


Duke Anesthesiology

Update on Epidural Safe Use Guidelines

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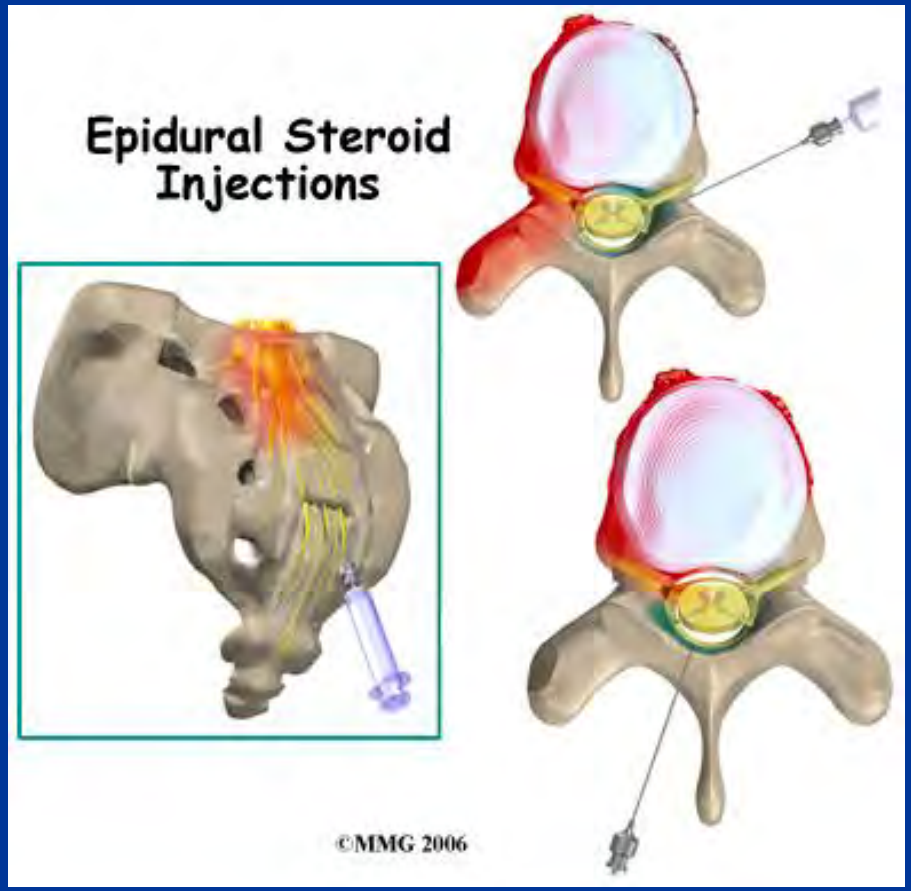
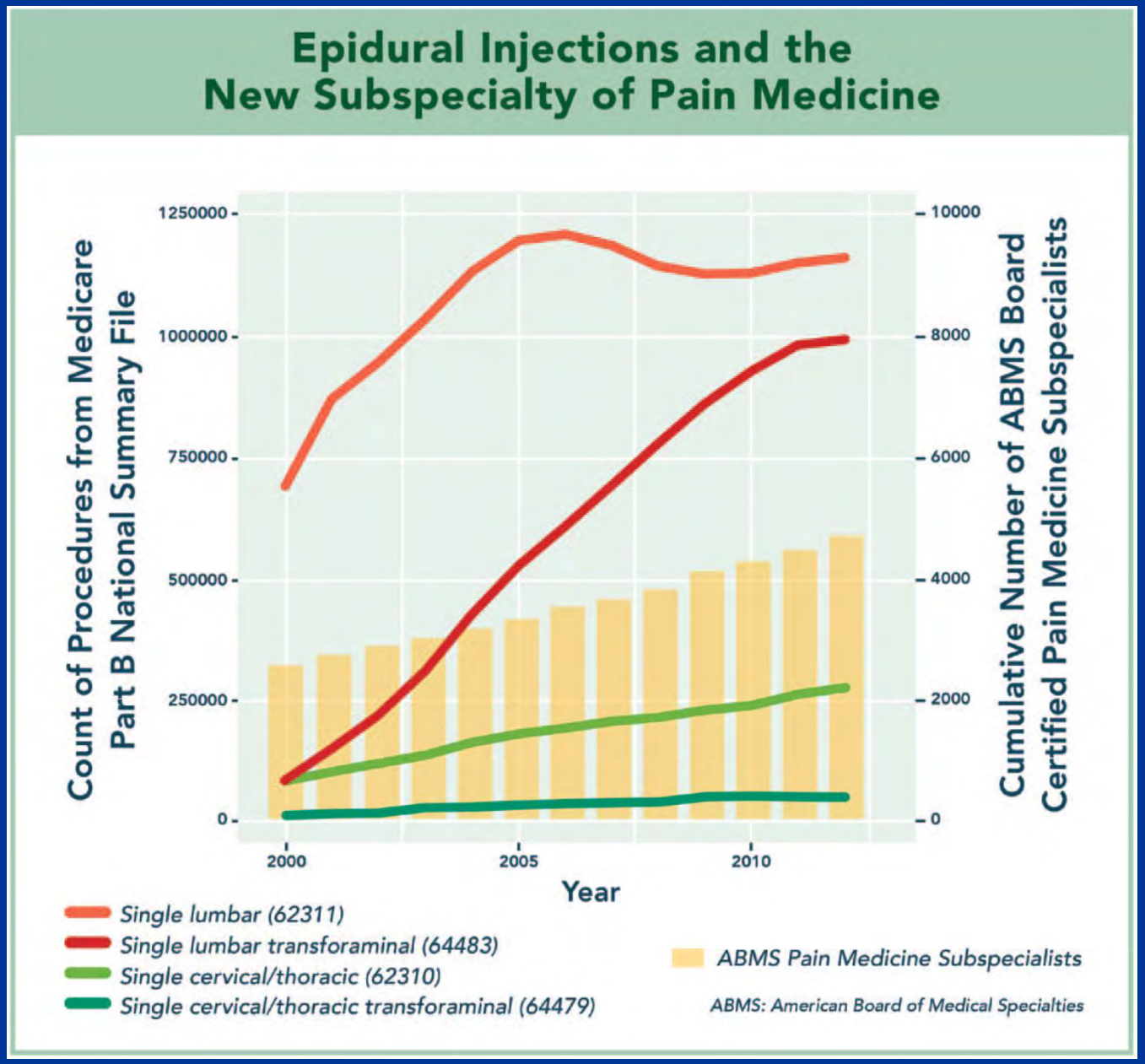
Disclosures

- None





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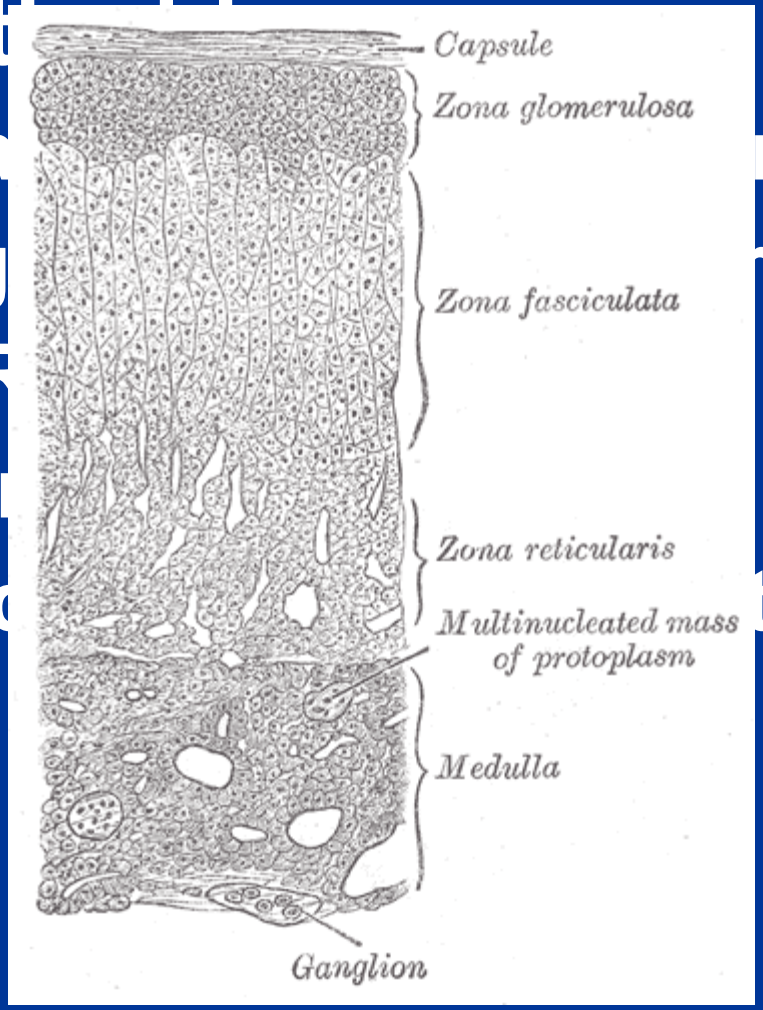
Steroid Effects

- Glucocort
  - Upregula ry proteins
  - Downreg ry proteins
  - Binds GR
  - Inhibits i
  - Produce ta



Steroid Names

- Kenalog
  - Triamcinolone
- Depomedrol
  - Methylprednisolone
- Celestone
  - Betamethasone
- Decadron
  - Dexamethasone

Steroid Comparison

Table 1. *Profile of commonly used epidural steroids*

Drug	Equivalent Dose	Epidural Dose	Anti-inflammatory Potency	Sodium Retention Capacity	Duration of Adrenal Suppression		
					IM	Single Epidural	Three Epidurals
Hydrocortisone	20 mg	N/A	1	1	N/A	N/A	N/A
Depo-Methyl Prednisolone (Depo-Medrol)	4 mg	40-80 mg	5	0.5	1-6 weeks	1-3 weeks	N/A
Triamcinolone diacetate (Aristocort)	4 mg	25-50 mg	5	0	1-2 weeks	1-5 weeks	N/A
Triamcinolone acetonide (Kenalog)	4 mg	40-80 mg	5	0	2-6 weeks	N/A	2-3 months
Betamethasone (Celestone Soluspan)	0.6 mg	6-12 mg	25	0	1-2 weeks	N/A	N/A

N/A = Not applicable Data adapted and modified from McEvoy et al (70), Jacobs et al (71), Kay et al (72), Hsu et al (74), Mikhail et al (75, 76), and Schimmer and Parker (77).

tion in inflamed areas; reducing leukocyte adhesion to the capillary endothelium; reducing capillary wall permeability and edema formation; decreasing complement components; antagonizing histamine activity, and release of kinin from substrates; reducing fibroblast proliferation, col-

types of neural blockade mentions very few complications that can be directly attributed either to the chemistry or the pharmacology of the steroids (9). Numerous formulations of injectable preparations are available in the United States and other countries. The most commonly used agents for

Steroid Side Effects

- Adrenal suppression
- Weight gain
- Osteoporosis
- Hyperglycemia (glucocorticoid)
- CHF/fluid retention
- Nerve toxicity (intrathecal)
  - Very controversial related to vehicle
  - Possibly due to concomitant LA dosing

Adrenal Suppression

Table 4. *Characteristics of adrenal insufficiency*

Type	Etiologies	Features
Tertiary Most common form	Usually from iatrogenic corticosteroid therapy and suppression of the hypothalamic-pituitary-adrenal axis	Hypothalamic/pituitary suppression or absence
Secondary Uncommon	Decreased or absent ACTH (may be panhypopituitary or anterior pituitary dysfunction)	ACTH dependent
	Pituitary depression, dysfunction/damage	Signs and symptoms usually due to loss of glucocorticoid function
	Tumor, postpartum	Usually have intact mineralocorticoid function
		Renal hypovolemic, more commonly hypoglycemic
Primary Rare	Autoimmune (70% -90% of cases in United States), frequently associated with a polyglandular deficiency syndrome Prevalence: 40-110 cases/million	ACTH independent Adrenal gland dysfunction, destruction, or replacement; requires >90% loss of adrenal tissue Loss of mineralocorticoid and glucocorticoid production
	Infection HIV is the most common infectious cause in the United States. AI develops in 30% of patients with advanced AIDS. Tuberculosis is the most common infectious cause worldwide	Increased ACTH production
	Inflammation	May be hyperpigmented
	Cancer (breast, lung, melanoma most common)	Requires lifetime therapy
	Acute addisonian crisis Incidence: 6 cases/million per year	

Data adapted and modified from Coursin and Wood (1) AI=adrenal insufficiency

ESI Effectiveness

Type of Pain	Method of Injection	Level of Evidence for Short-Term Pain Relief	Level of Evidence for Long-Term Pain Relief
Cervical radiculopathy	Interlaminar	Moderate	Moderate
Cervical nerve root	Transforaminal	Moderate	Moderate
Lumbar nerve root	Transforaminal	Strong	Strong
Lumbar radicular	Lumbar interlaminar	Strong	Limited
Lumbar radicular	Lumbar transforaminal	Strong	Moderate
Lumbar radicular pain post lumbar laminectomy		Moderate	Moderate
Lumbar spinal stenosis	Transforaminal	Limited	Limited
Lumbar radiculopathy	Caudal epidural	Strong	Moderate
Post-lumbar laminectomy syndrome	Caudal epidural	Strong	Moderate

Abdi S, Datta S, Trescot AM *et al.* Epidural steroids in the management of chronic spinal pain: a systematic review. *Pain.Physician.* 2007; **10:** 185-212.

FDA Safe Use Initiative

- Launched November 4, 2009
- Preliminary recommendations for epidural steroid injections presented at ANESTHESIOLOGY™ annual meeting October 12, 2013
- Collaboration with multi-society pain working group
- Final recommendations February 9th 2015

FDA Safe Use Initiative

- Increased chance of neurologic injury when particulate steroids are used for transforaminal injections.
- Increased chance of neurologic injury with transforaminal epidural approach compared to the interlaminar approach.
- Use of image-guidance is mandatory when performing transforaminal injections.

http://www.asahq.org/For-the-Public-and-Media/Press-Room/ASA-News/Safe-Use-Initiative-Epidural-Injections.aspx

FDA Drug Safety Communication: FDA requires label changes to warn of rare but serious neurologic problems after epidural corticosteroid injections for pain

A class of drugs commonly used to reduce swelling or inflammation

Injectable corticosteroids include methylprednisolone, hydrocortisone, triamcinolone, betamethasone, and dexamethasone

into the epidural space of the spine may result in rare but serious adverse events, including loss of vision, stroke, paralysis, and death. The injections are given to treat neck and back pain, and radiating pain in the arms and legs. We are requiring the addition of a *Warning* to the drug labels of injectable corticosteroids to describe these risks. Patients should discuss the benefits and risks of epidural corticosteroid injections with their health care professionals, along with the benefits and risks associated with other possible treatments.

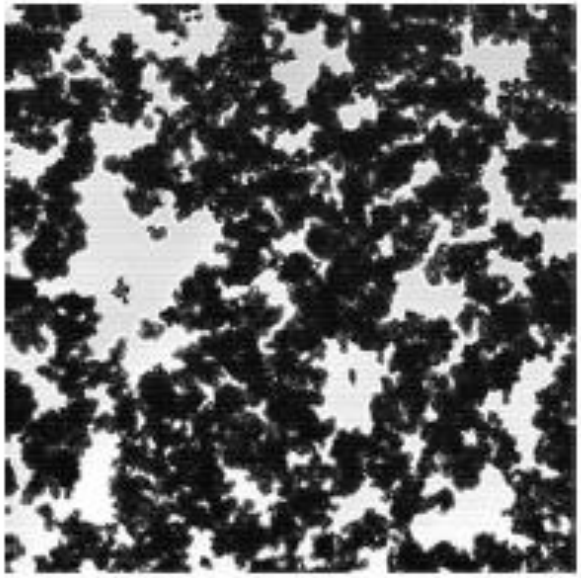
Particulation

- Can result in spinal cord infarct
- Dexamethasone non-particulate
- Betamethasone, methylprednisolone, and triamcinolone all particulate
- Variations in clumping

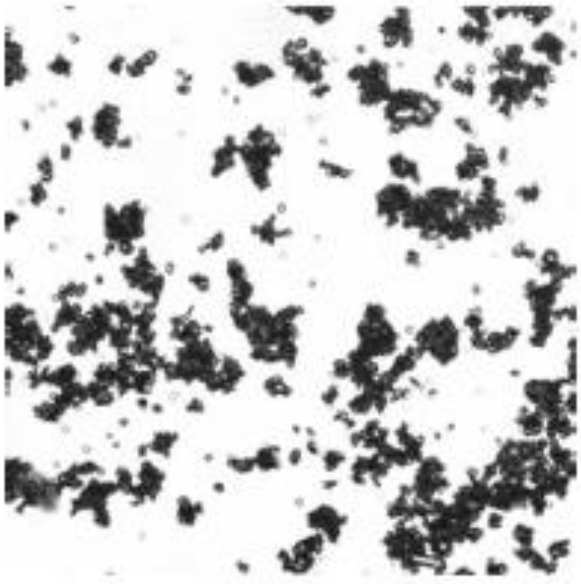
Particulation

Table 1. Particle Size Distribution of the Undiluted and Diluted Steroids

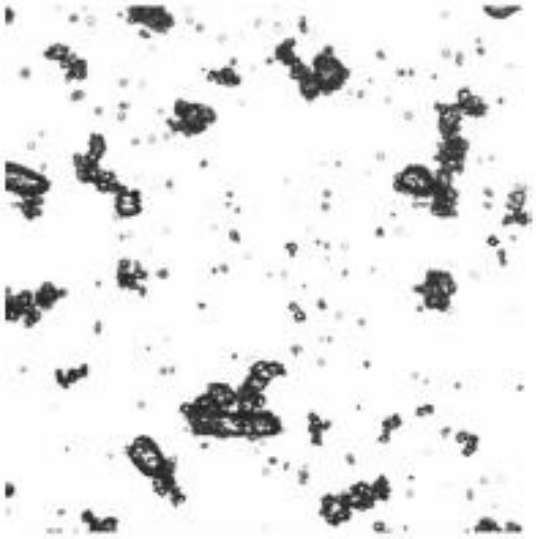
Preparation	Dilution	Diluent	No. of particles	Particle Distribution				*P* Value
				0–20 μm	21–50 μm	51–1,000 μm	>1000 μm	
Methylprednisolone acetate 80 mg/ml (MPA 80)	Undiluted		66	63	14	17	6	*
	1:1	Saline	164	73	11	12	4	0.03
	1:2	Saline	142	58	8	26	8	
	1:3	Saline	174	52	9	32	7	
	1:1	Lidocaine 1%	214	52	17	24	7	0.17
	1:2	Lidocaine 1%	226	63	11	22	4	
	1:3	Lidocaine 1%	224	55	15	28	2	
Methylprednisolone acetate 40 mg/ml (MPA 40)	Undiluted		298	64	8	27	1	*
	1:1	Saline	492	63	9	25	3	0.37
	1:2	Saline	415	67	15	16	2	
	1:3	Saline	281	67	15	17	1	
	1:1	Lidocaine 1%	311	51	20	28	1	0.28
	1:2	Lidocaine 1%	278	62	18	18	2	
	1:3	Lidocaine 1%	281	55	20	24	1	
Triamcinolone acetonide 40 mg/ml (TRA 40)	Undiluted		476	79	9	11	1	*
	1:1	Saline	324	66	10	23	1	0.15
	1:2	Saline	340	72	10	17	1	
	1:3	Saline	241	58	18	23	1	
	1:1	Lidocaine 1%	585	64	14	21	1	0.29
	1:2	Lidocaine 1%	580	63	14	23	0	
	1:3	Lidocaine 1%	376	68	15	17	0	
CLTN Betamethasone sodium phosphate/betamethasone acetate 6 mg/ml (Celestone Soluspan®)	Undiluted		1968	92	6	2	0	*
	1:1	Saline	519	93	5	2	0	0.29
	1:2	Saline	560	95	4	1	0	
	1:3	Saline	257	85	12	3	0	
	1:1	Lidocaine 1%	405	93	6	1	0	0.27
	1:2	Lidocaine 1%	588	91	8	1	0	
	1:3	Lidocaine 1%	270	83	15	2	0	
Betamethasone sodium phosphate/ betamethasone acetate 6 mg/ml (BTM Rep)	Undiluted		844	68	10	21	1	*
	1:1	Saline	517	82	8	10	0	0.12
	1:2	Saline	699	86	6	8	0	
	1:3	Saline	325	79	9	12	0	
	1:1	Lidocaine 1%	185	51	16	32	1	0.005
	1:2	Lidocaine 1%	108	51	20	29	0	
	1:3	Lidocaine 1%	217	76	11	13	0	



Methylprednisolone 80 mg/mL

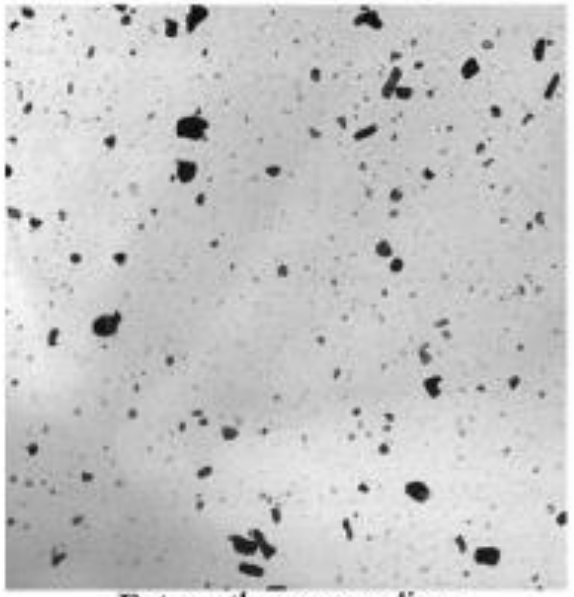


Methylprednisolone 40 mg/mL

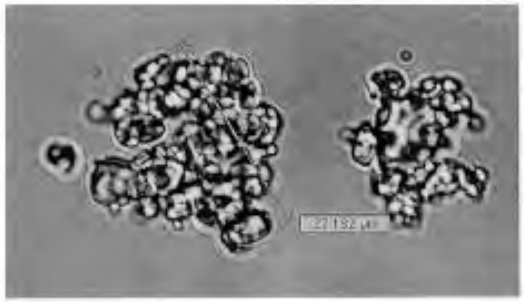


Triamcinolone 40 mg/mL

Betamethasone sodium phosphate/betamethasone acetate (Celestone Soluspan®)

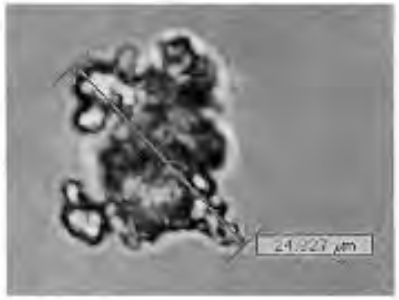


Betamethasone sodium



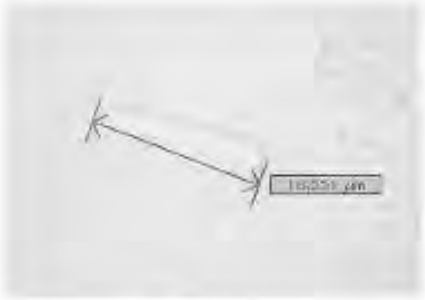
MPA

BSP-BA



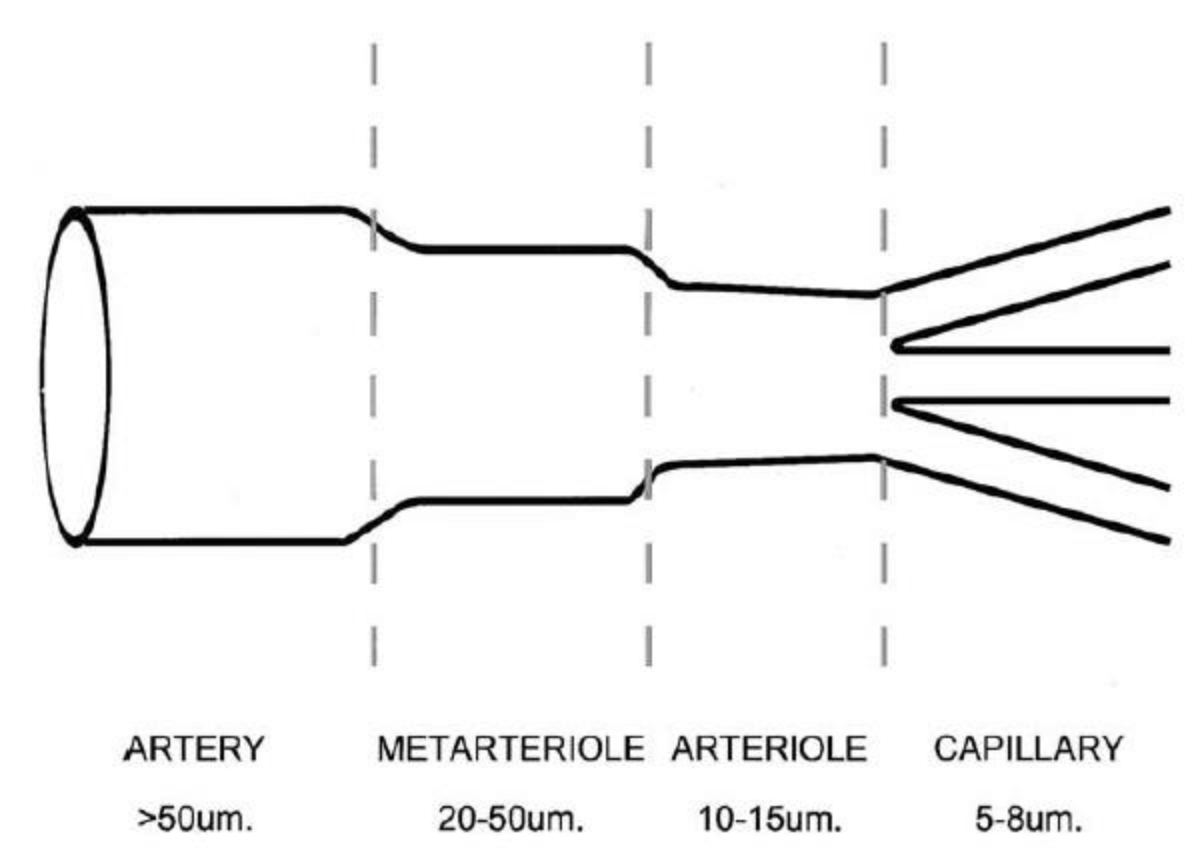
TA

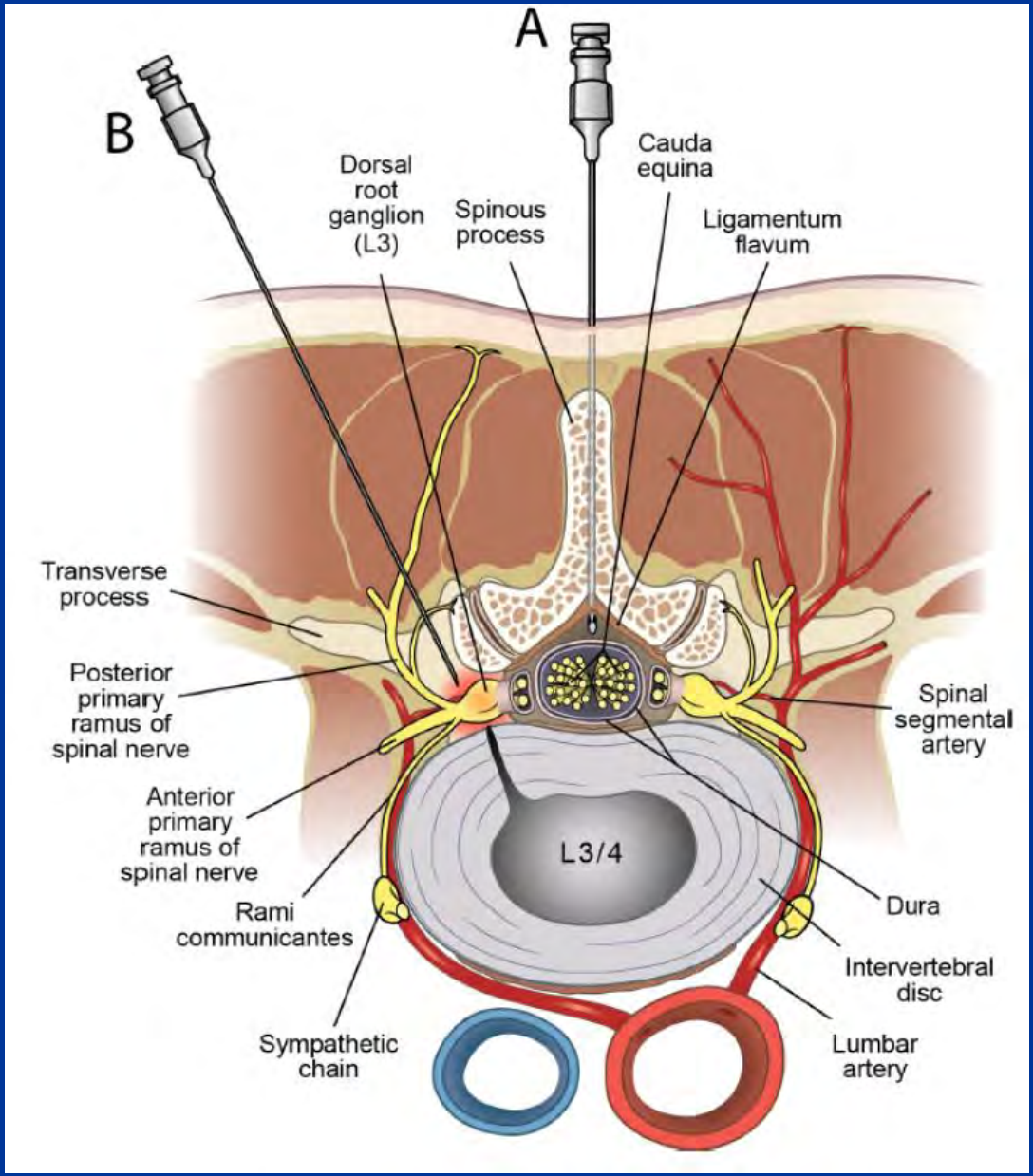
BSP

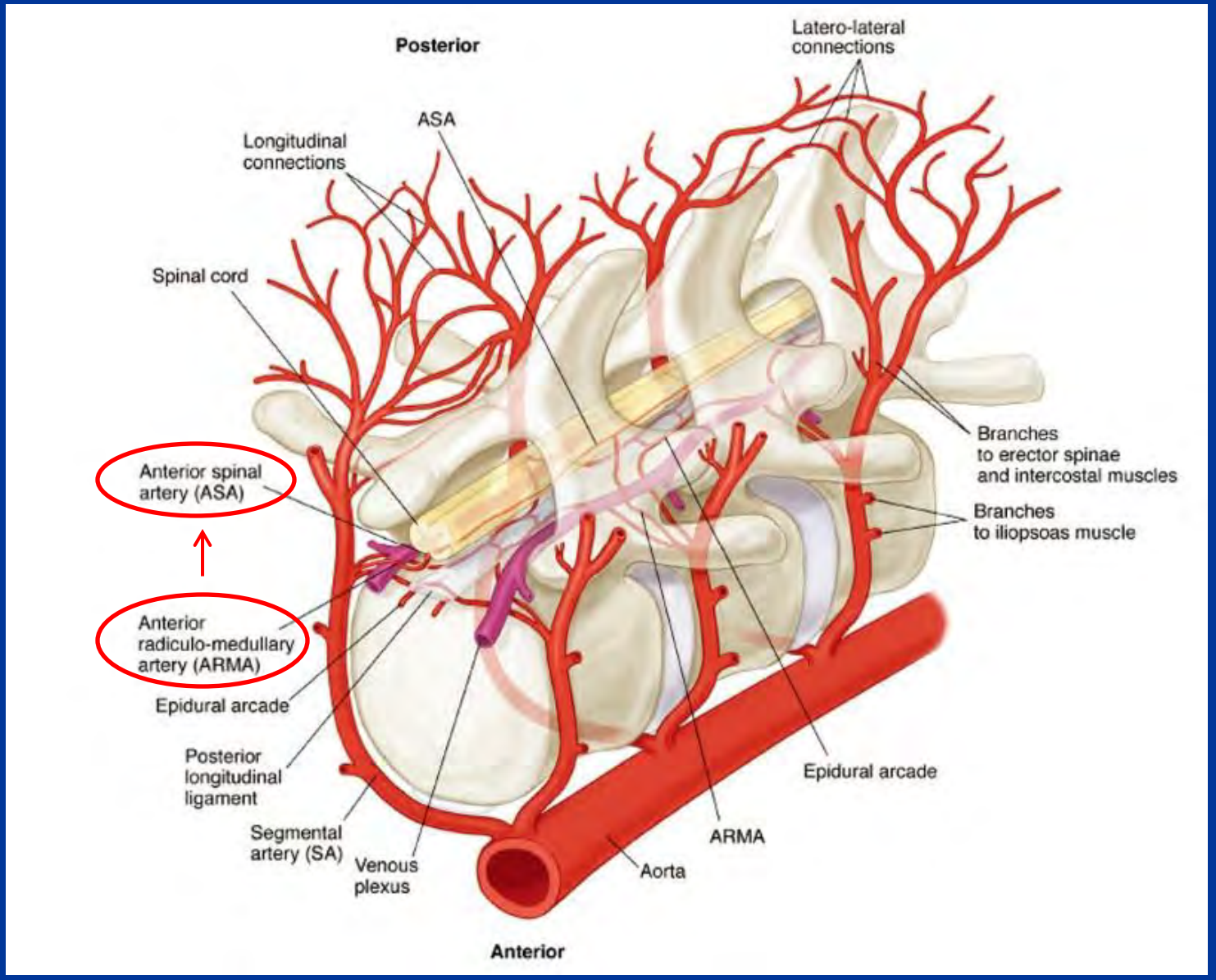


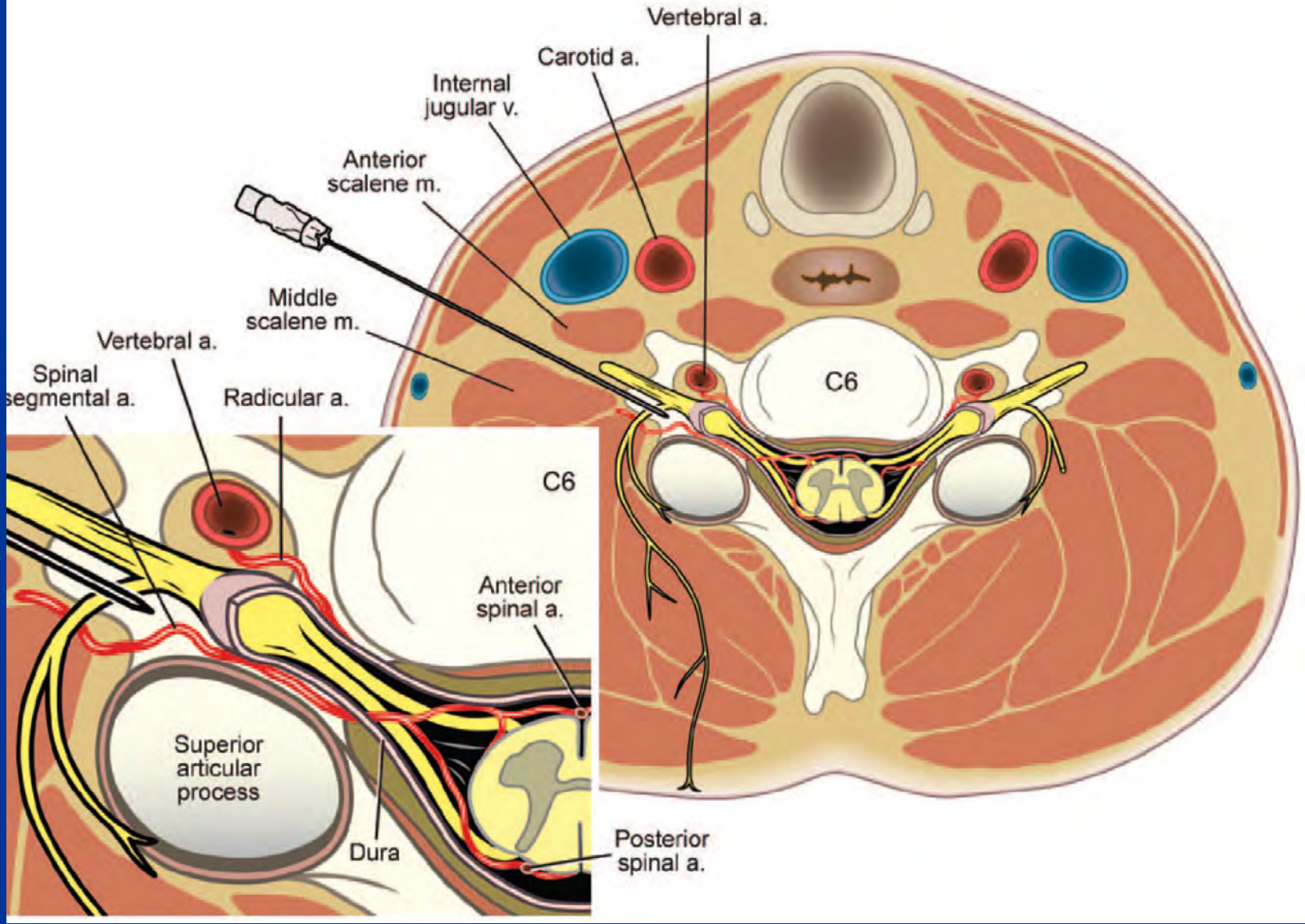
DSP

Embolization Anatomy




A
B
Dorsal root ganglion (L3)
Spinous process
Cauda equina
Ligamentum flavum
Transverse process
Posterior primary ramus of spinal nerve
Spinal segmental artery
Anterior primary ramus of spinal nerve
L3/4
Dura
Rami communicantes
Intervertebral disc
Sympathetic chain
Lumbar artery


Posterior
Latero-lateral connections
ASA
Longitudinal connections
Spinal cord
Anterior spinal artery (ASA)
Branches to erector spinae and intercostal muscles
Branches to iliopsoas muscle
Anterior radiculo-medullary artery (ARMA)
Epidural arcade
Posterior longitudinal ligament
Segmental artery (SA)
Venous plexus
Aorta
ARMA
Epidural arcade
Anterior


Vertebral a.
Carotid a.
Internal jugular v.
Anterior scalene m.
Middle scalene m.
Vertebral a.
Spinal segmental a.
Radicular a.
C6
C6
Anterior spinal a.
Superior articular process
Dura
Posterior spinal a.

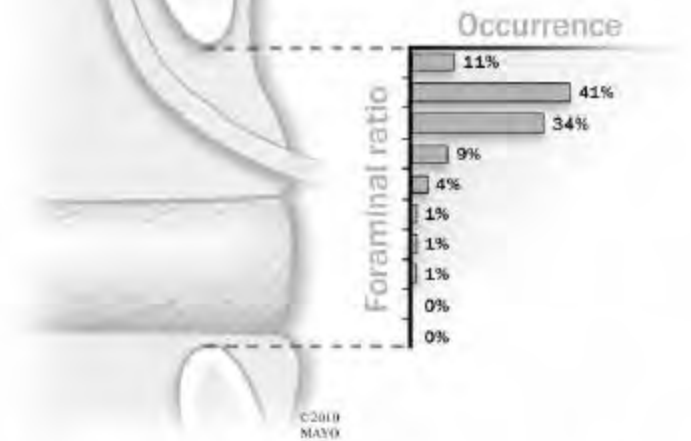


Figure 4 Distribution of the intraforaminal locations of the remaining 113 radiculomedullary arteries, as determined at the mid-pedicular plane, is graphically depicted using the foraminal ratio, in 0.10 increments. The artery of Adamkiewicz was located in the upper one-half of the foramen 97% of the time (110/113) and was never seen in the most inferior one-fifth of the foramen.

Murthy NS[1], Maus TP, Behrns CL. Intraforaminal location of the great anterior radiculomedullary artery (artery of Adamkiewicz): a retrospective review. Pain Med. 2010 Dec;11(12):1756-64. doi: 10.1111/j.1526-4637.2010.00948.x. Epub 2010 Sep 7.

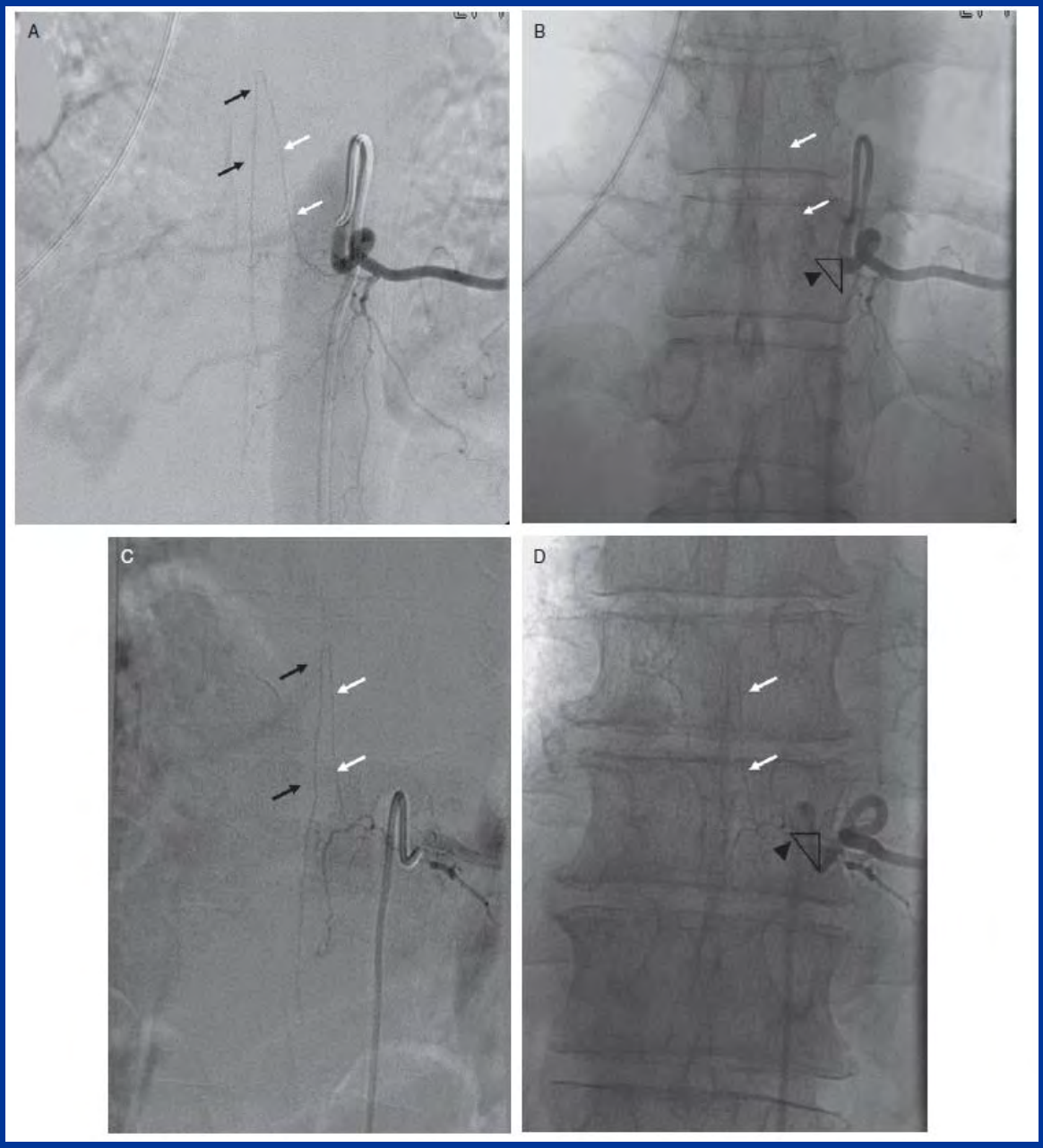
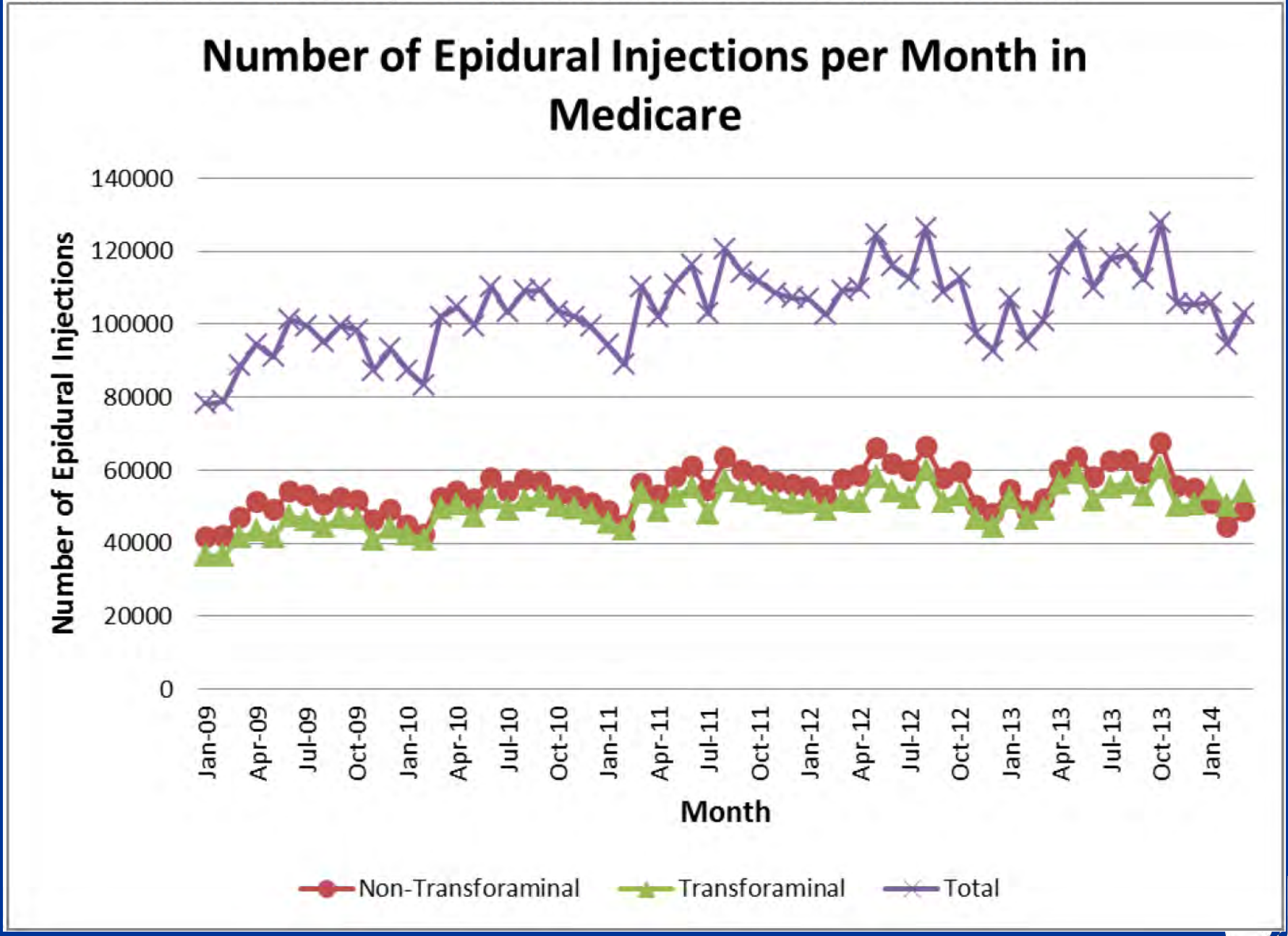

A
B
C
D

Figure 5. Number of Epidural Injections per Month in Medicare January 2009-March 2014



Particulate vs Non-particulate

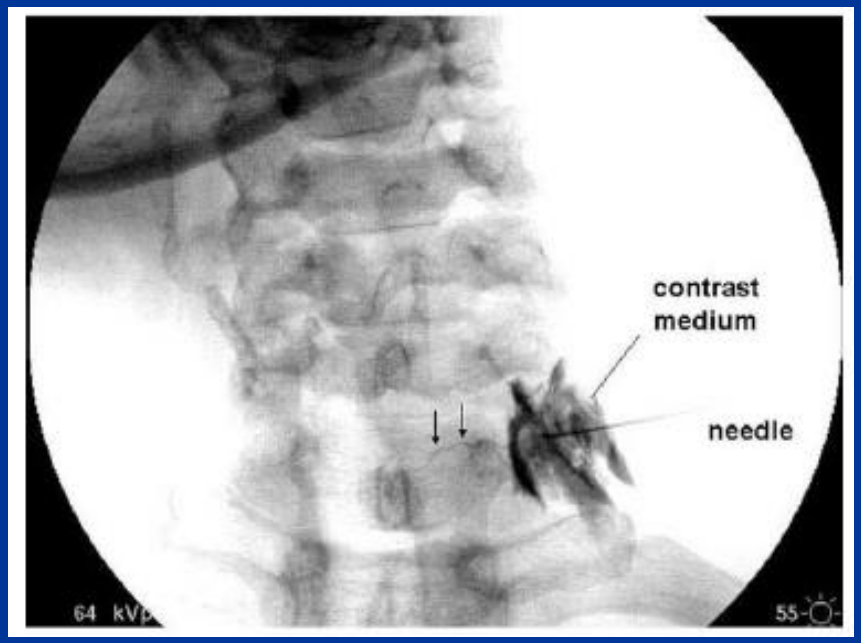
- Retrospective study of cervical TFESI for radiculopathy
- 220 patients received triamcinolone 40 mg and 221 patients dexamethasone 15 mg
- No statistically significant difference in the mean reduction in pain score between the two groups

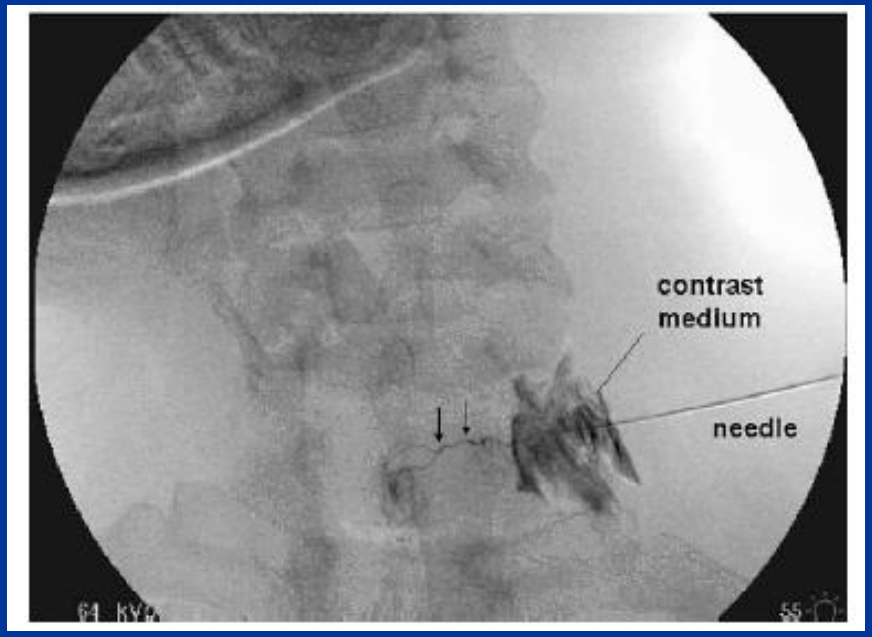
Shakir A, Ma V, Mehta B. Comparison of pain score reduction using triamcinolone vs. dexamethasone in cervical transforaminal epidural steroid injections. *Am J Phys.Med Rehabil.* 2013; 92: 768-75.

Particulate vs Non-particulate

Reference Year	Design	Subjects	Interventions	Results
Dreyfuss et al.[34] 2006	Randomized	30 Patients with unilateral cervical radiculopathy	TF ESI with 0.75Y1 mL 4% lidocaine + either: A: Dexamethasone 12.5 mg B: Triamcinolone 60 mg	Nonsignificant trend favoring particulate steroid
Lee et al.[35] 2009	Retrospective	159 Patients with cervical radiculopathy who failed IL ESI or had previous surgery	TF ESI with either: A: Dexamethasone 10 mg B: Triamcinolone 40 mg	Nonsignificant trend favoring particulate steroid
Kim and Brown[36] 2011	Randomized Single-blind	60 Patients with lumbar radiculopathy ≥ 6 mo	IL ESI with 10 mL consisting of 2 mL 0.25% bupivacaine + NS + either: A: Dexamethasone 15 mg B: Methylprednisolone 80 mg	Nonsignificant trend favoring particulate steroid
Park et al.[37] 2010	Randomized	106 Patients with lumbar radiculopathy	TF ESI with 1 mL 1% lidocaine + either: A: Dexamethasone 7.5 mg B: Triamcinolone 40 mg	Particulate > nonparticulate steroid for pain reduction
Noe and Haynsworth[38] 2003	Retrospective	52 Patients with LBP referred for ESI	IL ESI with either: A: Betamethasone 15 mg B: Methylprednisolone 80 mg	Particulate > nonparticulate steroid for pain reduction, improvement in disability
Shakir et al.[39] 2013	Retrospective	441 Patients with cervical radiculopathy	TF ESI with 1 mL of 1% lidocaine + either: A: Dexamethasone 15 mg B: Triamcinolone 40 mg	No difference in pain score reduction between groups

Why are we worried?





Why are we worried?

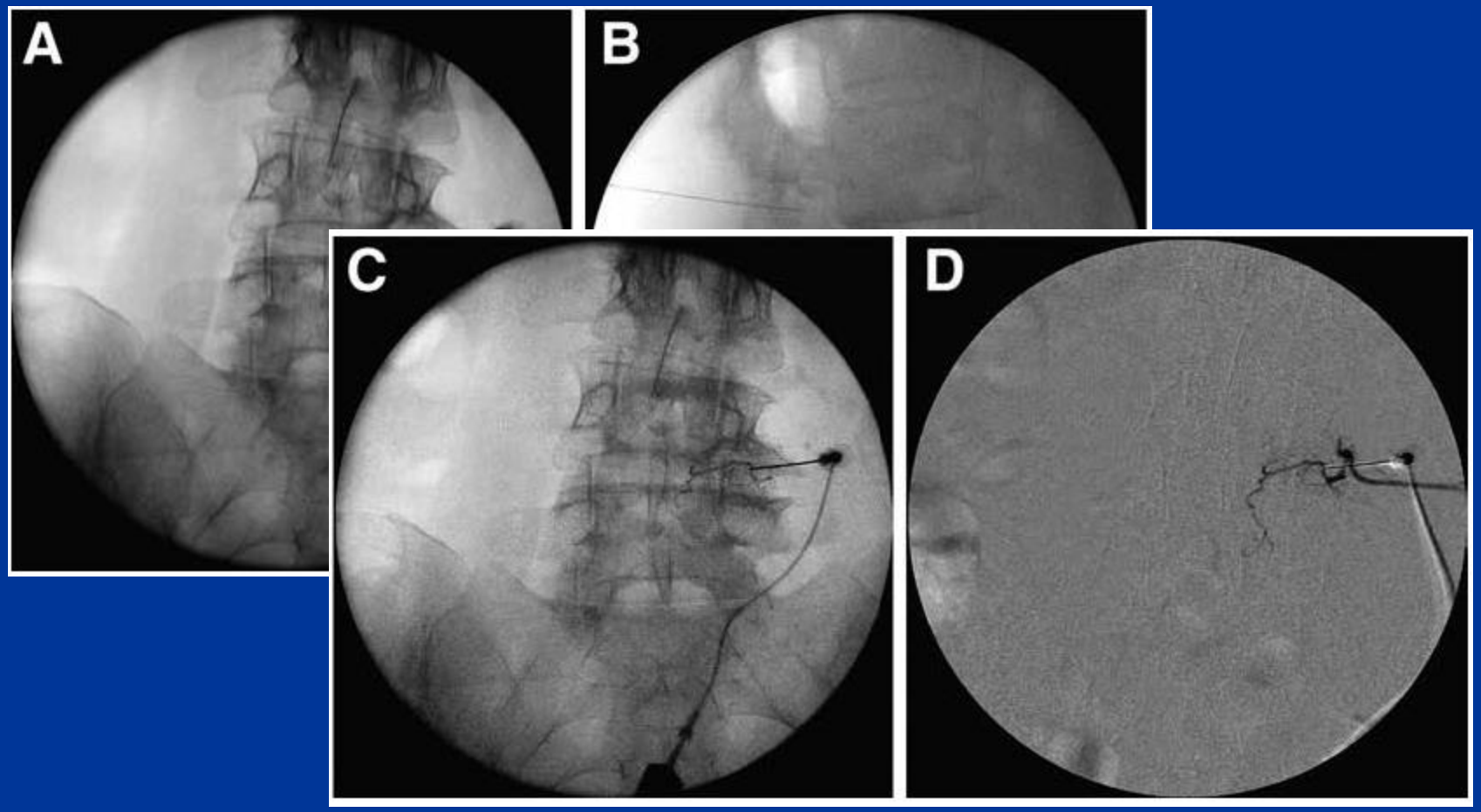


Table 5. Descriptive characteristics of FAERS cases of serious neurologic adverse events, excluding arachnoiditis, reported with ESI use, received by FDA from November 1, 1997 – April 23, 2014

	(N=90)	
Age (years) (n=79)	Mean	56.4
	Median	54
	Range	23-89
Gender (n=75)	Female	49
	Male	26
FDA Receipt Date	1997-2002	16
	2003-2008	32
	2009-2014	42
Report type	Expedited	59
	Direct	25
	Periodic	6
Reporter	Health Care Provider	43
	Consumer	47
Reported Primary Outcome	Death	3
	Hospitalization	35
	Life Threatening	1
	Disability	17
	Other serious	34
Steroid reported (n=88)	Methylprednisolone	45
	Triamcinolone	37
	Betamethasone	3
	Dexamethasone	3
Epidural route (n=22)	Transforaminal	15
	Interlaminar	5
	Caudal	2
Time to onset from start of therapy (n=62)	Within 1 day	47
	1 day – 1 month	13
	1 month – 6 months	1
	6 months – 1 year	1
Anesthetic administered* (n=35)	Bupivacaine	21
	Lidocaine	19
	Ropivacaine	1
Anesthetic route of administration (n=22)	Epidural	20
	Local	1
	Epidermal and local	1
Imaging (n=33)*	Contrast Agent	23
	Fluoroscopy	21
	Computed tomography	2
	Angiography	2

Embolic outcome case reports

1. Purdy, EP, Ajimal GS. Vision Loss after Lumbar Epidural Steroid Injection. Anaesthesia and Analgesia 1998; 86 (1): 119-122A
2. Hodges, S.D., et al., Cervical epidural steroid injection with intrinsic spinal cord damage. Two case reports. Spine (Phila Pa 1976), 1998. **23**(19): p. 2137-42; discussion 2141-2.
3. Huntoon MA, Martin DP. Paralysis
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5. Ludwig M, Burns A, Stephen P. Spinal cord infarction following cervical transforaminal epidural injection. Spine 2005;30:226-8.
6. Beckman WA, Mendez RJ, Paine GF, Mazzilli MA. Cerebellar Herniation After Cervical Transforaminal Epidural Injection.
7. Ziai W, Ardelt A, Llinas R. Brainstem stroke following uncomplicated cervical epidural steroid injection.
8. Tiso RL, Cutler T, Catania JA, Whalen K. Adverse central nervous system sequelae after selective transforaminal block: the role of corticosteroids. The Spine Journal 2004;4:468-74.
9. Popescu A et al. Stroke following Epidural Injections-Case Report and Review of Literature. Journal of Neuroimaging. 2013;23(1):118-121
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11. Schuchmann JA, McAllister RK, Armstrong CS, Puana R. Zoster sine herpete with thoracic motor paralysis temporally associated with thoracic epidural steroid injection. American Journal of Physical Medicine and Rehabilitation 2008 Oct 1;87:853-8
12. Morris PP, Lyder EM. A case of spinal cord infarction following lumbar transforaminal epidural steroid injection: MR imaging and angiographic findings. American Journal of neuroradiology,2009,30,9,1691-1693.
13. Kennedy DJ, Dreyfuss P, Aprill CN, Bogduk N. Paraplegia following image-guided transforaminal lumbar spine epidural steroid injection: two case reports. Pain Medicine 10: 1389-1394. No. 8. Nov-Dec 2009
14. Ramsin Benyamin MD. Corticosteroid Induced Psychosis in the Pain Management Setting. Pain Physician. 2008;11:6:917-920
15. Khan S, Pioro EP. Cervical epidural injection complicated by syrinx formation: a case report. Spine 35: E614-E616, No. 13, 1 Jun 2010.
16. G. Chang Chien. Spinal epidural hematoma resulting in tetraplegia after cervical interlaminar epidural steroid injection and intramuscular ketorolac: A case report. Phys Med Rehabil. 2012;4/10, Suppl. 1:S320
17. M.Ney. Spinal cord infarction following right sided L3-4 transforaminal epidural steroid/anesthetic injection: A case report, Phys Med Rehabil 2012;4(10 Suppl 1):S363.
18. Chang Chien GC, Candido KD, Knezevic NN. Digital subtraction angiography does not reliably prevent paraplegia associated with lumbar transforaminal epidural steroid injection. Pain Physician. 2012;15(6):515-23.
19. Lee J, Hausman E. Catastrophic Neurologic Outcome after Transforaminal Epidural Steroid Injection, 14 May 2010.

Table 1. Anaylsis of Cases of Spinal Cord and Posterior Circulation Ischemia

Case/ Reference	Injection Site	Medications	Method	Presentation/Clinical Course	Investigations	Outcome
1	C5-C6	Methylprednisolone	Typical	Flaccid quadriplegia, dissociative sensory loss with C5 level	MRI: cord infarct at C4-C6	3 weeks: quadriplegic
2[12]	(R)C5-C6	Triamcinolone Bupivacaine	Typical	Flaccid paralysis, transient coma then quadriplegic	MRI: extensive cord infarction	Death
3[13]	(L)C5-C6	Triamcinolone Bupivacaine	Typical	Quadriplegia, dissociative sensory loss	MRI: extensive cord infarction C2-T1	Unknown
4[6]	C6-C7	Methylprednisolone	Atypical	Quadriplegic, respiratory arrest	MRI: no infarction	6 months: regained some strength requiring daily assistance
5[15]	(L)C5-6 (L)C6-7	Methylprednisolone Bupivacaine	Atypical	Arms paretic with paraplegia, T4 sensory level	MRI: cervical cord edema and medullary infarction	8 weeks: ambulating with walker
6[14]	(R)C6-C7	Lidocaine	Atypical	Transient quadriparesis, dissociative sensory loss	None	20 minutes: resolution
7[18]	(L)C6-C7 (L)C7-C8	Steriod not named	Atypical	Numbness and weakness of (L) arm	MRI: petechial hemorrhages in lateral cord	(L) C7 radiculopathy with weakness and numbness
8[7]	(L)C5-C6	Unknown	Atypical	Confusion, (L) arm weakness	CT: dissection of left vertebral artery at (L) C3-C6	24 hours: resolution
9[19]	(L)C6-C7	Triamcinolone Mepivacaine	Atypical	Flaccid quadriplegia, respiratory arrest, C4 sensory level	MRI: high cervical to upper thoracic cord edema	3 months: breathing unassisted
10[8]	(L)C6-C7	None (contrast only)	Atypical	Quadriparesis, (L)C6 sensory level	CT: intracord air bubble MRI: cervical cord edema	(L) arm paresis otherwise restored strength
11[5]	(R)C5-C6	Triamcinolone Bupivacaine	Typical	Transient unresponsiveness, quadriplegia	MRI: cerebellar infarct.	Death
12[16]	(R)C7-T1	Methylprednisolone Lidocaine	Typical	Neck pain, headache, nausea then intermittent apnea, posturing	MRI: cerebellar infarct with edema and subsequent herniation	Posterior fossa craniectomy and meningitis. Recovered with diplopia and memory deficits
13[17]	(L)C5-C6	Methylprednisolone	Typical	Nausea, vomiting and headache followed by decreased consciousness and dysarthria	MRI: midbrain, pons, L thalamic infarction.	Death
14[18]	(L)C5-C6	Betamethasone Lidocaine	Atypical	Transient unresponsiveness. Dysarthria, ataxia, numb arms, (L) arm plegic, (R) arm paretic	MRI: cerebellar infarct and C1-C4 cord infarct	Unknown
15[9]	(L)C5-C6	Anesthetics, unspecificed	Atypical	Nystagmus. Subsequent blindness, seizures, obtundation, aphasia, dysphagia	MRI: L occipital cortex cerebral edema	Day 30: memory deficits and (R) homonymous hemianopia
16[11]	(L)C6-C7	Methylprednisolone Bupivacaine	Atypical	Immediately noncommunicative	CT: brainstem hemorrhage, intraventricular hemorrhage	Death

Popescu A et al. Stroke following Epidural Injections-Case Report and Review of Literature. Journal of Neuroimaging. 2013;23(1):118-121

FDA Safe Use Guidelines

Safeguards to Prevent Neurologic Complications after Epidural Steroid Injections

Consensus Opinions from a Multidisciplinary Working Group and National Organizations

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Table 1. Statements and Clinical Considerations of the Working Group Endorsed by the MultiSpecialty Work Group

Statement/Clinical Consideration	Number of Organizations Agreeing	Number of Organizations Disagreeing	Number of Organizations Unable to Reach Consensus
1. Cervical IL ESIs are associated with a rare risk of catastrophic neurologic injury (fig. 1).	13	0	0
2. TF ESI using particulate steroid is associated with a rare risk of catastrophic neurovascular complications (fig. 3).	13	0	0
3. All cervical IL ESIs should be performed using image guidance, with appropriate AP, lateral, or contralateral oblique views and a test dose of contrast medium (fig. 5).	13	0	0
4. Cervical TF ESIs should be performed by injecting contrast medium under real-time fluoroscopy and/or digital subtraction imaging, using an AP view, before injecting any substance that may be hazardous to the patient (fig. 6).	11	1*	1
5. Cervical IL ESIs are recommended to be performed at C7-T1, but preferably not higher than the C6-C7 level.	13	0	0
6. No cervical IL ESI should be undertaken, at any segmental level, without reviewing, before the procedure, prior imaging studies that show there is adequate epidural space for needle placement at the target level.	13	0	0
7. Particulate steroids should not be used in therapeutic cervical TF injections.	13	0	0
8. All lumbar IL ESIs should be performed using image guidance, with appropriate AP, lateral, or contralateral oblique views and a test dose of contrast medium.	13	0	0
9. Lumbar TF ESIs should be performed by injecting contrast medium under real-time fluoroscopy and/or digital subtraction imaging, using an AP view, before injecting any substance that may be hazardous to the patient (fig. 7).	12	1*	0
10. A nonparticulate steroid (*e.g.*, dexamethasone) should be used for the initial injection in lumbar transforaminal epidural injections.	11	0	2
11. There are situations where particulate steroids could be used in the performance of lumbar TF ESIs.	13	0	0
12. Extension tubing is recommended for all TF ESIs.	12	1	0
13. A face mask and sterile gloves must be worn during the procedure.	13	0	0
14. The ultimate choice of what approach or technique (IL *vs.* TF ESI) to use should be made by the treating physician by balancing potential risks *vs.* benefits with each technique for each given patient	13	0	0
15. Cervical and lumbar IL ESIs can be performed without contrast in patients with documented contraindication to use of contrast (*e.g.*, significant history of contrast allergy or anaphylactic reaction)	11	0	2
16. TF ESIs can be performed without contrast in patients with documented contraindication to use, but in these circumstances, particulate steroids are contraindicated and only preservative-free, particulate-free steroids should be used.	13	0	0
17. Moderate-to-heavy sedation is not recommended for ESIs, but if light sedation is used, the patient should remain able to communicate pain or other adverse sensations or events	13	0	0

* The organization voting against questions 4 and 9 commented, "Digital Subtraction Imaging should be mandatory before injecting a potentially hazardous substance transforaminally."

AP = anteroposterior; C6-C7 = the interspace between the sixth and seventh cervical vertebrae; C7-T1 = the interspace between the seventh cervical and first thoracic vertebrae; ESI = epidural steroid injection; IL = interlaminar; TF = trasforaminal.

Cervical IL ESIs are associated with a rare risk of catastrophic neurologic injury (fig. 1).

TF ESI using particulate steroid is associated with a rare risk of catastrophic neurovascular complications (fig. 3).

All cervical IL ESIs should be performed using image guidance, with appropriate AP, lateral, or contralateral oblique views and a test dose of contrast medium (fig. 5).

Cervical IL ESIs are recommended to be performed at C7-T1, but preferably not higher than the C6-C7 level.

No cervical IL ESI should be undertaken, at any segmental level, without reviewing, before the procedure, prior imaging studies that show there is adequate epidural space for needle placement at the target level.

8. All lumbar IL ESIs should be performed using image guidance, with appropriate AP, lateral, or contralateral oblique views and a test dose of contrast medium.
9. Lumbar TF ESIs should be performed by injecting contrast medium under real-time fluoroscopy and/or digital subtraction imaging, using an AP view, before injecting any substance that may be hazardous to the patient (fig. 7).
10. A nonparticulate steroid (*e.g.*, dexamethasone) should be used for the initial injection in lumbar transforaminal epidural injections.
11. There are situations where particulate steroids could be used in the performance of lumbar TF ESIs.

12. Extension tubing is recommended for all TF ESIs.
13. A face mask and sterile gloves must be worn during the procedure.

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14. The ultimate choice of what approach or technique (IL *vs.* TF ESI) to use should be made by the treating physician by balancing potential risks *vs.* benefits with each technique for each given patient
15. Cervical and lumbar IL ESIs can be performed without contrast in patients with documented contraindication to use of contrast (*e.g.*, significant history of contrast allergy or anaphylactic reaction)
16. TF ESIs can be performed without contrast in patients with documented contraindication to use, but in these circumstances, particulate steroids are contraindicated and only preservative-free, particulate-free steroids should be used.
17. Moderate-to-heavy sedation is not recommended for ESIs, but if light sedation is used, the patient should remain able to communicate pain or other adverse sensations or events

Conclusions

- Accepted to use particulate steroids for interlaminar injections
- Use image guidance with multiple views for epidural placement
- Strongly consider use of DSA for detection of vascular uptake
- Strongly consider use of non-particulate steroids for lumbar TFESI