
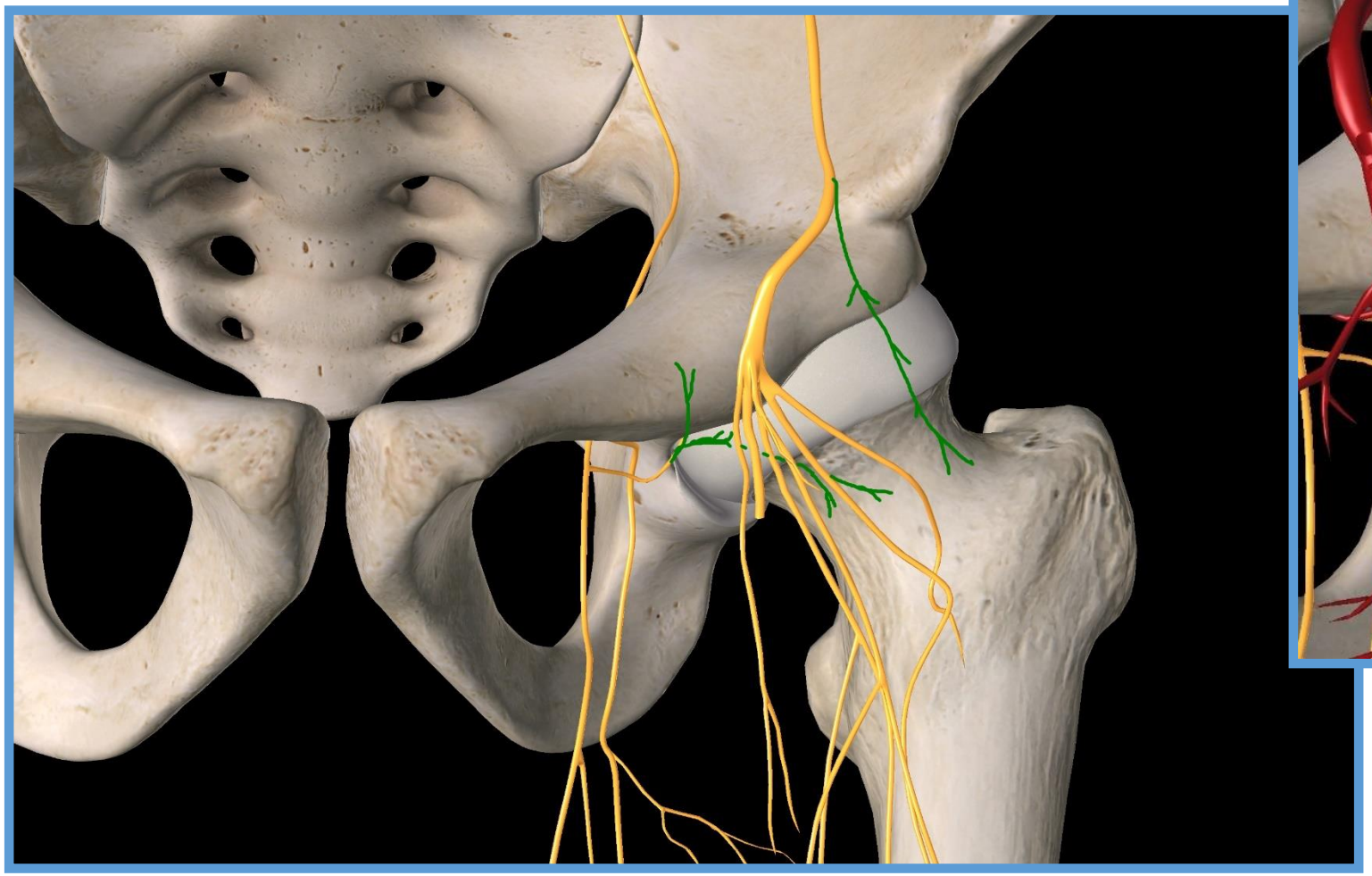
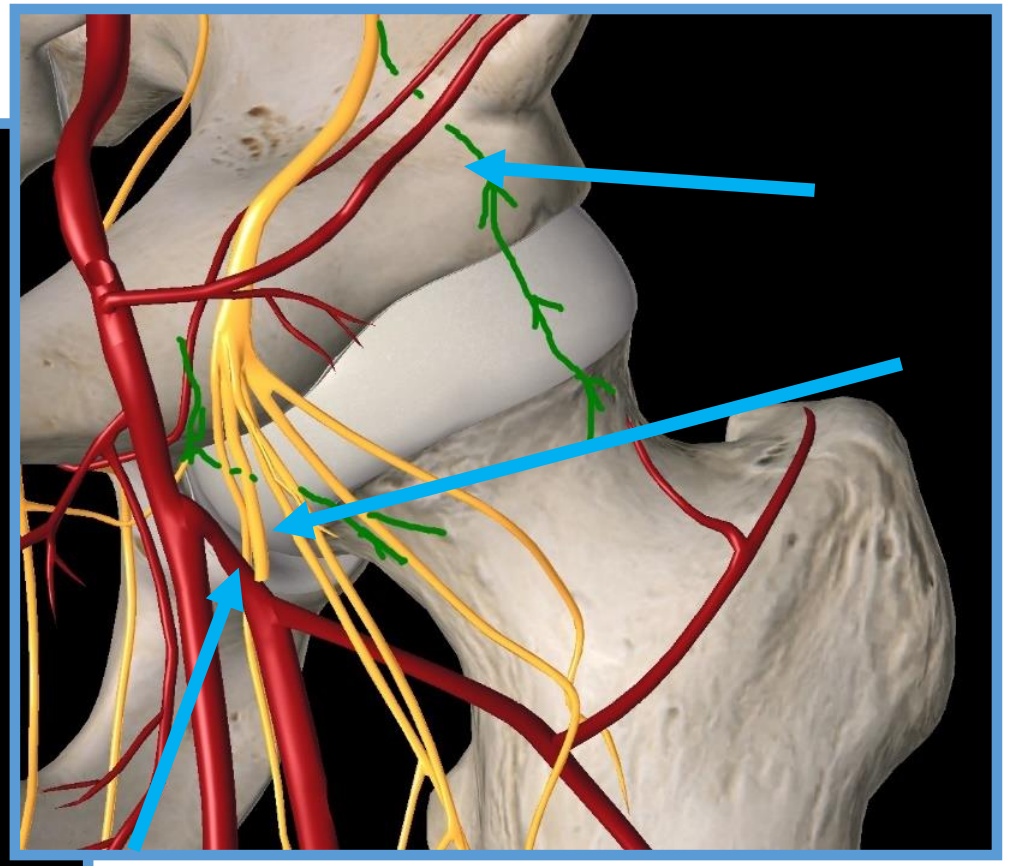


Figure 2

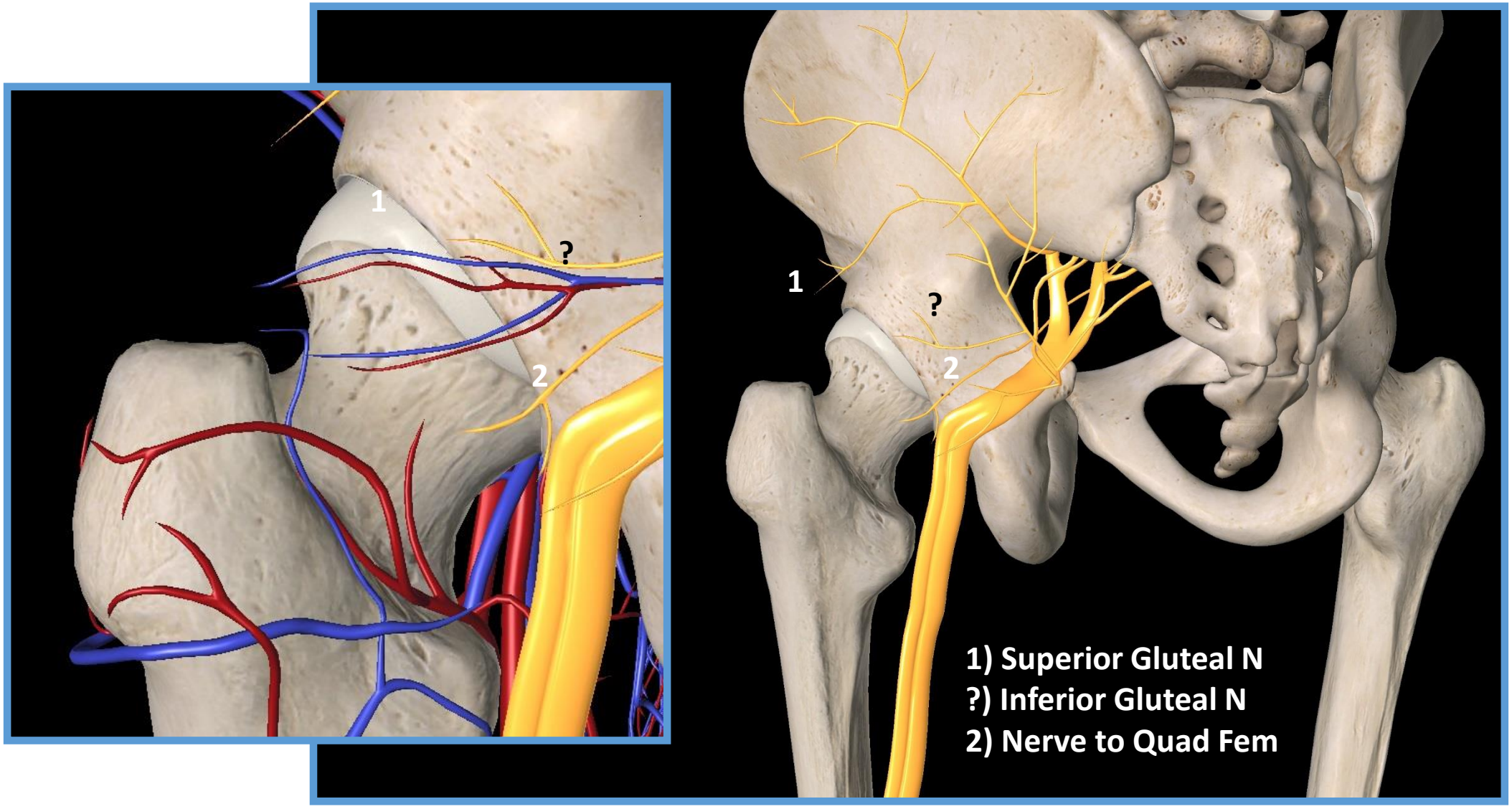
Figure 3

Anterior Hip Innervation





Future: Posterior Hip Innervation



Complications

WIP16-0157 FEMORAL NERVE INJURY FOLLOWING COOLED RADIOFREQUENCY LESIONING FOR THE TREATMENT OF HIP PAIN DESPITE ULTRASOUND GUIDANCE AND MOTOR TESTING

I. Gooding, E. Voogd, C. Sigmon

motor testing. Despite the safety measures employed, the patient developed quadriceps weakness following the procedure with numbness along the femoral and saphenous nerve distribution. EMG performed 6 weeks after the procedure note no voluntary motor unit action potentials consistent with severe femoral neuropathy.

Gooding I, et al. Pain Pract. 2016;16(S1):147.

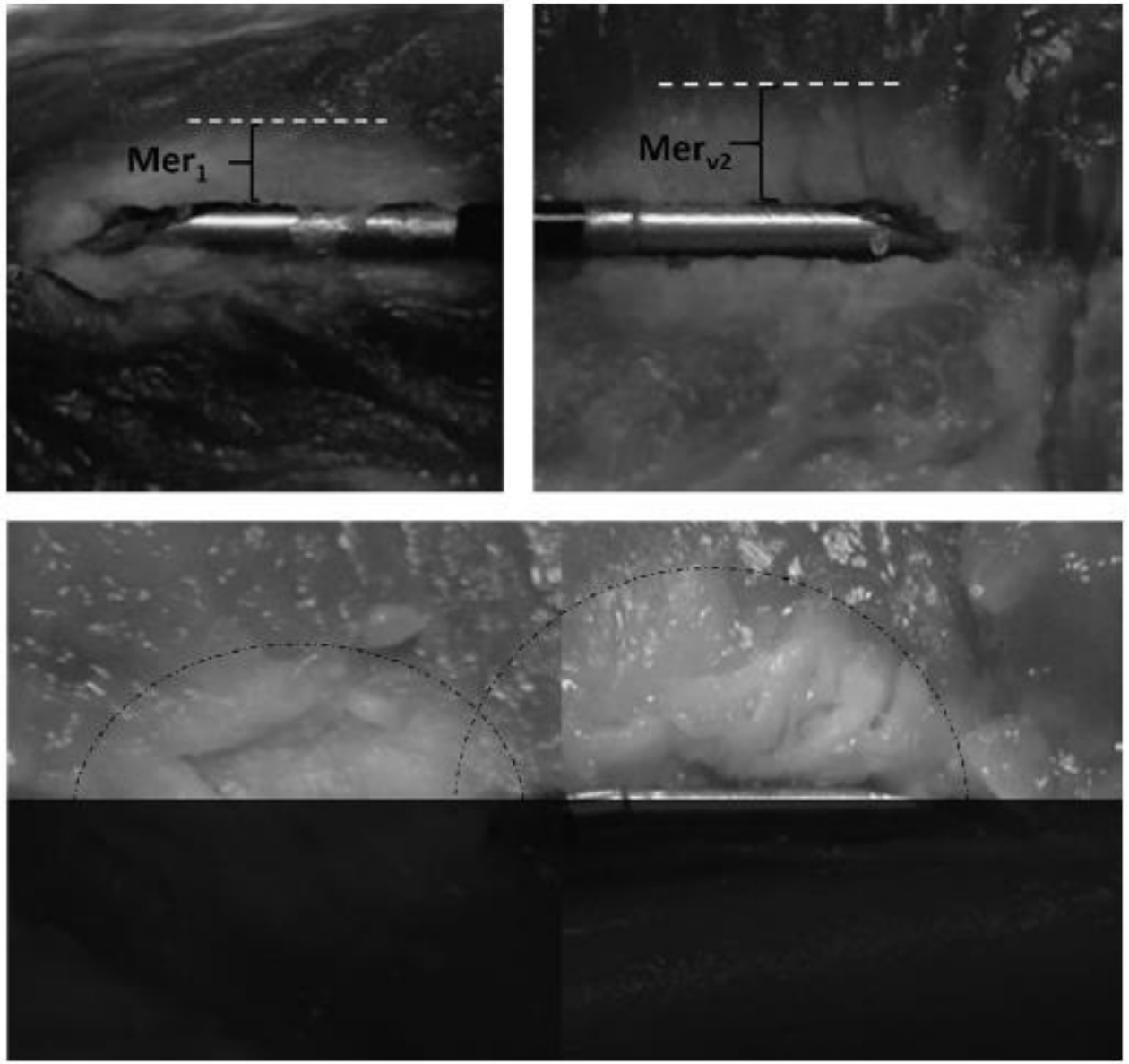
Complications summary, published and verbal reports

- Genicular CRFA
  - Hematoma
  - Skin Burns

- Hip Articular CRFA
  - Femoral Artery Cannulation / Hematoma
  - Femoral Nerve Injury

More is Better?

- 61 y/o patient
- T1-4 thoracic facet pain
- H/O posterior fusion C3-T1
- Probes placed at superiorlateral aspect of T2-T5 transverse process
- RFA 60 deg C, 150 seconds
- During RFA, patient complains of severe local pain at 90 sec
- Skin blanching noted
- Healing ultimately took 5 months



Walega D, Roussis C. Pain Pract. 2014 Jul;14(6):e154-8.
Eckmann MS, et. al. Reg Anesth Pain Med. 2015 May-Jun;40(3):270-5.

Shoulder Nerve Ablation?

Hilton's Law and Neurologic Innervation

- Hilton's Law (1863)

"The same trunks of nerves whose branches supply the groups of muscles moving a joint furnish also a distribution of nerves to the skin over the insertions of the same muscles; and—what at this moment more especially merits our attention—the interior of the joint receives its nerves from the same source."

Hilton's Law Applied to Glenohumeral Joint

TABLE 1. An Example of the Application of Hilton's Law: The Glenohumeral Joint

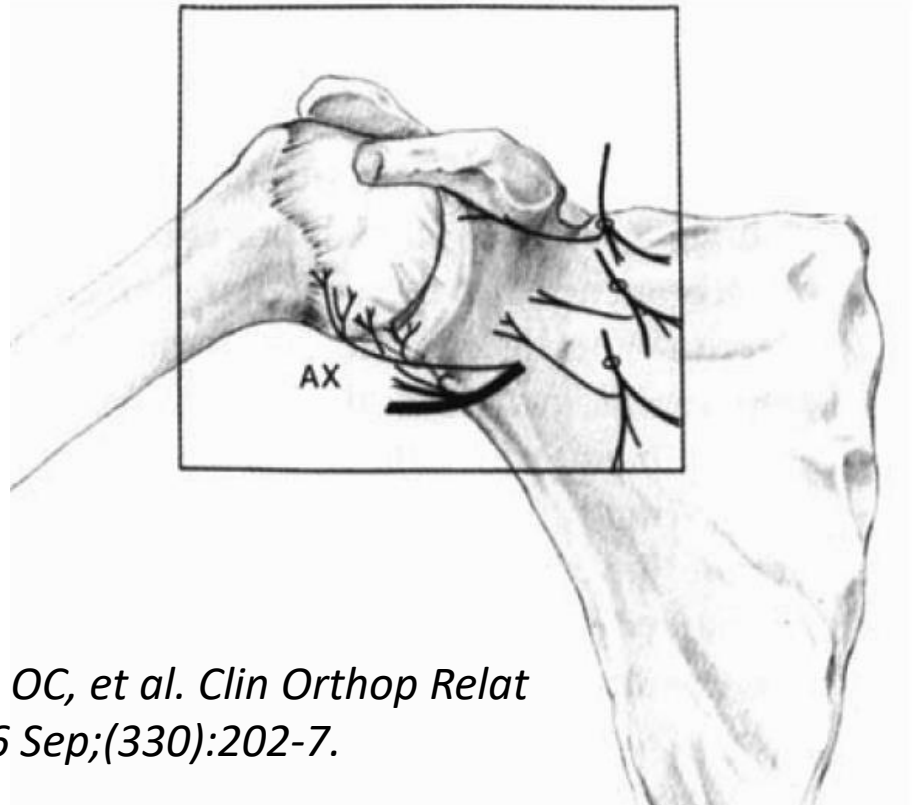
Nerve (origin)	Muscles moving joint	Cutaneous innervation	Explanation	Articular branch	Explanation
Suprascapular (C5-C6)	Supra and infraspinatus	Yes or axillary	Same nerve or same source	Yes	Same nerve
Lateral pectoral (C5-C6-C7)	Pectoralis major (clavicular head)	Sensory branch (variations) or axillary	Same nerve or same source	Yes	Same nerve
Medial pectoral (C8-T1)	Pectoralis major (sternal head), *chondro-epitochlearis*	Sensory branch of lateral pectoral or axillary	Double innervation or neural communication (ansa pectoralis)	Lateral pectoral branch	Double innervation or neural communication (ansa pectoralis)
Upper subscapular (C5-C6)	Subscapularis	Axillary	Same source	Yes (controversial) or axillary	Same nerve or same source
Lower subscapular (C5-C6)	Subscapularis, teres major	Axillary	Same source	Yes (controversial) or axillary	Same nerve or same source
Thoracodorsal (C5-C6-C7)	Latissimus dorsi, *axillary arch*	Axillary	Same source	Lateral pectoral branch	Same source
Axillary (C5-C6)	Deltoid, teres minor	Yes	Same nerve	Yes	Same nerve
Musculo-cutaneous (C5-C6-C7)	Biceps, coraco-brachialis	Yes	Same nerve	Lateral pectoral branch	Same source
Radial (C5-C6-C7-C8-T1)	Triceps	Yes	Same nerve	Yes or from posterior cord	Same nerve or same source

Hébert-Blouin MN, et al. Clin Anat. 2014 May;27(4):548-55.

Neurologic Innervation: Joint Capsule

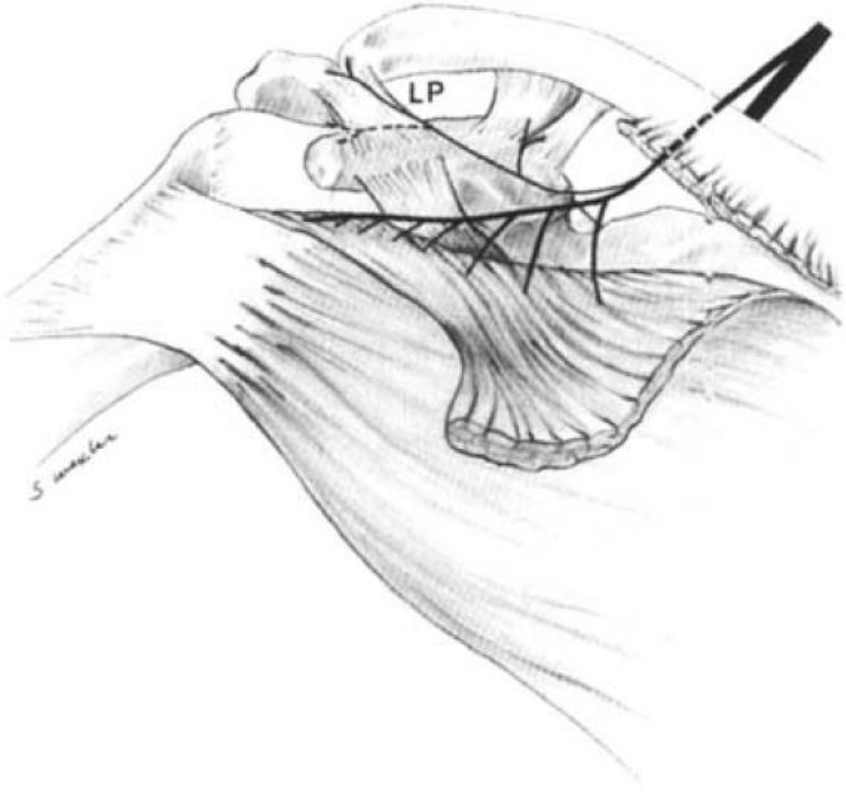
Anterior Shoulder Joint

- Subscapular Branches
- Axillary Nerve (Anterior Branch)



Aszmann OC, et al. Clin Orthop Relat Res. 1996 Sep;(330):202-7.

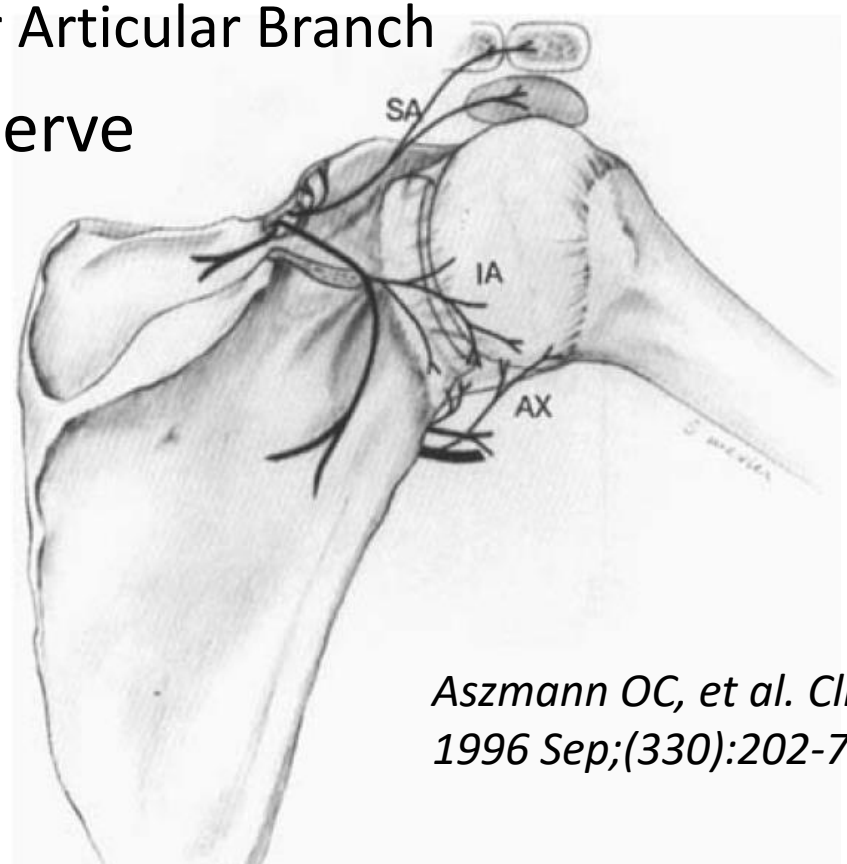
- Lateral Pectoral Nerve (Articular Branch)



Neurologic Innervation: Joint Capsule

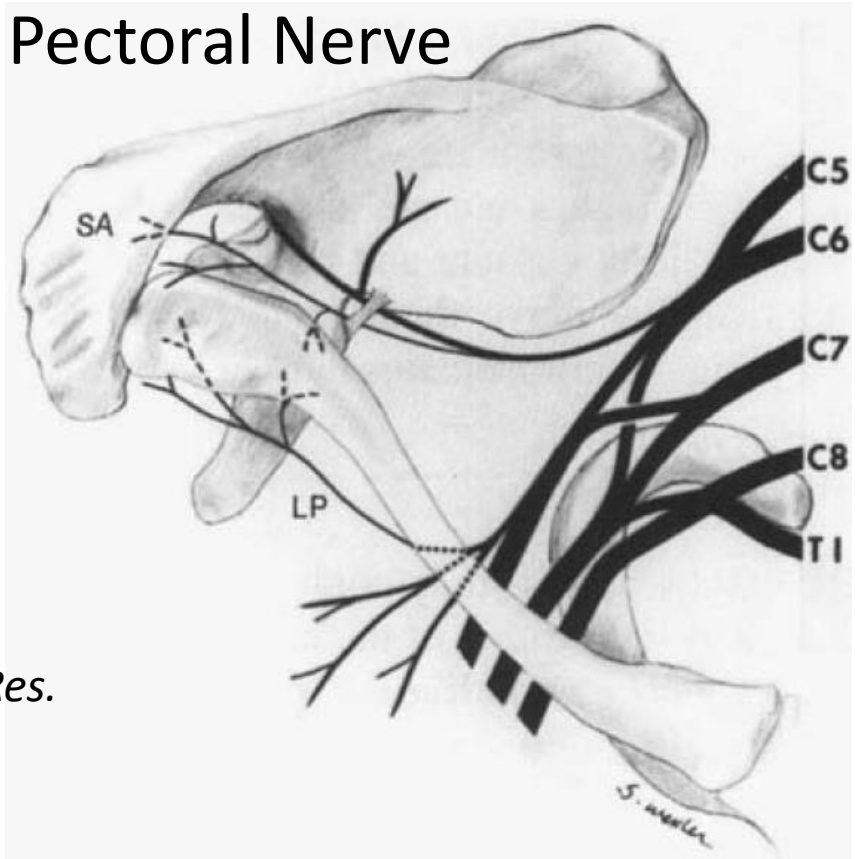
Posterior Shoulder Joint

- Suprascapular Nerve
  - Superior Articular Branch
  - Inferior Articular Branch
- Axillary Nerve



Superior Shoulder Joint

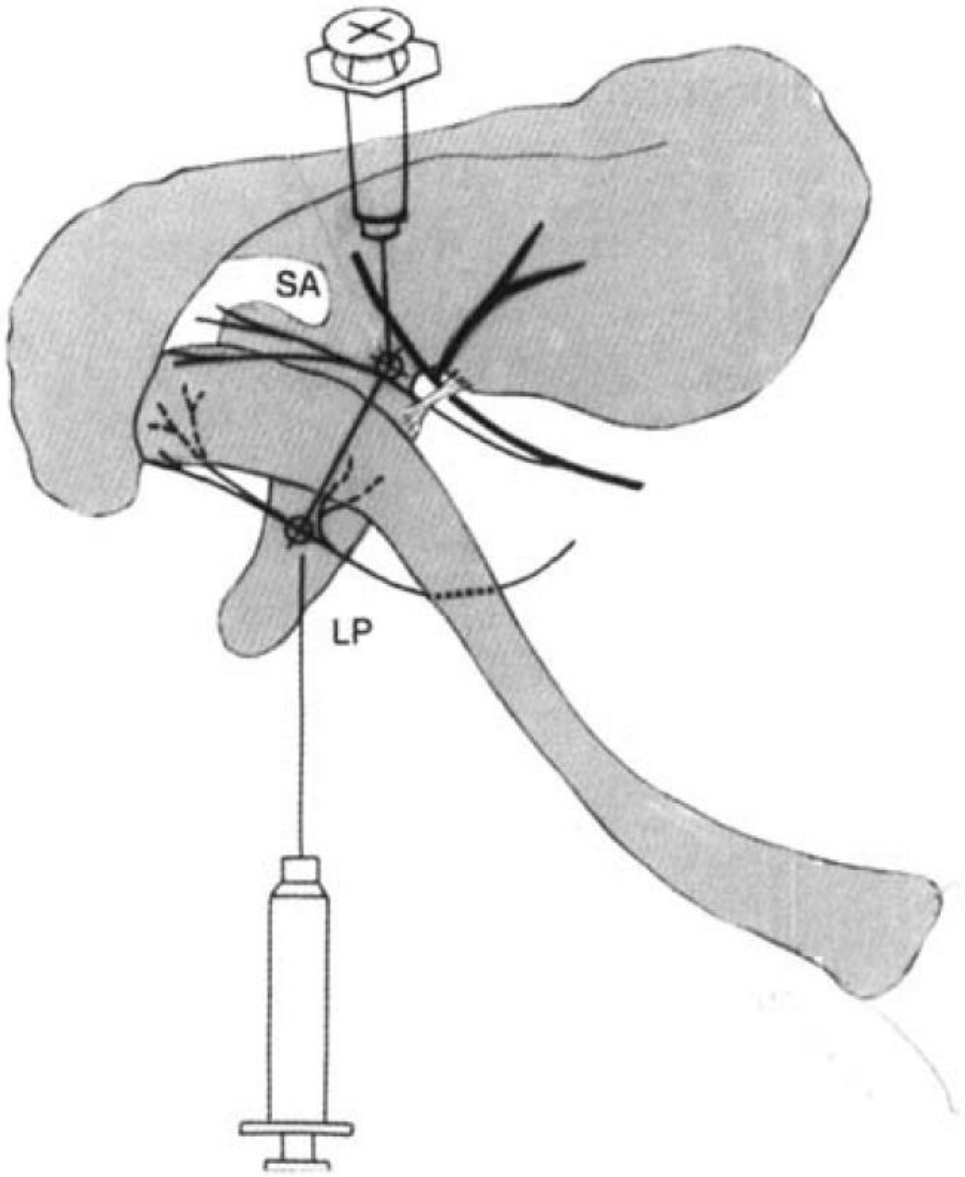
- Suprascapular Nerve
  - Superior Articular Branch
- Lateral Pectoral Nerve



Aszmann OC, et al. Clin Orthop Relat Res. 1996 Sep;(330):202-7.

Lateral Pectoral Nerve Block

- Indications
  - Anterior superior shoulder capsule, AC joint, lateral clavicle, subacromial bursa
- Landmarks
  - Deltopectoral groove
  - Clavicle
  - Coracoid Process
- Technique
  - At confluence of these 3 landmarks
  - Medial aspect of coracoid
  - Just under the clavicle
  - (Upper subscapular N can be reached 2 cm beyond and lateral)
- Ultrasound Guided
  - Has been described for breast surgery but techniques appear distal to articular fibers



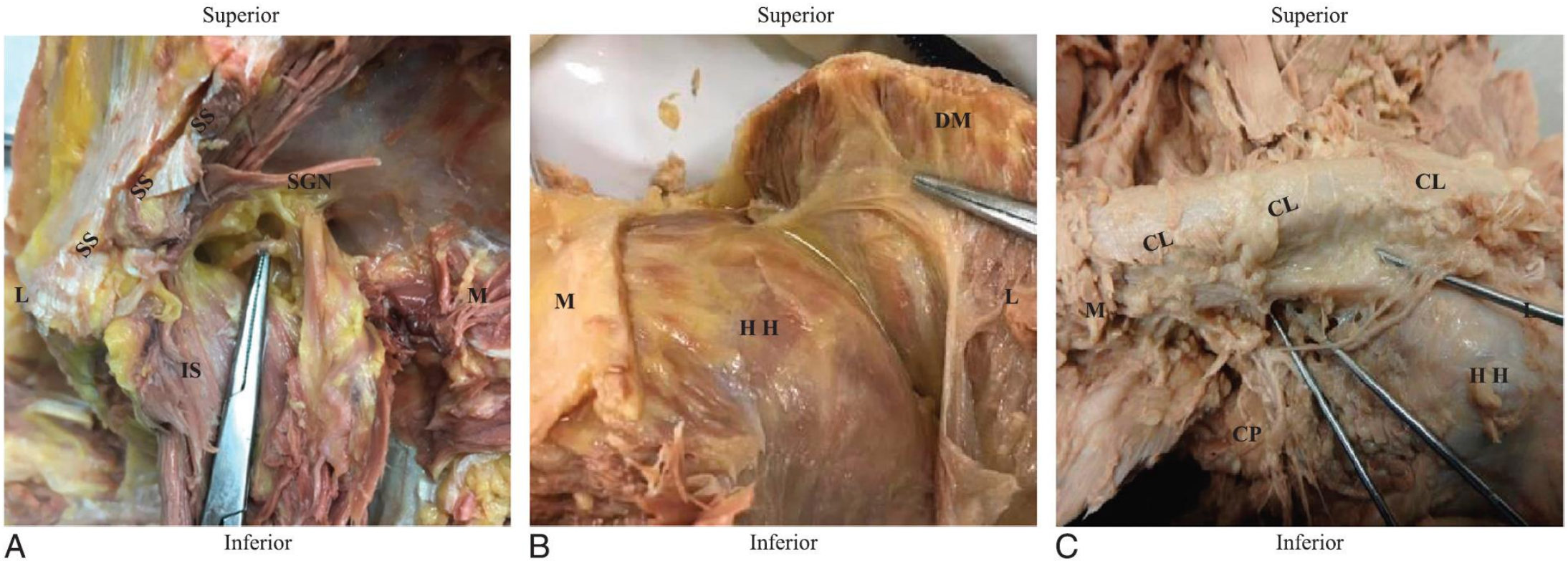
Aszmann OC, et al. Clin Orthop Relat Res. 1996 Sep;(330):202-7.

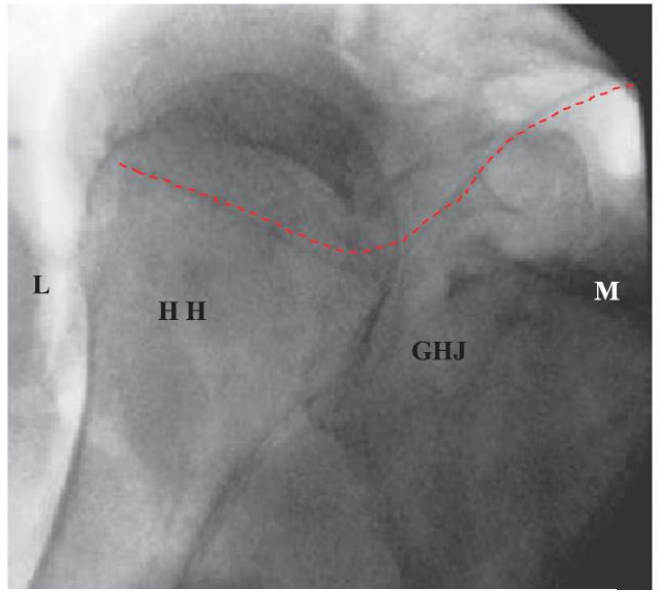
REGIONAL ANESTHESIA AND ACUTE PAIN

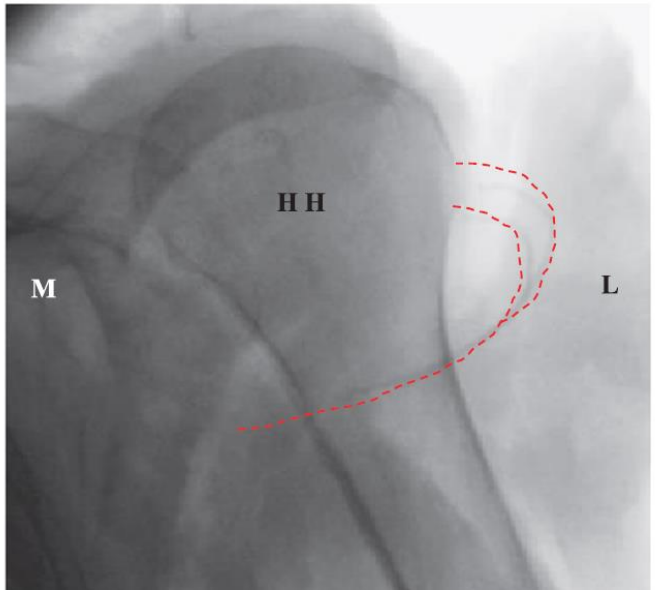
ORIGINAL ARTICLE

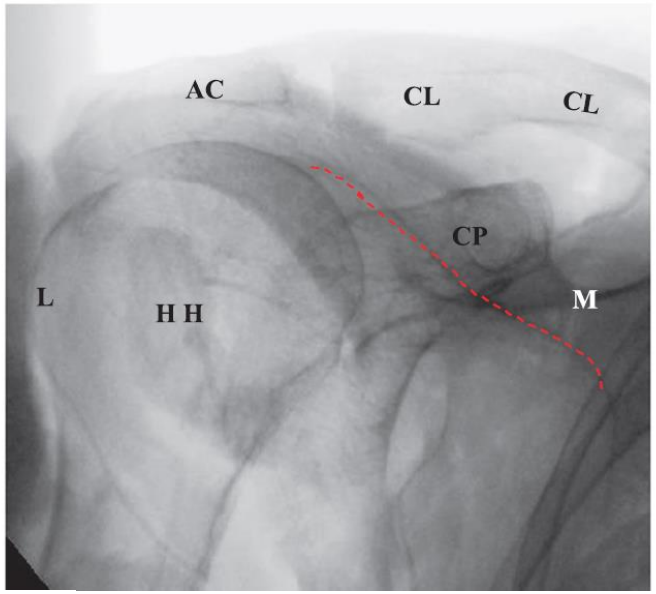
Cadaveric Study of the Articular Branches of the Shoulder Joint

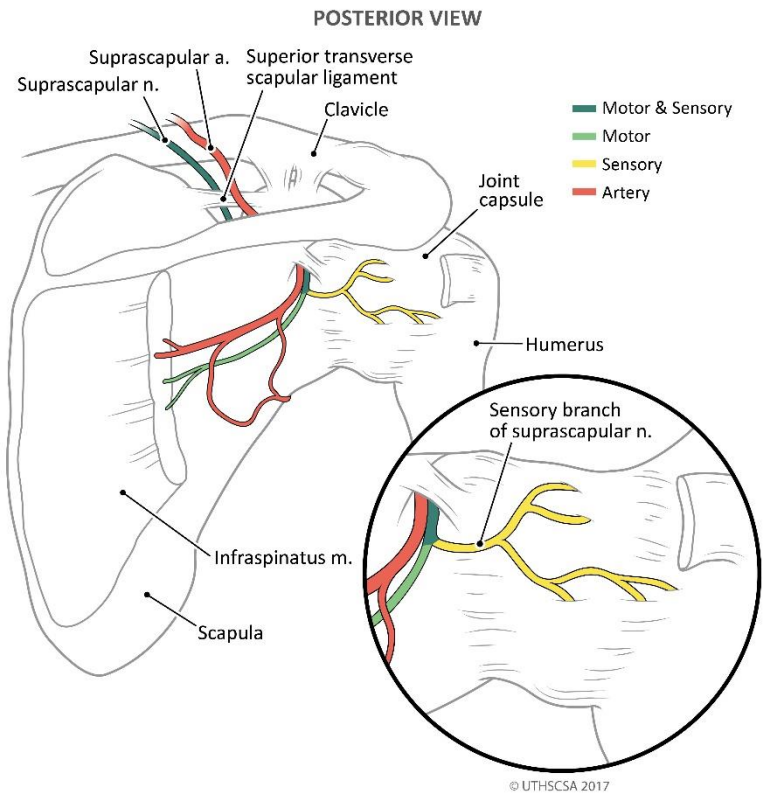
Maxim S. Eckmann, MD, Brittany Bickelhaupt, MD,† Jacob Fehl, MD,† Jonathan A. Benfield, DO,* Jonathan Curley, MD,‡ Ohmid Rahimi, PhD,§ and Ameet S. Nagpal, MD, MS, Med**

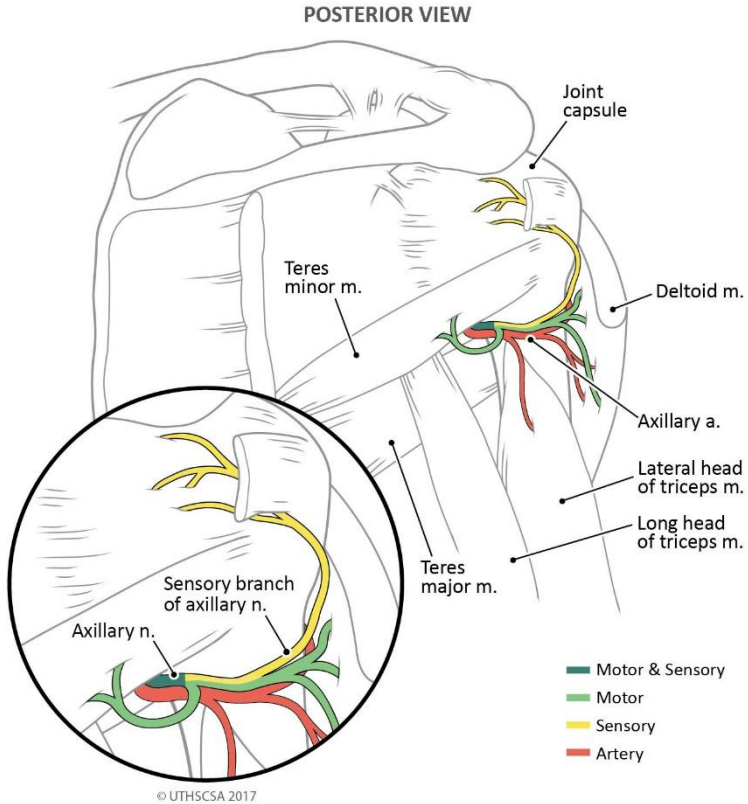


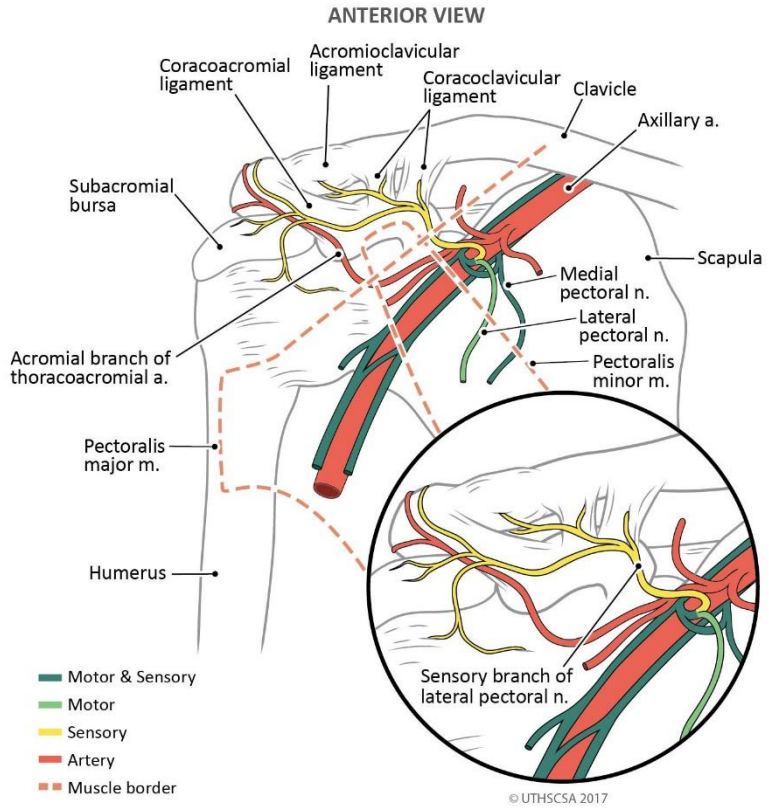

L
H H
GHJ
M


H H
M
L


AC
CL
CL
CP
L
H H
M


POSTERIOR VIEW
Suprascapular a.
Suprascapular n.
Superior transverse scapular ligament
Clavicle
Joint capsule
Humerus
Sensory branch of suprascapular n.
Infraspinatus m.
Scapula
Motor & Sensory
Motor
Sensory
Artery
© UTHSCSA 2017

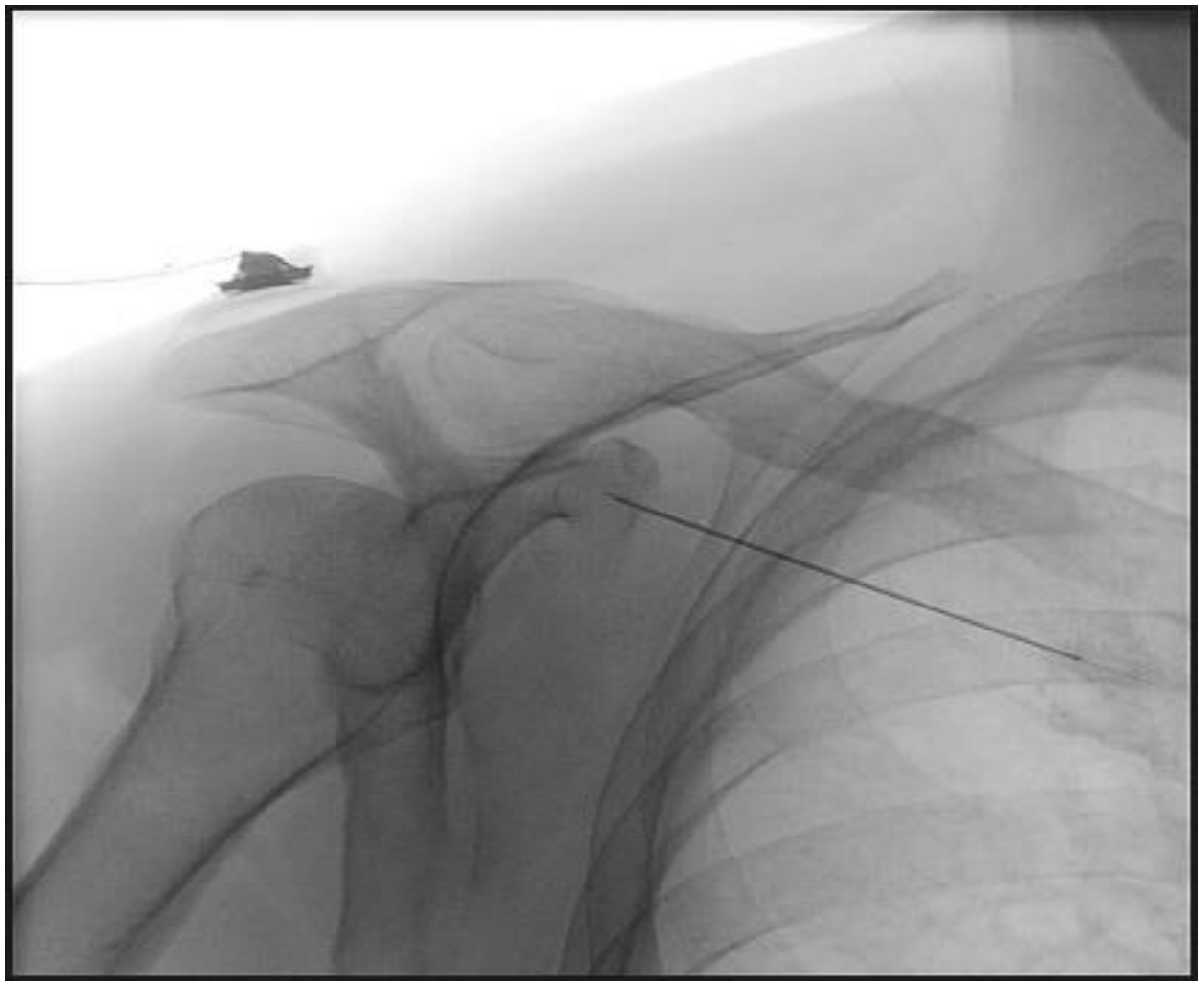

POSTERIOR VIEW
Joint capsule
Teres minor m.
Deltoid m.
Axillary a.
Lateral head of triceps m.
Long head of triceps m.
Teres major m.
Sensory branch of axillary n.
Axillary n.
Motor & Sensory
Motor
Sensory
Artery
© UTHSCSA 2017


ANTERIOR VIEW
Coracoacromial ligament
Acromioclavicular ligament
Coracoclavicular ligament
Clavicle
Axillary a.
Subacromial bursa
Scapula
Medial pectoral n.
Lateral pectoral n.
Acromial branch of thoracoacromial a.
Pectoralis minor m.
Pectoralis major m.
Humerus
Sensory branch of lateral pectoral n.
Motor & Sensory
Motor
Sensory
Artery
Muscle border
© UTHSCSA 2017

First Cases, UT Health San Antonio (in press)

Posterior

Anterior



Posterior

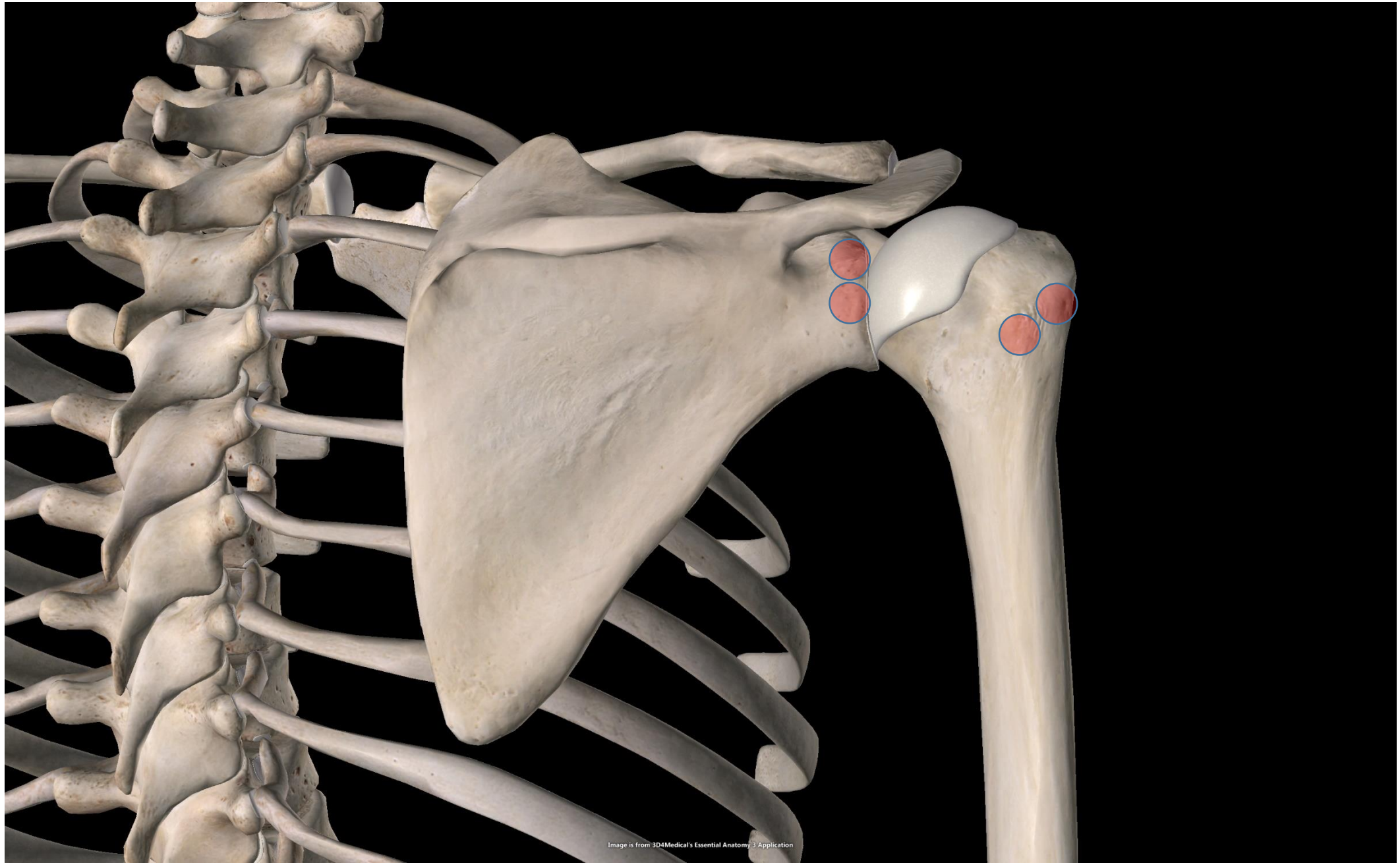
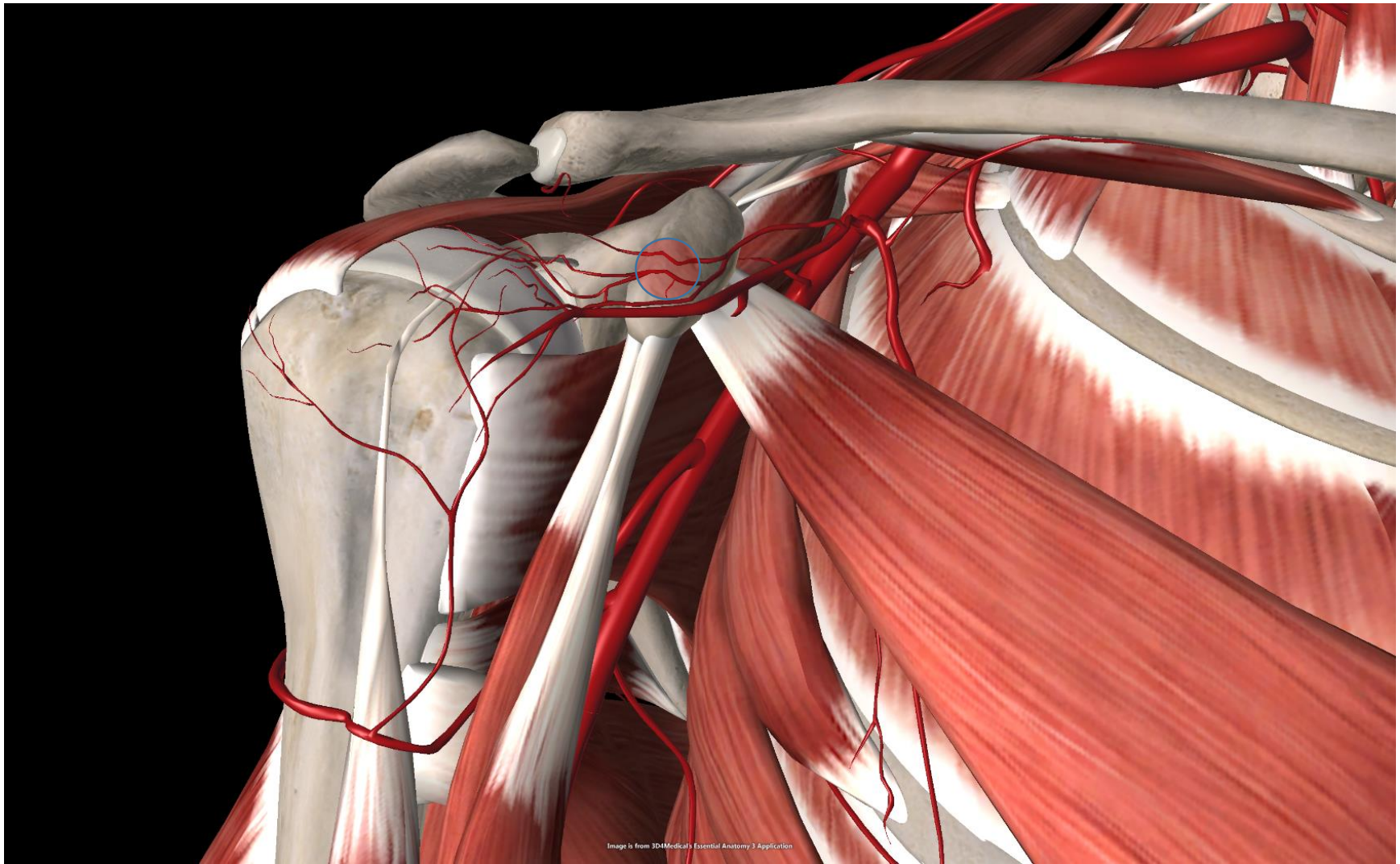


Image is from 3D4Medical's Essential Anatomy 3 Application

Anterior

Possible arterial injury – use finder needle/US?



Summary: Technical Advances in RFA

- Beginning: Reliability
  - Closed loop temperature control
- Later: Versatility
  - All shapes and sizes
- Current: Larger and Larger Lesion Sizes
  - Possibly improved outcomes
  - New complications
  - Safe trajectories are needed

Thank you!