

NÖROABLATİF TEKNİKLER

Çile AKTAN ¹
Burak ERKEN ²
Ahmet BAŞARI ³
Güngör Enver ÖZGENÇİL ⁴

ÖZET

Kanser ile ilişkili ağrı primer patolojiye, metastaz veya tedavi yan etkilerine bağlı gelişmektedir. Kanser ağrısı, kişilerin fiziksel, psikolojik ve sosyal durumunu ciddi şekilde etkilemektedir. Medikal tedavinin tolere edilememesi veya yeterli ağrı kontrolü sağlanamadığı durumlarda girişimsel ağrı tedavileri uygulanmaktadır. Sinir blokları gibi konvansiyonel tedaviler ile etkin ağrı palyasyonunun sağlanamaması durumunda ise nöroablatif tedaviler gündeme gelmektedir. Nöroablatif tedavilerde amaç ağrı yollarını kesintiye uğratmaktır. Kanser ve ağrının lokalizasyonuna göre intrakranial, medulla spinalis, sempatik ve parasempatik ganglionlar ile periferik sinirlerde nörolitik veya ablatif yöntemler uygulanabilir. Nöroablatif uygulamalar ciddi komplikasyonlara neden olabileceğinden uygun koşullarda, alanında yetkin, tecrübeli hekimler tarafından uygulanmalıdır.

GİRİŞ

Üç aydan uzun süren, tedavisi zor, oldukça büyük bir popülasyonu etkileyen ve dünya çapında engelliğin önde gelen bir nedeni olan kronik ağrı olgularının önemli bir kısmını kanser ilişkili ağrı olguları oluşturmaktadır (1). Ağrı tedavisindeki tüm gelişmelere rağmen, henüz tatmin edici bir şekilde tedavi sağlandığını söylemek güçtür (2). Özellikle kanser hastalarında kitleye bağlı sinir kompresyonları, kemik metastazları ve kırıklarının neden olduğu ağrının medikal tedavi ile palyasyonu oldukça güç

olabilmekte ve bu durumda girişimsel ağrı tedavi teknikleri uygun hastalarda alternatif tedavi seçeneği olabilmektedir (3, 4). Dünya Sağlık Örgütü kanser hastalarında basamak tedavisini önermektedir (5). Bu tedavi algoritmasına göre birinci basamakta basit analjezikler, ikinci basamakta birinci basamağa ek zayıf opioidler ve üçüncü basamakta da güçlü opioidlerin eklenmesi önerilir. Ayrıca herhangi bir basamakta adjuvan ajanların da eklenebileceği belirtilmektedir. Ancak çalışmalar, kanser ağrısının tedavisinde %20-40 olguda analjezik basamak tedavisi ile yeterince etkinlik sağlanamadığını gös-

¹ Uzm. Dr., Gaziantep Dr. Ersin Arslan Eğitim Araştırma Hastanesi, Algoloji Kliniği drcilezengin@hotmail.com

² Uzm. Dr., İstanbul Başakşehir Çam ve Sakura Şehir Hastanesi, Algoloji Kliniği burak_erken@hotmail.com

³ Arş. Gör., Ankara Üniversitesi Tıp Fakültesi Algoloji BD., dr.ahmetbasari07@hotmail.com

⁴ Prof. Dr., Ankara Üniversitesi Tıp Fakültesi Algoloji BD., ozgencilge@gmail.com

%60-80 solüsyon olarak uygulanır. Bu yüksek konsantrasyonlarda kan dolaşımına hızla emilir ve sedasyona veya disülfirm benzeri reaksiyona neden olabilir. Ayrıca enjeksiyon sırasında yanma vasfında ağrı yakınmasının neden olur, bu nedenle etil alkol enjeksiyonundan önce lokal anestetik uygulanmalıdır. Fenol, gecikmiş nöroliz sağlar (15 dakika) ve ticari olarak mevcut olmayan ve eczacı tarafından ayrı ayrı birleştirilmesi gereken %4-10'luk çözeltiler hâlinde steril su ile hazırlanmalıdır. Fenol zayıf lokal anestetik etkilidir (156).

Sonuç olarak kanser ağrı tedavisinde tüm nöroablatif prosedürlerde altın standart uygun hasta seçimidir. Bu uygunlukta da konvansiyonel tedavi seçeneklerinin etkisiz olduğu veya yan etkiler nedeni ile uygulanmadığının teyidi önemlidir. Uygun hasta seçimi sonrası uygulama muhakkak uygulama tekniği, görüntüleme kılavuzluğu ve komplikasyonlara hakim, tecrübeli ve gerekli eğitimi almış, yetkin uzman hekimler tarafından gerçekleştirilmelidir.

KAYNAKLAR

- Global Burden of Disease Study 2013 Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet*. 2015;386(9995):743-800. doi: 10.1016/S0140-6736(15)60692-4.
- Breivik H, Collett B, Ventafridda V, et al. Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *Eur J Pain*. 2006;10(4):287-333. doi: 10.1016/j.ejpain.2005.06.009.
- McHugh ME, Miller-Saultz D, Wuhrman E, et al. Interventional pain management in the palliative care patient. *Int J Palliat Nurs*. 2012;18(9):426-428, 430-433. doi: 10.12968/ijpn.2012.18.9.426.
- Joshi M, Chambers WA. Pain relief in palliative care: a focus on interventional pain management. *Expert Rev Neurother*. 2010;10(5):747-756. doi: 10.1586/ern.10.47.
- Mercadante S, Fulfarò F. World Health Organization guidelines for cancer pain: a reappraisal. *Ann Oncol*. 2005;16 Suppl 4:iiv132-135. doi: 10.1093/annonc/mdi922.
- Twycross R, Harcourt J, Bergl S. A survey of pain in patients with advanced cancer. *J Pain Symptom Manage*. 1996;12(5):273-282. doi: 10.1016/s0885-3924(96)00149-2.
- Weiss SC, Emanuel LL, Fairclough DL, et al. Understanding the experience of pain in terminally ill patients. *Lancet*. 2001;357(9265):1311-13115. doi: 10.1016/S0140-6736(00)04515-3.
- Melzack R, Torgerson WS. On the language of pain. *Anesthesiology*. 1971;34(1):50-59. doi: 10.1097/00000542-197101000-00017.
- Boccard SG, Fernandes HM, Jbabdi S, et al. Tractography Study of Deep Brain Stimulation of the Anterior Cingulate Cortex in Chronic Pain: Key to Improve the Targeting. *World Neurosurg*. 2016;86:361-370.e1-3. doi: 10.1016/j.wneu.2015.08.065.
- Melzack R. From the gate to the neuromatrix. *Pain*. 1999;Suppl 6:S121-S126. doi: 10.1016/S0304-3959(99)00145-1.
- Foltz EL, White LE Jr. Pain "relief" by frontal cingulotomy. *J Neurosurg*. 1962;19:89-100. doi: 10.3171/jns.1962.19.2.0089.
- Rolls ET, O'Doherty J, Kringelbach ML, et al. Representations of pleasant and painful touch in the human orbitofrontal and cingulate cortices. *Cereb Cortex*. 2003;13(3):308-317. doi: 10.1093/cercor/13.3.308.
- Viswanathan A, Harsh V, Pereira EA, et al. Cingulotomy for medically refractory cancer pain. *Neurosurg Focus*. 2013;35(3):E1. doi: 10.3171/2013.6.FOCUS13236.
- Yen CP, Kung SS, Su YF, et al. Stereotactic bilateral anterior cingulotomy for intractable pain. *J Clin Neurosci*. 2005;12(8):886-890. doi: 10.1016/j.jocn.2004.11.018.
- Foltz EL, White LE. The role of rostral cingulotomy in "pain" relief. *Int J Neurol*. 1968;6(3-4):353-373.
- Hassenbusch SJ, Pillay PK, Barnett GH. Radiofrequency cingulotomy for intractable cancer pain using stereotaxis guided by magnetic resonance imaging. *Neurosurgery*. 1990;27(2):220-223. doi: 10.1097/00006123-199008000-00008.
- Patel NV, Agarwal N, Mammis A, et al. Frameless stereotactic magnetic resonance imaging-guided laser interstitial thermal therapy to perform bilateral anterior cingulotomy for intractable pain: feasibility, technical aspects, and initial experience in 3 patients. *Oper Neurosurg (Hagerstown)*. 2015;11 Suppl 2:17-25; discussion 25. doi: 10.1227/NEU.0000000000000581.
- Sharim J, Pouratian N. Anterior Cingulotomy for the Treatment of Chronic Intractable Pain: A Systematic Review. *Pain Physician*. 2016;19(8):537-550.
- Dalle R, Raboisson P, Auroy P, Woda A. The rostral part of the trigeminal sensory complex is involved in orofacial nociception. *Brain Res*. 1988;448(1):7-19. doi: 10.1016/0006-8993(88)91096-7.
- Cosman ER, Nashold BS, Bedenbaugh P. Stereotactic radiofrequency lesion making. *Appl Neurophysiol*. 1983;46(1-4):160-166. doi: 10.1159/000101256.
- Fox JL. Intractable facial pain relieved by percutaneous trigeminal tractotomy. *JAMA*. 1971;218(13):1940-1941.
- Garber JE, Hassenbusch SJ. (2001). Neurosurgical operations on the spinal cord. In Loeser JD, Chapman R, Turk DC (eds): *Bonica's Management of Pain*, (3rd ed, pp. 2023-2037). Philadelphia: Williams and Wilkins
- Sjöqvist O. Studies on pain conduction in the trigeminal nerve. A contribution to the surgical treatment of facial pain. *JAMA*. 1940;115(5):408. doi:10.1001/jama.1940.02810310066025

24. Crue BL, Todd EM, Carregal EJ, Kilham O. Percutaneous trigeminal tractotomy. Case report-utilizing stereotactic radiofrequency lesion. *Bull Los Angeles Neurol Soc.* 1967;32(2):86-92.
25. Hitchcock E. Stereotactic trigeminal tractotomy. *Ann Clin Res.* 1970;2(2):131-135.
26. Teixeira MJ, de Almeida FF, de Oliveira YS, et al. Microendoscopic stereotactic-guided percutaneous radiofrequency trigeminal nucleotomectomy. *J Neurosurg.* 2012;116(2):331-335. doi: 10.3171/2011.8.JNS11618.
27. Kanpolat Y, Kahilogullari G, Ugur HC, et al. Computed tomography-guided percutaneous trigeminal tractotomy-nucleotomy. *Neurosurgery.* 2008;63(1 Suppl 1):ONS147-153; discussion ONS153-155. doi: 10.1227/01.neu.0000335029.85402.89.
28. Thompson EM, Burchiel KJ, Raslan AM. Percutaneous trigeminal tractotomy-nucleotomy with use of intraoperative computed tomography and general anesthesia: report of 2 cases. *Neurosurg Focus.* 2013;35(3):E5. doi: 10.3171/2013.6.FOCUS13218.
29. Kanpolat Y, Savas A, Ugur HC, et al. The trigeminal tract and nucleus procedures in treatment of atypical facial pain. *Surg Neurol.* 2005;64 Suppl 2:S96-100; discussion S100-101. doi: 10.1016/j.surneu.2005.07.018.
30. Bekar A, Eser Ocak P, Taskapilioglu MO, et al. CT-Guided Percutaneous Trigeminal Tractotomy-Nucleotomy for Intractable Craniofacial Pain. *Stereotact Funct Neurosurg.* 2020;98(5):350-357. doi: 10.1159/000509316
31. Raslan AM. Percutaneous computed tomography-guided radiofrequency ablation of upper spinal cord pain pathways for cancer-related pain. *Neurosurgery.* 2008;62(3 Suppl 1):226-233; discussion 233-234. doi: 10.1227/01.neu.0000317397.16089.f5.
32. Menon JP. Intracranial ablative procedures for the treatment of chronic pain. *Neurosurg Clin N Am.* 2014;25(4):663-670. doi: 10.1016/j.nec.2014.06.003.
33. Ouhaz Z, Fleming H, Mitchell AS. Cognitive Functions and Neurodevelopmental Disorders Involving the Prefrontal Cortex and Mediodorsal Thalamus. *Front Neurosci.* 2018;12:33. doi: 10.3389/fnins.2018.00033.
34. Franzini A, Rossini Z, Moosa S, et al. Medial thalamotomy using stereotactic radiosurgery for intractable pain: a systematic review. *Neurosurg Rev.* 2022;45(1):71-80. doi: 10.1007/s10143-021-01561-x.
35. Franzini A, Moosa S, Servello D, et al. Ablative brain surgery: an overview. *Int J Hyperthermia.* 2019;36(2):64-80. doi: 10.1080/02656736.2019.1616833.
36. Burchiel KJ, Raslan AM. Contemporary concepts of pain surgery. *J Neurosurg.* 2019;130(4):1039-1049. doi: 10.3171/2019.1.JNS181620.
37. Weigel R, Krauss JK. Center median-parafascicular complex and pain control. Review from a neurosurgical perspective. *Stereotact Funct Neurosurg.* 2004;82(2-3):115-126. doi: 10.1159/000079843.
38. Frighetto L, De Salles AA, Smith ZA, et al. Noninvasive linear accelerator radiosurgery as the primary treatment for trigeminal neuralgia. *Neurology.* 2004;62(4):660-662. doi: 10.1212/wnl.62.4.660.
39. Hitchcock ER, Teixeira MJ. A comparison of results from center-median and basal thalamotomies for pain. *Surg Neurol.* 1981;15(5):341-351. doi: 10.1016/0090-3019(81)90164-6.
40. Jeanmonod D., Morel A. (2009). The Central Lateral Thalamotomy for Neuropathic Pain. In: Lozano, A.M., Gildenberg, P.L., Tasker, R.R. (eds) *Textbook of Stereotactic and Functional Neurosurgery* (2nd ed, pp.2081-2096) Berlin: Springer,. https://doi.org/10.1007/978-3-540-69960-6_123
41. Rinaldi PC, Young RF, Albe-Fessard D, et al. Spontaneous neuronal hyperactivity in the medial and intralaminar thalamic nuclei of patients with deafferentation pain. *J Neurosurg.* 1991;74(3):415-421. doi: 10.3171/jns.1991.74.3.0415.
42. Sano K. Neurosurgical treatments of pain--a general survey. *Acta Neurochir Suppl (Wien).* 1987;38:86-96. doi: 10.1007/978-3-7091-6975-9_14.
43. Steiner L, Forster D, Leksell L, et al. Gammathalamotomy in intractable pain. *Acta Neurochir (Wien).* 1980;52(3-4):173-184. doi: 10.1007/BF01402072.
44. Franzini A, Attuati L, Zaed I, et al. Gamma Knife central lateral thalamotomy for the treatment of neuropathic pain. *J Neurosurg.* 2020:1-9. doi: 10.3171/2020.4.JNS20558.
45. Jeanmonod D, Magnin M , Morel, A et al. Surgical control of the human thalamocortical dysrhythmia: I. Central lateral thalamotomy in neurogenic pain. *Thalamus & Related Systems,* 2001;1(1), 71-79. doi:10.1017/S1472928801000036
46. Jeanmonod D, Werner B, Morel A, et al. Transcranial magnetic resonance imaging-guided focused ultrasound: noninvasive central lateral thalamotomy for chronic neuropathic pain. *Neurosurg Focus.* 2012;32(1):E1. doi: 10.3171/2011.10.FOCUS11248.
47. Rezaei Haddad A, Hayley J, Mostofi A, et al. Stereotactic Radiofrequency Thalamotomy for Cancer Pain: A Systematic Review. *World Neurosurg.* 2021;151:225-234.e6. doi: 10.1016/j.wneu.2021.04.075.
48. Mullan S, Harper PV, Hekmatpanah J, et al. Percutaneous interruption of spinal-pain tracts by means of a strontium90 needle. *J Neurosurg.* 1963; 20:931-939. doi: 10.3171/jns.1963.20.11.0931.
49. Spiller WG, Martin E. The treatment of persistent pain of organic origin in the lower part of the body by division of the anterolateral column of the spinal cord. *JAMA.* 1912;LVIII(20):1489-1490. doi:10.1001/jama.1912.04260050165001
50. Kanpolat Y, Deda H, Akyar S, Bilgiç S. CT-guided percutaneous cordotomy. *Acta Neurochir Suppl (Wien).* 1989;46:67-68. doi: 10.1007/978-3-7091-9029-6_16.
51. Fonoff ET, Lopez WO, de Oliveira YS, et al. Microendoscopy-guided percutaneous cordotomy for intractable pain: case series of 24 patients. *J Neurosurg.* 2016;124(2):389-396. doi: 10.3171/2014.12.JNS141616.
52. Raslan AM. Percutaneous computed tomography-guided transdiscal low cervical cordotomy for cancer pain as a method to avoid sleep apnea. *Stereotact Funct Neurosurg.* 2005;83(4):159-164. doi: 10.1159/000088992.
53. Jack TM, Lloyd JW. Long-term efficacy of surgical cordotomy in intractable non-malignant pain. *Ann R Coll Surg Engl.* 1983;65(2):97-102.

54. Porter RW, Hohmann GW, Bors E, et al. Cordotomy for pain following cauda equina injury. *Arch Surg*. 1966;92(5):765-770. doi: 10.1001/archsurg.1966.01320230113021.
55. Javed S, Viswanathan A, Abdi S. Cordotomy for Intractable Cancer Pain: A Narrative Review. *Pain Physician*. 2020;23(3):283-292
56. Bellini M, Barbieri M. Percutaneous cervical cordotomy in cancer pain. *Anaesthesiol Intensive Ther*. 2016;48(3):197-200. doi: 10.5603/AIT.a2014.0070.
57. Sanders M, Zuurmond W. Safety of unilateral and bilateral percutaneous cervical cordotomy in 80 terminally ill cancer patients. *J Clin Oncol*. 1995;13(6):1509-1512. doi: 10.1200/JCO.1995.13.6.1509.
58. Rosomoff HL, Carroll F, Brown J, et al. Percutaneous Radiofrequency Cervical Cordotomy: Technique, *Journal of Neurosurgery*, 1965;23(6),639-644. <https://doi.org/10.3171/jns.1965.23.6.0639>
59. Kanpolat Y, Ugur HC, Ayten M, Elhan AH. Computed tomography-guided percutaneous cordotomy for intractable pain in malignancy. *Neurosurgery*. 2009;64(3 Suppl):ons187-93; discussion ons193-194. doi: 10.1227/01.NEU.0000335645.67282.03.
60. Yegul I, Erhan E. Bilateral CT-guided percutaneous cordotomy for cancer pain relief. *Clin Radiol*. 2003;58(11):886-889. doi: 10.1016/s0009-9260(03)00266-6.
61. Bain E, Hugel H, Sharma M. Percutaneous cervical cordotomy for the management of pain from cancer: a prospective review of 45 cases. *J Palliat Med*. 2013;16(8):901-907. doi: 10.1089/jpm.2013.0027.
62. Kanpolat Y, Ozdemir M, Al-Beyati E. CT-guided percutaneous cordotomy for intractable pain in what is more than a disease: lung malignancies. *Turk Neurosurg*. 2013;23(1):81-87. doi: 10.5137/1019-5149.JTN.6980-12.0.
63. Bekar A, Taskapilioglu MO, Eser P, et al. CT-Guided High-Level Percutaneous Cervical Cordotomy for Intractable Cancer Pain. *Turk Neurosurg*. 2017;27(1):133-137. doi: 10.5137/1019-5149.JTN.14558-15.1.
64. Strauss I, Berger A, Arad M, et al. O-Arm-Guided Percutaneous Radiofrequency Cordotomy. *Stereotact Funct Neurosurg*. 2017;95(6):409-416. doi: 10.1159/000484614.
65. France BD, Lewis RA, Sharma ML, et al. Cordotomy in mesothelioma-related pain: a systematic review. *BMJ Support Palliat Care*. 2014;4(1):19-29. doi: 10.1136/bmjspcare-2013-000508.
66. Viswanathan A, Vedantam A, Hess KR, et al. Minimally Invasive Cordotomy for Refractory Cancer Pain: A Randomized Controlled Trial. *Oncologist*. 2019;24(7):e590-e596. doi: 10.1634/theoncologist.2018-0570.
67. Tranmer BI, Tucker WS, Bilbao JM. Sleep apnea following percutaneous cervical cordotomy. *Can J Neurol Sci*. 1987;14(3):262-267. doi: 10.1017/s0317167100026585.
68. Bowsher D. Contralateral mirror-image pain following anterolateral cordotomy. *Pain*. 1988;33(1):63-65. doi: 10.1016/0304-3959(88)90204-7.
69. Higaki N, Yorozuya T, Nagaro T, et al. Usefulness of cordotomy in patients with cancer who experience bilateral pain: implications of increased pain and new pain. *Neurosurgery*. 2015;76(3):249-256; discussion 256; quiz 256-257. doi: 10.1227/NEU.0000000000000593.
70. Nagaro T, Adachi N, Tabo E, et al. New pain following cordotomy: clinical features, mechanisms, and clinical importance. *J Neurosurg*. 2001;95(3):425-431. doi: 10.3171/jns.2001.95.3.0425.
71. Lukas A, van der Weide M, Boogerd W, et al. Adhesive arachnoiditis following percutaneous cervical cordotomy--may we still use lipiodol? *J Pain Symptom Manage*. 2008;36(5):e1-4. doi: 10.1016/j.jpainsymman.2008.07.003.
72. White JC. Cordotomy: assessment of its effectiveness and suggestions for its improvement. *Clin Neurosurg*. 1965;13:1-19.
73. Harsh V, Viswanathan A. Surgical/radiological interventions for cancer pain. *Curr Pain Headache Rep*. 2013;17(5):331. doi: 10.1007/s11916-013-0331-1.
74. Hitchcock E. Stereotactic cervical myelotomy. *J Neurol Neurosurg Psychiatry*. 1970;33(2):224-230. doi: 10.1136/jnnp.33.2.224.
75. Schvarcz JR. Stereotactic extralemniscal myelotomy. *J Neurol Neurosurg Psychiatry*. 1976;39(1):53-57. doi: 10.1136/jnnp.39.1.53.
76. Kanpolat Y, Atalağ M, Deda H, et al. CT guided extralemniscal myelotomy. *Acta Neurochir (Wien)*. 1988;91(3-4):151-152. doi: 10.1007/BF01424574.
77. Kanpolat Y. Percutaneous Cordotomy, Tractotomy, and Midline Myelotomy: Minimally Invasive Stereotactic Pain Procedures. *Seminars in Neurosurgery* 2004;15: 203-219.
78. Kanpolat Y (2002) Percutaneous stereotactic pain procedures: percutaneous cordotomy, extralemniscal myelotomy, trigeminal tractotomy-nucleotomy. In: Burchiel K (eds) *Surgical management of pain*. (2nd ed. pp 745-762) , Stuttgart: Thieme
79. Kanpolat Y. The surgical treatment of chronic pain: destructive therapies in the spinal cord. *Neurosurg Clin N Am*. 2004;15(3):307-317. doi: 10.1016/j.nec.2004.02.013.
80. Kanpolat Y, Savas A, Caglar S, et al. Computerized tomography-guided percutaneous extralemniscal myelotomy. *Neurosurg Focus*. 1997;2(1):e5. doi: 10.3171/foc.1997.2.1.6.
81. Konrad P. Dorsal root entry zone lesion, midline myelotomy and anterolateral cordotomy. *Neurosurg Clin N Am*. 2014;25(4):699-722. doi: 10.1016/j.nec.2014.07.010.
82. Sampson JH, Cashman RE, Nashold BS Jr, et al. Dorsal root entry zone lesions for intractable pain after trauma to the conus medullaris and cauda equina. *J Neurosurg*. 1995;82(1):28-34. doi: 10.3171/jns.1995.82.1.0028.
83. Denkers MR, Biagi HL, Ann O'Brien M, et al. Dorsal root entry zone lesioning used to treat central neuropathic pain in patients with traumatic spinal cord injury: a systematic review. *Spine (Phila Pa 1976)*. 2002;27(7):E177-184. doi: 10.1097/00007632-200204010-00018.

84. Soloman M, Mekhail MN, Mekhail N. Radiofrequency treatment in chronic pain. *Expert Rev Neurother*. 2010;10(3):469-474. doi: 10.1586/ern.09.153.
85. Kapural L, Nageeb F, Kapural M, et al. Cooled radiofrequency system for the treatment of chronic pain from sacroiliitis: the first case-series. *Pain Pract*. 2008;8(5):348-354. doi: 10.1111/j.1533-2500.2008.00231.x.
86. Rawlings CE 3rd, el-Naggar AO, Nashold BS Jr. The DREZ procedure: an update on technique. *Br J Neurosurg*. 1989;3(6):633-642. doi: 10.3109/02688698908992686.
87. Ruiz-Juretschke F, Garcia-Salazar F, Garcia-Leal R, et al. Treatment of neuropathic deafferentation pain using DREZ lesions; long-term results. *Neurologia*. 2011;26(1):26-31. doi:10.1016/j.nrl.2010.10.003.
88. Monaco BA, Lopes AJM, Teixeira MJ. Ultrasound-guided DREZotomy: technical note. *Stereotact Funct Neurosurg*. 2019;97(2):127-131. doi:10.1159/000500491.
89. Choi EJ, Choi YM, Jang EJ, et al. Neural ablation and regeneration in pain practice. *Korean J Pain*. 2016;29(1):3-11. doi:10.3344/kjp.2016.29.1.3.
90. Konrad P, Caputi F, El-Naggar AO. (2009) Radiofrequency dorsal root entry zone lesions for pain. In: Lozano AM, Gildenberg PL, Tasker RR, eds. *Textbook of stereotactic and functional neurosurgery*. (2nd ed. pp. 2251-68) Berlin: Springer
91. Kanpolat Y, Tuna H, Bozkurt M, et al. Spinal and nucleus caudalis dorsal root entry zone operations for chronic pain. *Neurosurgery*. 2008;62(3 Suppl 1):235-242; discussion 242-244. doi: 10.1227/01.neu.0000317398.93218.e0.
92. Sindou MP, Blondet E, Emery E, et al. Microsurgical lesioning in the dorsal root entry zone for pain due to brachial plexus avulsion: a prospective series of 55 patients. *J Neurosurg*. 2005;102(6):1018-1028. doi: 10.3171/jns.2005.102.6.1018.
93. Rawlings CE 3rd, el-Naggar AO, Nashold BS Jr. The DREZ procedure: an update on technique. *Br J Neurosurg*. 1989;3(6):633-642. doi: 10.3109/02688698908992686.
94. Chen HJ. Dorsal root entry zone lesions in the treatment of pain following brachial plexus avulsion and herpes zoster. *J Formos Med Assoc*. 1992;91(5):508-512.
95. Sindou MP, Blondet E, Emery E, et al. Microsurgical lesioning in the dorsal root entry zone for pain due to brachial plexus avulsion: a prospective series of 55 patients. *J Neurosurg*. 2005;102(6):1018-1028. doi: 10.3171/jns.2005.102.6.1018.
96. Ellis H, Feldman S (1979) *Anatomy for the anaesthetists* (Third edit). Oxford: Blackwell Scientific Publications,
97. Gofeld M, Bhatia A, Abbas S, et al. Development and validation of a new technique for ultrasound-guided stellate ganglion block. *Reg Anesth Pain Med*. 2009;34(5):475-479. doi: 10.1097/AAP.0b013e3181b494de.
98. Wang QX, Wang XY, Fu NA, et al. Stellate ganglion block inhibits formalin-induced nociceptive responses: mechanism of action. *Eur J Anaesthesiol*. 2005;22(12):913-918. doi: 10.1017/S0265021505001559.
99. Mulvaney SW, McLean B, de Leeuw J. The use of stellate ganglion block in the treatment of panic/anxiety symptoms with combat-related post-traumatic stress disorder; preliminary results of long-term follow-up: a case series. *Pain Pract*. 2010;10(4):359-365. doi: 10.1111/j.1533-2500.2010.00373.x.
100. Lipov EG, Joshi JR, Sanders S, et al. A unifying theory linking the prolonged efficacy of the stellate ganglion block for the treatment of chronic regional pain syndrome (CRPS), hot flashes, and posttraumatic stress disorder (PTSD). *Med Hypotheses*. 2009;72(6):657-661. doi: 10.1016/j.mehy.2009.01.009.
101. Gunduz OH, Kenis-Coskun O. Ganglion blocks as a treatment of pain: current perspectives. *J Pain Res*. 2017;10:2815-2826. doi: 10.2147/JPR.S134775.
102. Harden N, Oaklander AL, Burton AW, et al. Complex regional pain syndrome: practical diagnostic and treatment guidelines, 4th edition. *Pain Med*. 2013;14(2):180-223.
103. Irastorza RM, Bovaira M, García-Vitoria C, et al. Effect of the relative position of electrode and stellate ganglion during thermal radiofrequency ablation: a simulation study. *Int J Hyperthermia*. 2021;38(1):1502-1511. doi: 10.1080/02656736.2021.1974580.
104. Kastler A, Aubry S, Saille N, et al. CT-guided stellate ganglion blockade vs. radiofrequency neurolysis in the management of refractory type I complex regional pain syndrome of the upper limb. *Eur Radiol*. 2013;23(5):1316-1622. doi: 10.1007/s00330-012-2704-y.
105. Arter OE, Racz GB. Pain management of the oncologic patient. *Semin Surg Oncol*. 1990;6(3):162-172. doi: 10.1002/ssu.2980060307.
106. Piraccini E, Munakomi S, Chang KV. Stellate Ganglion Blocks. 2022 Aug 9. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. PMID: 29939575.
107. David EA, Marshall MB. Review of chest wall tumors: a diagnostic, therapeutic, and reconstructive challenge. *Semin Plast Surg*. 2011;25(1):16-24. doi: 10.1055/s-0031-1275167.
108. Skaebuland C, Racz G. Indications and Technique of Thoracic(2) and Thoracic(3) Neurolysis. *Curr Rev Pain*. 1999;3(5):400-405. doi: 10.1007/s11916-999-0082-1.
109. Yoo HS, Nahm FS, Lee PB, et al. Early thoracic sympathetic block improves the treatment effect for upper extremity neuropathic pain. *Anesth Analg*. 2011;113(3):605-609. doi: 10.1213/ANE.0b013e3182274803.
110. Stogicza, A.R. (2020). Thoracic Sympathetic Block and Radiofrequency Ablation. In: Stogicza A.R., Mansano A.M., Trescot A.M. (eds) *Interventional Pain (A Step-by-Step Guide for the FIPP Exam pp.79-85)* Cham: Springer
111. Gulati A, Shah R, Puttanniah V, et al. A retrospective review and treatment paradigm of interventional therapies for patients suffering from intractable thoracic chest wall pain in the oncologic population. *Pain Med*. 2015;16(4):802-810. doi: 10.1111/pme.12558.
112. Wong FC, Lee TW, Yuen KK, et al. Intercostal nerve blockade for cancer pain: effectiveness and selection of patients. *Hong Kong Med J*. 2007;13(4):266-70.
113. Swarm RA, Karanikolas M, Cousins MJ. (2005) Anaesthetic techniques for pain control. In: Doyle DD, Hanks G, Cherny NI, Calman SK (Eds). *Oxford textbook of*

- palliative medicine*. (3rd ed, pp. 378-396). New York: Oxford University Press
114. Papadopoulos D, Kostopanagioutou G, Batistaki C. Bilateral thoracic splanchnic nerve radiofrequency thermocoagulation for the management of end-stage pancreatic abdominal cancer pain. *Pain Physician*. 2013;16:125-133.
 115. Koyyalagunta D, Engle MP, Yu J, et al. The effectiveness of alcohol versus phenol based splanchnic nerve neurolysis for the treatment of intra-abdominal cancer pain. *Pain Physician* 2016;19:281-292.
 116. Urits I, Jones MR, Orhurhu V, et al. A Comprehensive Review of the Celiac Plexus Block for the Management of Chronic Abdominal Pain. *Curr Pain Headache Rep*. 2020;24(8):42. doi: 10.1007/s11916-020-00878-4.
 117. Rahman A, Rahman R, Macrinici G, et al. Low Volume Neurolytic Retrocruial Celiac Plexus Block for Visceral Cancer Pain: Retrospective Review of 507 Patients with Severe Malignancy Related Pain Due to Primary Abdominal Cancer or Metastatic Disease. *Pain Physician*. 2018;21(5):497-504.
 118. Lillemoe KD, Cameron JL, Kaufman HS, et al. Chemical splanchnicectomy in patients with unresectable pancreatic cancer. A prospective randomized trial. *Ann Surg*. 1993;217(5):447-455; discussion 456-457. doi: 10.1097/00000658-199305010-00004.
 119. Mercadante S. Celiac plexus block versus analgesics in pancreatic cancer pain. *Pain*. 1993;52(2):187-192. doi: 10.1016/0304-3959(93)90130-H.
 120. Kawamata M, Ishitani K, Ishikawa K, et al. Comparison between celiac plexus block and morphine treatment on quality of life in patients with pancreatic cancer pain. *Pain*. 1996;64(3):597-602. doi: 10.1016/0304-3959(95)00189-1.
 121. Polati E, Finco G, Gottin L, et al. Prospective randomized double-blind trial of neurolytic coeliac plexus block in patients with pancreatic cancer. *Br J Surg*. 1998;85(2):199-201. doi: 10.1046/j.1365-2168.1998.00563.x.
 122. McGreevy K, Hurley RW, Erdek MA, et al. The effectiveness of repeat celiac plexus neurolysis for pancreatic cancer: a pilot study. *Pain Pract*. 2013;13(2):89-95. doi: 10.1111/j.1533-2500.2012.00557.x
 123. Dhanani N. (2019) Sympathetic Nervous System Blocks for the Treatment of Cancer Pain . In Amitabh G, Vinay P, Brian MB, William SR, Joseph CH (Eds.), *Essentials of Interventional Cancer Pain Management* (1nd ed., pp. 155-156) Switzerland: Springer Nature
 124. Amr SA, Reyad RM, Othman AH, et al. Comparison between radiofrequency ablation and chemical neurolysis of thoracic splanchnic nerves for the management of abdominal cancer pain, randomized trial. *Eur J Pain*. 2018;22(10):1782-1790. doi: 10.1002/ejp.1274.
 125. Koyyalagunta D, Engle MP, Yu J, et al. The Effectiveness of Alcohol Versus Phenol Based Splanchnic Nerve Neurolysis for the Treatment of Intra-Abdominal Cancer Pain. *Pain Physician*. 2016;19(4):281-292.
 126. Pello S, Miller A, Ku T, et al. Hemorrhagic gastritis and duodenitis following celiac plexus neurolysis. *Pain Physician*. 2009;12:1001-1003.
 127. Pello S, Miller A, Ku T, et al. Hemorrhagic gastritis and duodenitis following celiac plexus neurolysis. *Pain Physician*. 2009;12:1001-1003.
 128. Davies DD. Incidence of major complications of neurolytic coeliac plexus block. *J R Soc Med*. 1993;86(5):264-266. doi: 10.1177/014107689308600507.
 129. Dhanani N. (2019) Sympathetic Nervous System Blocks for the Treatment of Cancer Pain. In Amitabh G, Vinay P, Brian MB, William SR, Joseph CH (Eds.), *Essentials of Interventional Cancer Pain Management* (1nd ed.,pp.158-159) Switzerland: Springer Nature
 130. Pennekamp W, Krumova EK, Feigl GP, et al. Permanent lesion of the lateral femoral cutaneous nerve after low-volume ethanol 96% application on the lumbar sympathetic chain. *Pain Physician*. 2013;16(4):391-397.
 131. Doroshenko M, Turkot O, Horn DB. Sympathetic Nerve Block. [Updated 2022 Nov 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan
 132. Ding Y, Yao P, Li H, et al. Evaluation of combined radiofrequency and chemical blockade of multi-segmental lumbar sympathetic ganglia in painful diabetic peripheral neuropathy. *J Pain Res*. 2018;11:1375-1382. doi: 10.2147/JPR.S175514.
 133. Bale R. Ganglienblockade. Wann und wie? [Ganglion block. When and how?]. *Radiologe*. 2015;55(10):886-95. German. doi: 10.1007/s00117-015-0015-4.
 134. Lee RB, Stone K, Magelssen D, et al. Presacral neurectomy for chronic pelvic pain. *Obstet Gynecol*. 1986;68(4):517-521.
 135. Pitkin G: The Autonomic Nervous System.(1947) In Soutword JL, Hingson RA, Pitkin WM (Eds) *Pitkin's Conduction Anesthesia* (2nd ed. pp 189-276) Philedelpia: JB Lipincott Co.
 136. Snell RS, Katz J. (1988) Clinical Anatomy for Anesthesiologist (First edit) Norwalk:Appleton and Lange,
 137. Frier A. Pelvic neurectomy in gynecology. *Obstet Gynecol*. 1965;25:48-55.
 138. de Leon-Casasola OA, Kent E, Lema MJ. Neurolytic superior hypogastric plexus block for chronic pelvic pain associated with cancer. *Pain*. 1993;54(2):145-151. doi: 10.1016/0304-3959(93)90202-Z.
 139. Plancarte R, de Leon-Casasola OA, El-Helaly M, et al. Neurolytic superior hypogastric plexus block for chronic pelvic pain associated with cancer. *Reg Anesth*. 1997;22:562-568
 140. Kroll CE, Schartz B, Gonzalez-Fernandez M, et al. Factors associated with outcome after superior hypogastric plexus neurolysis in cancer patients. *Clin J Pain*. 2014;30(1):55-62. doi: 10.1097/AJP.0b013e3182869d68.
 141. Dhanani N. (2019) Sympathetic Nervous System Blocks for the Treatment of Cancer Pain . In Amitabh G, Vinay P, Brian MB, William SR, Joseph CH (Eds.), *Essentials of Interventional Cancer Pain Management* (1nd ed., pp.162) Switzerland: Springer Nature
 142. Noor NA, Urits I, Viswanath O, et al. Radiofrequency Ablation of the Splanchnic Nerve and Superior Hypogastric Plexus for Chronic Abdominal Pain Status Post-Abdominal Surgery. *Cureus*. 2020;12(12):e12189. doi: 10.7759/cureus.12189.

143. Punj J, Srivastava M. Prolonged relief of chronic pelvic pain by pulsed radiofrequency ablation of superior hypogastric plexus performed under ultrasound guidance: A case report. *Indian J Anaesth.* 2020;64(9):816-817. doi: 10.4103/ija.IJA_493_20.
144. Waldman, S. (2004) *Atlas of Interventional Pain Management* (Second edit). Philadelphia : Saunders.
145. Schultz DM. Inferior hypogastric plexus blockade: A transsacral approach. *Pain Physician.* 2007;10:757-763.
146. Oh CS, Chung IH, Ji HJ, et al. Clinical implications of topographic anatomy on the ganglion impar. *Anesthesiology.* 2004;101(1):249-250. doi: 10.1097/00000542-200407000-00039.
147. Reig E, Abejón D, del Pozo C, et al. Thermocoagulation of the ganglion impar or ganglion of Walther: description of a modified approach. Preliminary results in chronic, nononcological pain. *Pain Pract.* 2005;5(2):103-110. doi: 10.1111/j.1533-2500.2005.05206.x.
148. Scott-Warren JT, Hill V, Rajasekaran A. Ganglion impar blockade: a review. *Curr Pain Headache Rep.* 2013;17(1):306. doi: 10.1007/s11916-012-0306-7.
149. Malhotra N, Goyal S, Kumar A, et al. Comparative evaluation of transsacrococcygeal and transcoccygeal approach of ganglion impar block for management of coccygodynia. *J Anaesthesiol Clin Pharmacol.* 2021;37(1):90-96. doi: 10.4103/joacp.JOACP_588_20.
150. Plancarte R, Amescua C, Patt RB et al. Presacral blockade of the ganglion of Walther (ganglion impar) *Anesthesiology.* 1990;73: A751. doi: <https://doi.org/10.1097/00000542-199009001-00749>
151. Christo PJ, Mazloomdoost D. Interventional pain treatments for cancer pain. *Ann N Y Acad Sci.* 2008;1138:299-328. doi: 10.1196/annals.1414.034.
152. Kim JY, Sim SE, Yoo S, et al. A new technique of ganglion impar pulsed radiofrequency ablation. *Chin Med J (Engl).* 2021;134(10):1221-1223. doi: 10.1097/CM9.0000000000001423.
153. Choudhary R, Kunal K, Kumar D, et al. Improvement in Pain Following Ganglion Impar Blocks and Radiofrequency Ablation in Coccygodynia Patients: A Systematic Review. *Rev Bras Ortop (Sao Paulo).* 2021;56(5):558-566. doi: 10.1055/s-0041-1735829.
154. Kircelli A, Demirçay E, Özel Ö, et al. Radiofrequency Thermocoagulation of the Ganglion Impar for Coccydymia Management: Long-Term Effects. *Pain Pract.* 2019;19(1):9-15. doi: 10.1111/papr.12698.
155. Sir E, Eksert S. Comparison of block and pulsed radiofrequency of the ganglion impar in coccygodynia. *Turk J Med Sci.* 2019;49(5):1555-1559. doi: 10.3906/sag-1906-51.
156. Nantthasorn Z., Christopher RA, Sanjeet N.(2019) Peripheral Nerve Blocks In Amitabh G, Vinay P, Brian MB, William SR, Joseph CH (Eds.), *Essentials of Interventional Cancer Pain Management* (1st ed, pp.168-169) Switzerland: Springer Nature.