Optimizing Lumbar and Cervical Facet Radiofrequency Ablation Outcomes: Focus on Multispecialty Guideline Recommendations

Steven P. Cohen, MD

Johns Hopkins School of Medicine &

Walter Reed National Military Medical Center

Steven P. Cohen
Financial Relationship Disclosure

- Consultant for Avanos, Scilex, Persica, Releviate, SWORD & SPR
- This presentation does discuss off-label usage

Objectives

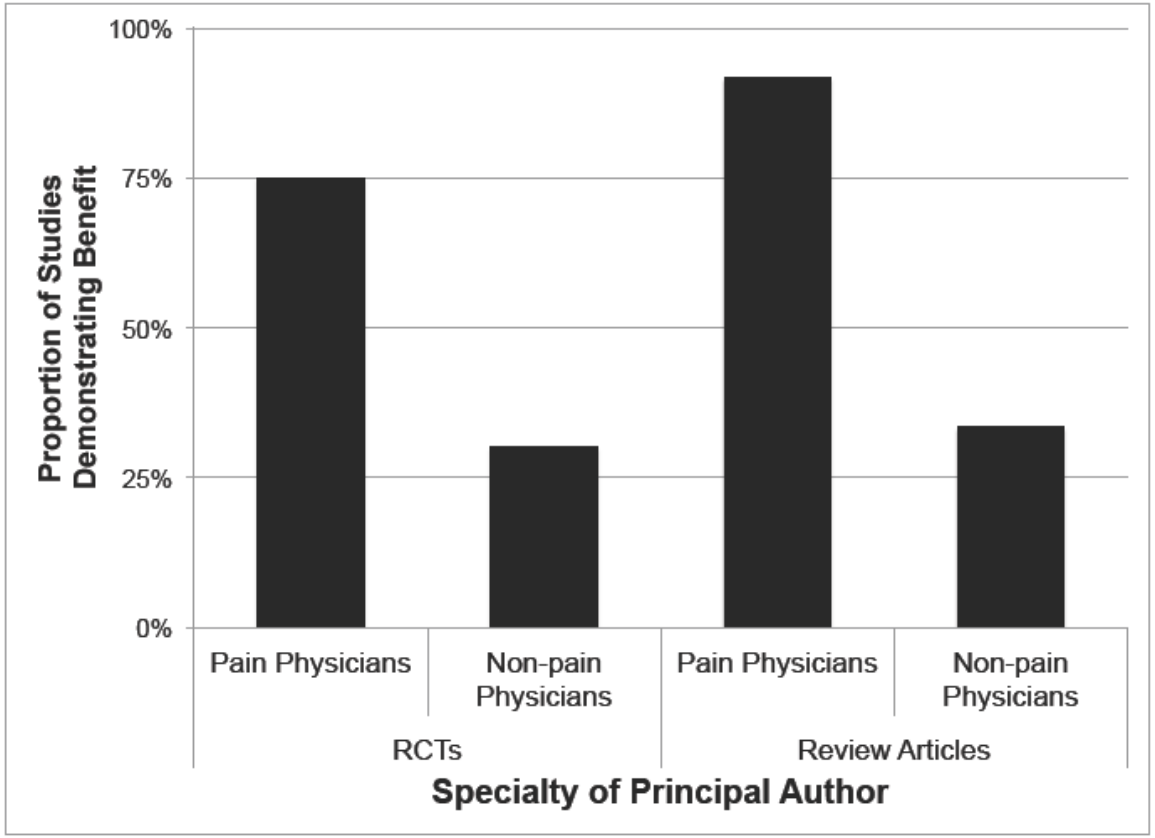
- Be cognizant of the effects raising diagnostic thresholds (increasing number of blocks and pain relief cutoffs) will have on access to care & the rationale for lowering them
- Understand the effects sedation will have on false-positive results
- Be familiar with the data and theoretical basis for using MBB (over IA injections) as prognostic tests before RFA
- Understand the rationale for employing parallel or near-parallel electrode insertion for RFA

How Important is Perspective?

- “The Philistines made frequent incursions against the Hebrews. There was almost perpetual war between the two peoples. But no Philistine writings survive, unlike the Old Testament, which is often taken at ‘face value’.”

- Unlike the common belief, the Philistines were not unsophisticated, uncultured brutes, but advanced, refined people. In fact, for several generations their culture was years ahead of Israel's, a disparity they maintained through their martial superiority.

ESI Positive Outcomes by Specialty



Cohen et al. RAPM 2013

Effect of Perspective on Outcome

- Although the UK guidelines suggest consideration of radiofrequency denervation for chronic low back pain that is unresponsive to non-surgical treatments, the subsequently published negative MINT trials challenge this recommendation.

Foster et al. Lancet 2018

Effect of Perspective on Outcome

- For mechanical LBP, RFA is effective in well-selected patients.
- RFA of the cervical and lumbar facet joints, SIJ, and knee are associated with modest long-term benefit, but clinical outcomes are highly dependent on careful patient selection and meticulous technique, with otherwise high-quality studies that have used lax recruitment criteria or ablation strategies resulting in small lesions, yielding negative or mixed results.

Knezevic et al. Lancet 2021; Cohen et al. Lancet 2021

Conceptual Basis for RF Denervation: MBB Relieve Pain

- Controlled trial in which 104 pts had lumbar MBB with saline and if (-), MBB with lidocaine
  - 16% had ≥ 50% relief with placebo
- 87 underwent MBB with lidocaine
- 62% had > 50% relief
  - 67% had relief @ 3 months
  - 33% had recurrence of pain, most within 1 week
- Only 17% considered "true responders"

- 227 pts randomized to lumbar MBB, IA or saline injections
  - Mean reduction in avg. LBP 47.3%, 47.4% and 37.4%
  - 55%, 54% and 30% had (+) block
- 50 pts with chronic neck pain after MVC rec'd MBB with bupivacaine, lidocaine or saline

TABLE 2. *Responses to comparative and placebo blocks*

Response group	Placebo negative	Placebo responder
Concordant	11	3
Concordant prolonged	2	0
Discordant prolonged	7	4
Discordant	4	2
Discrepant	6	11

Dias da Rocha et al. Clinics (Sao Paulo) 2014; Cohen et al. Anesthesiology 2018; Lord et al. CJP 1995

Are Medial Branch Blocks Diagnostic or Prognostic?

- Facet joint pathology in the absence of disc pathology is rare in low back, similar or slightly higher prevalence in neck
- Medial branches innervate multifidus, semispinalis cervicis & capitus and other structures
- One cannot "selectively" block the medial branch without other branches of the dorsal ramus (intermediate branch in l-spine, lateral branch in l- and c-spine)
- 11% of patients have "aberrant" innervation in lumbar spine

Kaplan et al. Spine 1998

Facet Blocks

Facet Block Not an "Ideal" Screening Test

- Screening test with high sensitivity and NPV important before a safe, inexpensive procedure
- Facet blocks have similar complication rate to RF
- Costs for 2 procedures comparable
- 20%-47% of pts with "negative" block will benefit from RF (Derby et al. 2013)

Utility of Medial Branch Blocks & NPV's

- Lord et al. CJP 1995:
  - Sensitivity 54%, Specificity 88%
  - PPV 88%, NPV 68%
- Derby et al. Pain Phys 2013
  - Sensitivity 55%, Specificity 77%
  - PPV 78%, NPV 53%
- Cohen et al. Spine J 2008
  - NPV 52% (lumbar facet)
- Stojanovic et al. CJP 2009
  - NPV 53% (lumbar facet)
- Cohen et al. RAPM 2007
  - NPV 44% (cervical facet)

Proper Diagnosis: False-Positive Blocks: Rationale for 2-Blocks

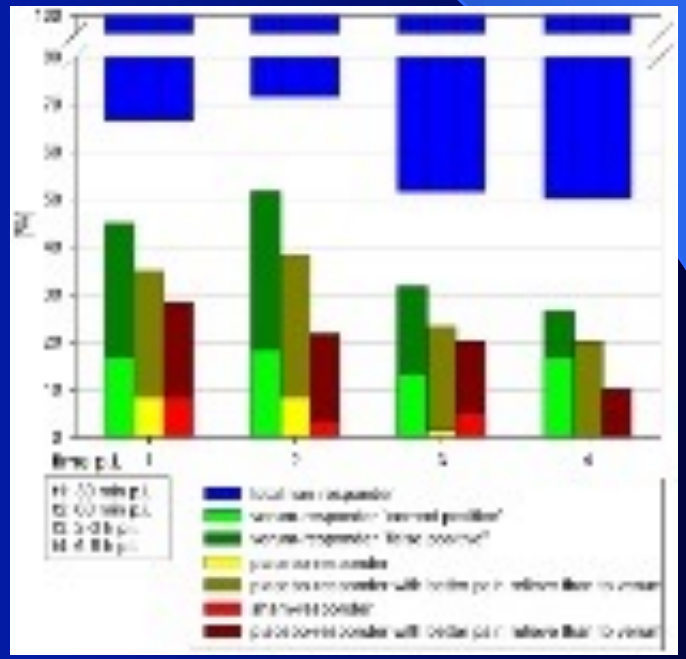
- Prevalence & FP rates of z-joint pain:
  - L-spine: Prev 10%-15%
    - FP: 25%-40%
  - T-spine: Prev 42%-48%
    - FP: 55%
  - C-spine: Prev 45%-60%
    - FP: 27%-63%
- Rates determined by non-validated comparative LA blocks
  - **Rates in T & C-Spine cannot be accurate**
  - **Could 2nd block be false-negative?**

Author	Patients	Region	FP/Placebo Response Rate
Revel, 1998	38	Lumbar	18%
Ackerman-1, 2004	15- 1st injection	Lumbar	73%
Ackerman-2, 2004	15- 2nd injection	Lumbar	12%
Lord, 1993	50	Cervical	19% (32% false-negative rate)
Cohen et al. 2018	42	Lumbar	30%
Dias da Rocha et al. 2014	104	Lumbar	16%

False-Positive Rates with Sham Injections

Value of Diagnostic Injections

- False-positive rate of "uncontrolled blocks" estimated at 25-40%
- Comparative LA blocks found to be highly specific (88%), but marginally sensitive (54%)
- Schutz et al. 2011: Randomized, SB, 3-stage crossover study in 60 pts with FJ degeneration
  - Injected 1.5 ml LA or saline into single joint or outside joint
- Small differences between verum & placebo and verum & sham
- Concluded single IA injections unreliable



Lord et al. CJP 1995; Ackerman et al. Pain Pract 2004; Schutz et al. PLoS One 2011

How Many Prognostic Blocks Should One Perform Before RF Ablation?

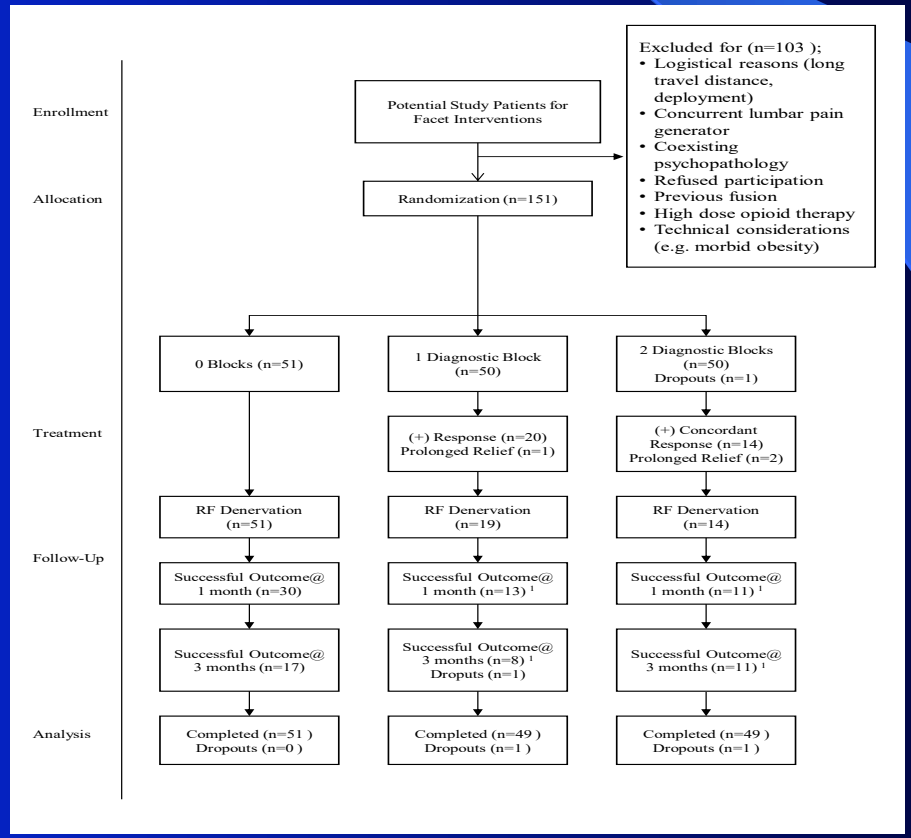
- Define Goals: Differ for pts, payers, organizations and providers
  - We prioritized patient access to care
- SIS, NASS & ASIPP recommend 2 blocks
- Screening test for RFA should have high sensitivity and NPV
  - Not the case with facet blocks
- Placebo response rate very high for procedures, and greater than intrinsic effect of RFA

- Retrospective study in 229 pts who underwent MBB
  - 107 had < 50% relief, and 15 had 2nd MBB
    - 7 had ≥ 70% relief, 4 underwent RF and all obtained (+) outcome
    - False-negative rate 47% (range 27%-60%)
    - Authors estimated it as possibly 46.7%, prob < 20%
  - 44 had 50-69% relief and 17 had 2nd MBB
    - 8 had ≥ 70% relief, 4 underwent RF and 2 had (+) outcome
    - False-negative rate 24% (range 12%-41%)
    - Authors estimated it as 47.1%
  - 78 had 70-100% relief and 23 had 2nd MBB
    - 18 had 70-100% relief, 15 underwent RF and 14 had (+) outcome
    - False-negative rate 9%
  - 75% (6/8) of people with "delayed pain relief" had a positive 2nd block (false-negative)
  - 87% success rate in all pts undergoing RF vs. 75% in false-negative blocks (p=NS)

Derby et al. Pain Physician 2013. Assumes same success rate for people who didn't undergo RF as for those who underwent RF after 2nd (+) block, and that those who had (+) response to RF were FN; Positive response to 2nd block (i.e. 1st block FN) estimated as those who would obtain > 50% relief

How Many Prognostic Blocks Should One Perform Before RF Ablation?

- Stojanovic et al. CJP 2010: 127 pts, retrospective study on L-RFA
  - Identical 47% success rates for ≥80% relief on 2 blocks and those with ≥50 <80% on 2 blocks or 1 block
- Cohen et al. RAPM 2015: 511 pts, multi-center, case-control, L-RFA
  - 63% success rate with single blocks vs. 70% with double blocks
- van Eerd et al. Pain Pract 2014: C-RFA, 65 pts, observational study
  - 55% RFA success rate with 0 blocks
  - Subsequent RCT in C-spine found success rates > 50% in both control & rx groups
- McCormick et al. Pain Med 2018: Knee RFA, 54 pts, RCT
  - 64% success rate in 0-block vs. 59% in single-block group
- Derby et al. Pain Physician 2013: 51 pts, L-RFA, retrospective study on L-RFA
  - 63.2% success rate in single-block pts vs. 84.6% in the 13 double-block pts
- Cohen et al. Anesthesiology 2010: RCT in 151 pts



Successful Outcomes by Treatment Group

	0-Block (RF)	Single-Block	Double-Block	P-Value
Successful Outcome @ 1-Month (%)	30 (58.8)	13 (26.0)	11 (22.5)	< 0.001
Success at 1-month among persons with RF	30 (58.8, n = 51)	12 (63.2, n = 19)	9 (64.3, n = 14)	0.905
Successful Outcome @ 3-Months	17 (33.3)	8 (16.0)	11 (22.0)	0.115
Success at 3- months among persons with RF	17 (33.3, n = 51)	7 (38.9, n = 18)	9 (64.3, n = 14)	0.111

Cost Per Successful Treatment

	0-Block (RF)	Single-Block	Double-Block
Cost Per Successful Treatment	$6286.03	$17,142.11	$15,241.31
Cost Per Successful Treatment Excluding Medication Costs and Missed Work Days	$6053.68	$16,236.12	$14,237.76
Total Cumulative Costs for Facility Fees	$63,936	$86,247	$103,563
Total Cumulative Costs for Diagnostic Blocks	$0	$29,294.38	$42,718.26
Total Cumulative Costs for RF Denervation	$38,976.51	$14,345.46	$10,323.10
Estimated Cost of Missed Work Days	$7650	$10,050	$13,350
Estimated Savings on Medications	$3700	$2800	$2300

Does Concordant Response to Diagnostic MBB Make Sense?

- Retrospective study on 112 pts who underwent cervical & lumbar RFA after obtaining ≥ 70% based on comparative LA blocks
  - Used 1 mL and 0.5 mL for MBB in low back and neck, respectively
  - 50 had 3-month data available
  - Individuals with complete pain relief had higher baseline disability
- Patients underwent RFA using 18-gauge electrodes with 10 mm active tips
  - 80° C, 105 s, multiple lesions
  - Electrodes placed parallel to nerves

3-Month Outcome Variable	Concordant (Both blocks ≥ 70%)	Discordant	P-Value
Pain Relief (%)	53.1	44.4	0.47
Mean Improvement in Function	- 12.9	- 15.1	0.72

Holz & Sehgal. Pain Physician 2016

Outcomes Stratified by % Pain Reduction and Duration of Benefit after MBB: Powerful Placebo Response

MBB Analgesic Response (Lidocaine)	Pain Relief @ 3 mo (%)	Function @ 3 mo
100% reduction	49.7	32.0
70-100% reduction	42.0	27.6
> 8h pain relief	73.9	16.8
≤ 8h pain relief	40.4	34.5

MBB Analgesic Response (Bupivacaine)	Pain Relief @ 3 mo (%)	Function @ 3 mo
100% reduction	58.5	25.3
70-100% reduction	41.5	30.9
> 8h pain relief	53.8	27.2
≤ 8h pain relief	49.8	28.2

Holz & Seghal. Pain Physician 2016

Unique Considerations for Cervical Region

- Pre-test probability of facet pathology in chronic neck pain greater than for LBP
  - Whiplash injuries may damage z-joints
  - Greater surface area relative to discs, and greater motion in the neck
- Lower incidence of false-positive blocks (main rationale for double blocks), possibly higher false-negative rate
- Cohen et al. 2020: 7% (6/86) incidence of missed nerves despite accurate needle placement
  - Reportedly higher than in l-z region
- Lord et al. 1995: 34 of 50 pts with whiplash classified as 'negative' based on lack of concordant response to lidocaine & bupivacaine. When criterion changed to reproducible relief with lidocaine & bupivacaine but not with saline, 11 were considered FN (32.4%)
- Higher technical and clinical success rates in c-spine based on direct and indirect comparisons
  - Less nerve variability and smaller size
  - Lower false-negative rate for diagnostic blocks
  - Possibly less psychopathology

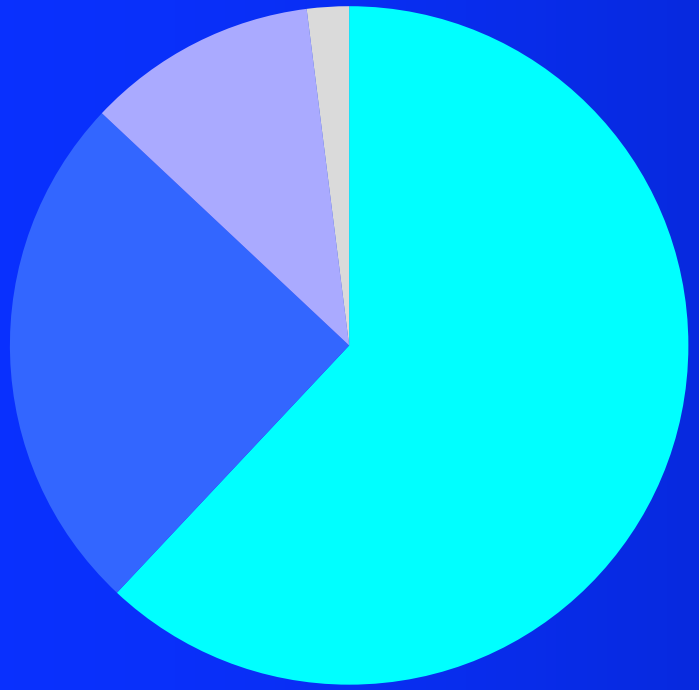
Level of Evidence

- We recommend a single block for clinical practice
  - Double-blocks will result in a higher success rate (and should be used in clinical trials designed to determine efficacy)
  - 0 blocks will result in highest overall success rate & lowest overall costs in U.S.
  - Ultimate decision on # of blocks should be tailored to individuals

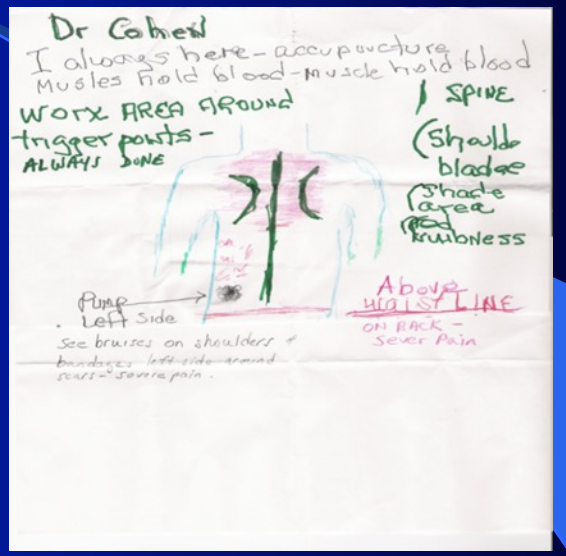
- GRADE C RECOMMENDATION, LOW-TO-MODERATE LEVEL OF CERTAINTY FOR L-SPINE
- GRADE B RECOMMENDATION, LOW-TO-MODERATE LEVEL OF CERTAINTY FOR C-SPINE

Patient Selection is “Key”

Causes of Treatment Failure



- Poor patient selection
- Misdiagnosis
- Technical treatment failure
- Complication



Studies with (+) Outcomes Twice as Selective as (-) Studies

Patients Screened and Enrolled	Outcome
Gallagher 1994: Single-blind RCT. 41 pts with clear-cut or equivocal relief with 1 IA injection	RF ≥ placebo
Van Kleef 1999: DB RCT. Screened 256 pts with 1 MBB (50% relief) for 31 subjects	RF > placebo
Van Wijk 2005: DB RCT. Screened 462 pts with IA injection (50% relief) for 81 subjects	RF= placebo
Tekin 2007: DB, 3-arm RCT. 60 pts based on 1 MBB (50% relief)	RF > PRF > placebo
Moussa 2016: DB RCT. Screened 213 pts with 2 MBB (2/3 had 'near complete relief') to enroll 120 subjects	RF capsule ≥ RF MB > placebo
Lakemeier 2013: DB RCT. Screened 89 pts with 1 IA injection (50% relief) for 56 subjects.	IA steroid injection + placebo = RF
Nath 2008: DB RCT. Screened 376 pts with 3 MBB (80% relief) for 40 subjects	RF > placebo
Dreyfuss 2000: Prospective audit. Screened 460 pts with 2 MBB (80% relief) for 15 subjects	87% had relief @ 1-yr
Leclaire 2001: DB RCT. Screened 76 pts with 1 IA injection (significant relief) for 70 subjects	RF= placebo
Van Tilberg 2016: DB RCT. Screened 104 pts with 1 MBB (≥ 2-pt decrease) for 60 subjects	RF = placebo
Juch 2017: Pragmatic open-label RCT. Screened 931 for 251 subjects (> 70% had ≥ 50% relief with 1 MBB)	RF = placebo
Cohen 2018: DB, 2-phase RCT. Screened 967 pts to enroll 142 in RFA phase. 50% cutoff for single IA injections and MBB	RF ≥ placebo
van Eerd 2021: DB RCT. Screened 240 pts with 0 MBB to enroll 76 subjects	**RF ≥ placebo**
Lord 1996. DB RCT. Screened 54 neck pain pts with 3 MBB (100% relief, no relief with saline) for 24 subjects	**RF > placebo**
Stovner 2004: DB RCT. 12 pts with cervicogenic H/A. Pts had MBB and GON blocks, but blocks not used to selective pts.	**RF ≥ placebo**

The literature strongly suggests “efficacy” (i.e. benefit in well-selected individuals), but what about utility, effectiveness & objective outcomes?

Does RFA Affect Opioid Use and Healthcare Utilization?

- 44,936 pts underwent lumbar MB RFA from 2007-16 via MarketScan database
  - 90 days after RFA, 7.1% of pts stopped filling opioid prescriptions while 5.9% started receiving opioids
  - Exclusively examining pre-RFA opioid users (2 scripts within 60 d of procedure), 22.1% and 24.9% stopped filling opioid prescriptions 90 and 180 days s/p RFA
- 2887 opioid-naïve pts underwent lumbar MB RFA from 2007-16
  - 78.9% had peri-procedure opioid fill
  - New persistent opioid use rate was 5.6% in those who had peri-RFA opioid prescription vs. 2.8% in those who did not
- 4653 pts from Ontario who underwent RFA for axial spine pain from 2009-15
  - 24% reduction in doctor visits and 86% reduction in procedures for 12-mo post-RFA
  - No change in opioid consumption

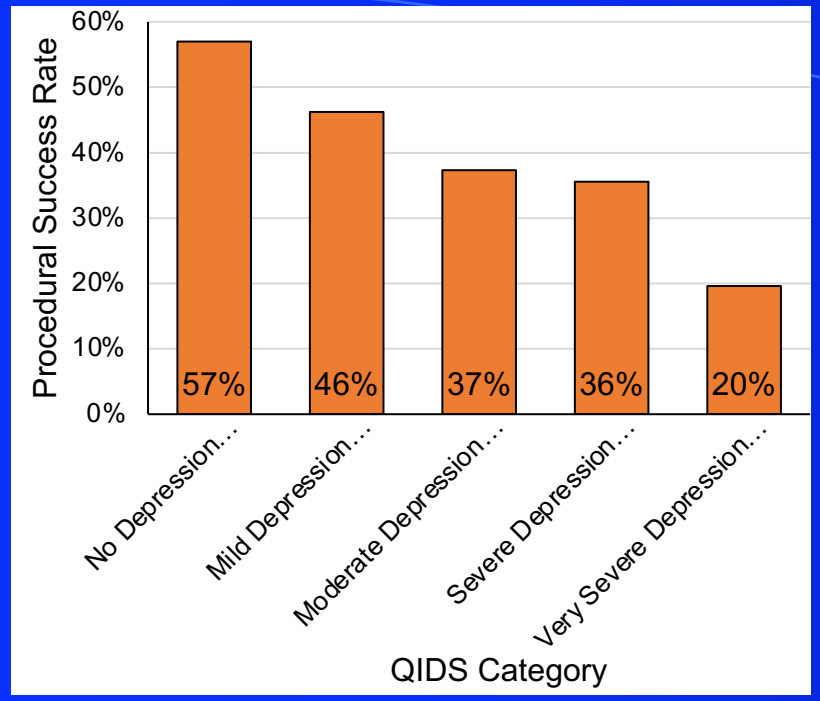
Starr et al. Spine J 2020; Southren et al. Anesthesiology 2020; Loh et al. RAPM 2019

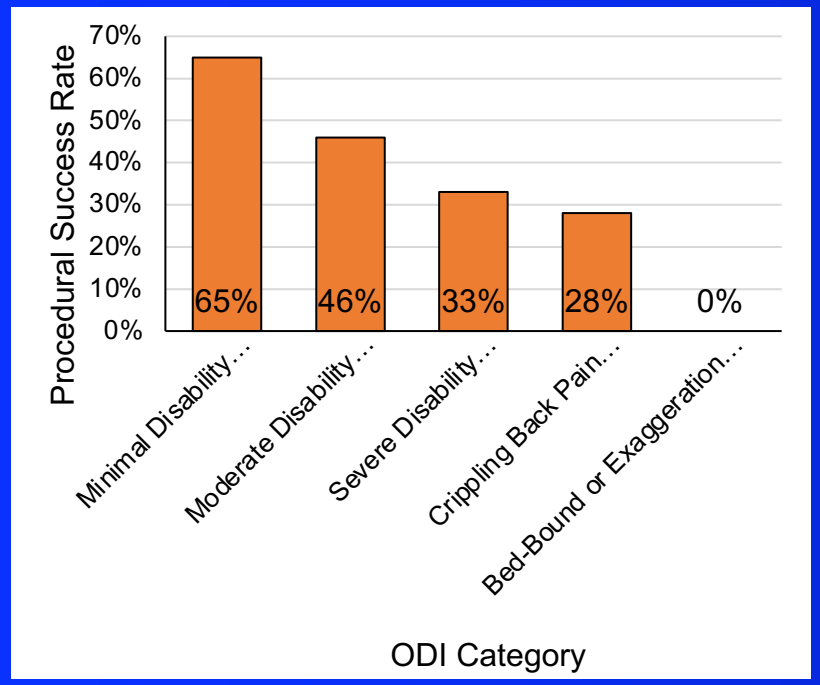
Factors Associated with LBP Procedures

Cohen et al. RAPM 2022

- 346 pts who received facet interventions, SIJ blocks or ESI for LBP prospectively followed to determine factors associated with outcome
- (+) Outcome = ≥2-point decrease in back or leg pain at 1° endpoint & > 3/5 satisfaction
- Examined > 2-dozen variables

Variable	Unadjusted Odds Ratio (95% CI)[1]	P-Value	Adjusted Odds Ratio, Full Model (95% CI)[1]	P-Value	Adjusted Odds Ratio, Revised Model (95% CI)[1]	P-Value
Age, years	1.02 (1.00, 1.03)	0.039	1.02 (1.00, 1.04)	0.024		
Duration of Pain, years	0.96 (0.93, 1.00)	0.051	0.96 (0.93, 1.00)	0.072		
Obesity	0.58 (0.36, 0.92)	0.022	0.62 (0.37, 1.03)	0.066		
Smoking	0.41 (0.23, 0.74)	0.003	0.64 (0.33, 1.24)	0.19		
Any Daily Opioid Use	0.68 (0.42, 1.12)	0.13	0.75 (0.42, 1.35)	0.34		
Athens Insomnia Scale (mean ± SD)	0.93 (0.89, 0.97)	0.002	1.01 (0.95, 1.09)	0.66		
QIDS (Depression)	0.94 (0.91, 0.97)	<0.0001	0.96 (0.91, 1.00)	0.077	0.94 (0.91, 0.97)	<0.0001
Nonorganic Signs, number	0.73 (0.59, 0.90)	0.004	0.94 (0.72, 1.22)	0.63		
Oswestry Disability Score (mean ± SD)	0.97 (0.96, 0.99)	<0.0001	0.99 (0.97, 1.01)	0.31	0.59 (0.36, 0.96)	0.034
Average Baseline NRS Primary Pain Location Score[2]	0.86 (0.76, 0.98)	0.019	0.94 (0.80, 1.10)	0.41		





Lumbar Facet Intervention Guideline Recommendations

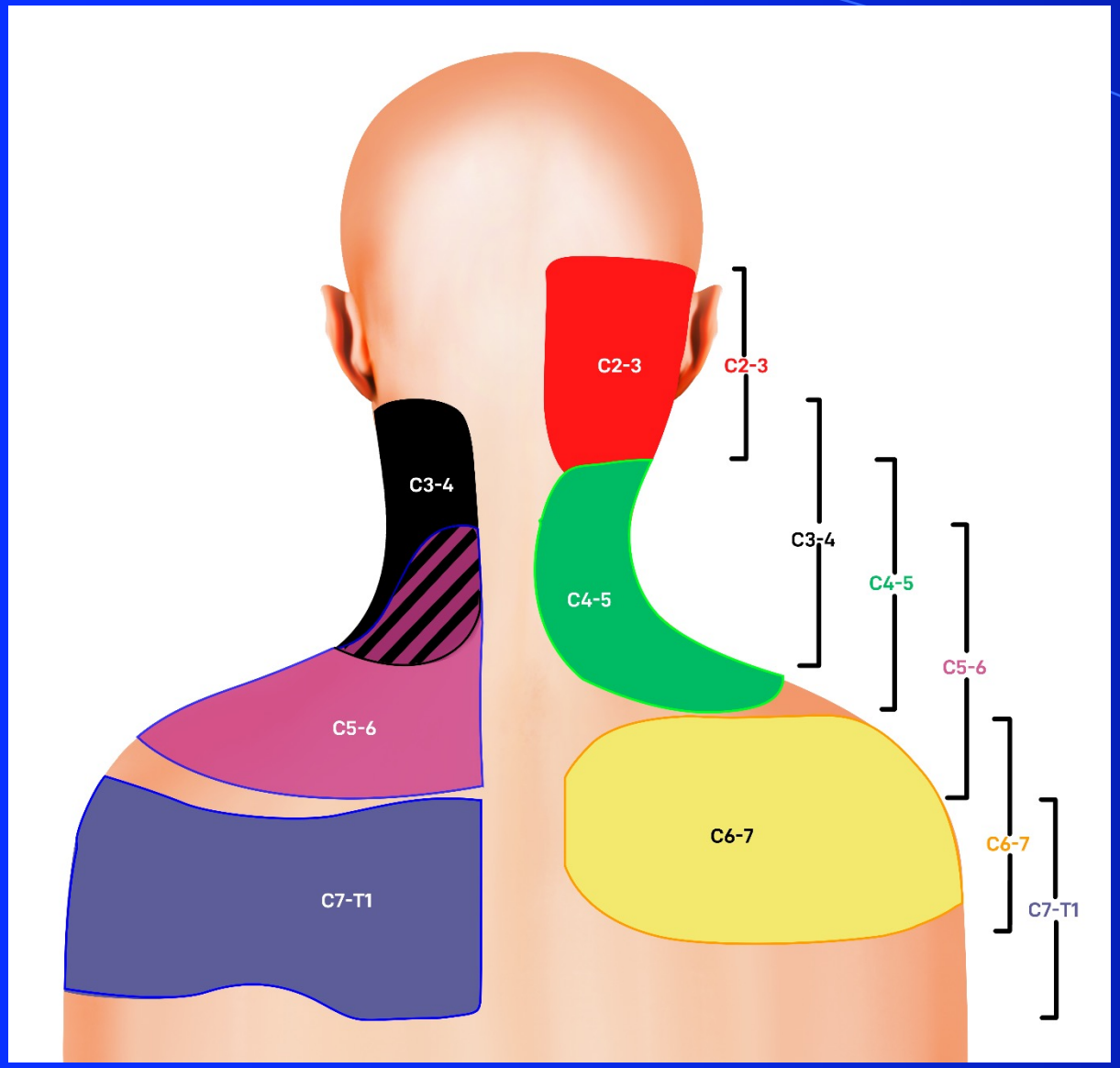
There are no pathognomonic PE or historical signs that reliably predict response to facet joint blocks although pain not predominantly in the midline and possibly tenderness overlying the facet joints, are weakly associated with a (+) response to l-z joint interventions. Studies have shown that maneuvers associated with radiculopathy may be predictive of (-) blocks. Similar to other interventions for chronic pain, greater disease burden and psychiatric comorbidities may be associated with treatment failure. When selecting targets for blocks, levels should be determined based on clinical presentation (radiological findings when available, tenderness on palpation performed under fluoroscopy, pain referral patterns); grade C evidence, low level of certainty.

Table 5 Studies examining history (including referral patterns) and physical examination signs for patients with cervical facetogenic pain

Author, year	Patients	Design	Results	Comments
Dwyer *et al* 1990[76]	4 asymptomatic volunteers and 1 patient with neck pain whose cervical facet joint capsules were 'stimulated' using 1 mL IA contrast	Prospective cohort study	Pain referral maps produced for C2–3 (lower head, upper neck), C3–4 (upper neck), C4–5 (well localized to mid-neck below C3–4), C5–6 (top of scapula and shoulder above the scapular spine) through C6–7 (lower neck to inferior angle of scapula) joints	Pain produced by injection in 9 out of 11 joints
Aprill *et al* 1990[13]	10 pts with neck pain received MBB with LA and steroid	Prospective cohort study	Concordance between painful joint level(s) predicted based on clinical evaluation and response to diagnostic blocks	4 pts had undergone anterior cervical fusions. 3 pts had negative discography results for cervical discogenic pain
Barnsley and Bogduk, 1993[75]	16 pts with chronic neck pain, with or without referred pain in the head or shoulder after MVC received controlled MBB with LA	Prospective study	11 of 16 pts had complete relief of neck pain with restoration of neck movements after cervical MBB; 4 of the remaining 6 had a positive cervical MBB at non-predicted levels	No control group. Levels for cervical MBB chosen based on pain maps and sites of maximal tenderness. No patient had radiculopathy. Normal imaging studies. The 25 MBB performed were highly specific
Lord *et al* 1994[74]	100 pts with chronic neck pain after whiplash received double diagnostic MBB with LA	Prospective study	C2–3 joint was responsible for headaches in 27% of pts confirmed by diagnostic TON block. Tenderness over C2–3 joint on examination predicted positive block	No control group. C2–3 joint responsible for headaches in 53% of pts when headache was main symptom
Lord *et al* 1996[67]	68 pts with chronic neck pain after MVC with Quebec Task Force WAD grade I–IV selected by double diagnostic MBB with LA and placebo injection who underwent medial branch RFA	Prospective RCT	60% of pts who completed the study had headache and neck pain from cervical facet joints	Sham medial branch RFA group included C2–3 facet joint pain in 50% of pts with headache as dominant symptom
Fukui *et al* 1996[51]	61 pts with neck pain from the cervical facet joints confirmed by IA capsular stimulation or electrical stimulation of dorsal rami C3–7	Prospective cohort study	Pain region and source (joint and/or DR): Occipital region: C2–3 and C3 DR Upper posterolateral cervical region: C0–1, C1–2, and C2–3 Upper posterior cervical region: C2–3, C3–4, and C3 DR Middle posterior cervical region: C3–4, C4–5, and C4 DR Lower posterior cervical region: C4–5, C5–6, C4, and C5 DR Suprascapular region: C4–5, C5–6, and C4 DR Superior angle of scapula: C6–7, C6, and C7 DR Mid-scapular region: C7/TI and C7 DR	
Jull *et al* 1998[409]	20 pts with neck pain who had complete pain relief with dual MBB. Assessed the diagnostic accuracy of physical examination	Observational study	15 of 15 (100%) pts with cervical MBB-proven facet joint pain (and no CMBB-negative pts) were correctly identified based on physical examination. The correct segmental level was identified in all pts	Internal controls were asymptomatic joints. 100% sensitivity and specificity of physical examination to predict block response. Incidence of cervical facet joints as the cause of neck pain was 75%
Cooper *et al* 2007[49]	194 pts with neck pain who underwent dual comparative MBB	Prospective observational study	Segmental patterns of pain arising from cervical facet joints identified: Suboccipital: C1–2, C2–3 Posterolateral neck: C3–4 Neck to shoulder girdle: C4–5 Lower neck to upper limb girdle: C5–6, C6–7	Pain patterns of adjacent segments overlapped
Cohen *et al* 2007[20]	92 pts who underwent cervical medial branch RFA	Retrospective study to determine factors associated with successful RFA	Paraspinal tenderness associated with successful outcome	Radiation of pain to head, opioid use, and pain exacerbated by neck extension and/or rotation associated with failure
King *et al* 2007[78]	173 pts with suspected cervical facet joint pain based on physical examination studied with MBB	Observational study	Physical examination lacked validity, refuting results of a previous study with overlapping authors.[409] Examination had a high sensitivity (88%) but low specificity (39%)	Pts with previous cervical spine surgery and those with negative physical examination signs were excluded
Smith *et al* 2013[72]	90 subjects with WAD >6 months duration post-MVC who received IA injections and MBB; 30 healthy controls	Cross-sectional design comparing physical and psychological examination in responders and non-responders with WAD to control pts	58 of 90 (64%) achieved at least 50% pain relief with IA or MBB. No difference in objective sensory testing, muscle activity or ROM between facet block responders and non-responders, but all were abnormal compared with controls. Facet non-responders had greater medication use and catastrophizing scores compared with responders	Large proportion of participants were lost to follow-up
Schneider *et al* 2014[79]	125 pts with neck pain in whom a clinical examination protocol was validated against positive dual cervical MBB outcome (≥80% reduction of pain)	Prospective cohort study	A protocol consisting of MSE, PST, and ER test had a specificity of 84% (95% CI 77% to 90%) and a positive likelihood ratio of 4.94 (95% CI 2.8 to 8.2) for cervical facet joints as the source of neck pain	Sensitivity of PST and MSE were 94% (95% CI 90% to 98%) and 92% (95% CI 88% to 97%), respectively. Any single test was insufficient for diagnosis

Historical and PE Findings Associated with Cervical Facet Block and RFA Outcomes & Guideline Recommendations

There are no single pathognomonic historical or PE signs that reliably predict response to cervical facet joint blocks, although a history of whiplash and presence of paraspinal tenderness are weakly associated with a positive response to facet joint interventions. Maneuvers associated with radiculopathy may be predictive of (-) blocks. There does not appear to be differences between the psychological profiles of responders and non-responders to c-z joint interventions. When selecting targets for blocks, levels should be determined based on clinical presentation and pain referral patterns); grade C recommendation, low level of certainty.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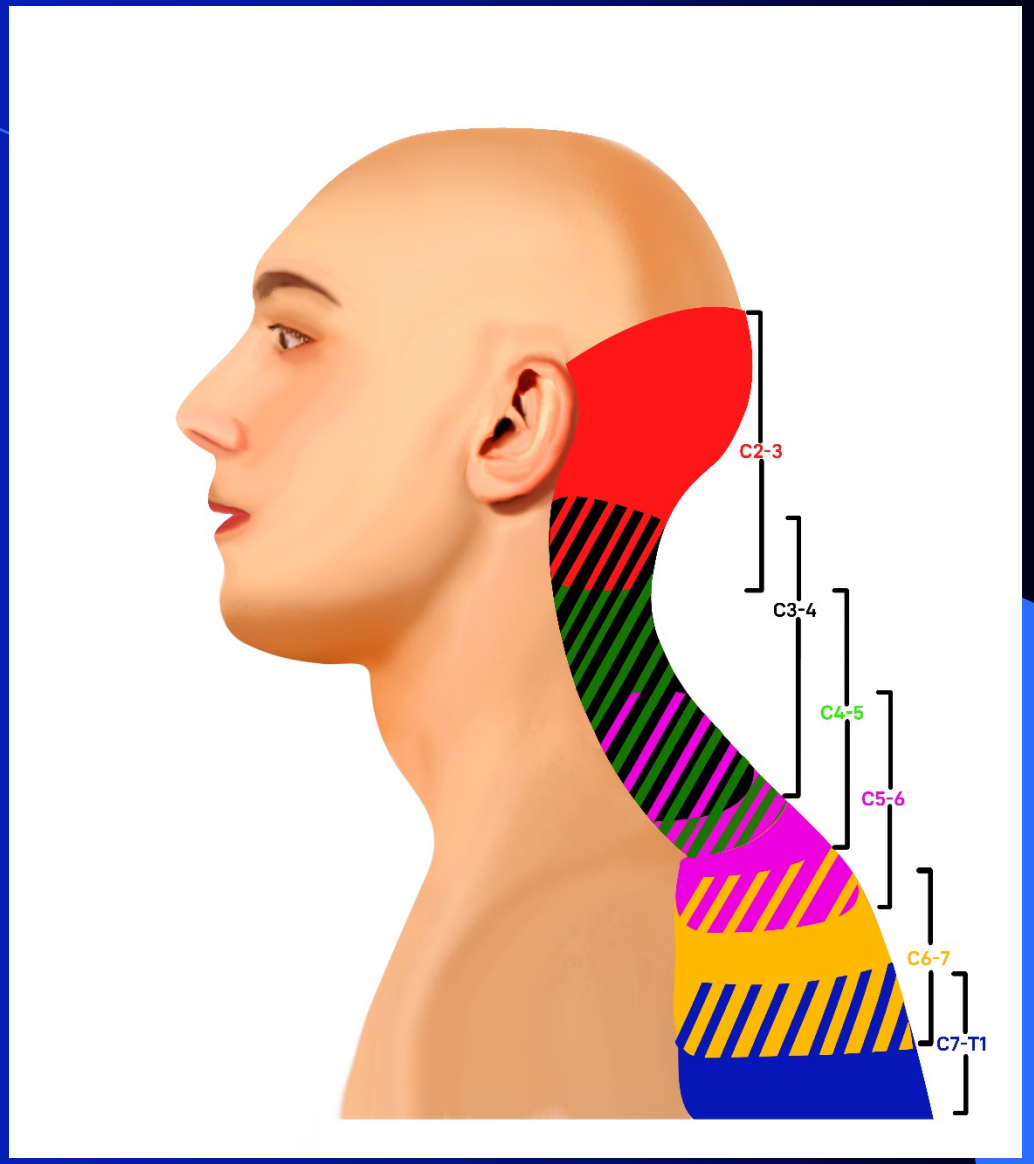

C2-3
C3-4
C4-5
C5-6
C6-7
C7-T1

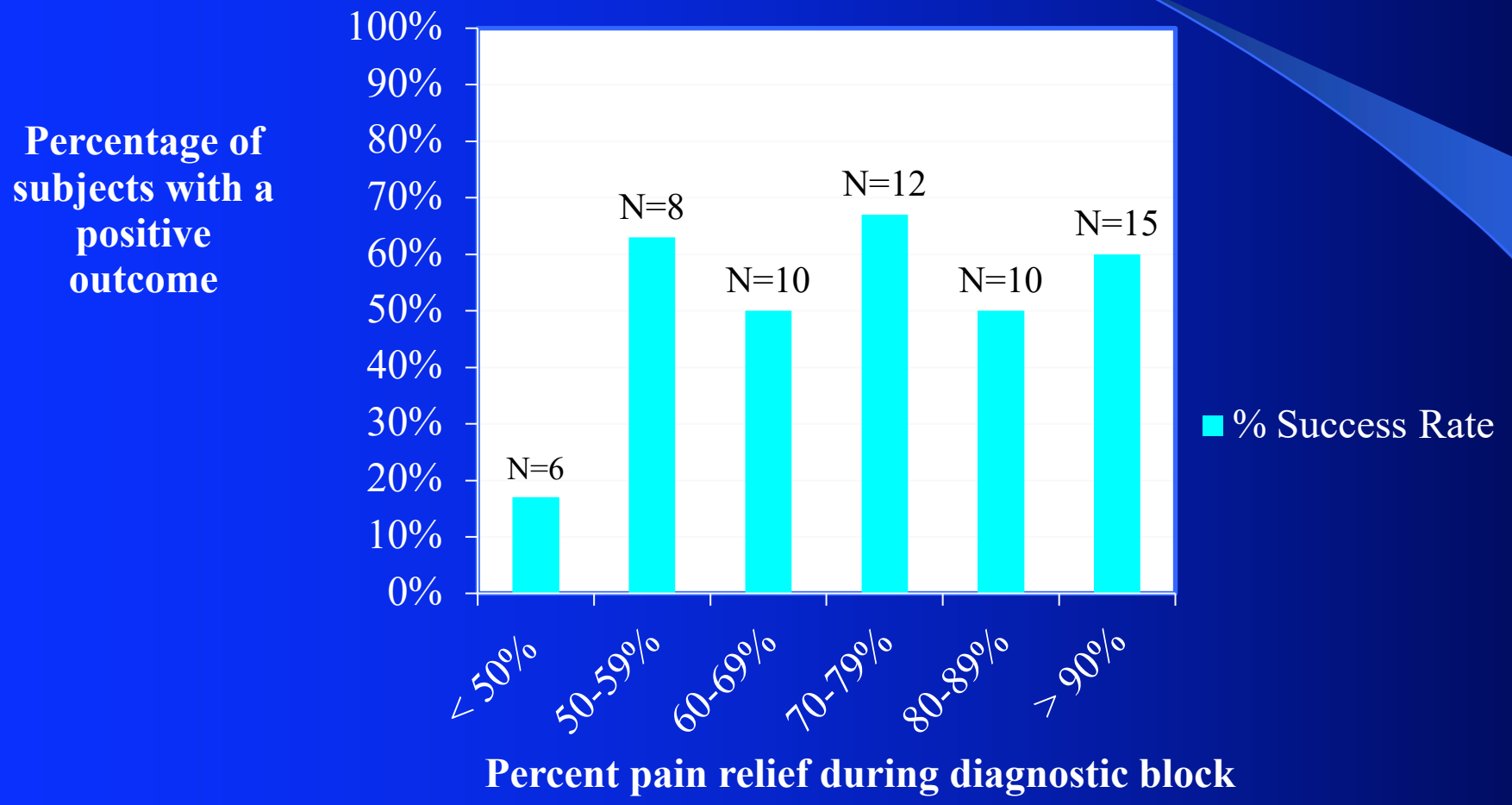
What Should the Cutoff be for Designating a Block as Positive?

- SIS guidelines: Complete relief in a "distinct topographical area" is necessary for (+) positive block
- ASIPP guidelines: Stronger evidence for 75% relief than 50%
- NASS guidelines: 'Insufficient evidence' for use of 50% MBB pain relief cutoff for diagnosing facet joint pain
- IMMPACT guidelines and most FDA studies designate 30% relief as "clinically meaningful"
- L-z pathology rare without disc disease or myofascial pathology
- Cervical disc and z-joint pain comparable in prevalence
  - Rydman et al. Spine J 2019: 55% prevalence of z-joint vs. 45% disc pathology in non-recovered pts with whiplash
- Factors that can affect block results: placebo response, extravasation of LA into other tissues, superficial anesthesia, sedation, blockade of non-MB nerves that innervate erector spinae and deep intrinsic muscles
- Predictive modeling: Pain relief, # of blocks predicated on demographic & clinical variables
  - McCormick used 2 blocks in individuals who had "only" 50-74% pain relief after 1st block
  - No difference in outcomes

Interventional Pain Outcomes Stratified by "Cutoff" Threshold

Author	# of Pts	Procedure	Comparison	Results
Cohen et al. 2007	92	Cervical facet RF	≥ 50% vs. ≥ 80%	56% success rate in ≥ 50% group vs. 58% in > 80% group
Erdek et al. 2010	50	Celiac plexus neurolysis	≥ 50% vs. ≥ 80%	56% success rate in ≥ 50% group vs. 54% in ≥ 80% group
Cohen et al. 2007	262	Lumbar facet RF	≥ 50% vs. ≥ 80%	52% success rate in ≥ 50% group vs. 56% in ≥ 80% group
Stojanovic et al. 2010	77	Lumbar facet RF	≥ 50% vs. ≥ 80%	47% success rates in both groups
Williams et al. 2011	244	Spinal cord Stimulation	< 50% vs. ≥ 50% vs. ≥ 75%	18% in < 50% vs. 90% in ≥ 50% vs. 71% in ≥ 75% groups
Cohen et al. 2009	77	SI joint RF	≥ 50% vs. ≥ 80%	51% success rate in ≥ 50% group vs. 49% in ≥ 80% group
Huang et al. 2012	101	Pulsed RF of occipital nerves	< 50% vs. ≥ 50% vs. ≥ 80%	50% in < 50% vs. 48% in ≥ 50% vs. 58% in ≥ 75% groups
McGreevy 2013	32	Superior hypogastric neurolysis	% pain relief	Mean pain relief of 75% for (+) outcomes vs. 82% for (-)
Holt & Seghal 2016	50	Lumbar & cervical facet	Both blocks ≥ 80% vs. 1 of 2 blocks ≥ 80%	53.1% for concordant relief vs. 44.4% for discordant (P=NS)
Derby et al. 2012	51	Lumbar RF	≥ 50% vs. ≥ 80%, both 1 & 2 blocks	56% success in > 50% group vs. 84% in > 80% group
Burnham et al. 2020	92	Cervical facet RF	80-99% vs. 100%	Identical 54% success rates
Shin et al. 2006	28	Cervical facet RF	25% vs. 50% vs. 75% vs. 80% vs. 100%	No correlation between dx block pain relief & RF outcomes
Chen et al. 2021	265	Genicular RF	< 50% vs. 50-79% vs. ≥ 80%	<5% for <50%, 29.3% for 50-79%, 69% for ≥80%
Cohen et al. 2022	346	Lumbar facet (n=101), SIJ injections (n=66)	≥ 50% vs. ≥ 80%	39.5% for ≥50%, 65.45 for ≥80% for facet; ≥50% superior to ≥80% for SIJ

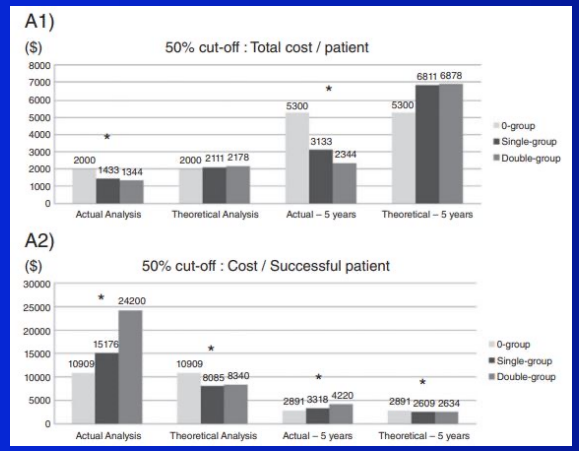
Success Rate Broken Down by Percent Pain Relief Following Diagnostic MBB

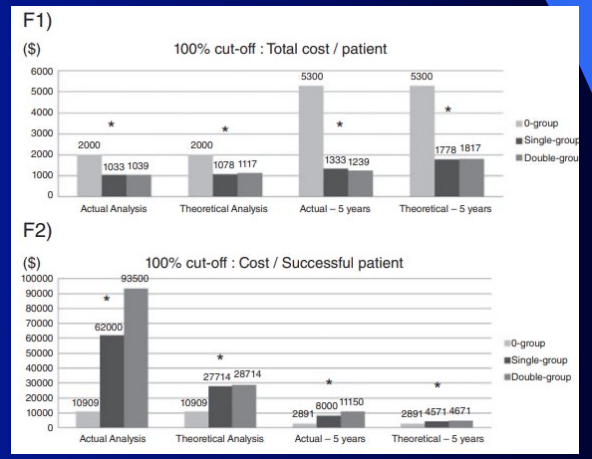


Cohen et al. Clin J Pain 2013

Selecting Patients for Lumbar Facet RFA

- Derby et al. Pain Med 2012: Retrospective study in 38 pts who underwent RFA after 1 block & 13 after 2 blocks
  - 84% of those with ≥ 80% relief on 1 or 2 blocks had success @ 3 mo vs. 56% in those with ≥ 50% relief
- Manchikanti et al. Pain Physician 2010: Retrospective study in 252 pts
  - At 1-year, success rates in the ≥ 50% but < 80% and ≥ 80% relief groups were 75% and 93%, respectively
  - Not all pts rec'd RFA
- Derby et al. Pain Med 2013: Retrospective actual and theoretical cost-effective analysis in 180 pts who underwent lumbar MBB
  - Total cost per patient: In theoretical analysis, single blocks most cost-effective at higher cutoffs (≥80%) while 0-blocks are most cost-effective at lower cutoffs (< 80%)
  - Cost per successful treatment: Actual 5-year analysis showed 0 blocks is most cost-effective. Theoretical 5-year analysis showed 0 blocks most cost-effective at cutoffs ≥ 80%, but single or double blocks at cutoffs between 50% & 79%.





Studies Evaluating Cervical Facet RFA Success Rates Stratified by Pain Relief from MBB

Facet joints play a more prominent role in chronic neck pain than in the low back

- Higher density of nociceptors in cervical z-joints than lumbar
- More stress on c-z joints, more motion in neck than lumbar region, especially @ C2-3 @ C5-6
- Meaningful pain relief similar to low back and neck
- Greater procedure-related pain for cervical than lumbar procedures
- Prevalence of c-z joint degeneration > c-disc degeneration or l-z joint degeneration

Author	Patient Population	Design	Results	Comments
Cohen et al. 2007	92 pts	Retrospective, 6-mo f/u	56% success rate in pts who rec'd 50-79% relief from single MBB vs. 58% for those who obtained ≥80% relief	Multicenter study
Burnham et al. 2020	50 pts who obtained ≥ 80% relief from MBB	Cross-sectional, 6-mo f/u	54% success rate in pts who obtained 80-99% pain relief from MBB and those who obtained 100% relief	Dual MBB. Follow-up calls conducted at various points after 6-mo
Holz & Sehgal 2016	112 pts with lumbar and cervical pain (28% cervical)	Retrospective, 3-mo f/u	48% avg. pain relief. No correlation between percent or duration of pain relief after MBB and pain relief after RFA. Individuals with 100% relief from lidocaine lasting > 8h responded best	Dual MBB, 70% relief was cutoff for (+) block
Shin et al. 2006	28 pts	Observational, 3,6 & 12-mo f/u	No correlation between categorical pain relief on prognostic blocks (25%, 50%, 75%, 80% and 100%) and pain relief after RFA	Dual comparative MBB

Level of Evidence

- We recommend that 50% pain relief be used as a cutoff for a '+' block
  - Higher cutoffs will yield higher success rates, but a significant proportion (> 50%) of individuals will be denied a beneficial procedure

- GRADE B RECOMMENDATION, MODERATE LEVEL OF CERTAINTY FOR L-SPINE
- GRADE C RECOMMENDATION, LOW-TO-MODERATE LEVEL OF CERTAINTY FOR C-SPINE

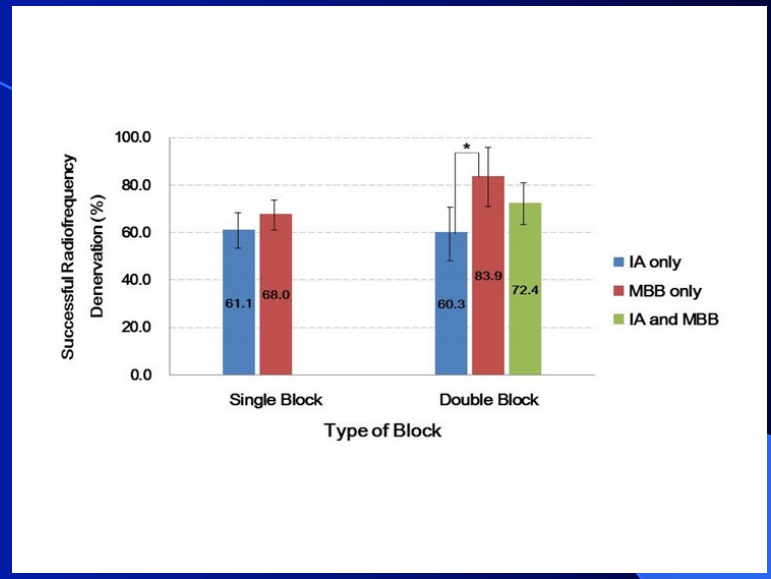
Intra-Articular vs. Medial Branch Blocks

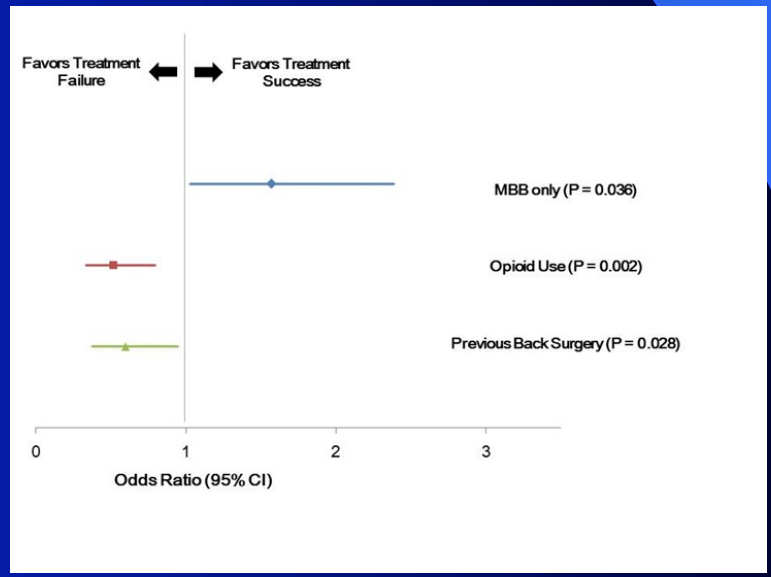
- 5 controlled studies found no long-term efficacy for IA steroid injections & 4 of 5 RCTs that used IA injections before RFA were negative or equivocal
- Logic dictates that a MBB would be a better prognostic indicator of success than an IA block
- 11% false-negative rate of MBB, partially 2º aberrant innervation
- MBB are easier to perform (i.e. less procedure-related pain) & have documented "sensitivity"
  - 29-38% "failure" rate for IA injections per l-z joint, 22% for c-z joints (> 90% when any extra-articular spread is included)
  - No randomized cervical medial branch RFA studies used prognostic IA injections
- *IA injections not predictive of RF outcomes (Ruiz et al. unpublished)
- Schutz et al. demonstrated lack of validity with single lumbar facet IA injections
- Guidelines: SIS recommends MBB; ASIPP recommends MBB, doesn't mention IA; WIP recommends MBB; UK's NHS in Greater Manchester no longer commissions IA injections

Lilius et al. 1998; Carette et al. 1991; Barnsley et al. 1994; Kaplan et al. 1998; Cohen et al. 2018; Gallagher et al. 1994; Lakemeier et al. 2013; Bureau et al. 2020; Freire et al. 2016; Schutz et al. 2011

Case-Control Study Comparing Prognostic Value of IA vs. MBB

- Multi-center, case-control study (n=510) comparing RF outcomes for IA vs. MBB
- (+) outcome at 3 mo: 70.3% of MBB, 60.8% of IA; p=0.04
  - Held true for single & double blocks
- Multivariable analysis: IA blocks, higher baseline pain scores, opioid use and FBSS associated with treatment failure





Cohen et al. RAPM 2015

FACet Treatment Study (FACTS)

- Multi-center study involving military, VA & civilian practices
- 229 patients with suspected lumbar facet arthropathy
- Randomized in 2:2:1 ratio to receive IA, MBB with LA and steroid, or saline
  - Patients and outcome adjudicators blinded
- Patients followed for up to 6 months to determine efficacy of facet injections
- Patients in groups 1 and 2 with positive block underwent RF ablation, while all placebo group patients were eligible for RF ablation
  - $\geq$ 50% pain relief constituted (+) block
  - (+) response $\geq$ 2-point decrease in average pain + > 3/5 satisfaction score

Cohen et al. Anesthesiology 2018

Outcomes from Facet Block Study Phase

Variable	Intra-Articular Block (n=89)	Medial Branch Block (n=91)	Saline Control Block (n=47)	P-Value
Percent Reduction in Pre-Block Pain Score (mean, SD)	47.4 ± 31.0	47.3 ± 32.6	37.4 ± 30.9	0.16
Facet Block Positive (number, %)	49, 54%	51, 55%	14, 30%	0.009
Reduction in Average NRS Pain Score from Baseline @ 1-mo, (mean, SD)	0.7 ± 1.6	0.7 ± 1.8	0.7 ± 1.5	0.99
Reduction in Worst NRS Pain Score from Baseline @ 1-mo, (mean, SD	1.0 ± 1.9	0.9 ± 1.9	1.1 ± 2.1	0.93
Positive Outcome @ 1-mo (n, %)	11, 12%	10, 11%	3, 6%	0.62

Outcomes from RF Treatment

Variable	IA Block (n=45)	MBB (n=48)	Saline Control (n=42)	P-Value
Reduction in Average NRS Pain Score from Baseline @ 1-mo, (mean, SD)	2.2 ± 2.1	2.1 ± 2.0	1.0 ± 1.6	**0.009**
Average NRS Pain Score @ 1-mo (mean, SD)	2.6 ± 1.8	2.9 ± 2.3	3.2 ± 1.9	0.42
Worst NRS Pain Score @ 1-mo (mean, SD)	4.5 ± 2.4	4.7 ± 2.8	5.4 ± 2.4	0.24
Positive Outcome @ 1-mo (n, %)	30, 67%	35, 73%	16, 38%	**0.002**
Reduction in Average NRS Pain Score from Baseline @ 3-mo, (mean, SD)	1.8 ± 2.3	1.8 ± 2.4	0.7 ± 1.5	**0.02**
Average NRS Pain Score @ 3-mo (mean, SD)	3.0 ± 2.0	3.2 ± 2.5	3.5 ± 1.9	0.49
Worst NRS Pain Score @ 3-mo (mean, SD)	4.9 ± 2.4	5.5 ± 3.0	5.8 ± 2.6	0.32
Positive Outcome @ 3-mo (n, %)	23, 51%	28, 57%	10, 24%	**0.004**
Reduction in Average NRS Pain Score from Baseline @ 6-mo, (mean, SD)	1.2 ± 2.1	1.3 ± 2.3	0.5 ±1.5	0.13
Reduction in Worst NRS Pain Score from Baseline @ 6-mo, (mean, SD)	1.7 ± 2.7	1.5 ± 2.6	0.7 ± 2.2	0.18
Positive Outcome @ 6-mo (n, %)	14, 31%	20, 42%	7, 17%	**0.036**

Level of Evidence

- Overall, we conclude that MBB should be screening test of choice before medial branch RFA. IA steroids may, however, be of therapeutic value for populations for which there is suspected inflammatory facetogenic pain, and in whom denervation may be relatively contraindicated. In these cases, they may concomitantly serve as prognostic blocks.
  - Young athletic individuals
  - Individuals who are pacemaker dependent or have AICDs.

- GRADE C RECOMMENDATION, MODERATE LEVEL OF CERTAINTY FOR LUMBAR AND CERVICAL REGIONS

WHAT IS THE EFFECT OF SEDATION ON THE VALIDITY OF DIAGNOSTIC OR PROGNOSTIC IA FACET BLOCKS OR MBB?

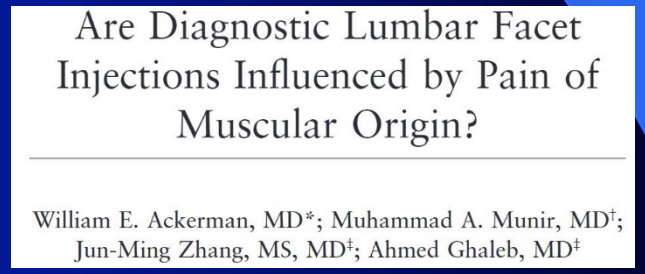
Background

- "Diagnostic" blocks used to identify pain generators and select patients for spine surgery, joint replacement, RFA, thoracic outlet surgery, pulsed radiofrequency and peripheral nerve stimulation etc.
  - Sedation increases risk of procedures and cost
- Deep sedation used in 67% of cervical cases associated with SC injury but only 19% of cervical procedure claims not associated with SC injury
- Use of sedation has dramatically increased in the past 10 years
  - In 2020, CMS stated sedation is not routinely needed for facet blocks & is not routinely reimbursable
  - 64% of 61 surveyed centers used sedation for ESI
  - Often financially driven

Rathmell et al. Anesthesiology 2011; van Tulder et al. Spine (Phila PA 1976) 2003
Chaparro et al. Spine 2014; Ackerman et al. Pain Pract 2004

Why BZD & Opioids Might Affect Block Results

- BZDs Reduce Muscle Pain
  - Acute LBP: 1 low quality trial found IM, followed by oral diazepam > placebo in short-term
  - Chronic LBP: 2 high quality trials found oral tetrazepam > placebo in short-term; one low quality trial found diazepam = placebo for muscle spasm
  - Interfere with normal activities (i.e. inaccurate pain diaries)
  - Reduce anxiety, which may exacerbate pain


Are Diagnostic Lumbar Facet Injections Influenced by Pain of Muscular Origin?

William E. Ackerman, MD*; Muhammad A. Munir, MD†; Jun-Ming Zhang, MS, MD‡; Ahmed Ghaleb, MD‡

- Opioids reduce spinal pain (acute > chronic), have anxiolytic and euphoric effects and interfere with ability to engage in activities

Use of Sedation is Balancing Act

Pro-Sedation

Anti-Sedation

Patient comfort (less pain, anxiety)
More $$
Reduce patient movement/Vasovagal events
Decreased false-negative

Increase false-positive rate (more accurate assessment)
-Worse treatment outcomes
Increased risks & costs

Effect of Sedation on Pain Relief after Diagnostic Facet Blocks

- Manchikanti et al. Pain Physician 2004
- 180 pts randomized to receive 1-5 mL of saline, 1 mg/mL midazolam or 50 mcg/mL fentanyl
  - Patients had a diagnosis of cervical facet joint pain & most were undergoing "therapeutic" MBB
  - "Double-Blinded": 70% of people in midazolam grp rec'd $\geq$ 3 mg, 72% in fentanyl group rec'd $\geq$ 150 mcg.
  - 40% relaxed in saline group, 88% in midazolam and 95% in fentanyl group
- Assessed pain before block
  - 8%, 13% and 27% in saline, midazolam & fentanyl groups obtained $\geq$ 50% pain relief
  - 5%, 8% and 8% obtained > 80% pain relief
- Performed same study for lumbar MBB with similar % relaxed but lower proportion obtaining pain relief
  - 7%, 5% and 13% in saline, midazolam & fentanyl groups obtained $\geq$ 50% pain relief
  - 2%, 5% and 7% obtained $\geq$ 80% pain relief

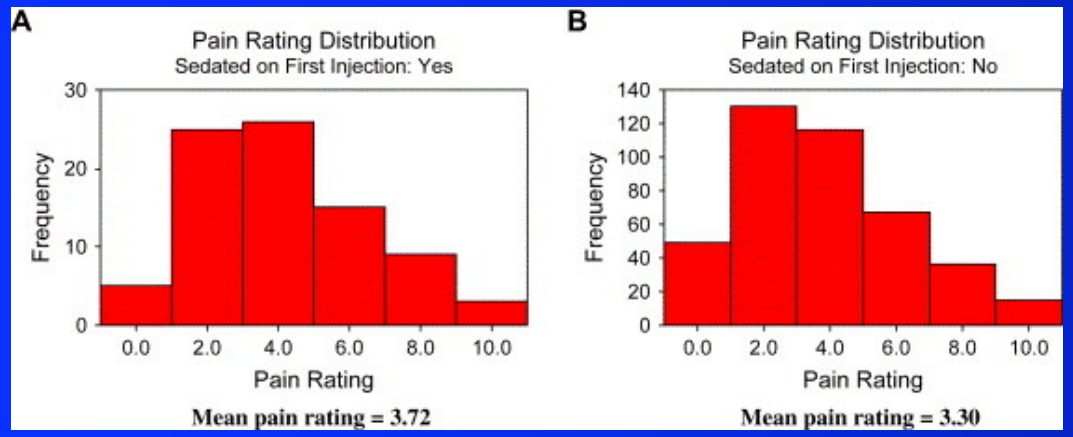
Do Patients Want or Need Sedation?

- Cucuzella et al. Spine J 2006
  - Survey in 500 pts who underwent ESI or facet inj.
  - Sedation with 2-5 mg IV diazepam
- 17% of pts requested sedation & 28% would request it before 2nd injection
- High pain and anxiety levels predicted need for sedation
- No difference between facet and epidural injections

- Kim et al. Spine 2007
  - Survey by same pvt. practice group in 301 pts undergoing ESI or facet injections
  - Discussed beforehand whether pts wanted oral or IV sedation
- 58% of pts chose to be sedated
- Those who chose to be sedated were more anxious
- Diazepam controlled anxiety 90% of time
- Concluded sedation is not routinely required before spinal injections

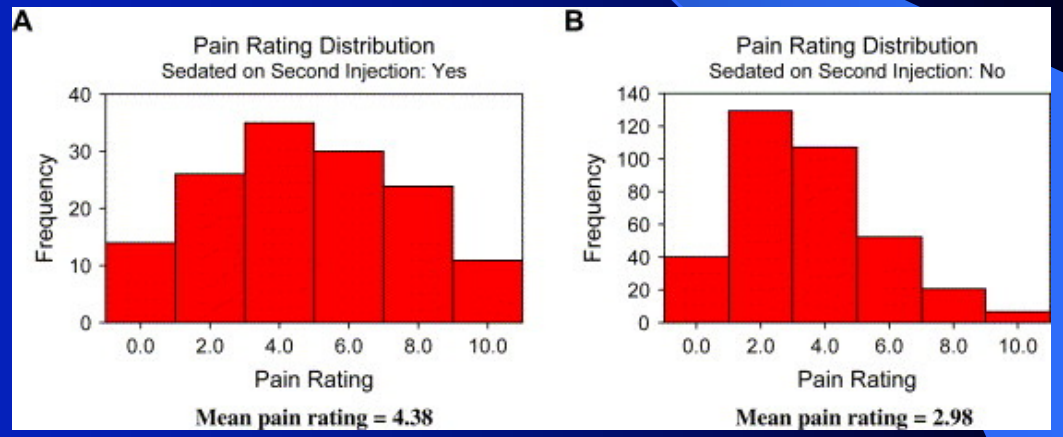
Procedure-Related Pain With & Without Sedation

First Injection



Cucuzella et al. 2006
P=0.12 favoring 'no sedation"

Second Injection



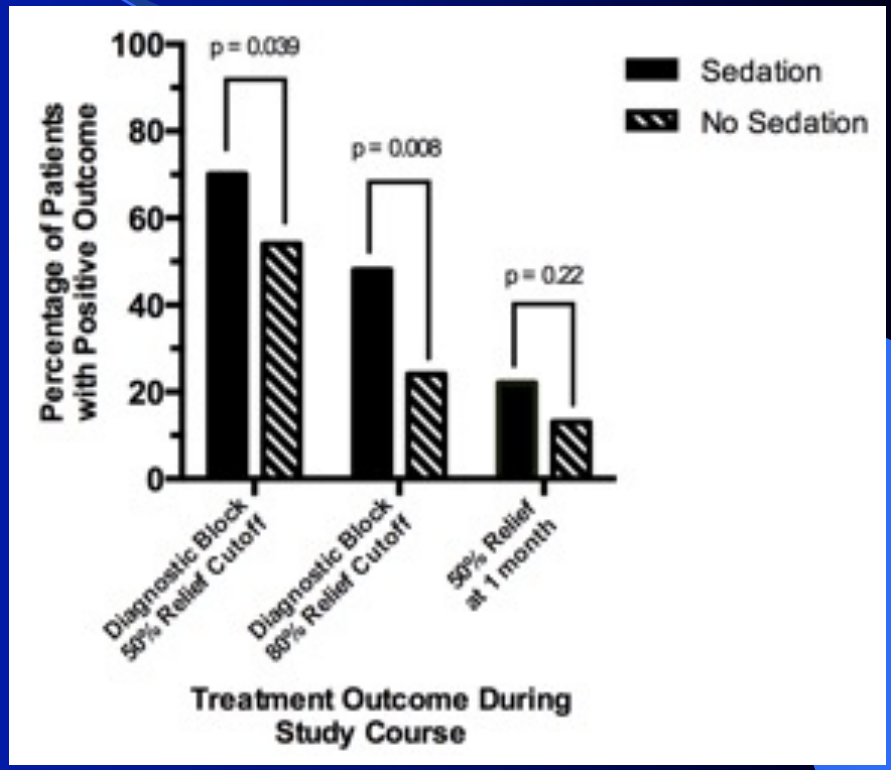
P<0.01 favoring 'no sedation'

Effect of Sedation on Immediate Pain Relief After ESI

- Dreyfuss et al. PMR 2009: Prospective study comparing light sedation to no sedation for ESI
  - No difference in immediate leg or back pain
- Erdek et al. Pain Med 2010
  - 73% celiac plexus neurolysis success rate in people who underwent prognostic blocks without sedation vs. 39% in those who rec'd sedation
- Samen et al. Pain Med 2022
  - 72% of people sedated had > 50% pain relief after sympathetic block vs. 51% who did not receive sedation
- Chen et al. RAPM 2021
  - Use of sedation during GNB had no effect on RFA outcomes

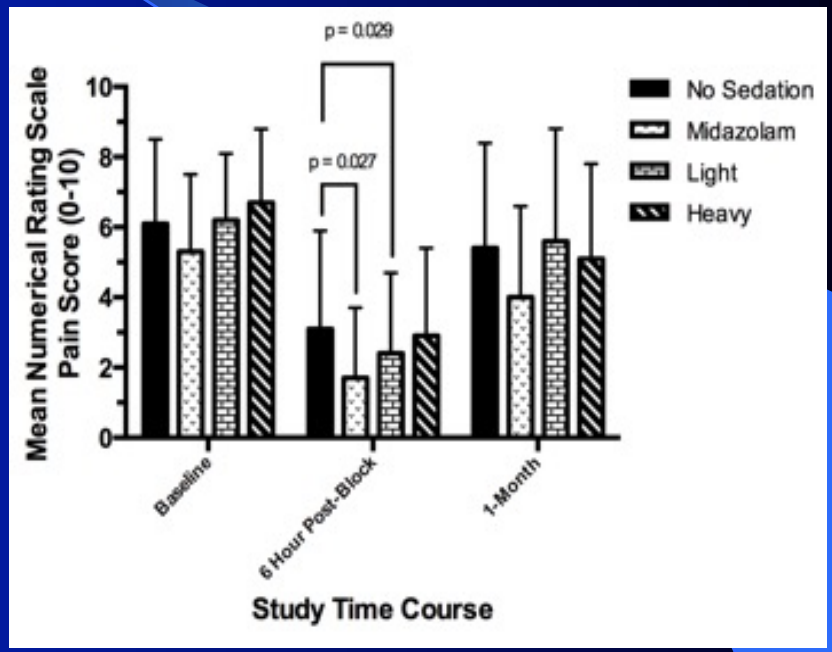
Effect of Sedation on Diagnostic Blocks

- Cohen et al. Pain Med 2014
  - Randomized, open-label crossover trial examining sedation on diagnostic validity of SIJ and sympathetic blocks (n=73)
  - Parallel (n=73), omnibus (n=119) and crossover (n=43) group comparisons for diagnostic value (e.g. pain diaries) showed increased rate of positive blocks and decreased procedure-related pain
    - No difference in procedure-related satisfaction or 1-month treatment outcomes



Treatment Results

- Crossover: 6-hour pain diary: mean 2.2 (2.3) sedation vs. 3.4 (2.8) no sedation; p=0.001
- Overall: 6-hr pain diary mean 2.4 (2.3) vs. 3.1 (2.8); p=0.003
  - No difference between SIJ and sympathetic blocks
- No difference in satisfaction scores
- Procedure-related pain (overall): mean 2.8 (2.6) sedation vs. 5.8 (2.6); p< 0.0001



Clinical Practice Guidelines:

SIS Fact Finder for Patient Safety: Conscious Sedation

- Myth: Conscious sedation is typically needed when performing most interventional pain procedures (e.g. epidural steroid injections, sacroiliac injections, medial branch blocks, and radiofrequency denervation).
- Fact: Sedation is not intrinsically necessary for interventional spine procedures. The decision to use sedation should be made on a case-by-case basis

ASA Standards & Guidelines and ASRA Practice Advisor

- The majority of minor procedures, under most routine circumstances, do not require anesthesia care other than local anesthesia (ESI, TPIs, SIJ injections, bursal injections, occipital nerve blocks, facet injections).

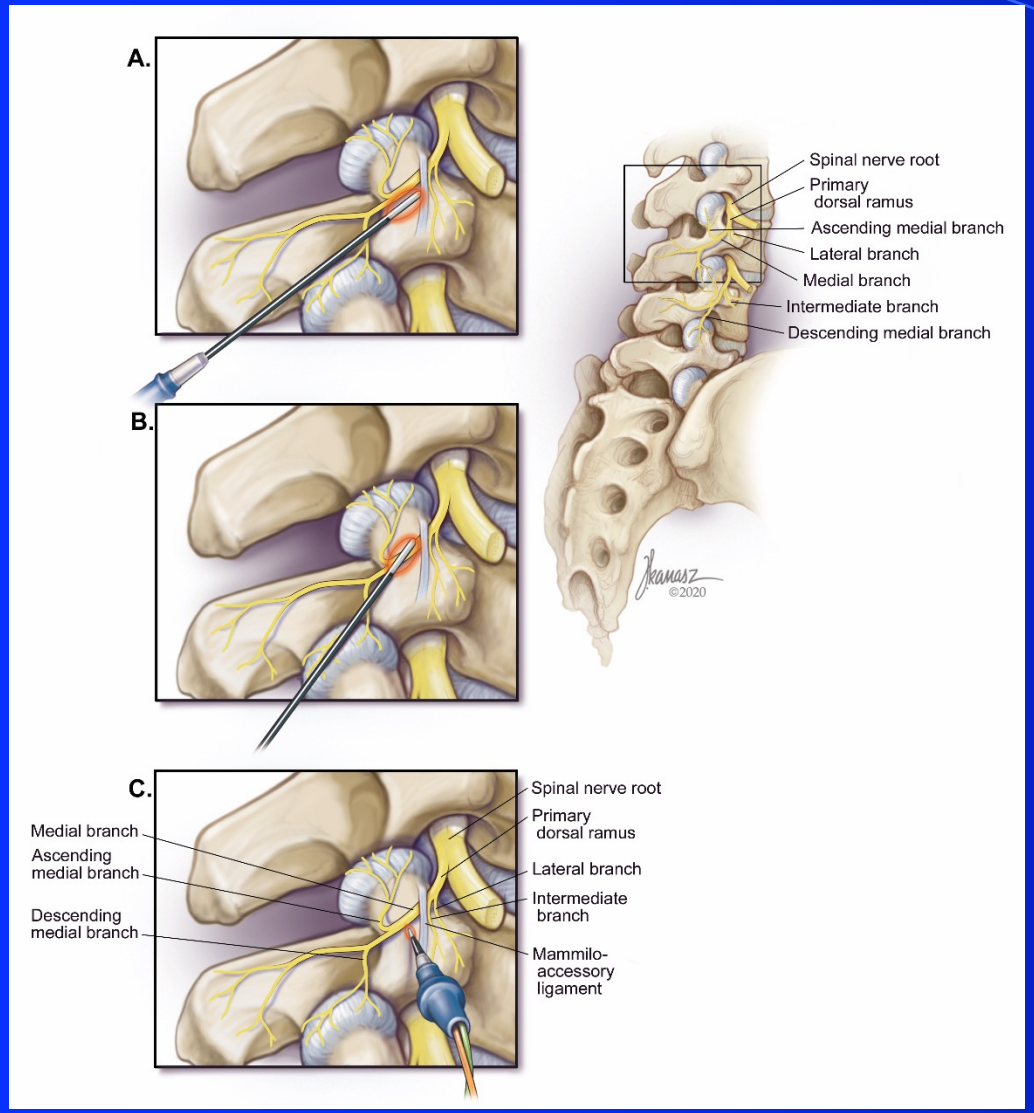
Level of Evidence

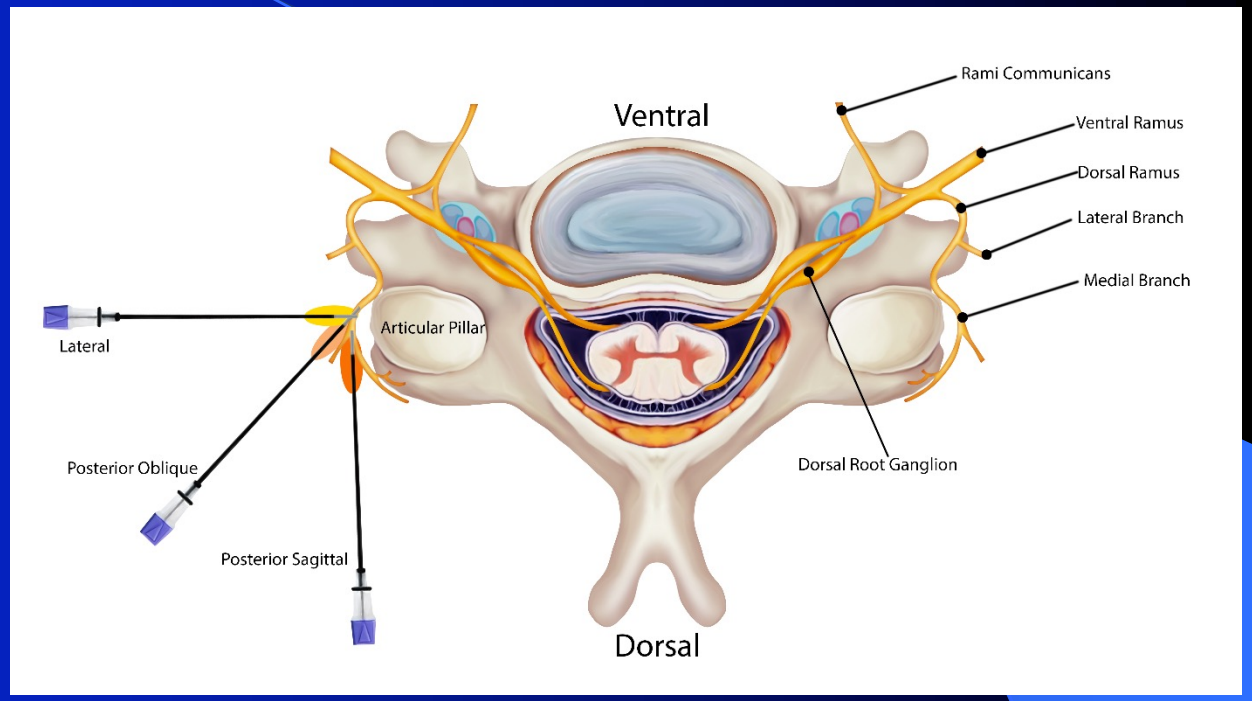
- We conclude that sedation should not be routinely administered for diagnostic or prognostic facet injections in the absence of reasonable indications. When sedation is used, patients should be educated on the increased risk of a false-positive block, and the lowest doses of short-acting sedatives, ideally without opioids, should be given.

- GRADE B RECOMMENDATION, LOW-TO-MODERATE LEVEL OF CERTAINTY FOR LUMBAR BLOCKS, MODERATE LEVEL OF CERTAINTLY FOR CERVICAL BLOCKS

Needle Orientation

- Lumbar & cervical medial branches usually within 2 mm of bone
- Transecting a nerve *anywhere* results in Wallerian degeneration
- Since lesions are longer along the longitudinal axis with 10 mm electrodes than the horizontal axis, it makes more theoretical sense to orient the electrode transversely across (perpendicular in same plane) the nerve
- Anatomy prevents this in lumbar region; to maximize lesion size on bone, many advocate inserting the electrode parallel to nerve
  - Lumbar MB may also be entrapped beneath MAL
- Inserting the needle perpendicular in a different plane theoretically results in the smallest lesions
- Because of impedance differences, inserting a needle perpendicular in a different plane will result in a larger than expected lesion on bone
- Investigators have obtained good results with different techniques





Cohen et al. RAPM 2020; Hurley et al. RAPM and Pain Med 2021

Do We Need an RCT to Justify Larger Lesions?

- Deductive reasoning: Conclusion is logical consequence of premises
  - Increasing lesion size increases the chance of ablating the target n.
  - Missing target n. is cause of rx failure
  - Increasing the likelihood of ablating the target n can increase success rate
- Inductive Reasoning: Moves from a specific set of facts to a general conclusion
  - Selective nerve root, facet and SI joint blocks improve outcomes; therefore, discography improves outcomes

Parachute use to prevent death and major trauma related to gravitational challenge: systematic review of randomised controlled trials

Gordon C S Smith, Jill P Pell

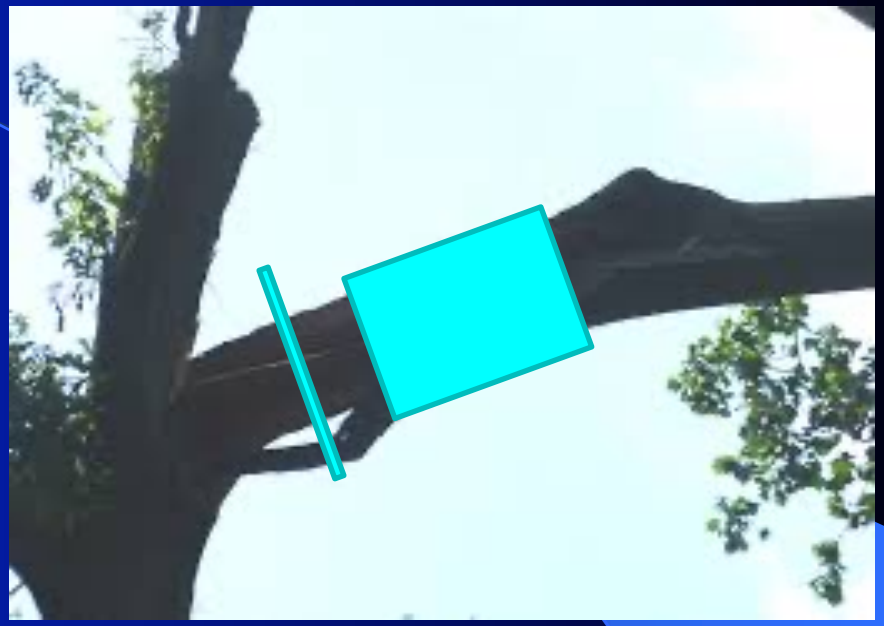
"Parachutes reduce the risk of injury after gravitational challenge, but their effectiveness has not been proved with randomised controlled trials."

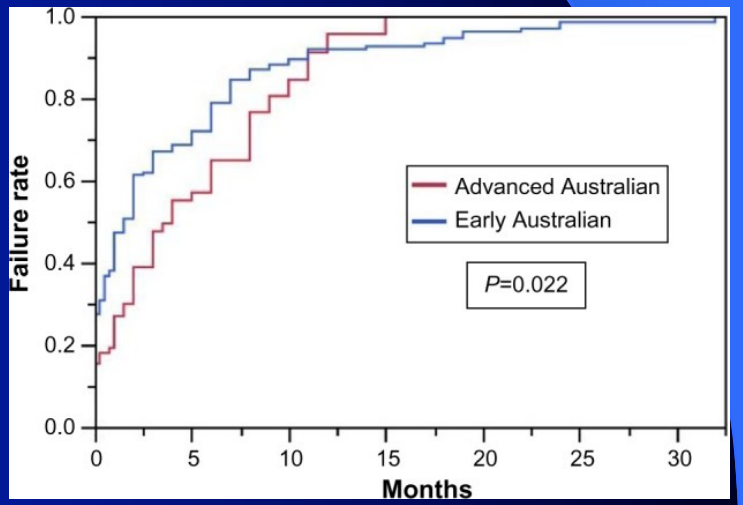
Studies with (+) Outcomes More Selective than (-) Studies, Obscures Small Effect Favoring Parallel Orientation

Study & Patients	RF Technique	Number of Lesions	Outcome
Gallagher 1994: 41 pts with LBP	Perpendicular	Single, suboptimal location	RF ≥ placebo
Van Kleef 1999: 31 pts with LBP	Perpendicular	Single	RF > placebo
Van Wijk 2005: 81 pts with LBP	States parallel, but images show perpendicular	Single	RF= placebo
Tekin 2007: 60 pts with LBP	Parallel	Single	RF > PRF > placebo
Moussa 2016: 120 pts with LBP	States parallel, but images show perpendicular	Three or four	RF capsule ≥ RF MB > placebo
Lakemeier 2013: 56 pts with LBP.	Perpendicular	Single	IA steroid injection + placebo = RF
Nath 2008: 40 pts with LBP	Parallel	Six	RF > placebo
Leclaire 2001: 70 pts with LBP	Perpendicular	Single	RF= placebo
Van Tilberg 2016: 60 pts with LBP	Perpendicular	Single	RF = placebo
Juch 2017: 251 pts with LBP	Perpendicular	Single	RF = placebo
Cohen 2018: 142 pts with LBP	Parallel	Single	RF ≥ placebo
van Eerd 2021: 76 pts with neck pain	Oblique	Single	RF ≥ placebo
Lord 1996: 24 with neck pain after whiplash	Parallel and Oblique	Two	RF > placebo
Stovner 2004: 12 pts with cervicogenic H/A	States parallel, but describe perpendicular	Three or four	RF ≥ placebo

Effect of Electrode Orientation & Lesion Size

Author	Design	Patients	Findings
Loh, 2015	Retrospective	323 pts with lumbar facet pain who rec'd parallel (n=82) or perpendicular RF approach	Parallel technique > perpendicular
Tinnirello, 2017	Retrospective	43 pts with SIJ pain who rec'd conventional (Simplicity; n=21) or cooled RF (n=22)	Cooled > conventional
Cheng, 2013	Retrospective	88 pts with SIJ pain who rec'd conventional (n=30) or cooled RF	No difference
Cohen, 2012	Retrospective	77 pts with SIJ pain who rec'd conventional (n=57) or cooled RF	Trend for cooled ≥ conventional
Cheng, 2013	Retrospective	82 pts with cervical facet joint pain who received perpendicular (n=38) or parallel approach	Perpendicular > parallel at 6 & 12 mo. but not earlier





- Preclinical studies suggest structural and functional lesions last longer with cooled RF or larger lesions, but effect on duration is unknown
- Multiple commentaries on MINT study criticized authors for creating small lesions

Loh et al. J Pain Res 2015; Zachariah C et al. RAPM 2020

Level of Evidence

- A near-parallel approach should be used for both lumbar and cervical MB RFA.
- GRADE B RECOMMENDATION, LOW-TO-MODERATE LEVEL OF CERTAINTY FOR CERVICAL, LOW LEVEL OF CERTAINTY FOR LUMBAR.

Take-Home Points

- MBB are more prognostic than diagnostic, but are characterized by significant FP & FN rates, which can be reduced by education, avoiding sedation, and using optimal technique
- The use of double blocks will reduce access to care and overall success rate, while resulting in higher costs
- The use of cutoff thresholds > 50% will reduce access to care, has not been proven to increase success rates, & will lead to many people who might otherwise benefit not receiving treatment
- More stringent selection criteria are associated with higher success rates in clinical trials
- Electrodes should theoretically be placed parallel to the nerve, but orientation is but one of many factors that can affect outcome

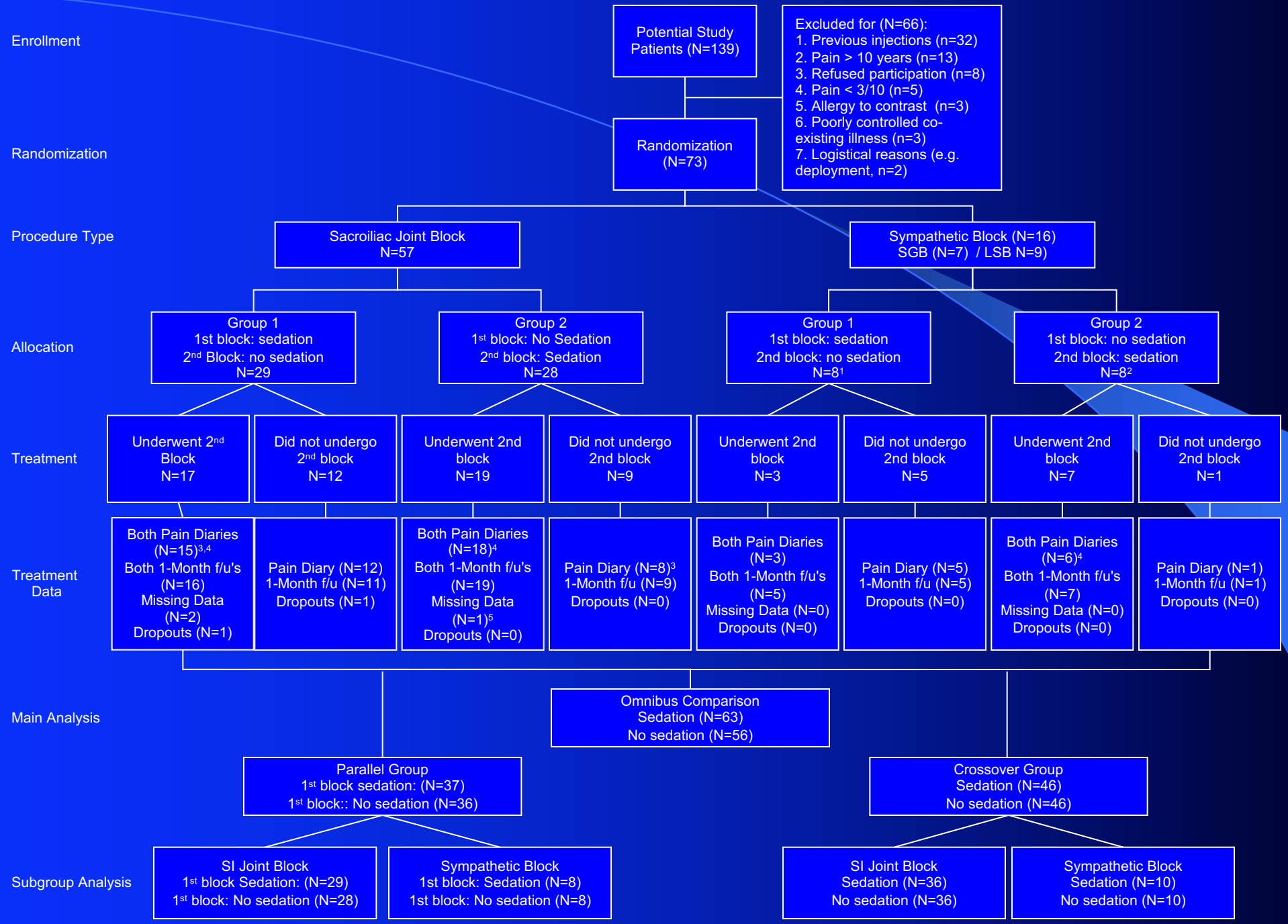
Historical and PE Findings Associated with Lumbar Facet Block and RFA Outcomes

Table 4 Studies evaluating physical examination findings and facet block results

Study	Design/criteria for positive block	Interventions	Findings
Fairbank *et al*[37]	Prospective n=25 Subjective pain relief	IA (double blocks, one injection at symptomatic level, another at a random level)	Responders: pain in the back and thigh; straight leg raising test causes back pain. Non-responders: pain in the back and leg; straight leg raising test causes leg pain
Lewinnek and Warfield[40]	Retrospective n=21 Partial or complete pain relief with resumption of activities immediately and at 3 months	IA (single block)	Patients who had no other cause of LBP or sciatica and had a combination of facet degeneration, pain and tenderness, were more likely to initially respond to injection.
Helbig and Lee[38]	Retrospective n=22 Subjective pain relief from hours to months	IA (single block)	A 100-point scorecard was developed: Back pain with groin or thigh pain: +30 Well-localized paraspinal tenderness: +20 Reproduction of pain with extension-rotation: +30 Significant corresponding radiographic changes: +20 Pain below the knee: −10 Individuals with high scores (≥60) were likely to be responders but a low score could not reliably predict negative response to facet joint injections.
Jackson *et al*[39]	Prospective n=454 Difference in pre- and post-pain scores associated with lumbar motion	IA (single block)	There were no unique characteristics identified in patients who reported either no or increased pain after injection. However, the following factors correlated significantly with greater postinjection pain relief: older age, a history of LBP, no leg pain, pain not aggravated by Valsalva maneuver, normal gait, no muscle spasm and pain on extension after forward flexion.
Lilius *et al*[41]	Prospective n=109 Outcomes (subjective, work and disability) were assessed at 3 months	IA steroid/anesthetic, IA saline or pericapsular steroid/anesthetic (single block)	Inappropriate (non-organic physical) signs and symptoms and previous back surgery were associated with treatment failure.
Schwarzer *et al*[42]	Prospective n=176 ≥50% pain relief after a confirmatory block	IA or MBB (double comparative diagnostic blocks)	Neither clinical features (range of motion and straight leg raising test) nor pain referral patterns could predict response to diagnostic blocks. No patient with central/midline spinal pain responded to a confirmatory block.
Schwarzer *et al*[43]	Prospective n=63 ≥50% LBP reduction to bupivacaine block×3 hours but no response to placebo	IA and placebo (placebo controlled: normal saline to superficial muscle)	Similar history and examination features were seen in patients with or without facet joint pain.
Revel *et al*[44]	Prospective n=40 ≥75% LBP reduction	IA (single block)	Seven characteristics (Revel's criteria) were more frequent in patients with pain relief from facet blocks: older age; absence of pain exacerbation by coughing, absence of pain exacerbation by lumbar hyperextension, absence of pain exacerbation by forward flexion and rising from forward flexion, absence of pain exacerbation by extension-rotation and pain relieved by recumbency.
Revel *et al*[45]	Prospective, controlled n=80–42 who received lidocaine ≥75% LBP reduction	IA local anesthetic or placebo (IA saline)	The presence of at least five of the seven Revel's criteria (above) including pain reduction by recumbency resulted in 92% sensitivity and 80% specificity.
Manchikanti *et al*[50]	Prospective n=120 ≥75% pain reduction	MBB (double comparative diagnostic blocks)	The prevalence of clinical findings (pain better by sitting/lying, pain worsened by sitting/standing/walking/coughing/lumbar spine range of motion, positive straight leg raising test and pain referral pattern) were similar between positive and negative block groups. Back pain with straight leg raising was weakly associated with positive blocks.
Manchikanti *et al*[52]	Prospective n=180 ≥75% pain reduction	MBB (double comparative diagnostic blocks, lidocaine±Sarapin±steroid, bupivacaine alone)	Back or leg pain during straight leg raising was negatively associated with pain relief from facet blocks.
Manchikanti *et al*[51]	Prospective n=200 ≥75% pain reduction	MBB (double comparative diagnostic blocks)	A large number of individual clinical characteristics did not correlate with facet mediated pain diagnosed by double blocks.
Young *et al*[46]	Prospective n=23 An injection produced concordant pain and ≥80% pain reduction	IA (single block)	Absence of worsening LBP during rising from sitting was associated with a positive response to facet injections. Centralization of pain was associated with negative response to facet injections.
Laslett *et al*[47]	Prospective n=116 ≥75% pain relief or complete eradication of primary pain	IA or MBB (single block)	Revel's criteria had low sensitivity and high specificity; therefore, the authors concluded they are not appropriate for screening purposes. Age ≥65 years reached predictive significance with complete eradication of primary pain as a reference; no pain with cough/sneezing and no worsening of pain when rising from flexion approached predictive significance with ≥75% LBP relief as a reference.
Laslett *et al*[48]	Prospective n=120 ≥75% pain reduction stratified in 5% increments	IA or MBB (single block)	CPR consist of combinations of seven characteristics: age ≥50; pain is least when walking/sitting; paraspinal pain; modified somatic perception questionnaire >13; positive extension-rotation test and absence of centralization. When positive response to facet block is set at 95% pain reduction, four CPRs have 100% sensitivity, one CPR improved post-test probability by five-fold.
Cohen *et al*[54]	Retrospective n=192 Patient selection: ≥50% pain reduction RFA success: ≥50% pain relief×6 months	MBB (single block) RFA	RFA success patients were more likely to have paraspinal tenderness, whereas positive 'facet loading' (pain worsened by extension-rotation) and chronic opioid use were more prevalent in RFA failure patients.

Table 4 Continued

Study	Design/criteria for positive block	Interventions	Findings
DePalma *et al*[49]	Retrospective n=160–52 with lumbar facet joint pain ≥75% pain reduction	IA (double comparative diagnostic blocks)	Paraspinal low back pain had a sensitivity of 95% and specificity of 25%. Lack of paraspinal tenderness suggested the facet joints were unlikely to be the source of axial LBP. The diagnostic sensitivity of midline LBP is low for facet joint pain.
DePalma *et al*[15]	Retrospective, n=157–49 with lumbar facet joint pain ≥75% pain reduction	MBB (double comparative blocks)	Facet joint pain patients were more likely to be older than those with internal disc disruption, and more likely to be obese than those with sacroiliac joint pain.
Streitberger *et al*[55]	Prospective n=275 Patient selection: Pain relief ≥50%, but one block had to result in ≥80% benefit RFA success: ≥50% pain relief	MBB (double comparative diagnostic blocks with lidocaine and bupivacaine) RFA	Only depression was associated with a shorter duration of RFA success.
Conger *et al*[56]	Retrospective n=111 ≥80% concordant pain relief RFA success: ≥50% pain relief at 6 months	MBB (double comparative diagnostic blocks with lidocaine and bupivacaine) RFA	Older age and larger Cobb angle associated with RFA treatment success.
Cohen *et al*[57]	Prospective n=318 (63 with suspected facet joint pain) Patient selection: ≥50% pain reduction after a block RFA success: ≥50% pain relief×3 months	MBB (single block) RFA	Number of Waddell signs inversely correlated with treatment outcomes. Factors associated with treatment success included older age, shorter duration of pain, lower baseline pain scores and functional disability, absence of secondary gain and not having concomitant pain and psychiatric conditions. Among concurrent comorbidities, the presence of pelvic or abdominal pain and depression were most strongly correlated with negative outcome.


Enrollment
Potential Study Patients (N=139)
Excluded for (N=66):
1. Previous injections (n=32)
2. Pain > 10 years (n=13)
3. Refused participation (n=8)
4. Pain < 3/10 (n=5)
5. Allergy to contrast (n=3)
6. Poorly controlled co-existing illness (n=3)
7. Logistical reasons (e.g. deployment, n=2)
Randomization
Randomization (N=73)
Procedure Type
Sacroiliac Joint Block N=57
Sympathetic Block (N=16) SGB (N=7) / LSB N=9)
Allocation
Group 1 1st block: sedation 2nd Block: no sedation N=29
Group 2 1st block: No Sedation 2nd block: Sedation N=28
Group 1 1st block: sedation 2nd block: no sedation N=8[1]
Group 2 1st block: no sedation 2nd block: sedation N=8[2]
Treatment
Underwent 2nd Block N=17
Did not undergo 2nd block N=12
Underwent 2nd block N=19
Did not undergo 2nd block N=9
Underwent 2nd block N=3
Did not undergo 2nd block N=5
Underwent 2nd block N=7
Did not undergo 2nd block N=1
Treatment Data
Both Pain Diaries (N=15)[3,4] Both 1-Month f/u's (N=16) Missing Data (N=2) Dropouts (N=1)
Pain Diary (N=12) 1-Month f/u (N=11) Dropouts (N=1)
Both Pain Diaries (N=18)[4] Both 1-Month f/u's (N=19) Missing Data (N=1)[5] Dropouts (N=0)
Pain Diary (N=8)[3] 1-Month f/u (N=9) Dropouts (N=0)
Both Pain Diaries (N=3) Both 1-Month f/u's (N=5) Missing Data (N=0) Dropouts (N=0)
Pain Diary (N=5) 1-Month f/u (N=5) Dropouts (N=0)
Both Pain Diaries (N=6)[4] Both 1-Month f/u's (N=7) Missing Data (N=0) Dropouts (N=0)
Pain Diary (N=1) 1-Month f/u (N=1) Dropouts (N=0)
Main Analysis
Omnibus Comparison Sedation (N=63) No sedation (N=56)
Parallel Group 1st block sedation: (N=37) 1st block:: No sedation (N=36)
Crossover Group Sedation (N=46) No sedation (N=46)
Subgroup Analysis
SI Joint Block 1st block Sedation: (N=29) 1st block: No sedation (N=28)
Sympathetic Block 1st block: Sedation (N=8) 1st block: No sedation (N=8)
SI Joint Block Sedation (N=36) No sedation (N=36)
Sympathetic Block Sedation (N=10) No sedation (N=10)