The Lumbar Plexus and the Transpsoas Approach

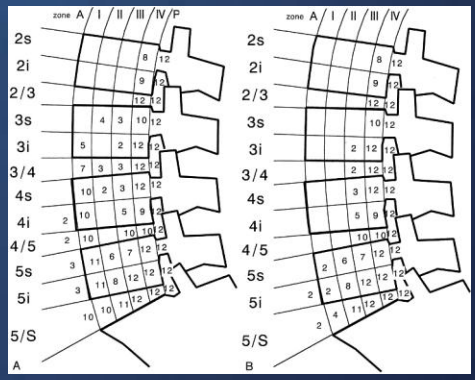
Anatomic and Neurophysiologic Review

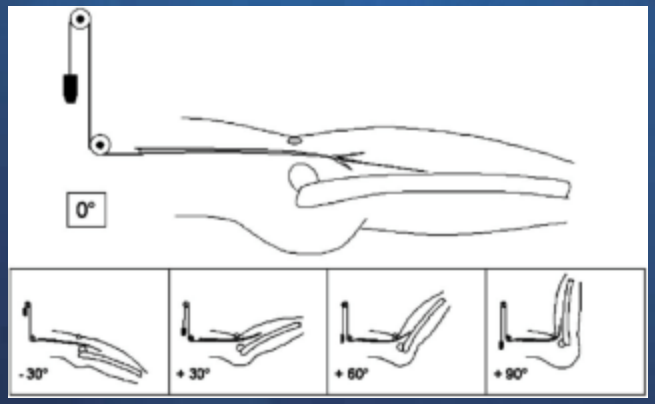
Timothy Davis MD, D.ABNM
Physical Medicine and Rehabilitation
The Spine Institute, Santa Monica
The Spine Center, Cedars Sinai

Focus on Safety

- Not as simple as previously described
- Neural Injury is possible
  - Sensory
  - Motor
- Understand the Anatomy
- Understand the Limitations of Neuromonitoring

- Moro et al.-Spine 2003 (2)
  - Anatomic “Safety Zone” L2-5 excluding the GF
  - Muscle should be split more anterior
  - GF higher risk at L3-4





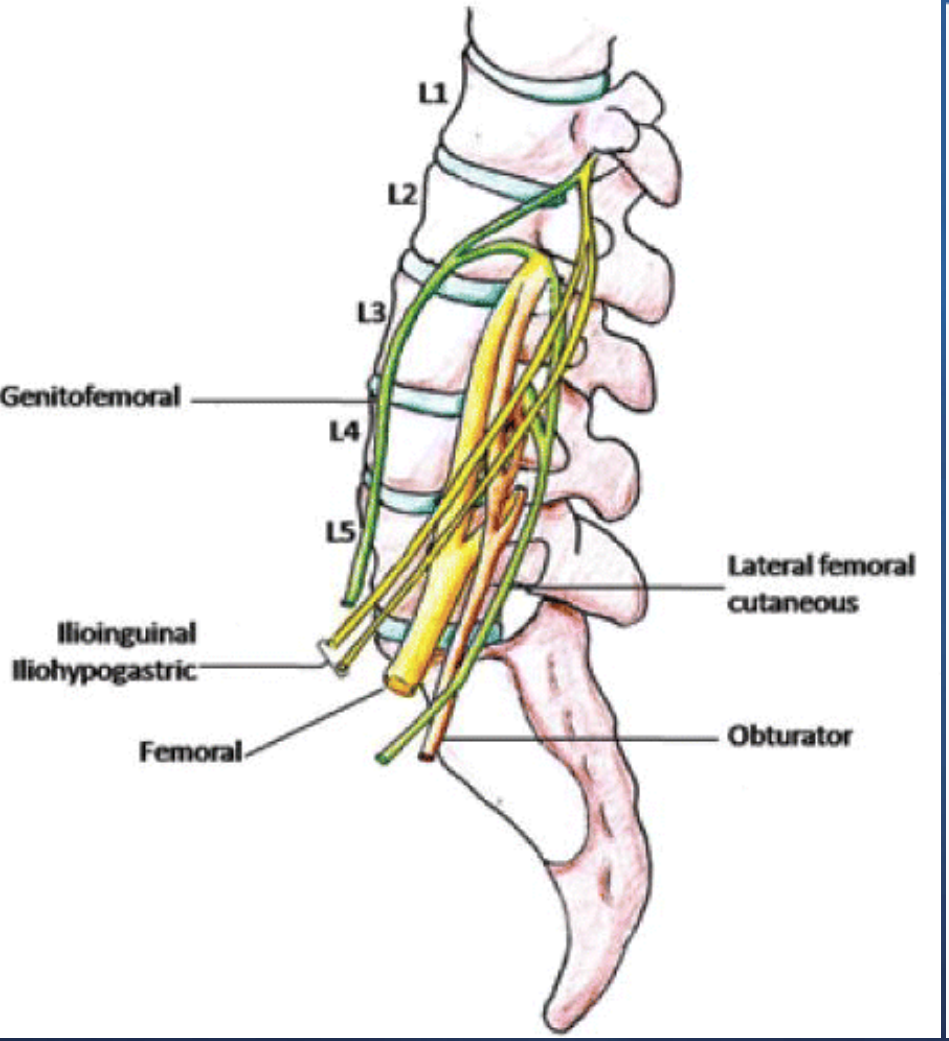
- Lu et al.-Zhonghua Wai Ke Za Zhi 2008 (Chinese) (3)
  - Safety zone decreases from L2-5
  - Incising psoas ventral 2/3 can prevent injury

- Park et al.- J Spinal Disord Tech 2010 (4)
  - Anatomic variations in a small number can place neural structures at risk
  - “Care is particularly warranted at L4-5”

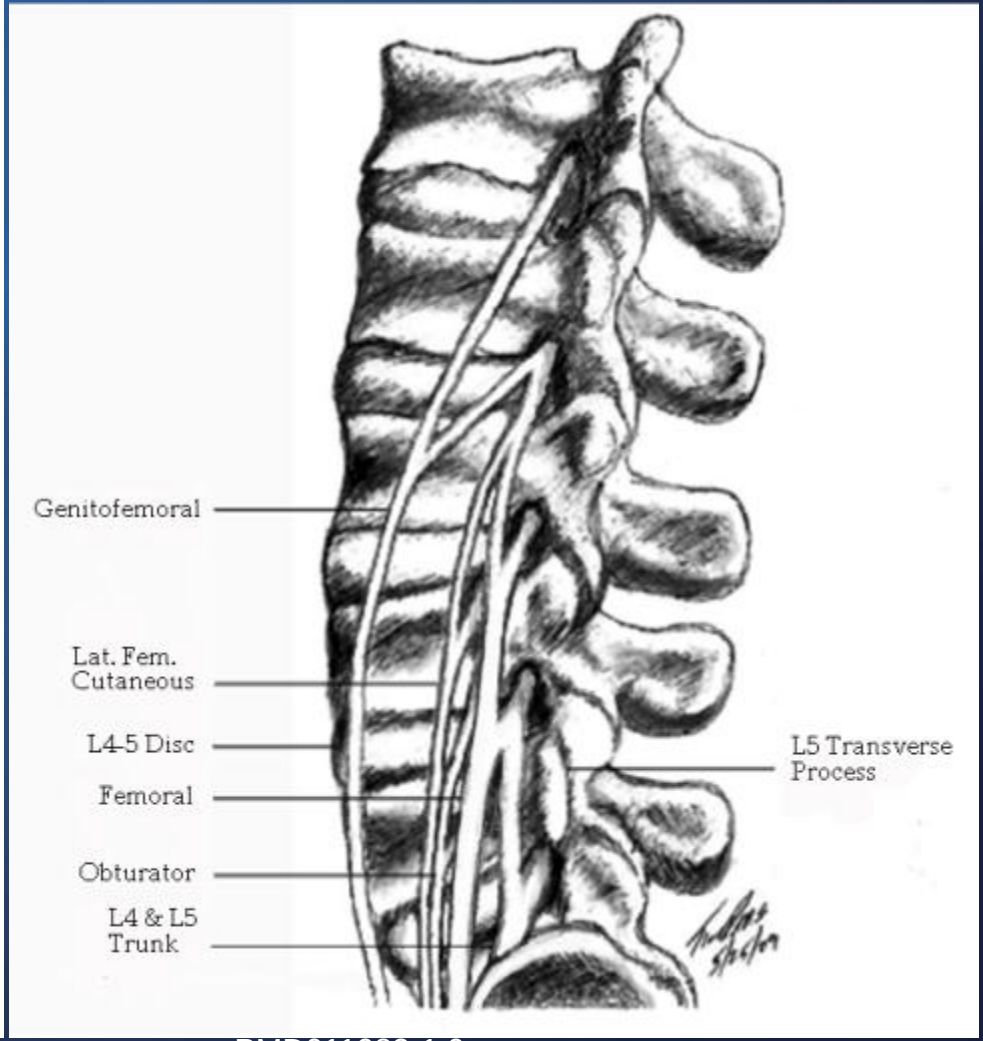
- Twenty lumbar segments L1-4 (5)
  - 5 Cadavars dissected in the lateral position
- Conclusion
  - In regard to Direct Nerve Injury
    - “the safe anatomical zones.. ..L1-4 are at the middle posterior quarter of the VB (midpoint Zone III)”
    - “at the L4-5 disc space is the midpoint of the VB (Zone II-III demarcation)
  - Ilioinguinal, iliohypogastric, lateral femoral cutaneous potential fo injury in the retroperitoneal space

Lumbar Plexus Illustration

Uribe: Obturator Posterior To Femoral



Obturator Anterior to Femoral



- 20 Lumbar Plexus on 18 Cadavars (1)
- Femoral N.
  - Average Diameter 13.1 mm
- Obturator N.
  - At similar risk to Femoral at L4-5
- L5 Transverse process
  - Post boundary against which neural structures can be compressed

Neural Symptoms

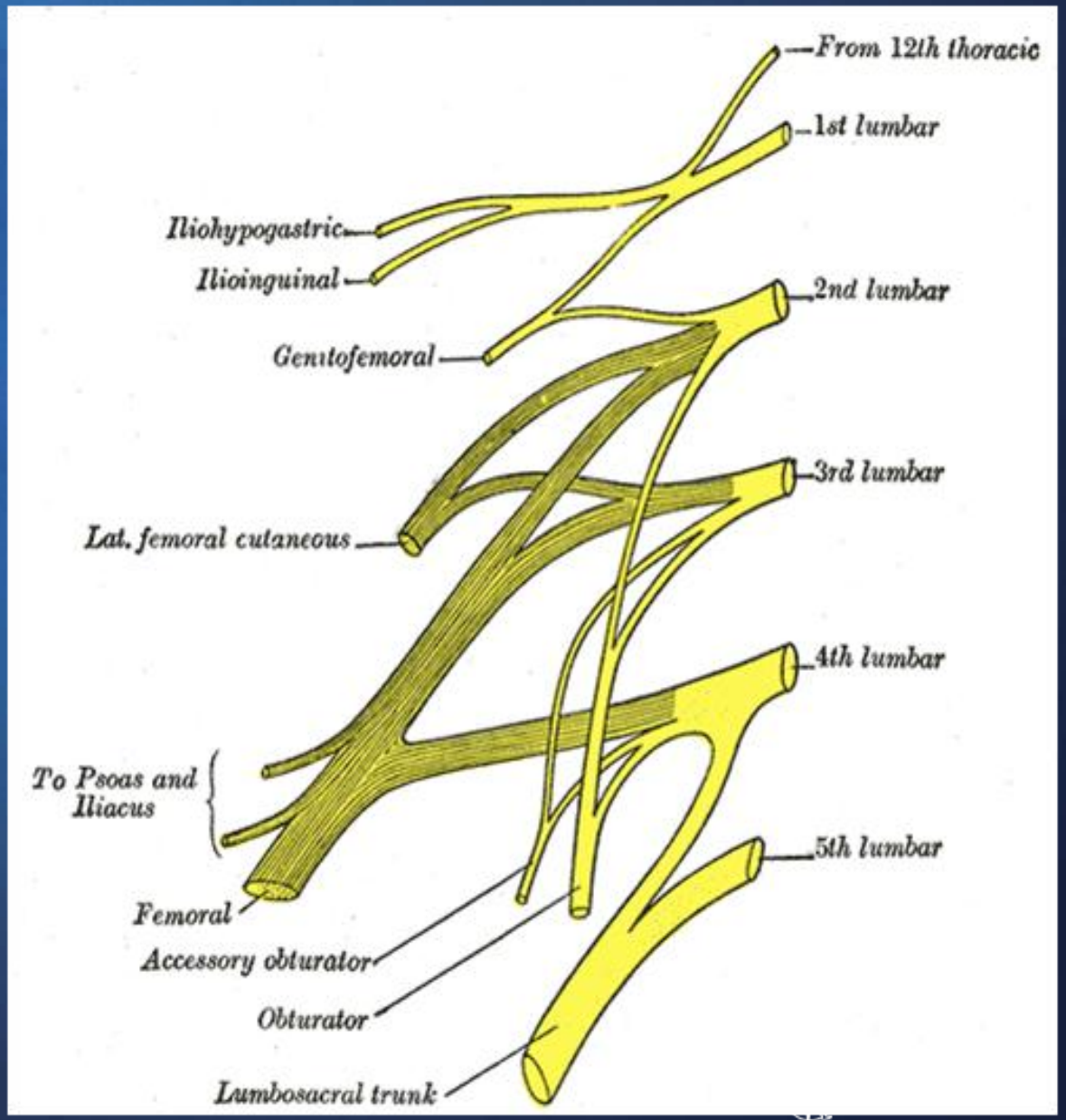
- Are neural injuries during the transpsoas more prevalent than reported?
  - Is it relevant?
  - Are they mostly resolving neuropraxia
    - Result of hematoma, stretch, compression?
- Femoral or Obturator palsy are the most potentially disabling
  - Transient Neuropraxia is more likely
    - 3 level cross innervation
    - Multiple muscles functioning in symphony

Neural Symptoms

- L4-5 suspected to be have a higher incidence than other levels
- No current means of predicting the femoral nerve course across the L4-5 disc space
- Imaging techniques have limited capabilities
- What are potential causes?
  - Direct nerve injury
  - Indirect nerve injury
  - Muscle trauma
  - Hematoma – reported to cause femoral nerve palsy
  - Combination

Anatomic Review

- Good for teaching
- Poor for surgical application
- No illustration from the direct lateral perspective



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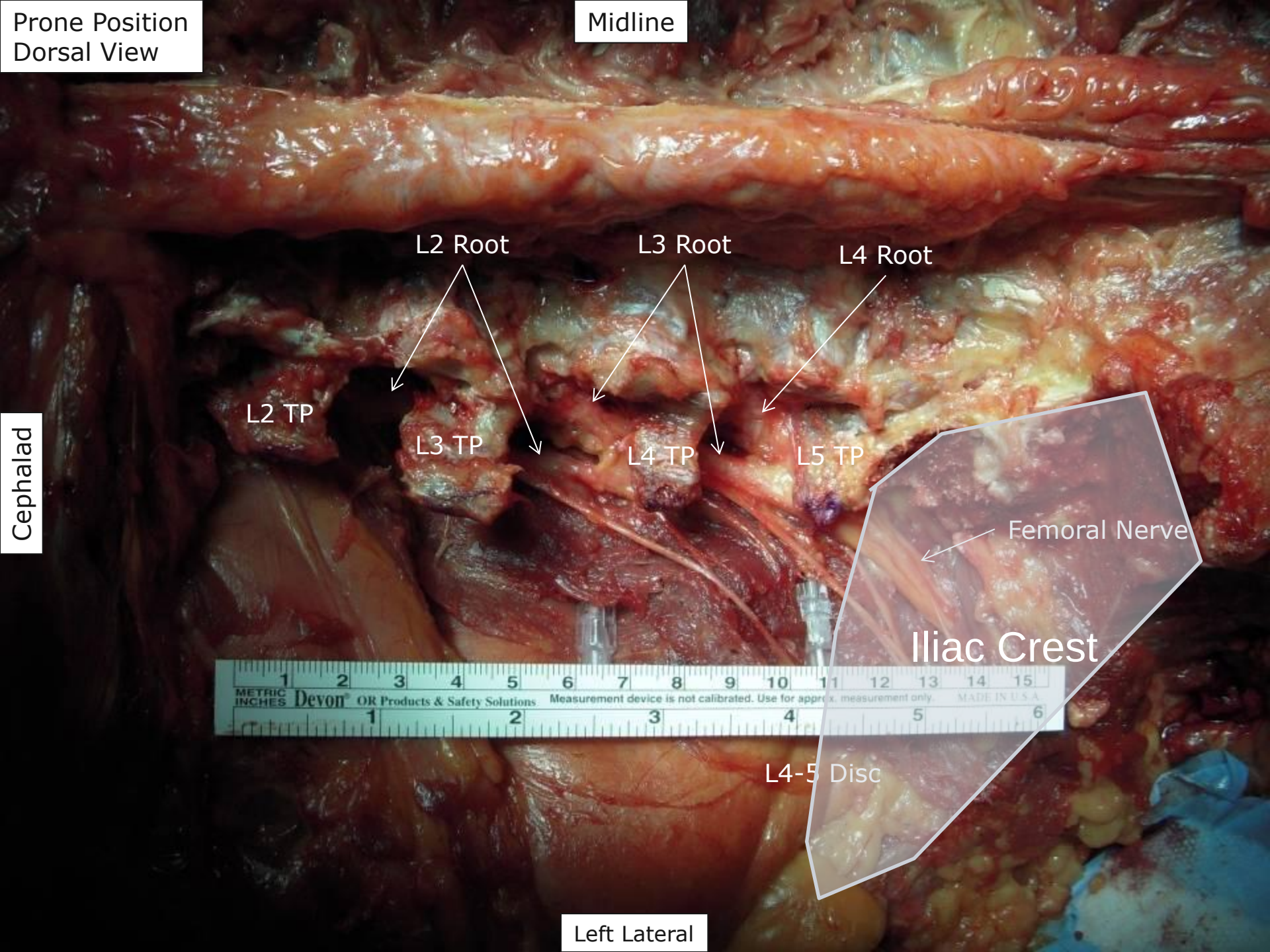
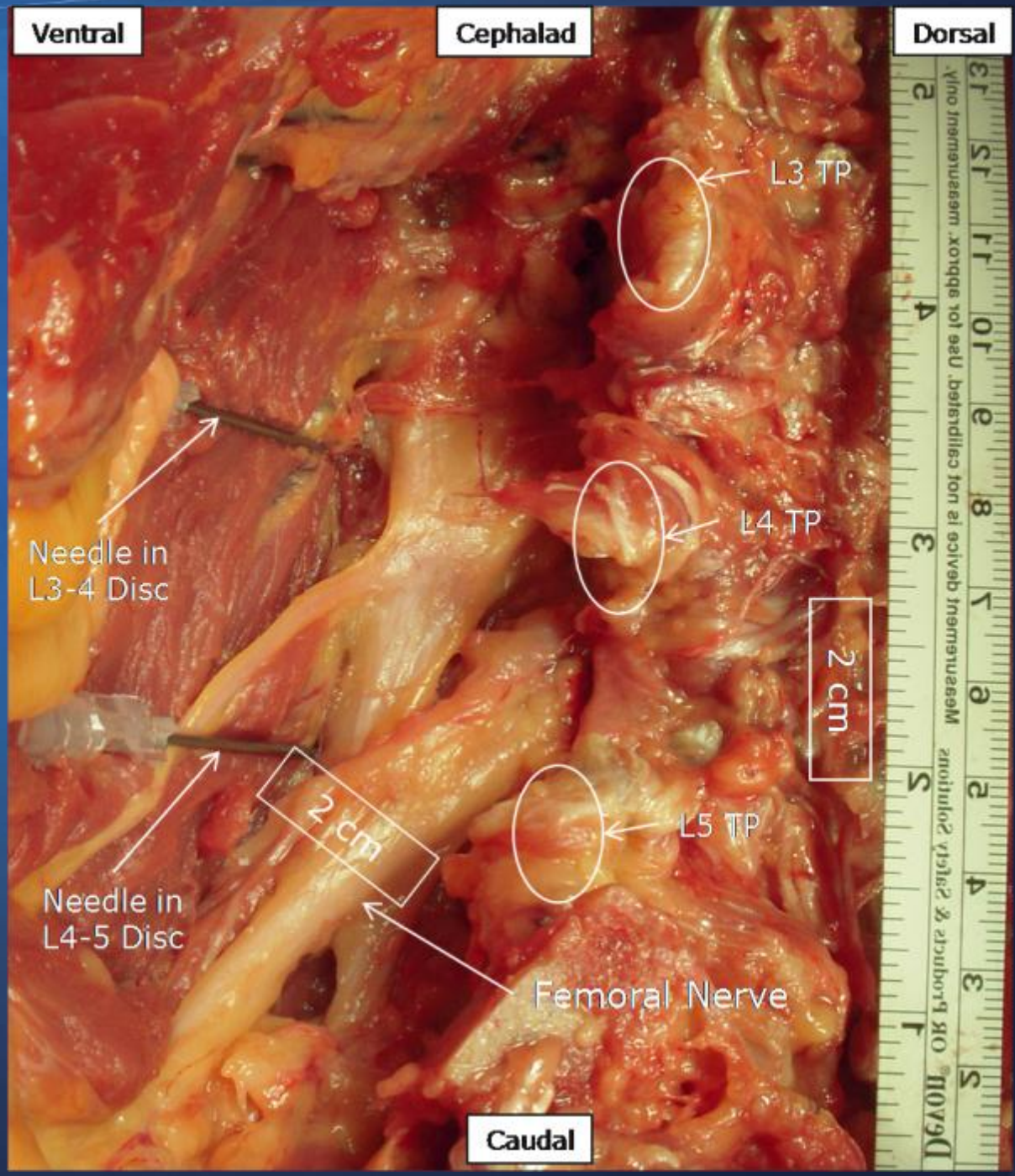

Prone Position
Dorsal View
Midline
L2 Root
L3 Root
L4 Root
L2 TP
L3 TP
L4 TP
L5 TP
Femoral Nerve
Iliac Crest
L4-5 Disc
Cephalad
Left Lateral

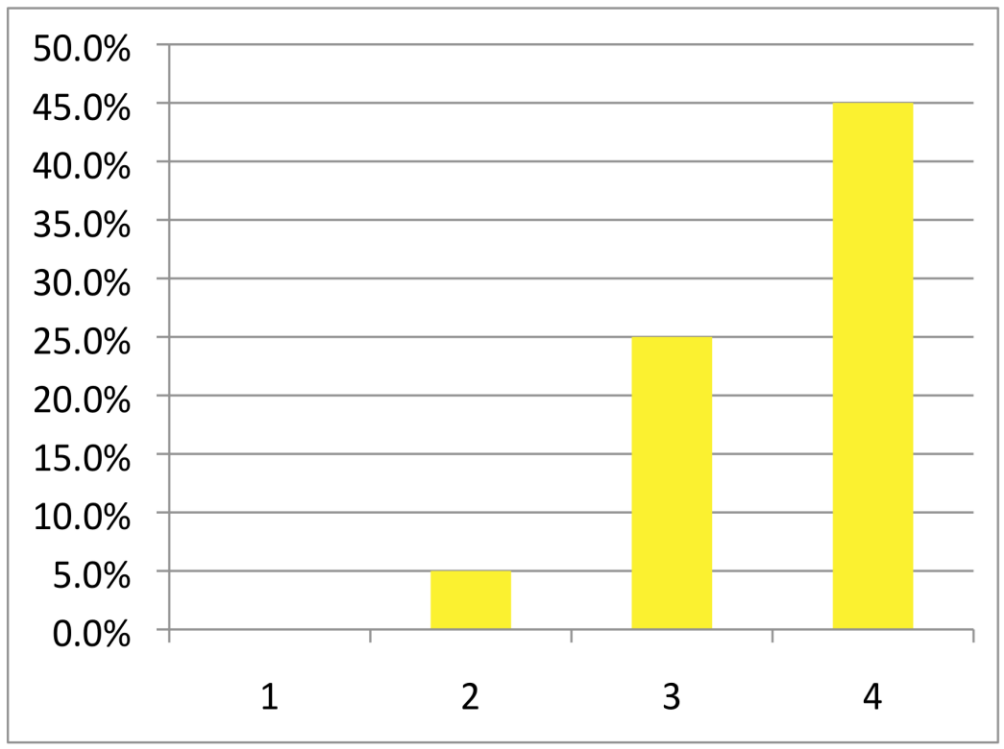
Anatomy

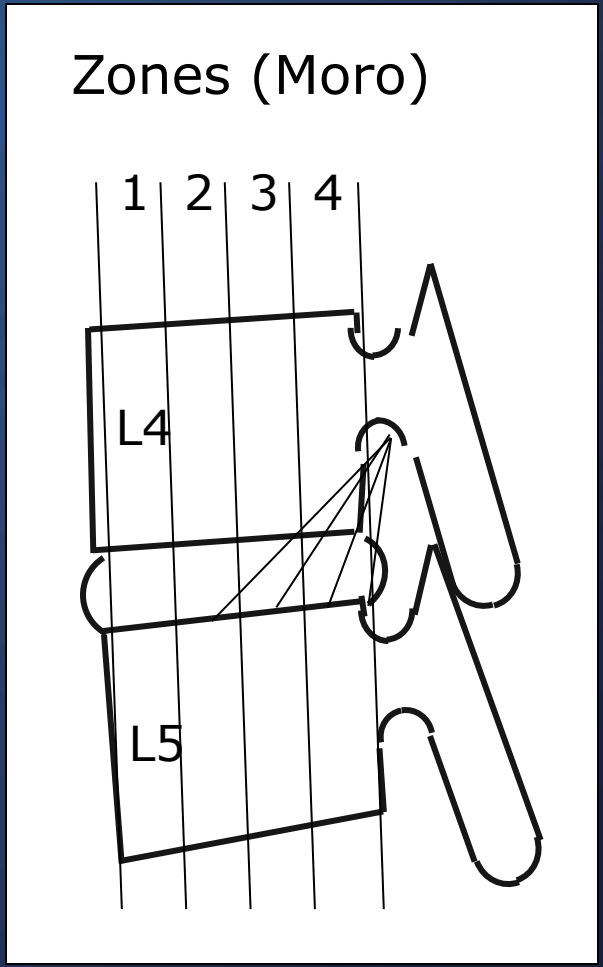
- 15% of femoral nerves contacting needle to variable degree
- Diameter ranged from 8-17 mm
- Average Diameter
- 13.1 mm – 14mm
- Obturator was noted to be just anterior to the femoral nerve
- L5 Transverse Process dorsal border



Cadaveric: Femoral Nerve Distribution

Distribution by Zone



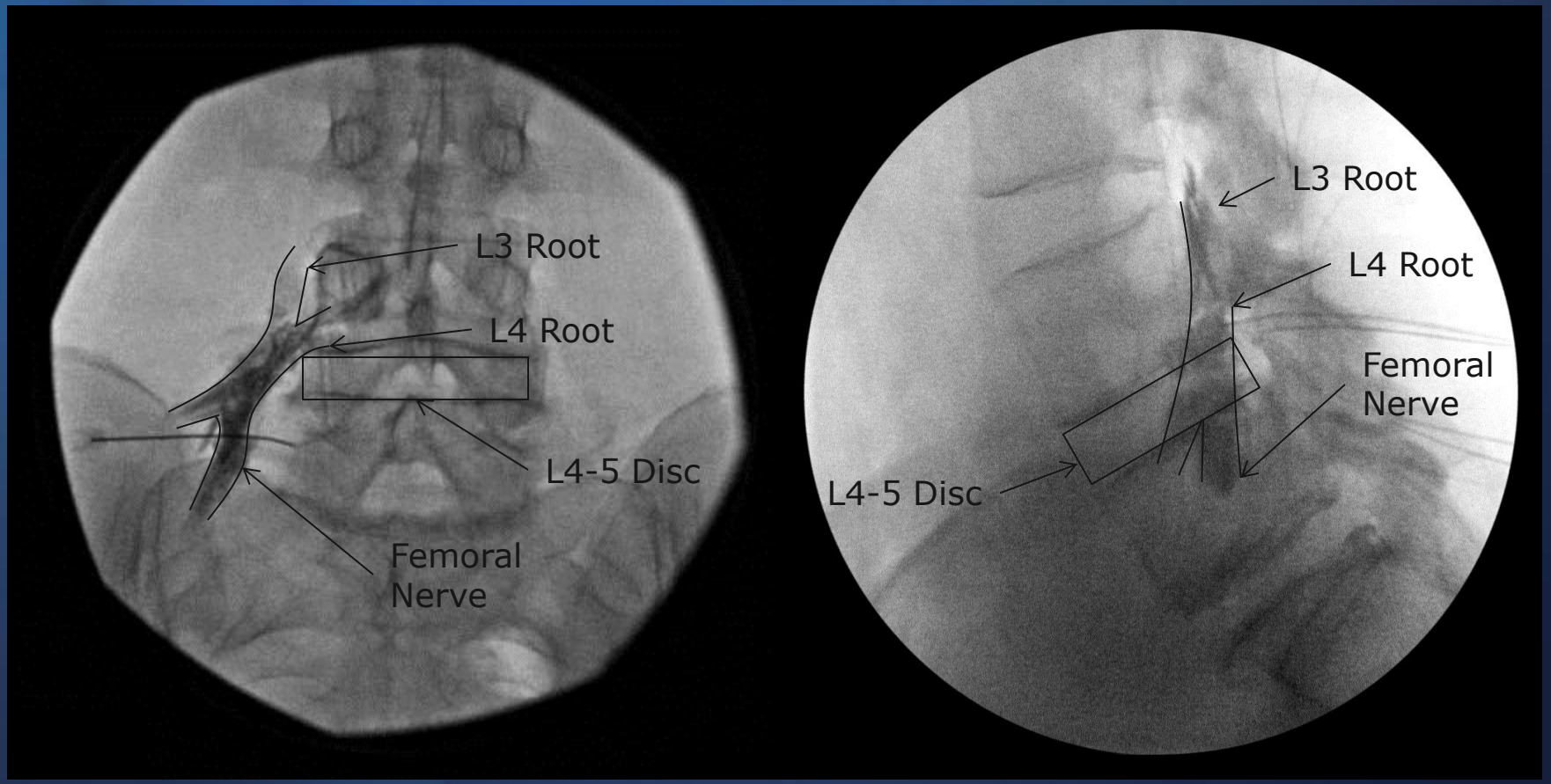


Medtronic

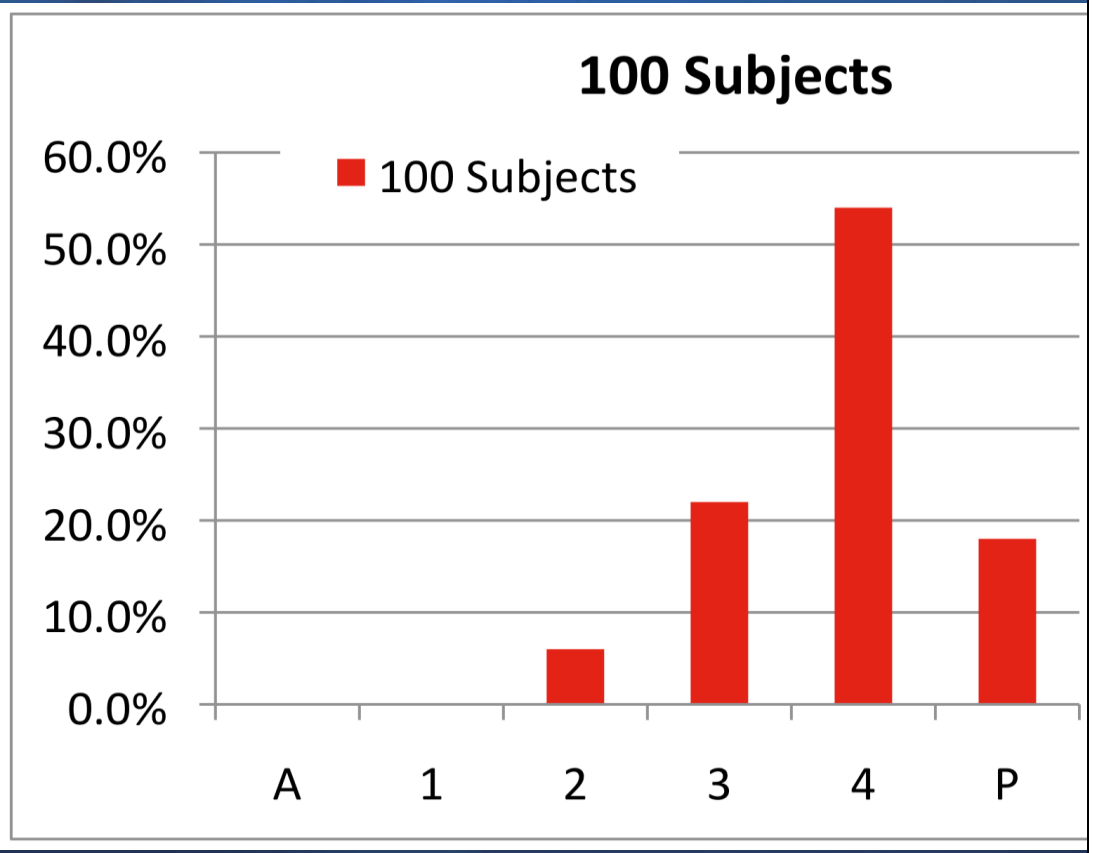
Davis et al. – Neurogram (1)

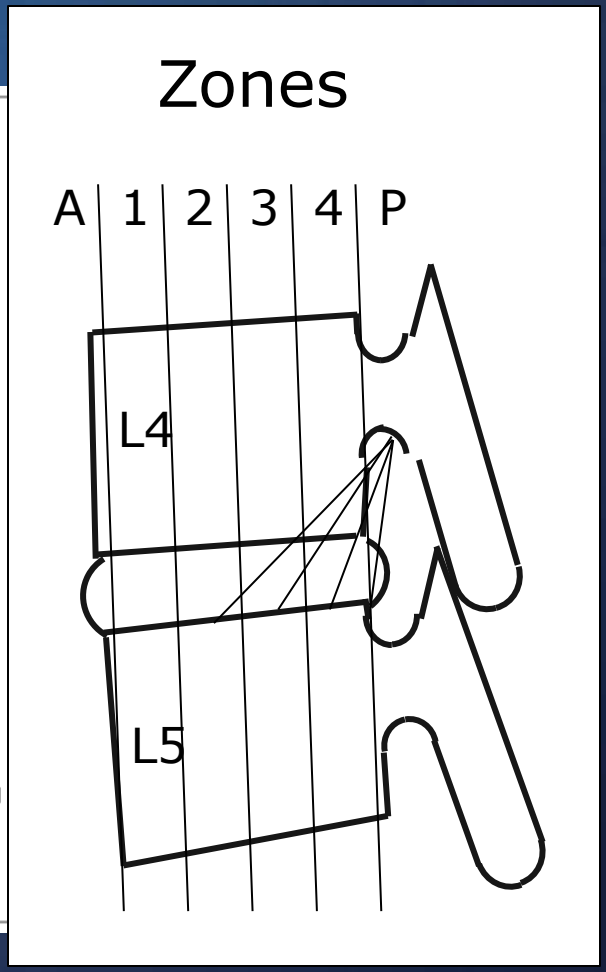
- L4-5 Transforaminal ESI are often attempted prior to surgical intervention
- Contrast
  - To avoid vascular or thecal injection
  - Outlines L4 root to verify proper placement
- Lateral flouroscopic image occasionally reveals contrast tracking caudal across the disc space

Zone 3 Neurogram(1)

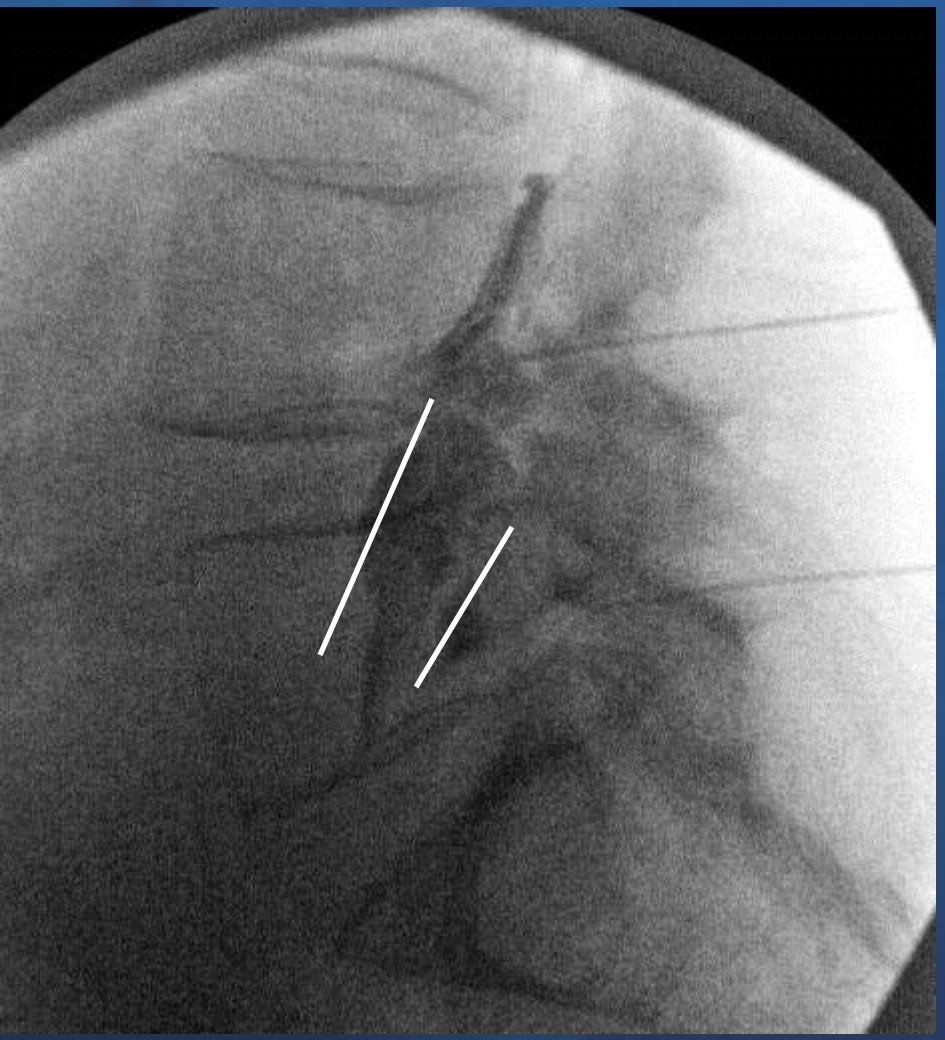


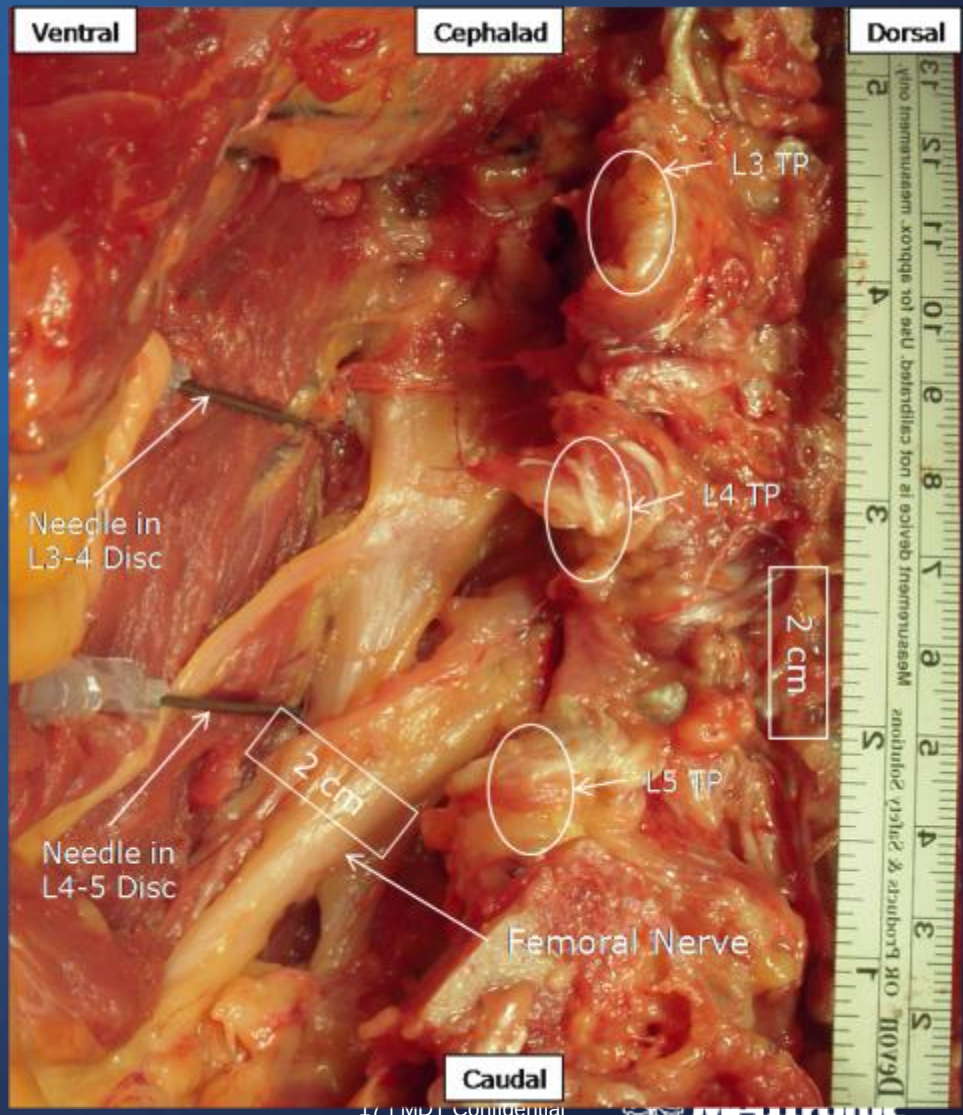
Neurogram: Femoral Nerve Distribution (1)



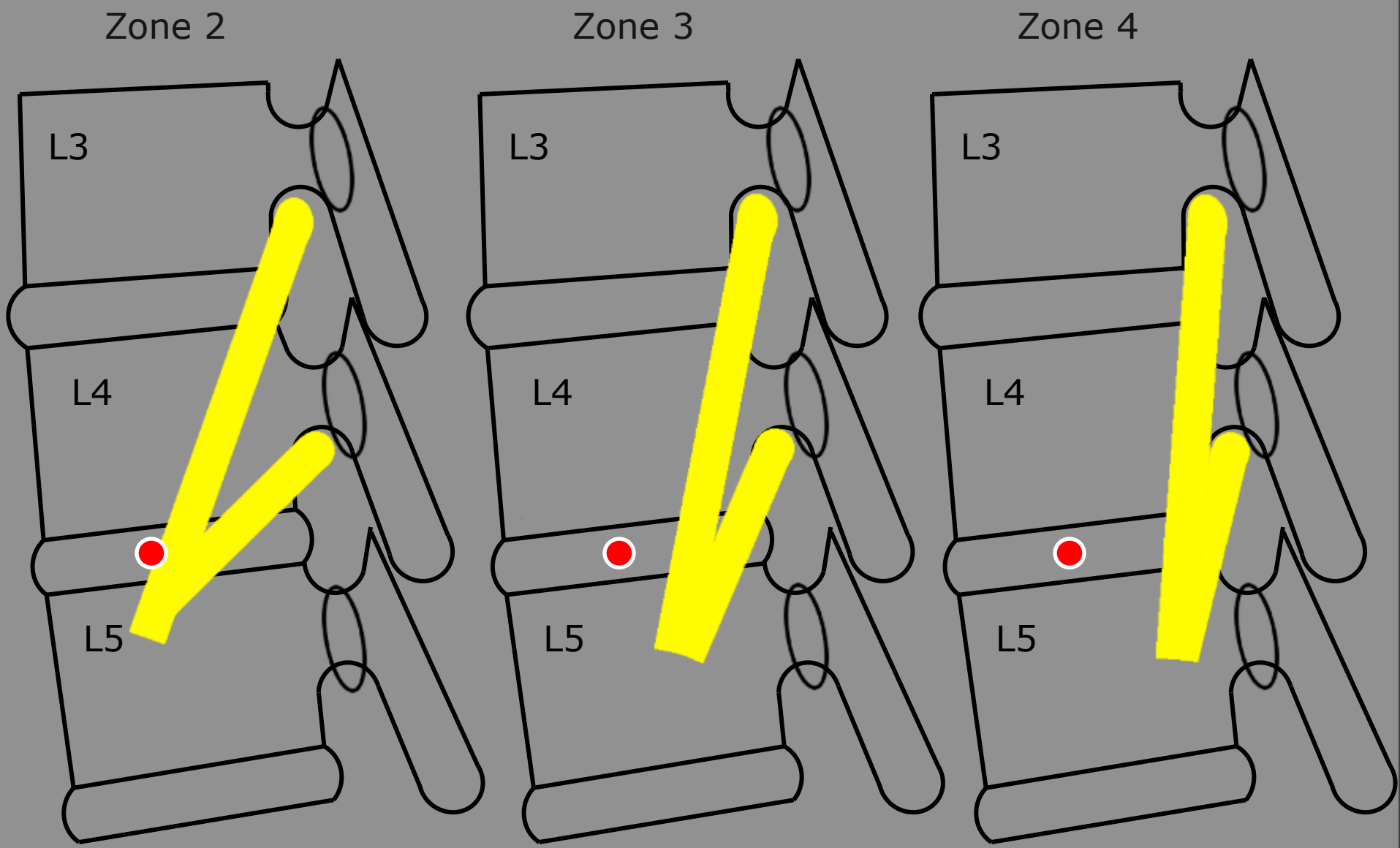


Neurogram and Gross Anatomy (1)



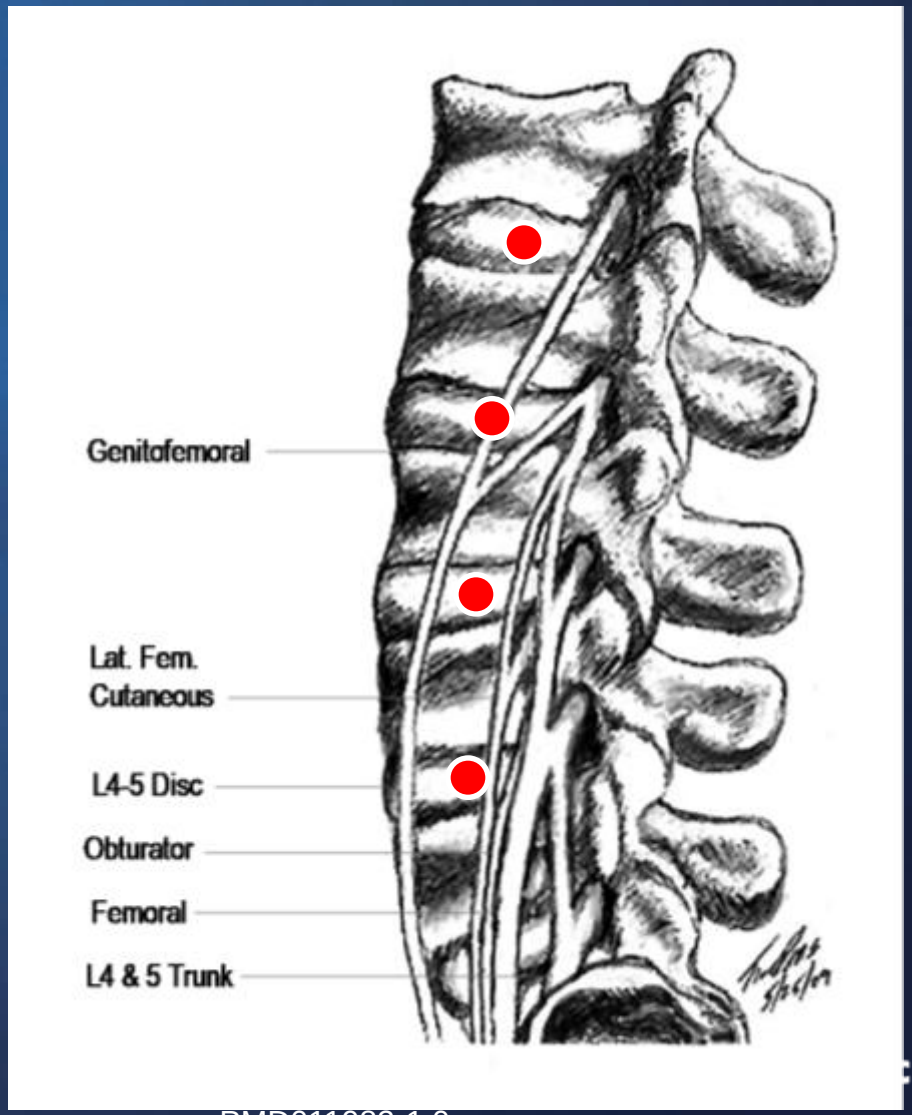


Femoral Nerve Angle Diagram

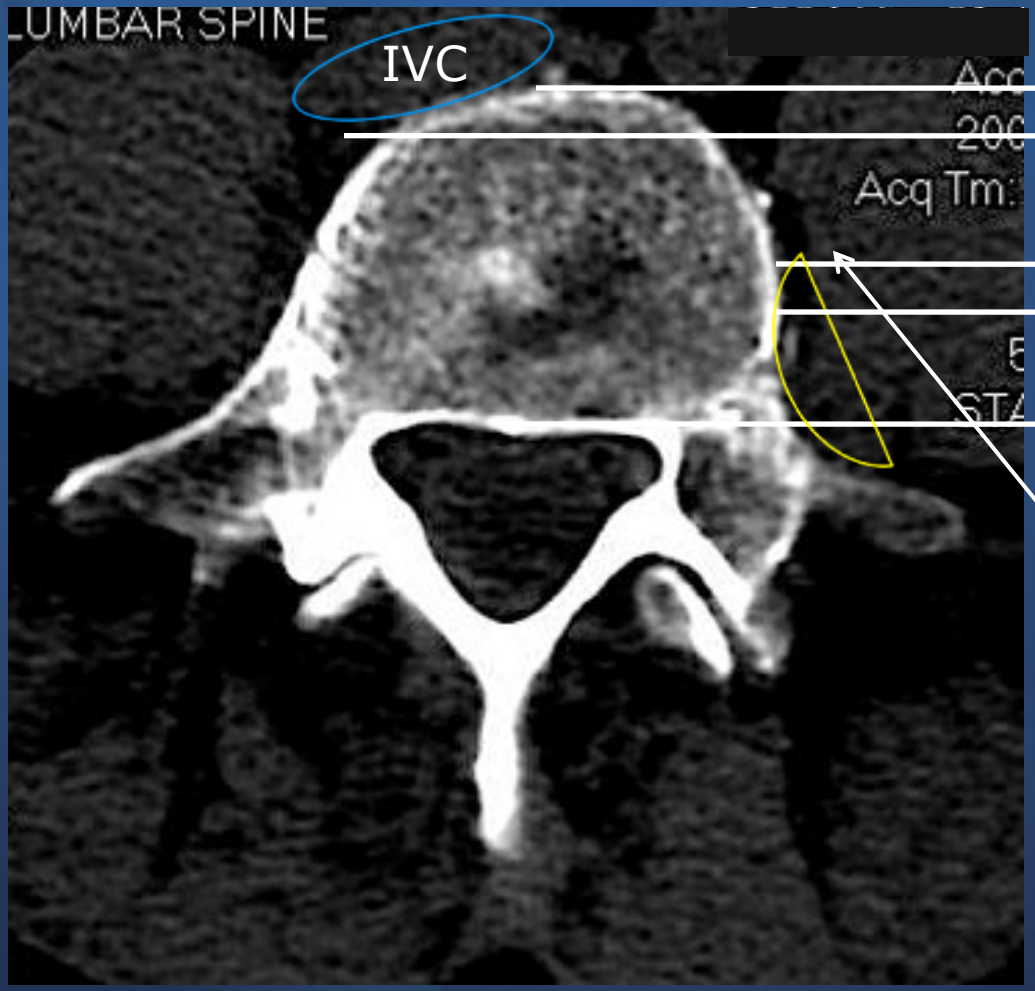


Neural Structure By Level

- L1-2
  - No Motor
- L2-3
  - Genitofemoral
  - Ilioinguinal
  - Iliohypogastric
  - L2 Root Dorsal
- L3-4
  - Genitofemoral Ant Psoas
  - L2-3 Trunk
  - LFC
- L4-5
  - Obturator, Femoral, LFC

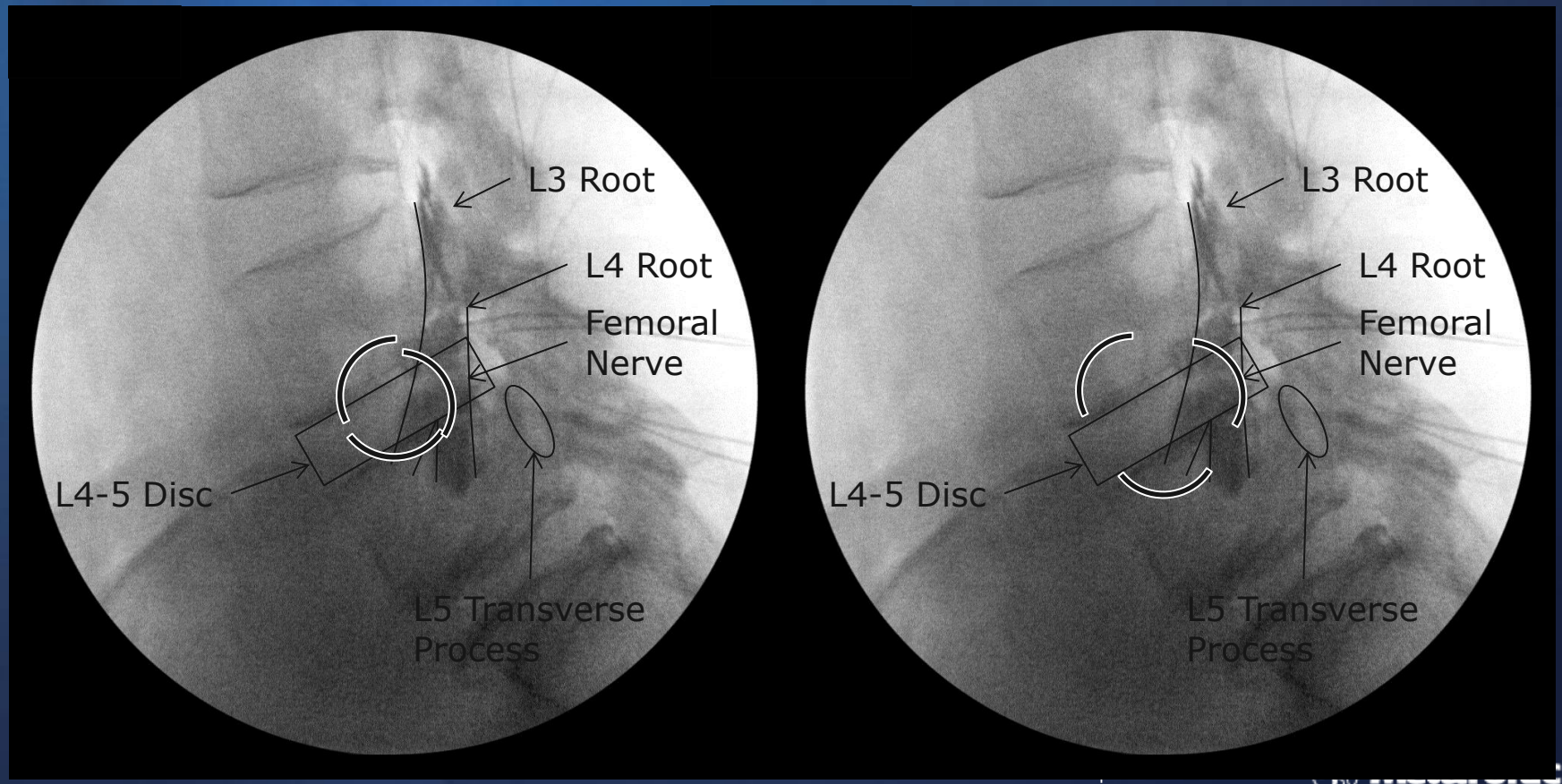


Safety Zone

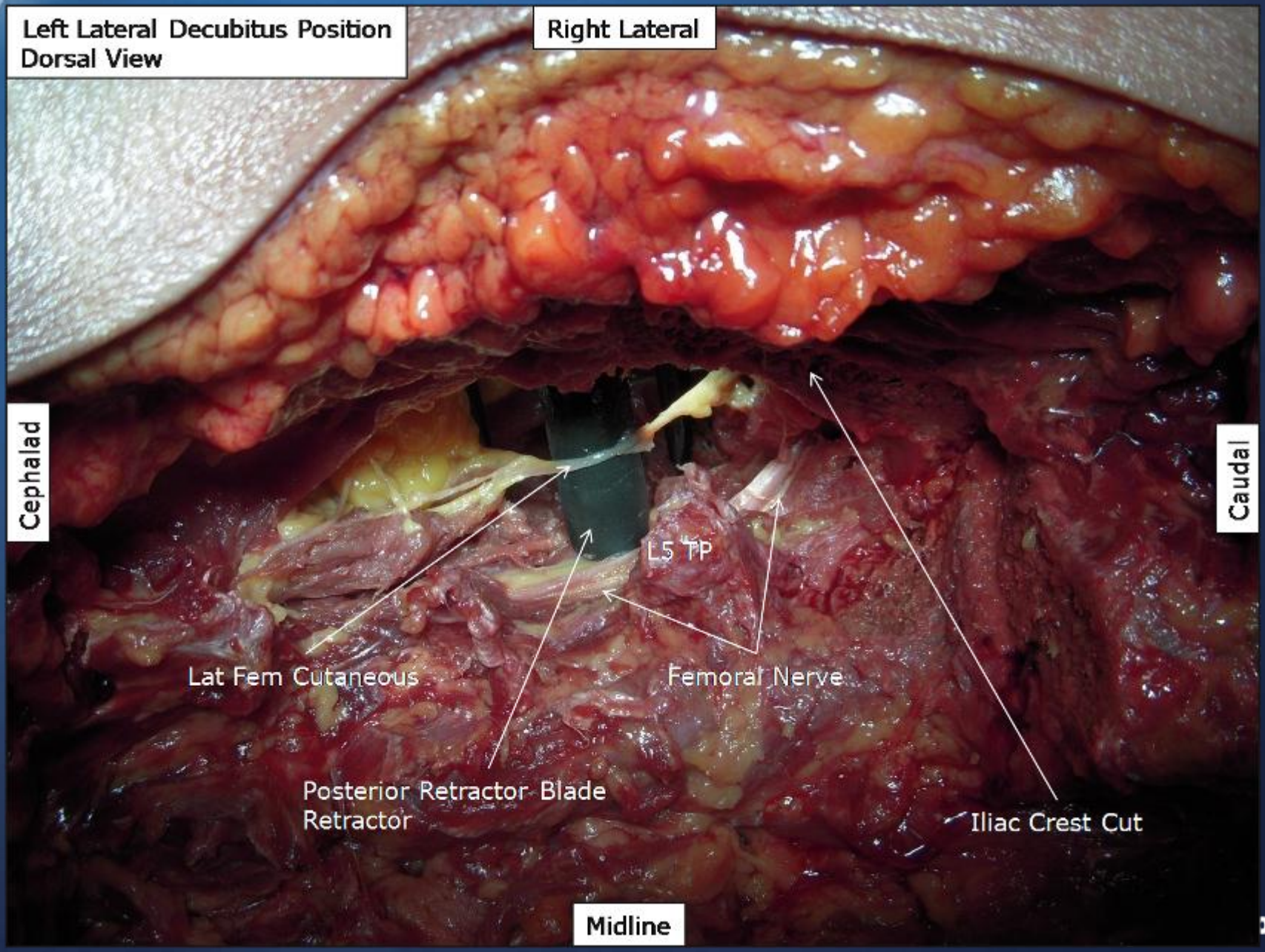


Neural Zone
Regev et al

Zone 3 Neurogram: 3 Blade Retractor (1)



Dissection with Lateral Retractor in Place



Sequence of Potential Neural Compomise

- Stretch – Jack-Knife
- Spear – During Disc Localization
- Severe – During incision into annulus
- Stretch - Displacement with Dilator
- Squeeze – Retractor Expansion against L5 TP
- Strangle – Vascular Compromise
  - When pressure upon a soft tissue structure exceeds that of MAP causes decrease vascular perfusion

Lateral Jack-Knife Vs. Lateral Decubitus Positioning Study

- 20 total subjects randomized to two groups
  - Right lateral Jack-knife position (RLJK)
    - 5 males
    - 5 females
    - Age range from 26 – 33
    - Average age 28.7
  - Right lateral decubitus position (RLD)
    - 6 males
    - 4 females
    - Age range from 25 - 34
    - Average age 28.7
- Bilateral hip flexion and knee extension strength was tested with the 10-repetition maximum test at baseline, immediately after one hour of positioning and after a one hour recovery period.
- Sensory testing was performed immediately after one hour of positioning and every 15 minutes up to an hour recovery period

As presented at the Napa Pain Conference, August 2013.

Lateral Jack-Knife Vs. Lateral Decubitus Positioning Study: Results

- **10-repetition maximum test results immediately after positioning**
  - 100% of subjects in the RLJK position were found to have knee extension and hip flexion weakness.
  - All subjects in the RLJK position were found to have 10% – 70% (Average of 30%) decrease in left knee extension strength.
  - 2 subjects in the RLJK position were found to have 10% decrease in right knee extension strength.
  - All subjects in the RLJK position were found to have 20% – 80% (Average of 43%) decrease in left hip flexion strength.
  - 2 subjects in the RLJK position were found to have 10% decrease in right hip flexion strength.
  - No subjects (0%) in the RLD position were found to have knee extension and hip flexion weakness.

				Post-positioning 10-repetition maximum 0'			
Subject #	Age	Gender	Position	Post RKE	Post-LKE	Post-RHF	Post-LHF
1	29	F	LD	10/10	10/10	10/10	10/10
2	33	M	JK	10/10	8/10	10/10	8/10
3	27	M	JK	10/10	3/10	10/10	5/10
4	27	F	JK	10/10	7/10	10/10	5/10
5	28	F	LD	10/10	10/10	10/10	10/10
6	28	M	JK	10/10	6/10	10/10	6/10
7	26	M	JK	10/10	9/10	9/10	2/10
8	31	M	LD	10/10	10/10	10/10	10/10
9	30	F	LD	10/10	10/10	10/10	10/10
10	25	M	LD	10/10	10/10	10/10	10/10
11	29	F	JK	9/10	5/10	9/10	7/10
12	27	M	LD	10/10	10/10	10/10	10/10
13	30	F	JK	9/10	8/10	10/10	5/10
14	27	M	JK	10/10	9/10	10/10	7/10
15	30	M	LD	10/10	10/10	10/10	10/10
16	26	M	LD	10/10	10/10	10/10	10/10
17	27	M	LD	10/10	10/10	10/10	10/10
18	28	F	JK	10/10	9/10	10/10	7/10
19	32	F	JK	10/10	6/10	10/10	5/10
20	34	F	LD	10/10	10/10	10/10	10/10

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Lateral Jack-Knife Vs. Lateral Decubitus Positioning Study: Results

- Pinprick
  - L1 and L2 were the most affected dermatomes.
  - 100% of subjects had abnormal pinprick sensation in the L1 dermatome.
    - Up to 70% still had deficits after one hour of recovery time.
  - 90% of subjects had abnormal pinprick sensation in the L2 dermatome.
    - Up to 70% still had deficits after one hour of recovery time.
- Light touch
  - Similar results to pinprick testing found

PINPRICK LEFT LOWER EXTREMITY RLJK GROUP				
DERMATOMES	TIME	ASIA 0	ASIA 1	ASIA 2
L1	0′	30%	70%	0
	15′	30%	70%	0
	30′	10%	80%	10%
	45′	0	80%	20%
	60′	0	70%	30%
L2	0′	30%	60%	10%
	15′	20%	60%	20%
	30′	10%	70%	20%
	45′	10%	50%	40%
	60′	0	50%	50%
L3	0′	0	20%	80%
	15′	0	20%	80%
	30′	0	20%	80%
	45′	0	20%	80%
	60′	0	20%	80%
L4	0′	0	0	100%
	15′	0	0	100%
	30′	0	0	100%
	45′	0	0	100%
	60′	0	0	100%

LIGHT TOUCH LEFT LOWER EXTREMITY RLJK GROUP				
DERMATOMES	TIME	ASIA 0	ASIA 1	ASIA 2
L1	0′	10%	70%	20%
	15′	0	80%	20%
	30′	0	70%	30%
	45′	0	50%	50%
	60′	0	20%	80%
L2	0′	30%	40%	30%
	15′	10%	60%	40%
	30′	10%	50%	40%
	45′	10%	40%	50%
	60′	0	20%	80%
L3	0′	0	50%	50%
	15′	0	40%	60%
	30′	0	40%	60%
	45′	0	20%	80%
	60′	0	20%	80%
L4	0′	0	20%	80%
	15′	0	10%	90%
	30′	0	0	100%
	45′	0	0	100%
	60′	0	0	100%

As presented at the Napa Pain Conference, August 2013.

Conclusion

- Jack-Knife likely starts the traction model
  - Time dependent
  - Saturday night palsy
- Disc Localization
  - L4-5 Highest Density of Neural Structures
- “Safety zone” is only relevant for entry point to disc space
- Retractor Placement
  - L4-5 will cause displacement posterior
  - L5 TP – Can be a site of compression
- Neural injury most commonly will be indirect
  - Stretch and compression
  - Likely causing some degree of anoxia

As presented at the Napa Pain Conference, August 2013.

References

- (1)Davis et al. Femoral Neurogram assessing the Anatomic Course pior to Transpsoas Spinal Access to the L4-5 Disc. Presented at AANS Annuyal Meeting, May 1, 2011[abstract].
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- (5)Interfascial Technique for Vertebral Artery exposure in the Suboccipital Triangle: The Road Map; Neurosurgery. 2010 Dec; 67(2 Suppl Operative): 355-61; Youssef AS, Uribe JS, Ramos E, Janjua R, Thomas LB, Van Loveren H.

- References › 10 years represent historical disease state information on Kyphosis of the lubmar spine; MDT comment September, 2013