Resident Lecture Series
Lumbar Epidural Steroid Injections: Who, What, When, Where, Why, and How?

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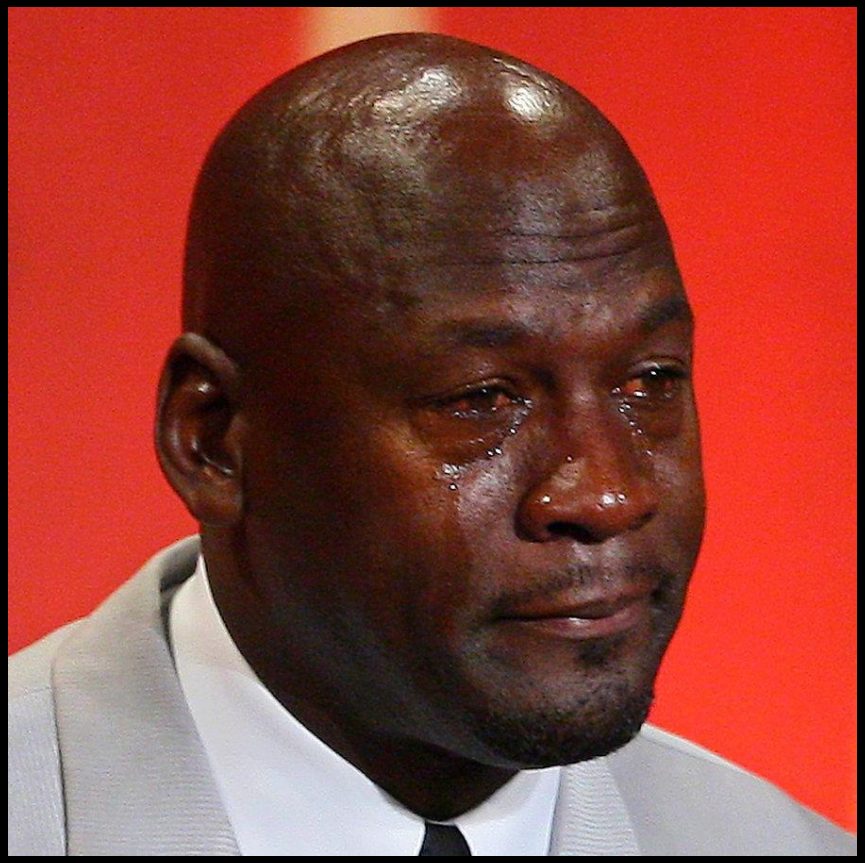
Vanderbilt University

Preview

- How (do we assess if ESI are effective?)
- Why (are we putting steroids there?)
- Who (should expect results?)
- When (how often should we be doing this?)
- Where (do we put the needle?)
- What (steroids are effective?)

How (do we know they work?)

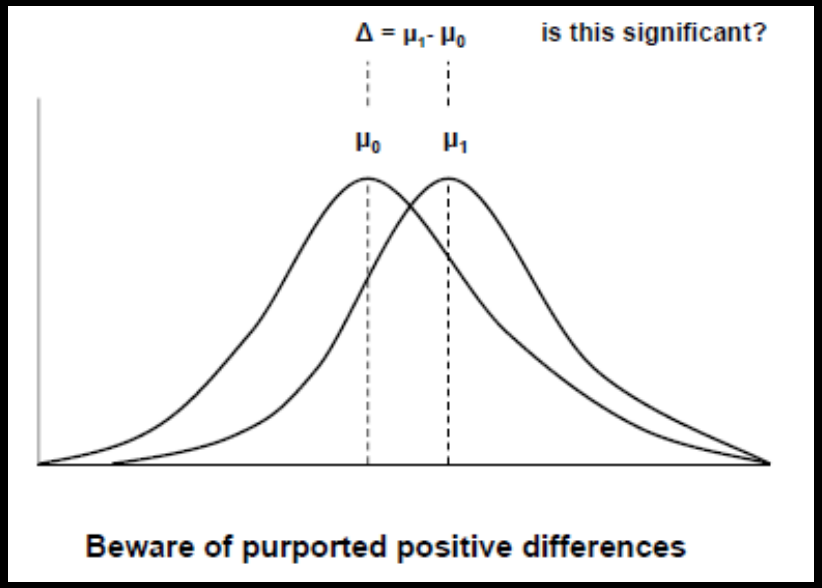
- This is code for “Statistics 101”



Same data…different p-value

Before	After	Diff
4	3.9	-0.1
4	3.8	-0.2
5	4.9	-0.1
6	5.9	-0.1
6	5.9	-0.1
7	6.9	-0.1
8	7.6	-0.4
8	7.9	-0.1
9	8.8	-0.2
10	9.9	-0.1

Paired t-test; p = 0.001



Beware of purported positive differences

Before	After	Diff
4	3.9	-0.1
4	3.8	-0.2
5	4.9	-0.1
6	5.9	-0.1
6	5.9	-0.1
7	6.9	-0.1
8	7.6	-0.4
8	7.9	-0.1
9	8.8	-0.2
10	9.9	-0.1
6.7	6.55	

Two-sample t-test; p = 0.875

Nobody Got Better!

Slide from Spine Intervention Society Evidence Based Medicine Course

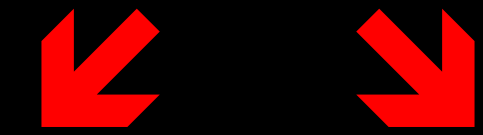
Categorical vs Mean Data

4, 6, 6, 6, 8

2, 4, 4, 4, 6

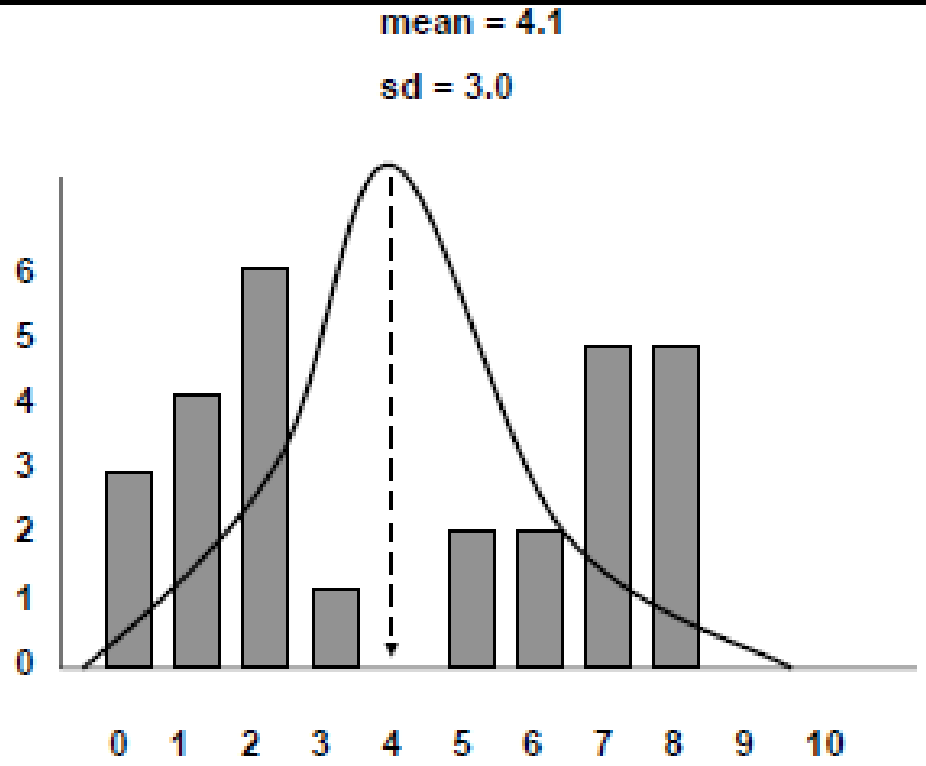
Categorical vs Mean Data

6, 6, 6, 6, 8

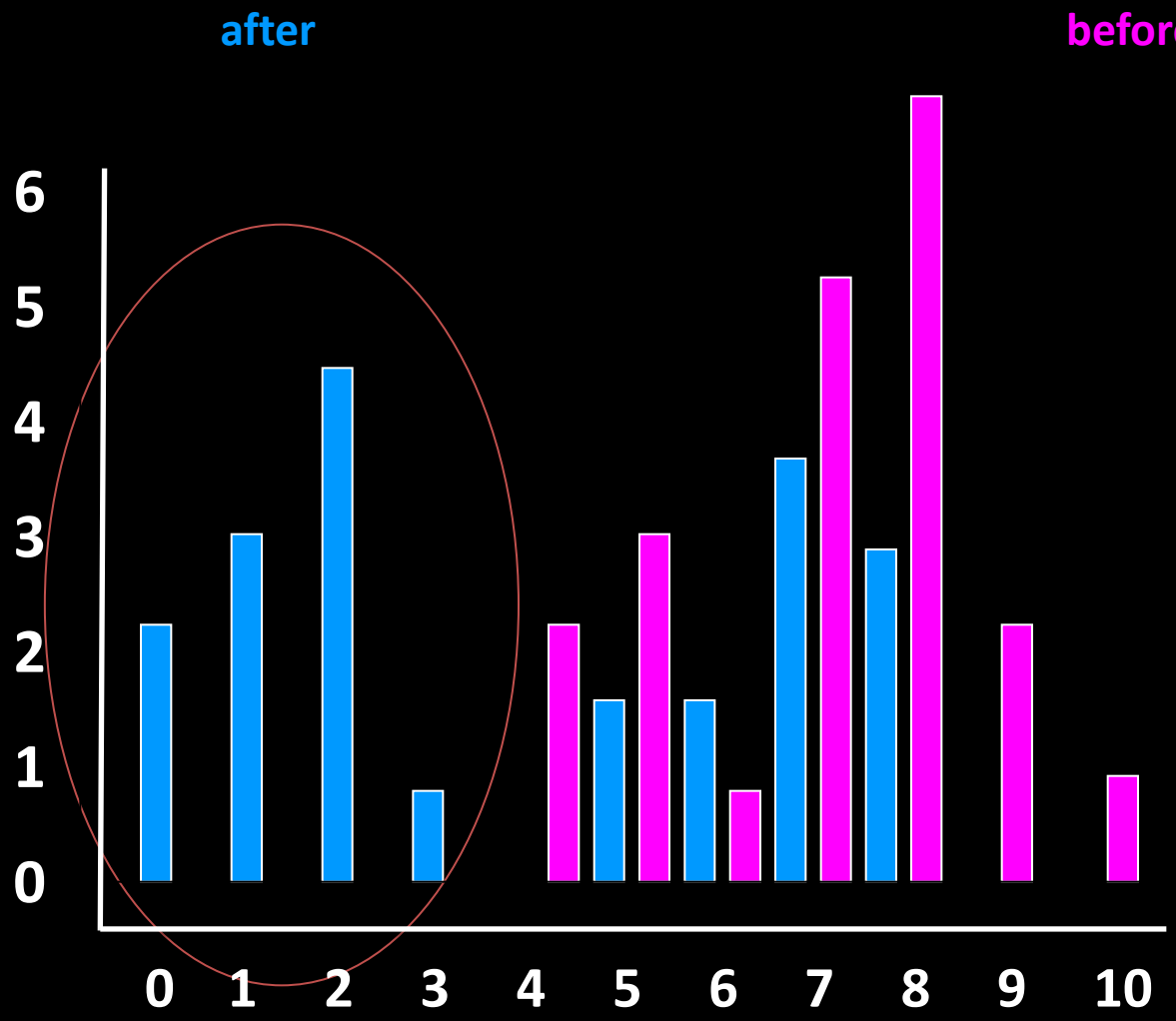


0,2 6,6,6

Categorical Data vs Mean Data



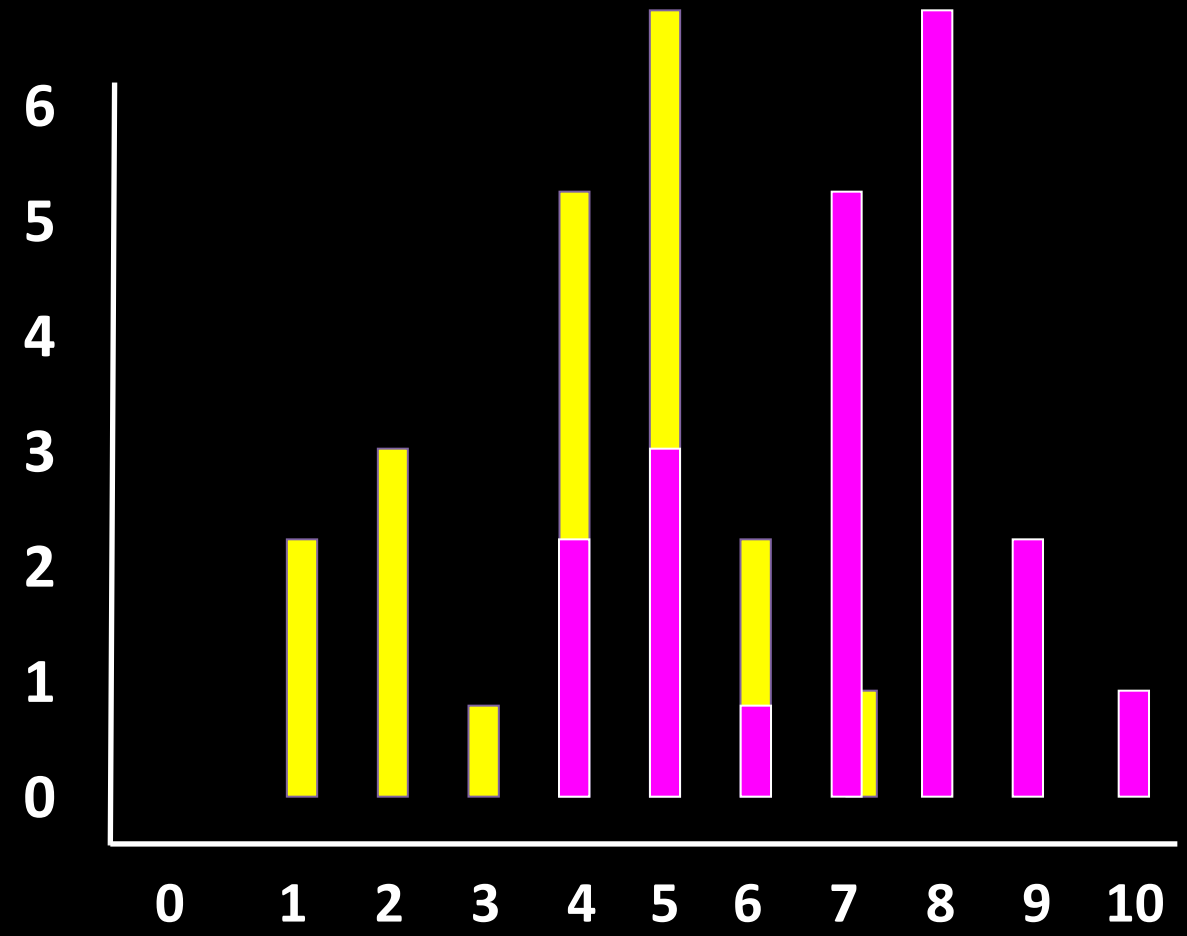
Data from: Ghahreman A, Ferch R, Bogduk N. The efficacy of transforaminal injection of steroids for the treatment of lumbar radicular pain. Pain Med 2010; 11:1149-1168.



MEAN went from 7 → 4.1

55% of people did substantially better (at least 50% improvement)

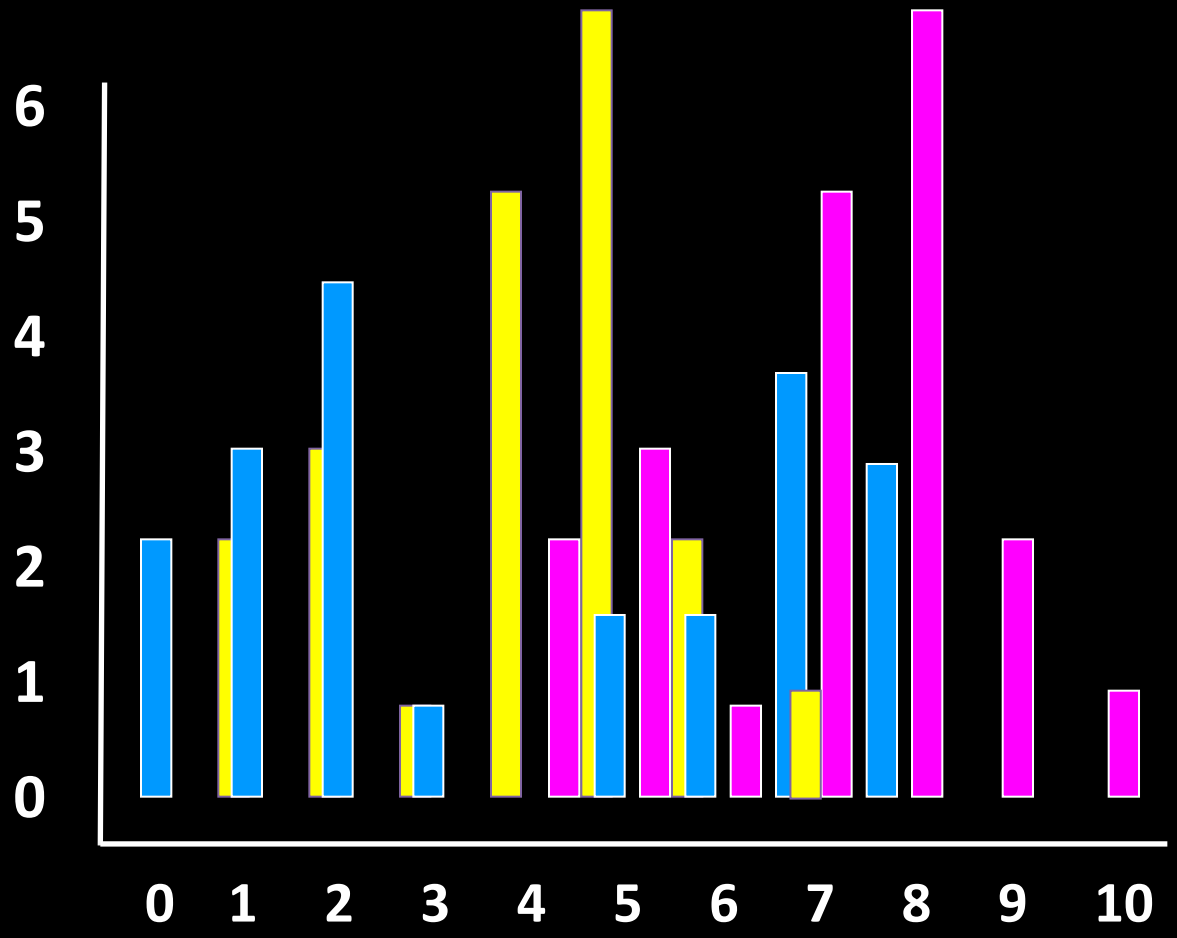
11 patients with pain 3 or less



MEAN went from 7 → 4.1

6 people with pain 3 or less

Nobody at 0 pain



Everyone can get a little better
OR
Some people can get significantly better
Without categorical analysis, we can't tell the difference

Why

- Steroids:
  - inhibit phospholipase 2
  - Inhibit leukocyte aggregation
  - prevent degranulation of granulocytes, mast cells, and macrophages
  - prevent transmission of nocioceptive C-fibers
  - stabilize ectopic discharge of neuronal membranes

Cohen SP, BogdukN, Dragovich A, Buckenmaier CC 3rd, Griffith S, Kurihara C, et al. Randomized, double-blind, placebo-controlled, dose-response, and preclinical safety study of transforaminal epidural etanercept for the treatment of sciatica. Anesthesiology. 2009 May;110(5):1116–26.

Johansson A, Hao J, Sjölund B. Local corticosteroid application blocks transmission in normal nociceptive C-fibres. Acta Anaesthesiol Scand. 1990 Jul;34(5):335–8.

Takahashi H, Suguro T, Okazima Y, Motegi M, Okada Y, Kakiuchi T. Inflammatory cytokines in the herniated disc of the lumbar spine. Spine. 1996 Jan 15;21(2):218–24.

Why - isn't it a "pinched nerve"?

- Radicular pain IS inflammatory
  - Phospholipase A1
  - Prostaglandin E2
  - Leukotrienes
  - Cytokines
  - Nitric Oxide
  - Interleukin 6
  - Tumor Necrosis Factor alpha

Takahashi H, Suguro T, Okazima Y, Motegi M, Okada Y, Kakiuchi T. Inflammatory cytokines in the herniated disc of the lumbar spine. Spine. 1996 Jan 15;21(2):218–24.

Goupille P, Jayson MI, Valat JP, Freemont AJ. The role of inflammation in disk herniation-associated radiculopathy. Semin Arthritis Rheum. 1998 Aug;28(1):60–71.

Why

- Pure mechanical compression of spinal nerves does not necessarily produce pain
- The degree of nerve root compression does not correlate to pain severity
- Various inflammatory markers or cells are required for the dorsal root ganglion to generate the painful discharges in radiculitis

MacNab I. The mechanism of spondylogenic pain. In: Cervical pain. Oxford: Pergamon, 1972: 89-95

Halperin N, Agasi M, Hendel D. Painless root compression following disc extrusion. A report of three cases. Arch Orthop Trauma Surg Arch Für Orthop Unf-Chir. 1982;101(1):63–6.

Wiesel SW, Tsourmas N, Feffer HL, Citrin CM, Patronas N. A study of computer-assisted tomography. I. The incidence of positive CAT scans in an asymptomatic group of patients. Spine. 1984 Sep;9(6):549–51.

Boden SD, Davis DO, Dina TS, Patronas NJ, Wiesel SW. Abnormal magnetic-resonance scans of the lumbar spine in asymptomatic subjects. A prospective investigation. J Bone Joint Surg Am. 1990 Mar;72(3):403–8.

Murphy RW. Nerve roots and spinal nerves in degenerative disk disease. Clin Orthop. 1977 Dec;(129):46–60.

Who

- Epidural Steroid Injection
- Targeting the spinal nerves
- Spinal nerve pain = radicular pain
- NOT:
  - Progressive nerve damage
  - Back pain
  - Disc Pain
  - Z-joint Pain

Pain Med. 2013 Jan;14(1):14-28. doi: 10.1111/j.1526-4637.2012.01508.x. Epub 2012 Oct 30.

The effectiveness of lumbar transforaminal injection of steroids: a comprehensive review with systematic analysis of the published data.

MacVicar J[1], King W, Landers MH, Bogduk N.

- The literature on TFESI for the treatment of radicular pain due to disc herniation is “abundant” and of “higher quality” and reveals that “about 60% of patients seems to achieve at least 50% relief of pain at between 1 and 2 months but that only 40% maintain this outcome for 12 months”

Lumbar TFESI for Lumbar Radicular Pain

- Effective (more so in patients with contained disc herniations, low grade compression, and acute symptom duration)(1-4)
- Statistically more than placebo effects (5,6)
- Reduce the burden of disease by improving function (5,7,8)
- Reduce the need for surgery (6, 9, 10, 11)
- Cost effective (12,13)

References

- 1. Jeong HS, Lee JW, Kim SH, Myung JS, Kim JH, Kang HS. Effectiveness of transforaminal epidural steroid injection by using a preganglionic approach: a prospective randomized controlled study. Radiology. 2007 Nov;245(2):584–90.
- 2. Tafazal S, Ng L, Chaudhary N, Sell P. Corticosteroids in peri-radicular infiltration for radicular pain: a randomised double blind controlled trial. One year results and subgroup analysis. Eur Spine J Off Publ Eur Spine Soc Eur Spinal Deform Soc Eur Sect Cerv Spine Res Soc. 2009 Aug;18(8):1220–5.
- 3. Lee JW, Kim SH, Choi J-Y, Yeom J-S, Kim K-J, Chung S-K, et al. Transforaminal epidural steroid injection for lumbosacral radiculopathy: preganglionic versus conventional approach. Korean J Radiol Off J Korean Radiol Soc. 2006 Jun;7(2):139–44.
- 4. Ackerman WE 3rd, Ahmad M. The efficacy of lumbar epidural steroid injections in patients with lumbar disc herniations. Anesth Analg. 2007 May;104(5):1217–22, tables of contents.
- 5. Ghahreman A, Ferch R, Bogduk N. The efficacy of transforaminal injection of steroids for the treatment of lumbar radicular pain. Pain Med Malden Mass. 2010 Aug;11(8):1149–68.
- 6. Riew KD, Yin Y, Gilula L, Bridwell KH, Lenke LG, Lauryssen C, et al. The effect of nerve-root injections on the need for operative treatment of lumbar radicular pain. A prospective, randomized, controlled, double-blind study. J Bone Joint Surg Am. 2000 Nov;82-A(11):1589–93.
- 7. Vad VB, Bhat AL, Lutz GE, Cammisa F. Transforaminal epidural steroid injections in lumbosacral radiculopathy: a prospective randomized study. Spine. 2002 Jan 1;27(1):11–6.
- 8. Thomas E, Cyteval C, Abiad L, Picot MC, Taourel P, Blotman F. Efficacy of transforaminal versus interspinous corticosteroid injectionin discal radiculalgia - a prospective, randomised, double-blind study. Clin Rheumatol. 2003 Oct;22(4-5):299–304.
- 9. Weiner BK, Fraser RD. Foraminal injection for lateral lumbar disc herniation. J Bone Joint Surg Br. 1997 Sep;79(5):804–7.
- 10. Riew KD, Park J-B, Cho Y-S, Gilula L, Patel A, Lenke LG, et al. Nerve root blocks in the treatment of lumbar radicular pain. A minimum five-year follow-up. J Bone Joint Surg Am. 2006 Aug;88(8):1722–5.
- 11. Wang JC, Lin E, Brodke DS, Youssef JA. Epidural injections for the treatment of symptomatic lumbar herniated discs. J Spinal Disord Tech. 2002 Aug;15(4):269–72.
- 12. Karppinen J, Ohinmaa A, Malmivaara A, Kurunlahti M, Kyllönen E, Pienimäki T, et al. Cost effectiveness of periradicular infiltration for sciatica: subgroup analysis of a randomized controlled trial. Spine. 2001 Dec 1;26(23):2587–95.
- 13. MacVicar J, King W, Landers MH, Bogduk N. The effectiveness of lumbar transforaminal injection of steroids: a comprehensive review with systematic analysis of the published data. Pain Med Malden Mass. 2013 Jan;14(1):14–28.

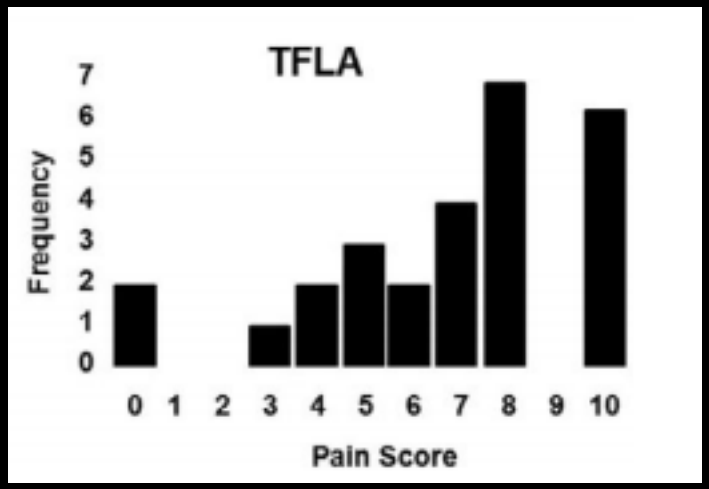
Pain Med. 2010 Aug;11(8):1149-68. doi: 10.1111/j.1526-4637.2010.00908.x.

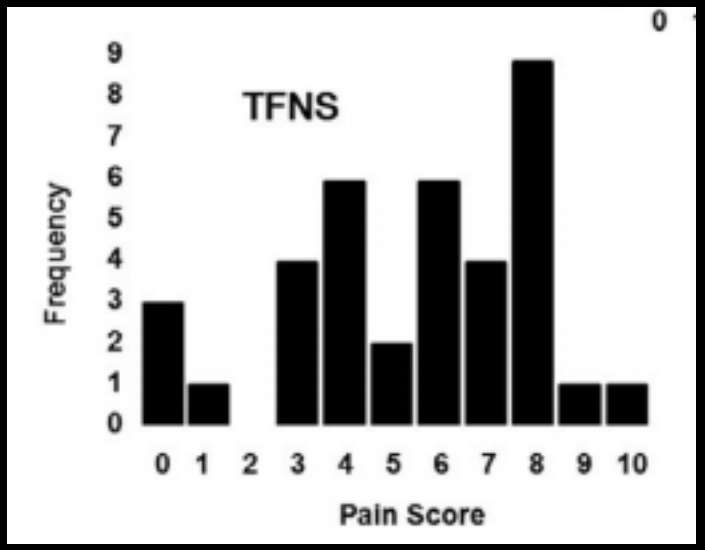
The efficacy of transforaminal injection of steroids for the treatment of lumbar radicular pain.

Ghahreman A[1], Ferch R, Bogduk N.

- Prospective Randomized Study
- Lumbar Radicular Pain
- Corresponding Findings on MRI
- 5 Arms:
  - Intramuscular Normal Saline
  - Intramuscular Steroid
  - Transforaminal Normal Saline
  - Transforaminal Local Anesthetic
  - Transforaminal Steroid

The data


TFLA
Frequency
0 1 2 3 4 5 6 7
0 1 2 3 4 5 6 7 8 9 10
Pain Score


TFNS
Frequency
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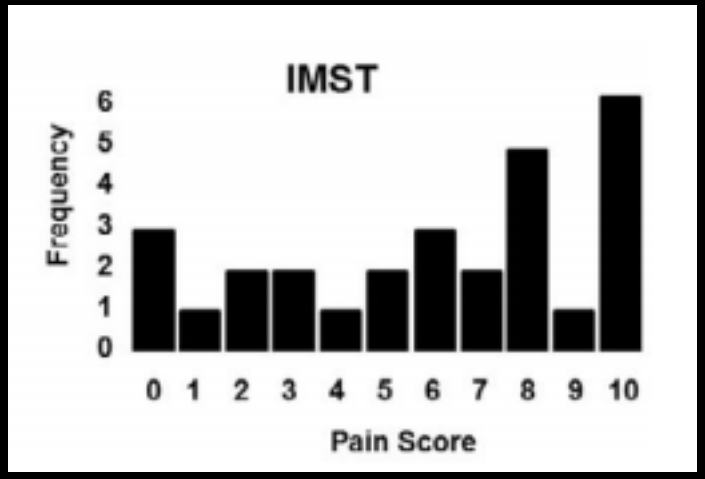
0 1 2 3 4 5 6 7 8 9 10
Pain Score


IMST
Frequency
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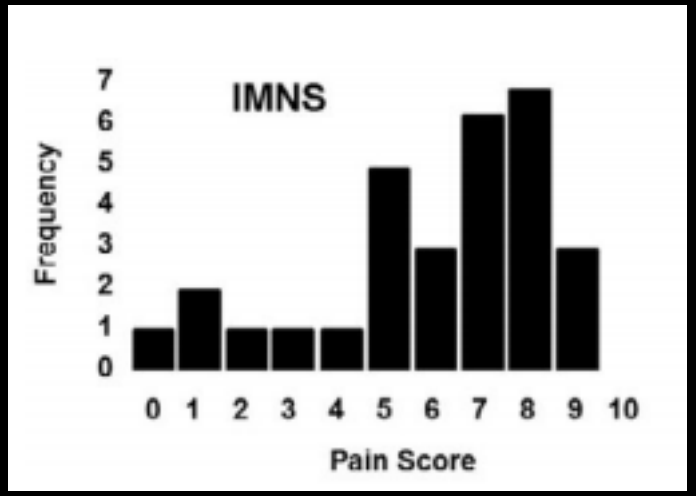
0 1 2 3 4 5 6 7 8 9 10
Pain Score


IMNS
Frequency
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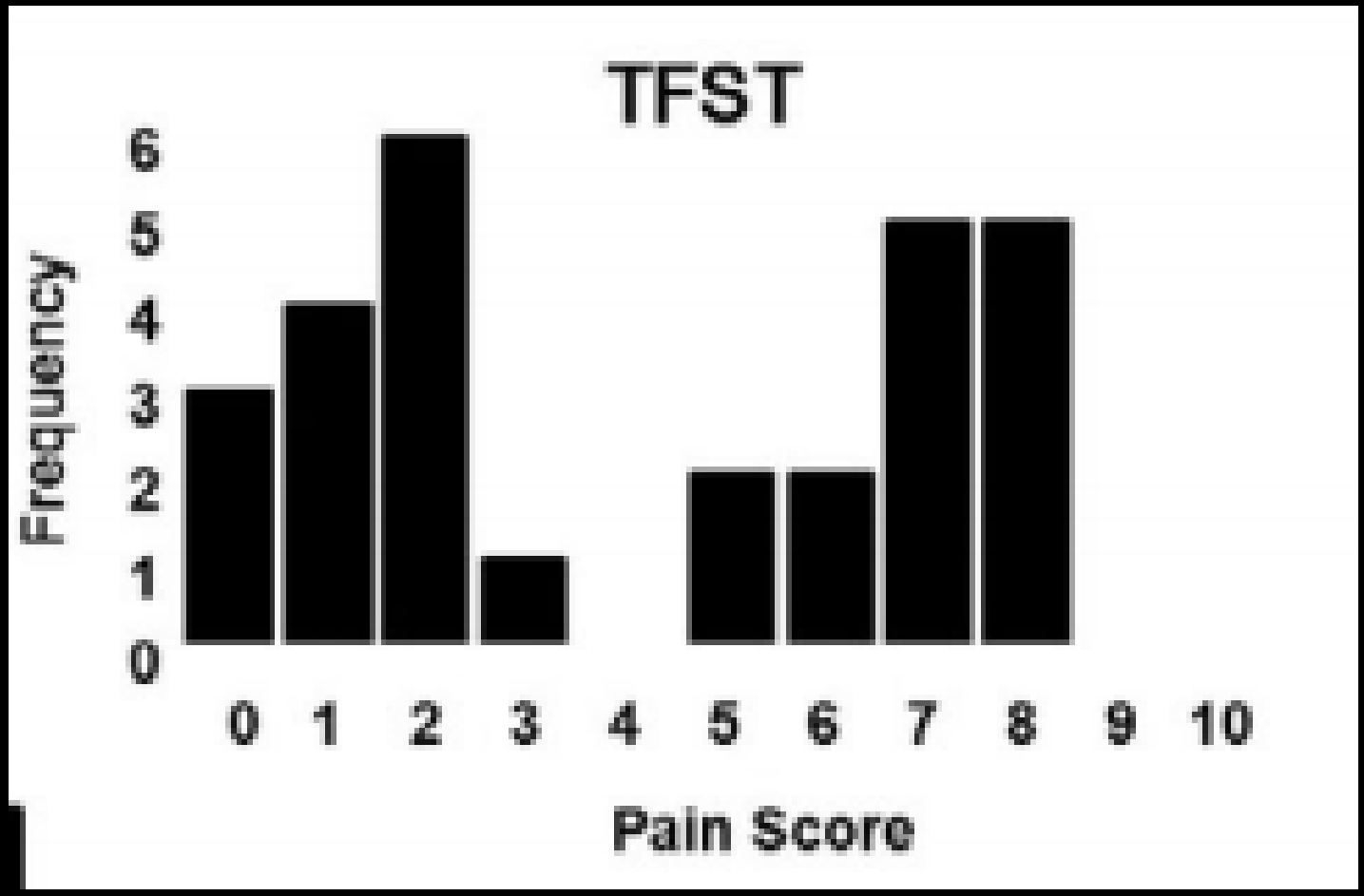
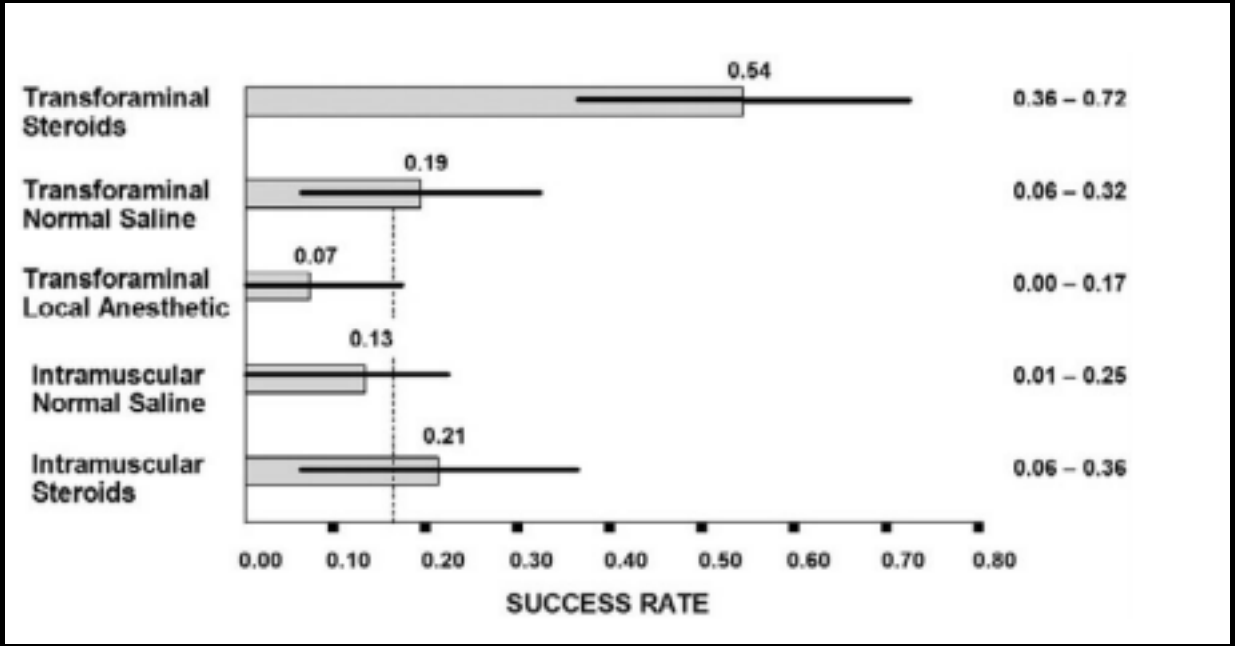
0 1 2 3 4 5 6 7 8 9 10
Pain Score

Transforaminal Steroid



Transforaminal Steroid



Surgical Sparing Effect

- In studies where patients enrolled were deemed surgical candidates but were offered TFESI first:
  - 79% avoided surgery (Weiner)
  - 71% avoided surgery vs 33% of those receiving epidural anesthetic injection (Riew)
  - 77% avoided surgery (Wang)
  - 83% avoided surgery (Kennedy)

Riew KD, Yin Y, Gilula L, Bridwell KH, Lenke LG, Lauryssen C, et al. The effect of nerve-root injections on the need for operative treatment of lumbar radicular pain. A prospective, randomized, controlled, double-blind study. J Bone Joint Surg Am. 2000 Nov;82-A(11):1589–93.

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Kennedy DJ, Plastaras C, Casey E, Visco CJ, Rittenberg JD, Conrad B, et al. Comparative effectiveness of lumbar transforaminal epidural steroid injections with particulate versus nonparticulate corticosteroids for lumbar radicular pain due to intervertebral disc herniation: a prospective, randomized, double-blind trial. Pain Med Malden Mass. 2014 Apr;15(4):548–55.

ESI for Stenosis

- "According to outcome studies, some 50% of patients achieve 50% relief of pain for 6 months or more, but rigorous studies are lacking and no controlled studies have corroborated this outcome" – McVicar et al.

Jeong HS, Lee J, Kim SH, et al. Effectiveness of transforaminal epidural steroid injection by using a preganglionic approach: A prospective randomized controlled study. Radiology 2007;245:584–90.

Lee JW, Kim SH, Choi JY, et al. Transforaminal epidural steroid injection for lumbosacral radiculopathy: Preganglionic versus conventional approach. Korean J Radiol 2006;7:139–44.

Delport EG, Cucuzzella AR, Marley JK, Pruitt CM, Fisher JR. Treatment of lumbar spinal stenosis with epidural steroid injections: A retrospective outcome study. Arch Phys Med Rehabil 2004;85:479–84.

Botwin KP, Gruber RD, Bouchlas CG, et al. Fluoroscopically guided lumbar transformational epidural steroid injections in degenerative lumbar stenosis. An outcome study. Am J Phys Med Rehabil 2002;8: 898–905.

Narozny M, Zanetti M, Boos N. Therapetuic efficacy of selective nerve root blocks in the treatment of lumbar radicular leg pain. Swiss Med Wkly 2001;131:75–80.

Cyteval C, Fesquet N, Thomas E, et al. Predictive factors of efficacy of periradicular corticosteroid injections for lumbar radiculopathy. AJNR. Am J Neuroradiol 2006;27:978–82.

Smith CC, Booker T, Schaufele MK, Weiss P. Interlaminar versus transforaminal epidural steroid injections for the treatment of symptomatic lumbar spinal stenosis. Pain Med 2010;11:1511–5.

N Engl J Med. 2014 Jul 3;371(1):11-21. doi: 10.1056/NEJMoa1313265.

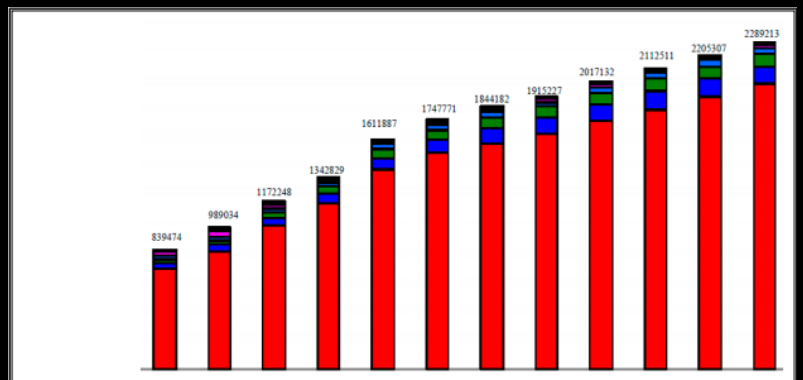
A randomized trial of epidural glucocorticoid injections for spinal stenosis.

Friedly JL[1], Comstock BA, Turner JA, Heagerty PJ, Deyo RA, Sullivan SD, Bauer Z, Bresnahan BW, Avins AL, Nedeljkovic SS, Nerenz DR, Standaert C, Kessler L, Akuthota V, Annaswamy T, Chen A, Diehn F, Firtch W, Gerges FJ, Gilligan C, Goldberg H, Kennedy DJ, Mandel S, Tyburski M, Sanders W, Sibell D, Smuck M, Wasan A, Won L, Jarvik JG.

- 400 patients with central stenosis and leg pain randomized to epidural injection (TF or IL) with steroid and anesthetic or anesthetic alone
- Reported no difference between groups as 6 weeks
- At 3 weeks, ESI was favored over anesthetic for RMDQ and leg pain
- Heterogeneity within study (approach, steroid dosing, patient selection, true sham?)
- Crossover between groups?

When?

- **Overutilization**
- Annual increase in ESI in Medicare population is 7.5% per 100,000 between 2000 and 2011
- 2.3 million ESI in 2011
- PM&R use increased 520%
- **Not ALL the time!**



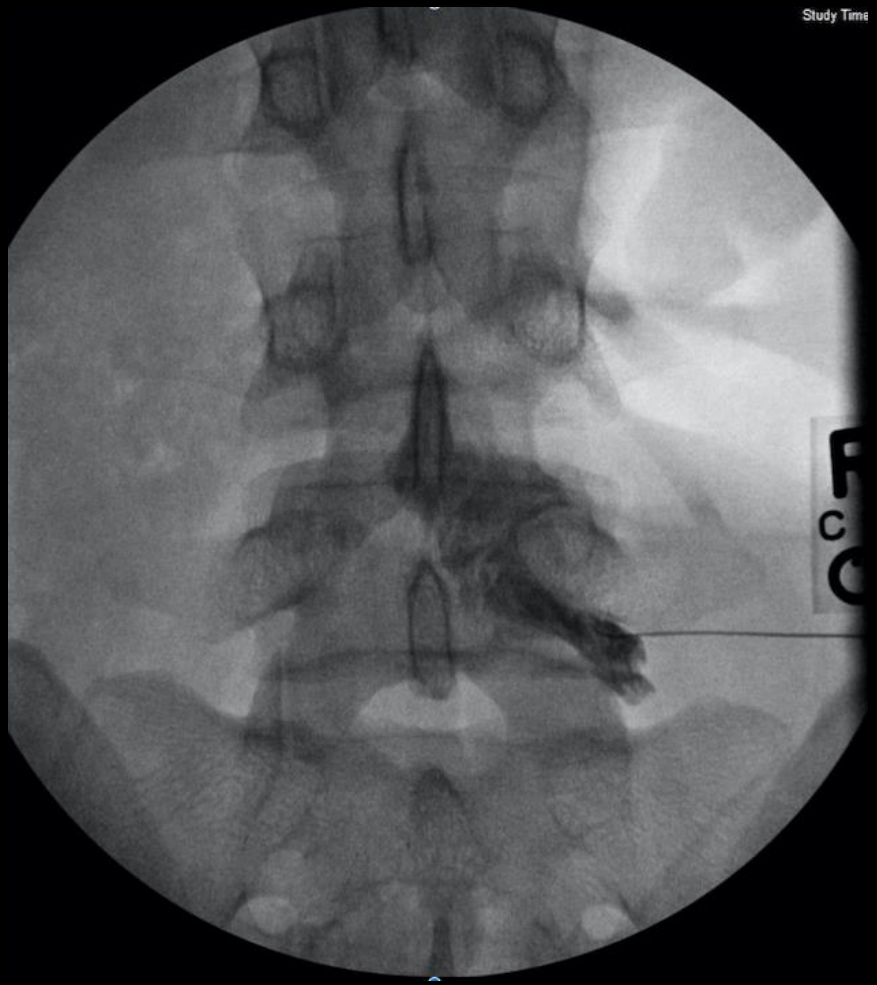
Specialty	F2000	F2001	F2002	F2003	F2004	F2005	F2006	F2007	F2008	F2009	F2010	F2011
IPM	83.7%	83.1%	85.4%	86.9%	86.8%	86.7%	86.1%	86.4%	86.1%	86.1%	86.7%	87.7%
Surgery	5.6%	5.4%	5.4%	5.2%	5.4%	5.3%	5.6%	5.8%	6.0%	6.4%	5.7%	5.1%
Radiology	2.7%	3.0%	3.4%	3.8%	4.0%	4.0%	4.1%	4.0%	4.0%	3.9%	3.8%	3.8%
General Physicians	2.6%	1.9%	1.9%	1.9%	1.9%	1.9%	2.2%	1.8%	1.7%	1.8%	2.1%	1.7%
Other Physicians	3.7%	4.7%	2.2%	1.0%	0.9%	0.9%	0.9%	1.0%	1.3%	0.9%	0.9%	0.9%
CRNA, NP & PA	1.7%	1.9%	1.7%	1.3%	1.0%	1.1%	1.1%	1.0%	0.9%	0.8%	0.8%	0.8%

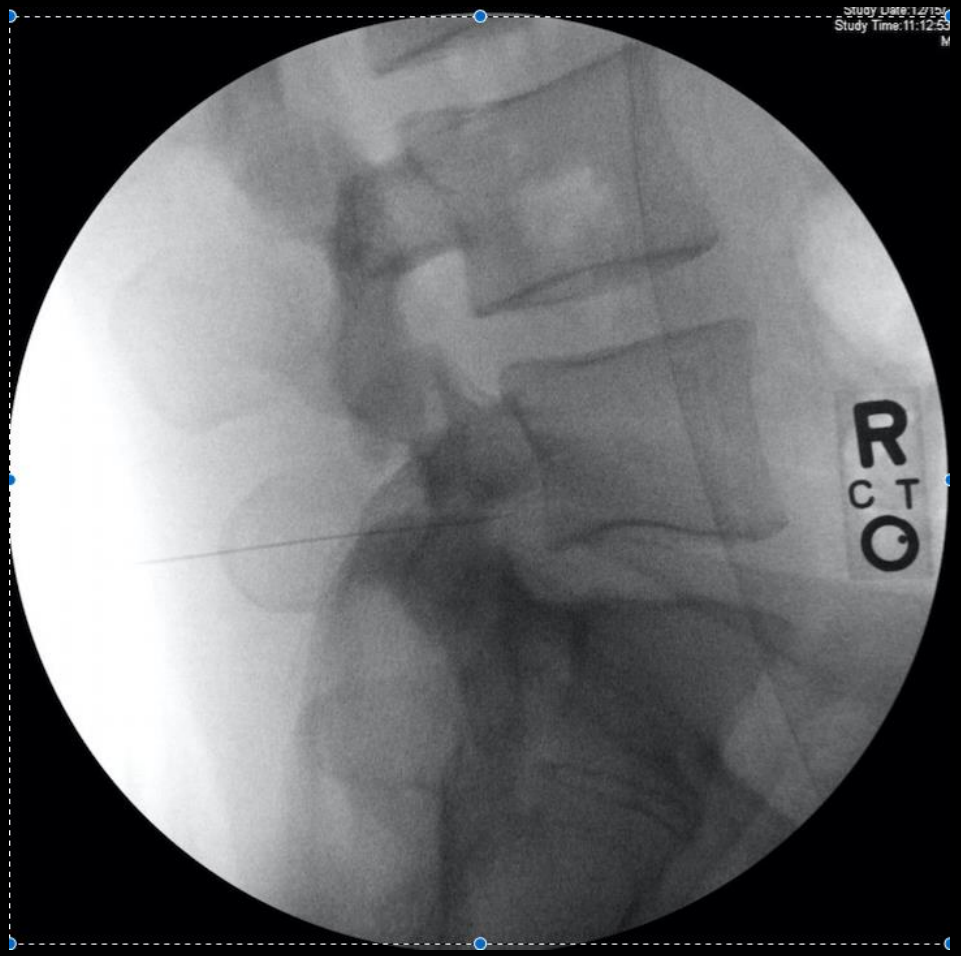
Fig. 1. Frequency of utilization of epidural injections by various specialties from 2000 to 2011, in Medicare recipients.

- Manchikanti L, Pampati V, Falco FJ, Hirch JA. Assessment of the growth of epidural injection in the medicare population from 2000 to 2011. Pain Physician. 2013:Jul-Aug;16(4)E349-64

Where?

- Transforaminal vs Interlaminar vs Caudal





Interlaminar Injection

- Posterior Epidural Space between the dura and ligamentum flavum
- Could be done “blind” so have been around longer
- Diffuse spread of Injectate (along path of least resistance)
- Often fails to wrap all the way around to ventral epidural space
  - Modified IL approach *may* have similar rates of ventral spread
    - Stojanovic MP, Vu T-N, Caneris O, Slezak J, Cohen SP, Sang CN. The role of fluoroscopy in cervical epidural steroid injections: an analysis of contrast dispersal patterns. Spine. 2002 Mar 1;27(5):509–14.
    - Kim ED, Roh MS, Park JJ. Comparison of the Ventral Epidural Spreading in Modified Interlaminar Approach and Transforaminal Approach: A Rondomized, Double-Blind Study. Pain Medicine. 2016 Oct; 17 (9): 1620-1628

Transforaminal Injection

- Directly targets suspected spinal nerve in the neuroforaminal space
- Targets the dorsal root ganglion
- More likely to achieve ventral spread (which happens to be where the herniated disc lies)*

Derby R, Kine G, Saal JA, Reynolds J, Goldthwaite N, White AH, et al. Response to steroid and duration of radicular pain as predictors of surgical outcome. Spine. 1992 Jun;17(6 Suppl):S176–83.

Schaufele MK, Hatch L, Jones W. Interlaminar versus transforaminal epidural injections for the treatment of symptomatic lumbar intervertebral disc herniations. Pain Physician. 2006 Oct;9(4):361–6.

Caudal Epidural Steroid Injection

- Through the sacral hiatus
- 68% of the time achieves only posterior epidural flow
- Medication does not typically spread above the L3-4 or L4-5 level (depending on volume injected)

Kim KM, Kim HS, Choi KH, Ahn WS. Cephalic spreading levels after volumetric caudal epidural injections in chronic low back pain. J Korean Med Sci. 2001 Apr;16(2):193–7.

Blackshear MB, Lutz C, Lutz G. Fluoroscopic Assessment of Epidural Contrast Spread After Caudal Injection. Journal of Orthopaedic Medicine. 2016 July; 22 (2): 38-41.

TFESI vs ILESI vs Caudal

- Schaufele: TFESI > ILESI
- Thomas: TFESI > ILESI
- Lee: (TFESI = ILESI) > CESI
- Ackerman: (TFESI = CESI) > ILESI

- Rados: TFESI = ILESI*

Thomas E, Cyteval C, Abiad L, Picot MC, Taourel P, Blotman F. Efficacy of transforaminal versus interspinous corticosteroid injectionin discal radiculalgia - a prospective, randomised, double-blind study. Clin Rheumatol. 2003 Oct;22(4-5):299–304.

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Lee JH, Moon J, Lee S-H. Comparison of effectiveness according to different approaches of epidural steroid injection in lumbosacral herniated disk and spinal stenosis. J Back Musculoskelet Rehabil. 2009;22(2):83–9.

What?
Particulate vs Non-particulate Steroids

- Particulate steroids (methylprednisolone, betamethasone, triamcinolone) were thought to stay in the epidural space longer and thus work BETTER
- Particulate steroids have also been implicated in major complications related to TFESI*
- Dexamethasone is a non-particulate steroid
  - Safer?*
  - As effective?

All of the studies

Dexamethasone

El-Yahchouchi C, Geske JR, Carter RE, Diehn FE, Wald JT, Murthy NS, et al. The noninferiority of the nonparticulate steroid dexamethasone vs the particulate steroids betamethasone and triamcinolone in lumbar transforaminal epidural steroid injections. Pain Med Malden Mass. 2013 Nov;14(11):1650–7.

EQUAL

Kim D, Brown J. Efficacy and safety of lumbar epidural dexamethasone versus methylprednisolone in the treatment of lumbar radiculopathy: a comparison of soluble versus particulate steroids. Clin J Pain. 2011 Aug;27(6):518–22.

El-Yahchouchi C, Geske JR, Carter RE, Diehn FE, Wald JT, Murthy NS, et al. The noninferiority of the nonparticulate steroid dexamethasone vs the particulate steroids betamethasone and triamcinolone in lumbar transforaminal epidural steroid injections. Pain Med Malden Mass. 2013 Nov;14(11):1650–7.

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Particulate

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Comparative effectiveness of lumbar transforaminal epidural steroid injections with particulate versus nonparticulate corticosteroids for lumbar radicular pain due to intervertebral disc herniation: a prospective, randomized, double-blind trial.

Kennedy DJ[1], Plastaras C, Casey E, Visco CJ, Rittenberg JD, Conrad B, Sigler J, Dreyfuss P.

- Randomized, double blind, multi-center, prospective study
- Patients had unilateral lumbar radicular pain from corresponding intervertebral disc herniation
- Randomized to 40 mg triamcinolone vs 10 mg dexamethasone

Pain Med. 2014 Apr;15(4):548-55. doi: 10.1111/pme.12325. Epub 2014 Jan 2.

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Kennedy DJ[1], Plastaras C, Casey E, Visco CJ, Rittenberg JD, Conrad B, Sigler J, Dreyfuss P.

	7–14 Days	3 Months	6 Months
Dexamethasone *(N= 41)*			
51% Reduction in ODI	26.8%	68.2%	70.7%
50% Pain reduction	31.7%	73.2%	73.2%
Triamcinolone *(N= 37)*			
ODI	35.1%	67.6%	64.9%
50% Pain reduction	43.2%	73%	75.7%

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Comparative effectiveness of lumbar transforaminal epidural steroid injections with particulate versus nonparticulate corticosteroids for lumbar radicular pain due to intervertebral disc herniation: a prospective, randomized, double-blind trial.

Kennedy DJ[1], Plastaras C, Casey E, Visco CJ, Rittenberg JD, Conrad B, Sigler J, Dreyfuss P.

- Both groups demonstrated statistically significant improvements in pain and function at 2 weeks, 3 months, and 6 months.
- Progression to surgery was similar between groups (14.6% dexamethasone vs 18.9% triamcinolone)
- To achieve these outcomes: 7/41 (17%) patients in the dexamethasone group vs 1/37 (3%) in the triamcinolone group needed a third injection

Pain Med. 2013 Nov;14(11):1650-7. doi: 10.1111/pme.12214. Epub 2013 Jul 30.

The noninferiority of the nonparticulate steroid dexamethasone vs the particulate steroids betamethasone and triamcinolone in lumbar transforaminal epidural steroid injections.

El-Yahchouchi C[1], Geske JR, Carter RE, Diehn FE, Wald JT, Murthy NS, Kaufmann TJ, Thielen KR, Morris JM, Amrami KK, Maus TP.

- Retrospective observational study
- 2,634 patients with 2 month follow up
- Dexamethasone 10 mg vs Triamcinolone 80mg or betamethasone 12 mg
- Categorical outcomes:
  - No difference in rates of those achieving >50% improvement in pain
  - Dexamethasone favored with respect to proportion of patients achieving >40% improvement on RMDQ

Summary

- When looking at studies, look for who/how many actually got better (categorical outcomes)
- Radicular pain is inflammatory
- ESI are effective in treating lumbar radicular pain
  - Evidence in support pain due to disc herniation is greater than pain due to stenosis
- Evidence supports TFESI > ILESI
- Dexamethasone appears as effective as particulate steroids (but it is safer too)

THANK YOU

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