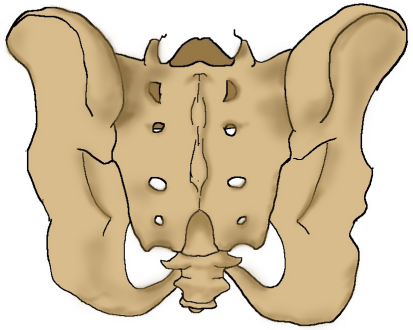


Radiofrequency (RF) Ablation for Sacroiliac Pain

David A Edwards, M.D. Ph.D.

Associate Professor of Anesthesiology, Neurological Surgery

Chief, Division of Pain Medicine

Vanderbilt University Medical Center

AAPM 2022 38TH ANNUAL MEETING

Disclosures

- David Edwards has documented that he has nothing to disclose

FLASH TALK
AAPM 2022
38TH
ANNUAL
MEETING

Objectives

The learner will be able to:

1. Identify the innervation of the sacroiliac joint
2. List 3 approaches to ablation of the posterior innervation of the sacroiliac joint
3. List 3 methods of ablation
4. Compare the efficacy of ablation techniques

Background

Radiofrequency Ablation for Chronic Posterior Sacroiliac Joint Complex Pain: A Comprehensive Review.

Pain Med. 2021

Yang AJ, Wagner G, Burnham T, McCormick ZL, Schneider BJ.

Diagnosis and treatment of posterior sacroiliac complex pain: a systematic review with comprehensive analysis of the published data.

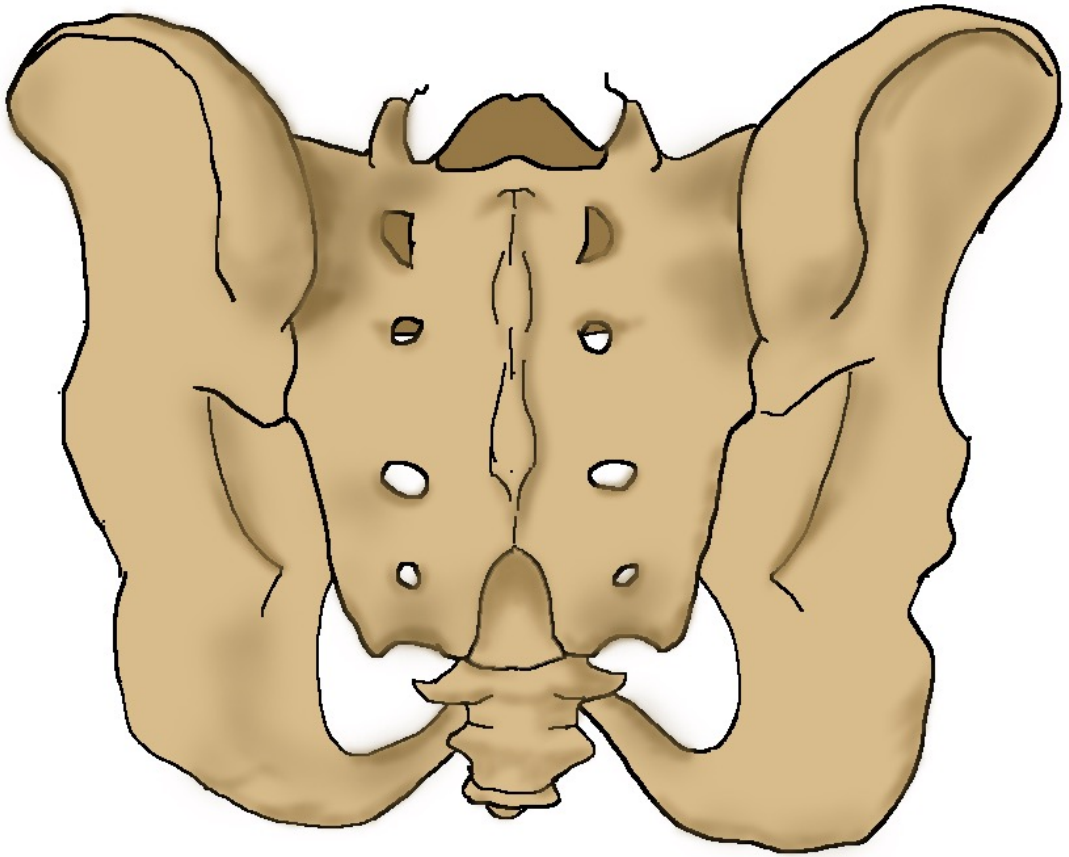
Pain Med. 2015

King W, Ahmed SU, Baisden J, Patel N, Kennedy DJ, Duszynski B, MacVicar J.

SLB RFA

- 13 observational studies (4 prospective)
- 2 explanatory studies
- 0 pragmatic studies
- Lesion location variable
- 4 different RF techniques

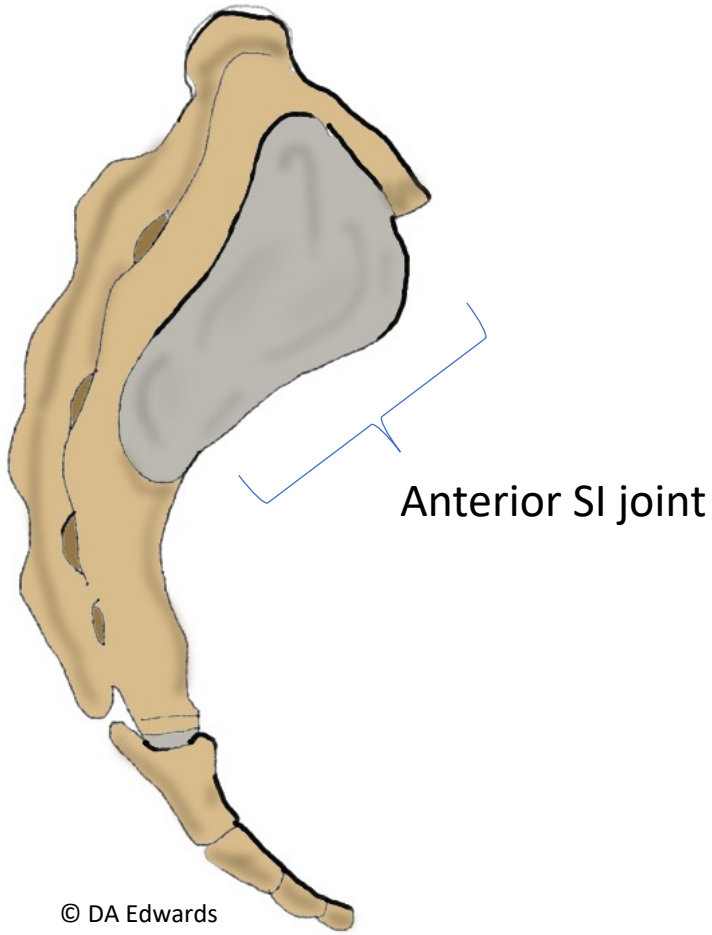
Background



© DA Edwards

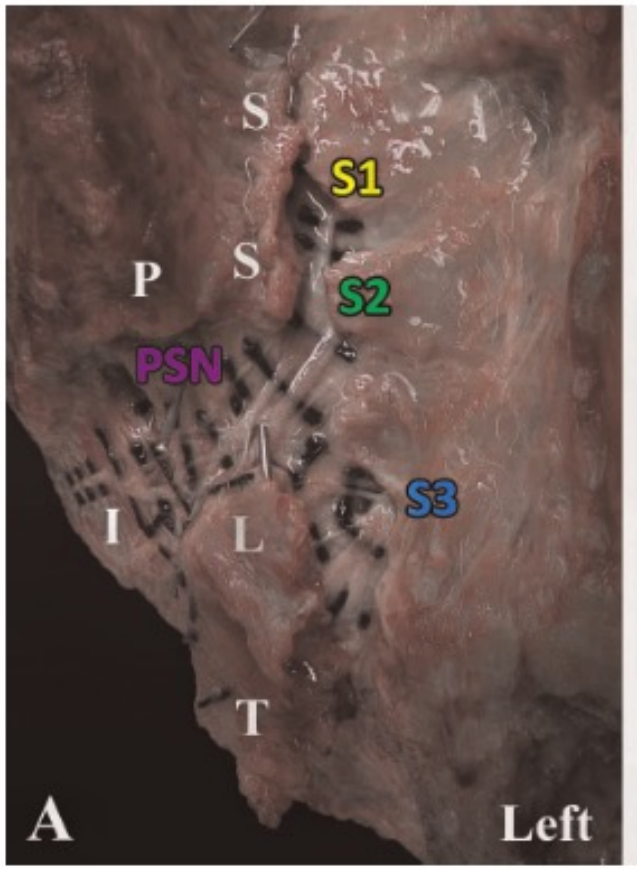
© DA Edwards

Anatomy of SI Pain



Anterior SI Joint	
	Innervates
• L1,2,3 (sup. gluteal nerve) • L2,3,4 (obturator nerve) • L5-S4 (ventral lumbosacral trunk)	• bone • articular cartilage • joint capsule

Anatomy of SI Pain



Roberts, Pain Med. 2018

Stout, Pain Med. 2018

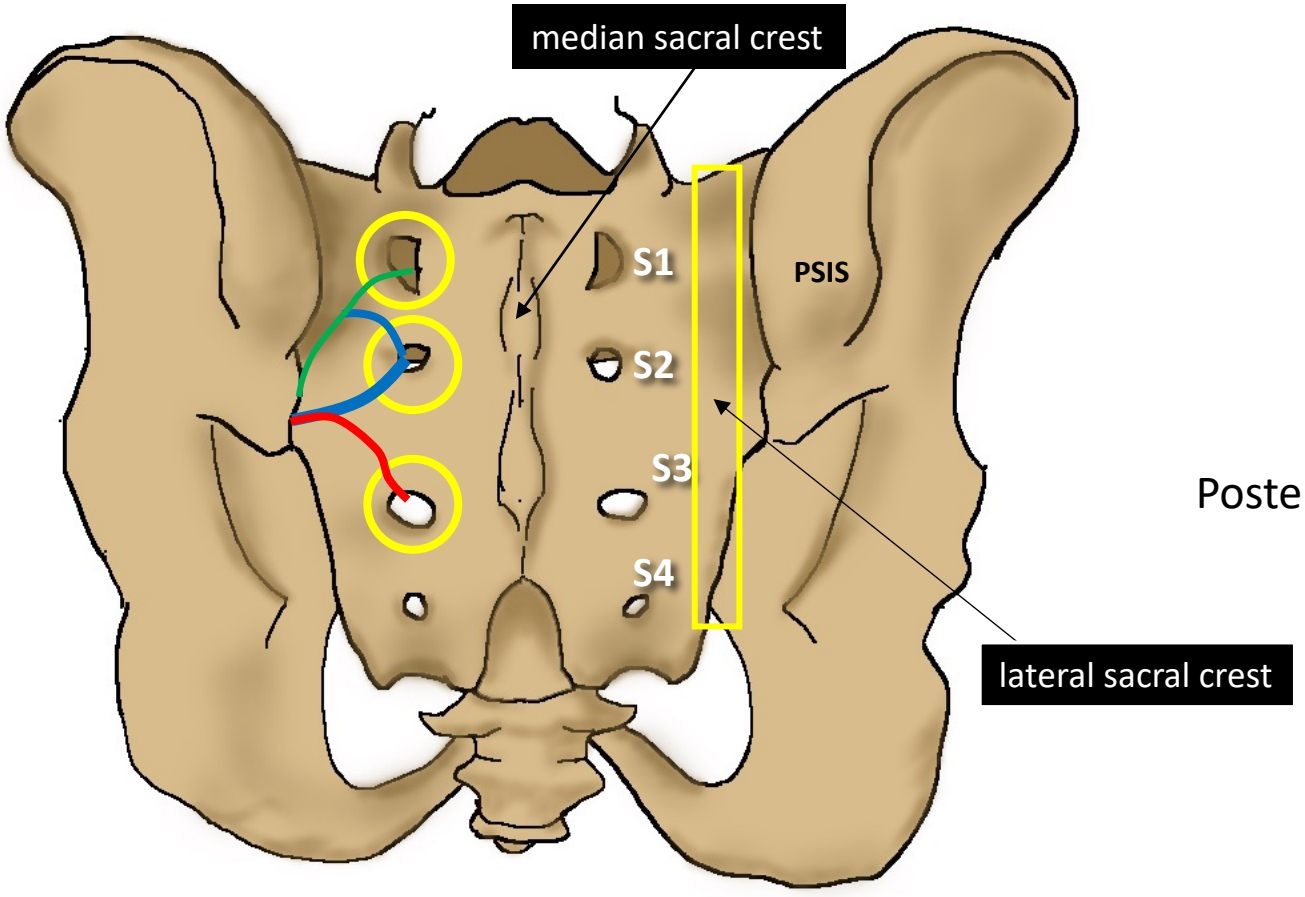
Posterior SI Joint	
Posterior sacral network (PSN) • L5 • **S1** (100%)* • **S2** (100%)* • **S3** (88%)* • S4 (4%)*	Innervates • the dorsal ligaments • posterior muscles • posterior tendons

Posterior SI Joint

© DA Edwards

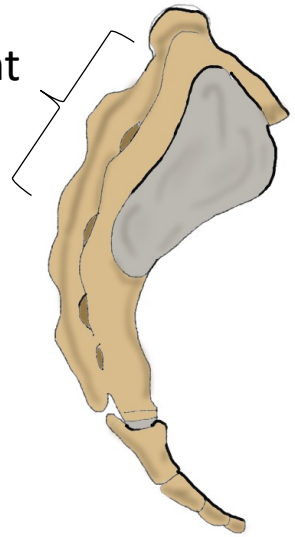
FLASH TALK AAPM 2022 38TH ANNUAL MEETING

Anatomy of SI Pain



Posterior SI Joint	
Posterior sacral network (PSN) • L5 • **S1** (100%)* • **S2** (100%)* • **S3** (88%)* • S4 (4%)*	Innervates • the dorsal ligaments • posterior muscles • posterior tendons

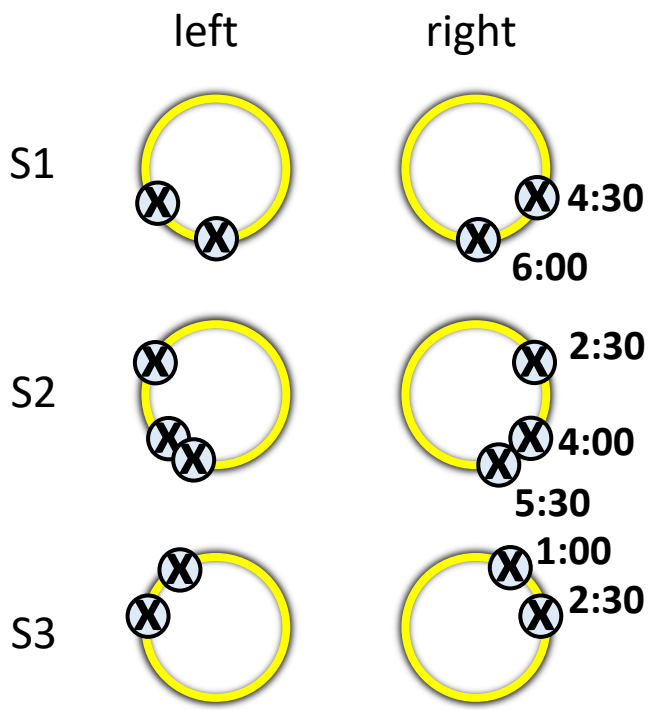
Posterior SI Joint



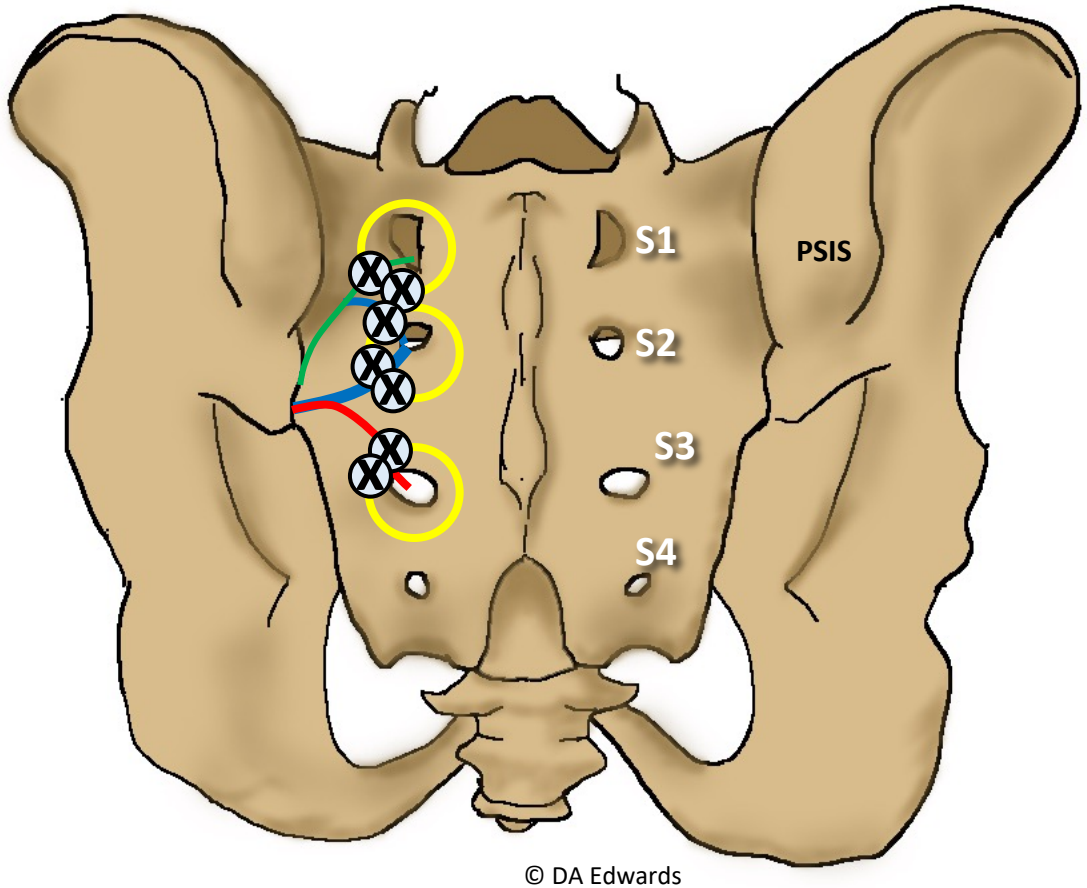
* Roberts SL, Burnham RS, Ravichandiran K, Agur AM, Loh EY. Cadaveric study of sacroiliac joint innervation: implications for diagnostic blocks and radiofrequency ablation. Reg Anesth Pain Med. 2014 Nov-Dec;39(6):456-64. doi: PMID: 25304483.

Radiofrequency Ablation Needle Placement Techniques

1. Periforaminal Lesioning



© DA Edwards



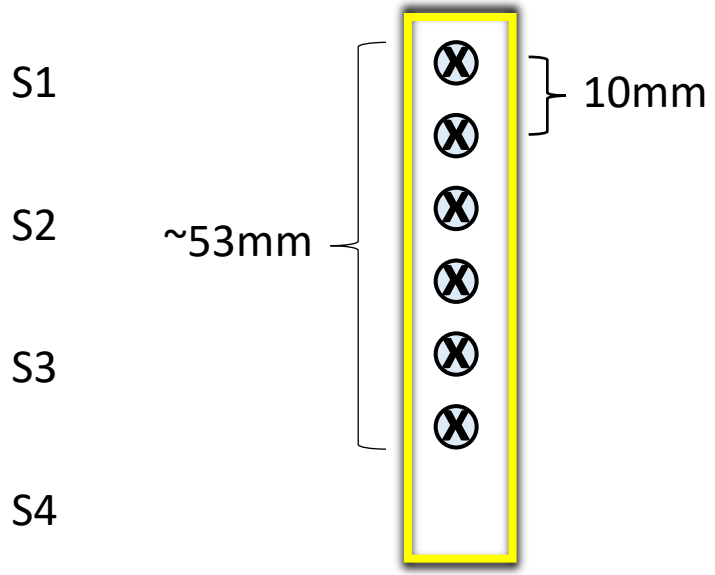
© DA Edwards

Capture of 95% in cadaveric specimens*

FLASH TALK
AAPM 2022
38TH
ANNUAL
MEETING

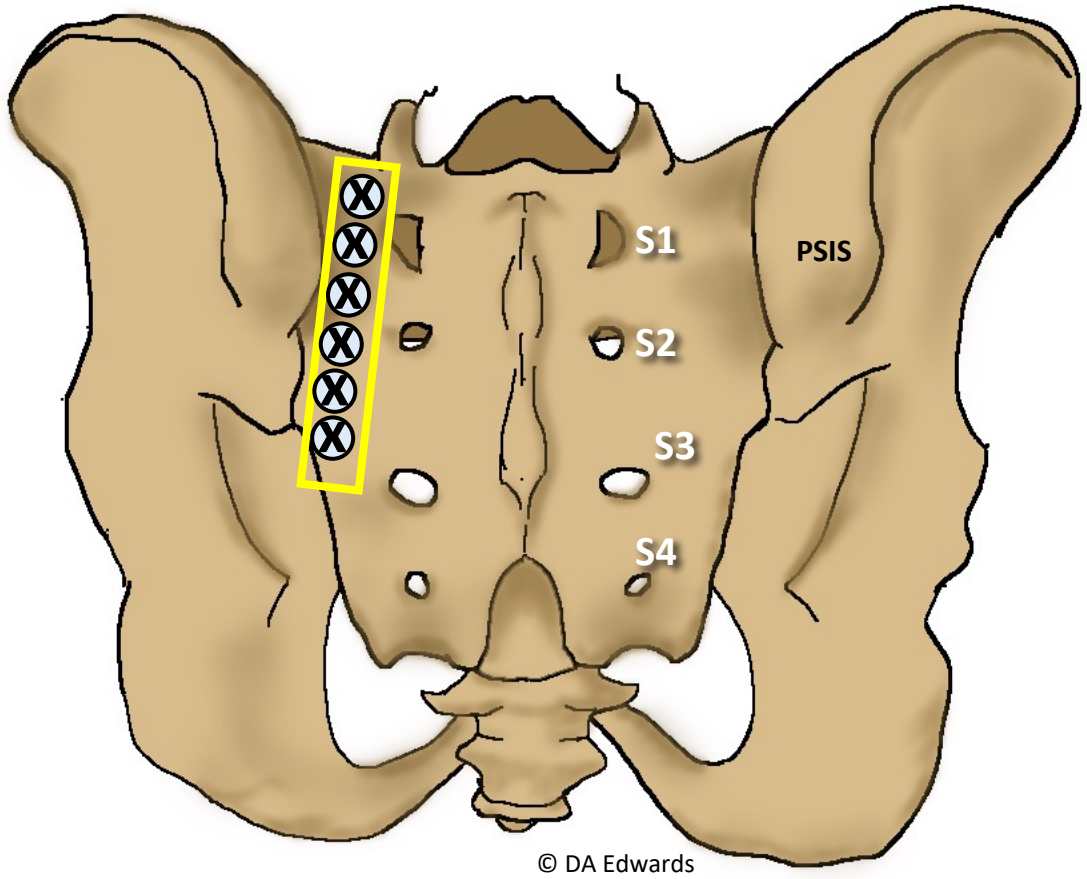
Radiofrequency Ablation Needle Placement Techniques

2. Linear Strip Lesioning using Fluoroscopy
(3. using ultrasound)



© DA Edwards

Capture of 95% in cadaveric specimens*



© DA Edwards

Radiofrequency Lesioning Methods

1. Conventional Monopolar Radiofrequency Ablation (RFA)
2. Conventional Bipolar Radiofrequency Ablation (RFA)
3. Cooled Radiofrequency Ablation (RFA)
4. Conventional + Monopolar in Multielectrode Probe

Radiofrequency Lesioning Methods

Anatomical Comparison of Radiofrequency Ablation Techniques for Sacroiliac Joint Pain.

Pain Med. 2018

Roberts SL, Stout A, Loh EY, Swain N, Dreyfuss P, Agur AM

1. Conventional Monopolar Radiofrequency Ablation (RFA) – 1 technique
2. Conventional Bipolar Radiofrequency Ablation (RFA) – 4 techniques
    - Periforaminal bipolar leapfrog
    - Palisade
    - Nimbus Continuum
    - PSN lateral crest
3. Cooled Radiofrequency Ablation (RFA) – 2 cooled techniques (Patel, Cohen)
    - 8-10 mm from the foramina (instead of the 3-5mm in Cohen)
4. Conventional + Monopolar in Multielectrode Probe
    - Not evaluated because “lesion may not reliably be sufficiently deep to capture the LBs.”

Radiofrequency Lesioning Methods

1. Conventional Monopolar Radiofrequency Ablation (RFA) – 1 technique

Roberts, Pain Med. 2018

RFA Technique (Image Guidance)	Authors [Ref.]	Study Type	N	Diagnostic Block(s) No.	Diagnostic Block(s) Location	Diagnostic Block(s) % Pain Relief	RFA Needle Placements Location*	RFA Needle Placements Distance From PSFA,† mm	Follow-up, mos	≥50% Pain Relief: N (95% CI), %
Periforaminal techniques										
Conventional monopolar (FL)	Cohen and Abdi [19]	Retro	9	1 ≥1	IAI SLBBs: L4 & L5 S1-S3: 1 needle between 2:30 & 4:30 5 mm from PSFA	≥80 ≥50	L4-S3: sites identified by sensory stimulation	NR	9	89 (68–100)
	Yin et al. [12]	Retro	14	2	DILIs	>70	L5 posterior sensory branch S1–S3: sites identified by sensory stimulation	NR	6	64 (39–89)
	Cohen et al. [20]	RCT crossover group	11	1	IAI	≥75	L4 & L5 S1 & S2: 1:00, 3:00, & 5:30	3–5	6	36 (8–65)
	Cohen et al. [21]	Retro	57	≥1 1	IAI SLBBs: L4 & L5 S1–S3: 3:00 5 mm from PSFA	≥50 ≥50	S3: 1:30 & 4:30 S4: 1 upper lesion§		6	47 (34–60)
	Speldewinde [22]	Pro	20	≥2	IAIs	>80	L5 S1–S3: "three evenly-spaced vertical placements"	NR	≥2	80 (63–98)
	Cheng et al. [23]	Retro	30	2	IAIs	≥50	L5 S1–S3: 1 or 2 lesions between 1:00 & 5:00	1–3	6	40 (23–58)

FLASH TALK AAPM 2022 38TH ANNUAL MEETING

Radiofrequency Lesioning Methods

2. Conventional Bipolar Radiofrequency Ablation (RFA) – 4 techniques
- Periforaminal bipolar leapfrog
- Palisade
- Nimbus Continuum
- PSN lateral crest

Roberts, Pain Med. 2018

RFA Technique (Image Guidance)	Authors [Ref.]	Study Type	N	Diagnostic Block(s)			RFA Needle Placements			≥50% Pain Relief: N (95% CI), %
				No.	Location	% Pain Relief	Location*	Distance From PSFA,† mm	Follow-up, mos	
Periforaminal bipolar leapfrog (FL)	Burnham and Yasui [32]	Pro	9	≥1 1	IAI SLBBs: same as RFA	>50 >50	L5 (3 conventional monopolar lesions) S1–S3: 4–6 needles placed 4–6 mm apart around lateral half of each PSF from 12:00 to 6:00	5	6	33 (3–64)

Roberts, Pain Med. 2018

2. Conventional Bipolar Radiofrequency Ablation (RFA) – 4 techniques
- Periforaminal bipolar leapfrog
- Palisade
- Nimbus Continuum
- PSN lateral crest

Palisade with guide block (FL)	Cheng et al. [30]	Pro	31	2	IAIs	≥50	7 or 9 needles placed 10 mm apart along a straight line from base of S1 SAP to lateral border of PSF3/4	Just lateral to PSFA	6	69 (53–85)

Radiofrequency Lesioning Methods

3. Cooled Radiofrequency Ablation (RFA)

Roberts, Pain Med. 2018

RFA Technique (Image Guidance)	Authors [Ref.]	Study Type	N	Diagnostic Block(s) No.	Location	% Pain Relief	RFA Needle Placements Location*	Distance From PSFA,† mm	Follow-up, mos	≥50% Pain Relief: N (95% CI), %
Cooled monopolar (FL)	Cohen et al. [20]	RCT Tx group	14	1	IAI	≥75	L4 & L5 (conventional)	3–5	6	57 (31–83)
	Cohen et al. [21]	Retro	20	≥1 1	IAI SLBBs: L4 & L5 S1–S3: 3:00 5 mm from PSFA	≥50 ≥50	S1 & S2: 1:00, 3:00, & 5:30 S3: 1:30 & 4:30 S4: 1 upper lesion§		6	65 (44–86)
	Karaman et al. [24]	Pro	15	2	IAIs	>75	L5 S1 & S2: 2:30, 4:00, & 5:30 S3: 2:30 & 4:00	8–10	6	80 (60–100)
	Patel et al. [25,26]	RCT Tx group	34	2	SLBBs: L5 S1–S3: 3:00	≥75	L5 S1 & S2: 2:30, 4:00, & 5:30	7	6	38 (22–56)
		crossover group	16		3–10 mm from PSFA		S3: 1:30 & 3:00		6	44 (20–70)
	Tinnirello et al. [27]	Retro	22	1	IAI	≥50			6	82 (73.6–90.4)
	Kapural et al. [2]	Retro	26	2	IAIs	>50	L5 (cooled or conventional)	8–10	3–4	50 (31–69)
	Kapural et al. [28]	Retro	100	2	IAIs	>50	S1 & S2: 3 lesions ~10 mm apart		NR	NR
	Cheng et al. [23]	Retro	58	2	IAIs	≥50	S3: 2 lesions ~10 mm apart		6	40 (27–53)
	Stelzer et al. [29]	Retro	26	1	IAI	≥50			4–6	86 (73–99)
	Cheng et al. [30]	Retro	62	2	IAIs	≥50	S1–S3: NR ±L5	NR	6	19 (9–29)
	Stelzer et al. [31]	Retro	109	1	IAI or LMBB	>50	L5 S1–S3: NR	NR	6	NR

FLASH TALK AAPM 2022 38TH ANNUAL MEETING

Anatomical Comparison of Radiofrequency Ablation Techniques for Sacroiliac Joint Pain.

Pain Med. 2018

Roberts SL, Stout A, Loh EY, Swain N, Dreyfuss P, Agur AM

Roberts, Pain Med. 2018

RFA Technique	Target Needle Distance,* mm	Lesion L×W,† mm	% of LBs that Would Be Captured: Mean ± SD (Range)	95% CI for Mean	100%: % (n/40)
Palisade V1	~4	15×8	99.7 ± 1.8 (88.9–100.0)	99.2–100.0	97.5 (39)
PSN lateral crest V1	LSC	23×8	99.7 ± 1.8 (88.9–100.0)	99.2–100.0	97.5 (39)
PSN lateral crest V2	LSC	25×10	99.7 ± 1.8 (88.9–100.0)	99.2–100.0	97.5 (39)
S1–S3/4 cooled monopolar V2	8	10×10	99.1 ± 3.3 (85.7–100.0)	98.0–100.0	92.5 (37)
Periforaminal bipolar V2	5	9×4	98.9 ± 4.2 (80.0–100.0)	97.5–100.0	92.5 (37)
Periforaminal bipolar V1	5	8×3	98.6 ± 4.5 (80.0–100.0)	97.2–100.0	90.0 (36)
Nimbus continuum V2	10	25×10	94.4 ± 8.7 (75.0–100.0)	91.6–97.1	67.5 (27)
Nimbus continuum V1	10	23×8	93.4 ± 9.1 (75.0–100.0)	90.5–96.3	62.5 (25)
S1-S3/4 cooled monopolar V1	8	8×8	89.5 ± 12.0 (60.0–100.0)	85.7–93.4	47.5 (19)
S1-S3/4 cooled monopolar V4	10	10×10	87.3 ± 11.4 (66.7–100.0)	83.6–90.9	37.5 (15)
S1-S3/4 cooled monopolar V3	10	8×8	79.0 ± 15.4 (33.3–100.0)	74.1–83.9	20.0 (8)
Conventional monopolar V4	5	4×4	64.6 ± 17.9 (20.0–100.0)	58.9–70.3	2.5 (1)
Conventional monopolar V2	3	4×4	61.4 ± 24.3 (0.0–100.0)	53.7–69.2	12.5 (5)
Conventional monopolar V3	5	3×3	54.8 ± 21.1 (12.5–100.0)	48.1–61.6	2.5 (1)
Conventional monopolar V1	3	3×3	49.6 ± 21.0 (0.0–100.0)	42.8–56.3	5.0 (2)

monopolar

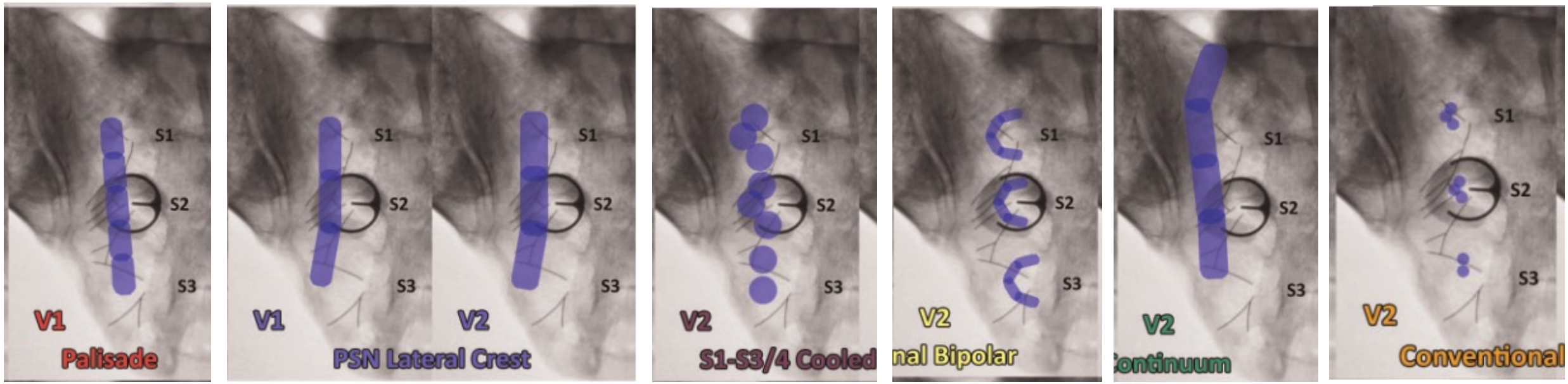
Anatomical Comparison of Radiofrequency Ablation Techniques for Sacroiliac Joint Pain.

Pain Med. 2018

Roberts SL, Stout A, Loh EY, Swain N, Dreyfuss P, Agur AM

Percentage where 100% of the LBs would be treated

97.5% 97.5% 97.5% 92.5% 92.5% 67.5% 12.5%



Roberts, Pain Med. 2018

SI Joint RFA Clinical Outcomes

Pain Medicine

Pain Medicine, 22(S1), 2021, S9–S13
doi: 10.1093/pm/pnab021
Review Article

OXFORD

Radiofrequency Ablation for Chronic Posterior Sacroiliac Joint Complex Pain: A Comprehensive Review

Aaron J. Yang, MD,* Graham Wagner, MD,† Taylor Burnham, MD,† Zachary L. McCormick, MD,† and Byron J. Schneider, MD†

*Department of Physical Medicine and Rehabilitation, Vanderbilt University Medical Center, Nashville, Tennessee; and †Division of Physical Medicine and Rehabilitation, University of Utah School of Medicine, Salt Lake City, Utah, USA

1. 2 RCTs - Proportion of subjects with >50% pain reduction

   Patel *et al.,* 2012 - Cooled RF vs. Sham at 3 months: 47% vs. 12%, p = 0.01

   Cohen *et al.,* 2008 - Cooled RF vs. Sham at 1 month: 79% vs. 14%, p < 0.01

2. Lower quality (observational cohorts)

   Cohen *et al.,* 2008 - Cooled RF vs. monopolar RF at 6 months: 57% vs. 36% (not powered for cf.)

   Cheng *et al.,* 2013 - Cooled RF vs. monopolar RF at X months: no difference

SI Joint RFA Clinical Outcomes

Cohen *et al.,* 2008 - Cooled RF vs. Sham at 1 month: 79% vs. 14%, $p < 0.01$

- N = 28 (14 cooled RF, 14 sham)
- 75% relief after single SIJ
- injection with LA + steroid
- non-responders to sham could cross over to unipolar RF
- 1, 3, 6 mo. follow-up
- outcome: 50% pain relief

Table 3 Success rates of SLBTRFN for achieving at least 50% relief of the index pain as shown by the explanatory study of Cohen et al. [18]

Cohen et al. [18] Patients Selected by ≥75% Relief after a Single SIJB

Group	RF Treatment	Follow-Up (Months)	Pain	Relieved ≥50% (%)
Active group	Cooled	1	11/14	79 (CI_{95} 58–100)
$n = 14$	Cooled	3	9/14	64 (CI_{95} 39–89)
	Cooled	6	8/14	57 (CI_{95} 31–83)
	Cooled	12	2/14	14 (CI_{95} 0–32)
Control group	Sham	1	2/14	14 (CI_{95} 0–32)
$n = 14$	Sham	3	0/14	0
	Sham	6	0/14	0
Cross-over group	Unipolar	1	7/11	64 (CI_{95} 36–92)
$n = 11$	Unipolar	3	6/11	55 (CI_{95} 26–84)
	Unipolar	6	4/11	36 (CI_{95} 8–64)

SIJB = sacroiliac joint block; SLBTRFN = sacral lateral branch thermal radiofrequency neurotomy.

SI Joint RFA Clinical Outcomes

Patel *et al.,* 2012 - Cooled RF vs. Sham at 3 months: 47% vs. 12%, p = 0.01

- N = 51 (2:1, 34 cooled RF, 17 sham)
- 75% relief after single L5, S1-3 SLB block x 2
- sham could cross over after 3 months
- 1, 3, 9 mo. follow-up
- outcome: 50% pain relief, ODI, SF-36

Table 4 Success rates of SLBTRFN for achieving at least 50% relief of the index pain as shown by the explanatory study of Patel et al. [13]

Patel et al. [13] Patients Selected by ≥75% Relief after Each of Two Sets of Single-Depth SLBBs

Group	RF Treatment	Follow-Up (Months)	Pain	Relieved ≥50% (%)
Active group	Cooled	3	16/34	47 (CI_{95} 30–64)
$n = 34$	Cooled	6	13/34	38 (CI_{95} 22–54)
	Cooled	9	20/34	59 (CI_{95} 42–76)
Control group	Sham	3	2/17	12 (CI_{95} 0–27)
$n = 17$				
Cross-over group	Cooled	3	7/16	44 (CI_{95} 20–68)
$n = 16$	Cooled	6	7/16	44 (CI_{95} 20–68)

SLBB = sacral lateral branch blocks; SLBTRFN = sacral lateral branch thermal radiofrequency neurotomy.

SI Joint RFA Clinical Outcomes

1. 2 RCTs - Proportion of subjects with >50% pain reduction

   Patel *et al.,* 2012 - Cooled RF vs. Sham at 3 months: 47% vs. 12%, p = 0.01

   Cohen *et al.,* 2008 - Cooled RF vs. Sham at 1 month: 79% vs. 14%, p < 0.01

2. Lower quality (observational cohorts)

   Cohen *et al.,* 2008 - Cooled RF vs. monopolar RF at 6 months: 57% vs. 36% (not powered for cf.)

   Cheng *et al.,* 2013 - Cooled RF vs. monopolar RF at X months: no difference

Summary

1. The Posterior Sacral Network innervates the structures of the posterior SI complex

2. Periforaminal and Linear Strip lesioning techniques are most common to capture the lateral branches

3. Conventional monopolar, cooled monopolar, and bipolar RFA lesioning methods are all used.

4. Linear bipolar methods seemingly ideal to capture all lateral branches in cadaver studies. Clinically, the cooled RF approach has the strongest evidence vs. sham treatment for efficacy.

References

Loh E, Burnham TR, Burnham RS. Sacroiliac Joint Diagnostic Block and Radiofrequency Ablation Techniques. Phys Med Rehabil Clin N Am. 2021 Nov;32(4):725-744. doi: 10.1016/j.pmr.2021.05.008. Epub 2021 Aug 6. PMID: 34593139.

Yang AJ, Wagner G, Burnham T, McCormick ZL, Schneider BJ. Radiofrequency Ablation for Chronic Posterior Sacroiliac Joint Complex Pain: A Comprehensive Review. Pain Med. 2021 Jul 25;22(Suppl 1):S9-S13. doi: 10.1093/pm/pnab021. PMID: 34308953.

Rashbaum RF, Ohnmeiss DD, Lindley EM, Kitchel SH, Patel VV. Sacroiliac Joint Pain and Its Treatment. Clin Spine Surg. 2016 Mar;29(2):42-8. doi: 10.1097/BSD.0000000000000359. PMID: 26889985.

Schmidt GL, Bhandutia AK, Altman DT. Management of Sacroiliac Joint Pain. J Am Acad Orthop Surg. 2018 Sep 1;26(17):610-616. doi: 10.5435/JAAOS-D-15-00063. PMID: 30059395.

Yang AJ, McCormick ZL, Zheng PZ, Schneider BJ. Radiofrequency Ablation for Posterior Sacroiliac Joint Complex Pain: A Narrative Review. PM R. 2019 Aug;11 Suppl 1:S105-S113. doi: 10.1002/pmrj.12200. Epub 2019 Jul 25. PMID: 31169356.

Forst SL, Wheeler MT, Fortin JD, Vilensky JA. The sacroiliac joint: anatomy, physiology and clinical significance. Pain Physician. 2006 Jan;9(1):61-7. PMID: 16700283.

Cohen SP, Chen Y, Neufeld NJ. Sacroiliac joint pain: a comprehensive review of epidemiology, diagnosis and treatment. Expert Rev Neurother. 2013 Jan;13(1):99-116. doi: 10.1586/ern.12.148. PMID: 23253394.

Falowski S, Sayed D, Pope J, Patterson D, Fishman M, Gupta M, Mehta P. A Review and Algorithm in the Diagnosis and Treatment of Sacroiliac Joint Pain. J Pain Res. 2020 Dec 8;13:3337-3348. doi: 10.2147/JPR.S279390. PMID: 33335420; PMCID: PMC7737553.

Cheng J, Chen SL, Zimmerman N, Dalton JE, LaSalle G, Rosenquist R. A New Radiofrequency Ablation Procedure to Treat Sacroiliac Joint Pain. Pain Physician. 2016 Nov-Dec;19(8):603-615. PMID: 27906939.

Roberts SL, Burnham RS, Ravichandiran K, Agur AM, Loh EY. Cadaveric study of sacroiliac joint innervation: implications for diagnostic blocks and radiofrequency ablation. Reg Anesth Pain Med. 2014 Nov-Dec;39(6):456-64. doi: PMID: 25304483.

Roberts SL, Stout A, Loh EY, Swain N, Dreyfuss P, Agur AM. Anatomical Comparison of Radiofrequency Ablation Techniques for Sacroiliac Joint Pain. Pain Med. 2018 Oct 1;19(10):1924-1943. doi: 10.1093/pm/pnx329. PMID: 29415262.

Bayerl SH, Finger T, Heiden P, Esfahani-Bayerl N, Topar C, Prinz V, Woitzik J, Dengler J, Vajkoczy P. Radiofrequency denervation for treatment of sacroiliac joint pain-comparison of two different ablation techniques. Neurosurg Rev. 2020 Feb;43(1):101-107. doi: 10.1007/s10143-018-1016-3. Epub 2018 Jul 31. PMID: 30066034.

Woiciechowsky C, Richter LM. Preliminary Results of Endoscopic Radiofrequency Treatment of the Sacroiliac Joint Syndrome. J Neurol Surg A Cent Eur Neurosurg. 2022 Mar;83(2):105-109. doi: 10.1055/s-0041-1740439. Epub 2021 Nov 17. PMID: 34788869.

Burnham TR, Smith A, McCormick ZL, Teramoto M, Burnham R. Evaluation of an Ultrasound-Assisted Longitudinal Axis Lateral Crest Approach to Radiofrequency Ablation of the Sacroiliac Joint. Am J Phys Med Rehabil. 2022 Jan 1;101(1):26-31. doi: 10.1097/PHM.0000000000001733. PMID: 34915543.

Ramasubba C, Cohen SP. Cooled sacroiliac radiofrequency denervation for the treatment of pain secondary to tumor infiltration: a case-based focused literature review. Pain Physician. 2013 Jan;16(1):1-8. PMID: 23340529.

Chen CH, Weng PW, Wu LC, Chiang YF, Chiang CJ. Radiofrequency neurotomy in chronic lumbar and sacroiliac joint pain: A meta-analysis. Medicine (Baltimore). 2019 Jun;98(26):e16230. doi: 10.1097/MD.0000000000016230. PMID: 31261580; PMCID: PMC6617467.

Kurklinsky S, Boone MK, Candler SA, Schwab A, Ghazi S. Repeat Cooled Radiofrequency Ablation Is Beneficial for Chronic Posterior Sacroiliac Joint Pain. Pain Med. 2020 Aug 1;21(8):1532-1537. doi: 10.1093/pm/pnz295. PMID: 32803218.

Ibrahim R, Telfeian AE, Gohlke K, Decker O. Endoscopic Radiofrequency Treatment of the Sacroiliac Joint Complex for Low Back Pain: A Prospective Study with a 2-Year Follow-Up. Pain Physician. 2019 Mar;22(2):E111-E118. PMID: 30921988.

Stout A, Dreyfuss P, Swain N, Roberts S, Loh E, Agur A. Proposed Optimal Fluoroscopic Targets for Cooled Radiofrequency Neurotomy of the Sacral Lateral Branches to Improve Clinical Outcomes: An Anatomical Study. Pain Med. 2018 Oct 1;19(10):1916-1923. doi: 10.1093/pm/pnx287. PMID: 29186577.

King W, Ahmed SU, Baisden J, Patel N, Kennedy DJ, Duszynski B, MacVicar J. Diagnosis and treatment of posterior sacroiliac complex pain: a systematic review with comprehensive analysis of the published data. Pain Med. 2015 Feb;16(2):257-65. doi: 10.1111/pme.12630. Erratum in: Pain Med. 2015 Nov;16(11):2216. Duszynski, Belinda [added]. PMID: 25677327.