Effect of intradiscal pulsed radiofrequency on refractory chronic discogenic neck pain
A case report

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Abstract
Rationale: Despite medication, exercise, and medical intervention, many patients complain of persistent discogenic neck pain. To manage discogenic neck pain, we performed intradiscal pulsed radiofrequency (PRF) stimulation in a patient with chronic discogenic neck pain refractory to oral medication and epidural steroid injection.

Patient concerns: A 26-year-old man presented with a numeric rating scale (NRS) score of 7 for chronic neck pain. His pain was worse when the neck was held in one position for a prolonged period. There was no pain in the upper extremities.

Diagnoses: Discography was positive at C4–5. Based on the pain characteristics, and the result of discography, we diagnosed him as having discogenic neck pain originating from C4–5.

Interventions: Intradiscal PRF on the C4–5 intervertebral disc was performed under C-arm fluoroscopy. The PRF treatment was administered at 2 Hz and a 20-ms pulsed width for 20 minutes at 60 V with the constraint that the electrode tip temperature should not exceed 42°C.

Outcomes: At the 2-week, and 1-month follow-up visits, the patient’s pain was completely relieved. At 2, and 3 months after intradiscal PRF, the pain was scored as NRS 2. No adverse effects of intradiscal PRF stimulation were observed.

Lessons: Application of intradiscal PRF appears to be an effective and safe technique for treating chronic discogenic neck pain.

Abbreviations: NRS = numeric rating scale, PRF = pulsed radiofrequency, RF = radiofrequency.

Keywords: chronic pain, discogenic neck pain, intradiscal stimulation, pulsed radiofrequency

1. Introduction

Neck pain is a common complaint among the general population. It affects up to 66% of individuals in their lifetimes, and approximately 14% develop chronic neck pain.[1,2] Structures with a sensory nerve supply can be potential sources of neck pain, and include muscles, ligaments, bone, zygapophysial joints, and intervertebral discs.[3] Among these various pain sources, discogenic neck pain is thought to be an important, and common cause, and its prevalence has been reported at 16 to 20%.[4,5] Abnormal nerve ingrowth and expression of painful nociceptors are known to be primary etiological factors in discogenic pain.[6] Several nonsurgical treatment modalities, including medication, exercise, and medical intervention, have been used for the management of discogenic neck pain.[7–9] However, many patients are unresponsive to these modalities.

Pulsed radiofrequency (PRF), a technique first described by Sluijter in the year 1997,[10] is known to be safe and effective in alleviating pain. The technique works by delivering an electrical field, and heat bursts to targeted nerves, or tissues without damaging those structures.[11–13] Conventional radiofrequency (RF) exposes target nerves, or tissues to continuous electrical stimulation, and ablates the structures by increasing the temperature around the RF needle tip.[14] In contrast to conventional RF, PRF applies a brief electrical stimulation followed by a long resting phase. Accordingly, PRF does not produce sufficient heat to result in structural damage.[13] The proposed mechanism of PRF is that the electrical field produced by PRF can alter pain signals.[15] Several studies on PRF treatment have demonstrated its effectiveness in alleviating neuralgia, muscle, and joint pain not responsive to conventional therapies.[17–20] In addition, several studies have reported that intradiscal PRF has beneficial effects in alleviating discogenic lower back pain.[21–27] It has been suggested that intradiscal PRF can reduce nociceptive input from the intervertebral disc. Although no studies have reported on the use of PRF for managing discogenic neck pain, we considered that intradiscal PRF may be effective for alleviating discogenic neck pain.

Here, we report a positive response to intradiscal PRF stimulation in a patient with chronic discogenic neck pain.

2. Case report

A 26-year-old man visited the Physical Medicine and Rehabilitation Department of a university hospital because of posterior
neck pain over a period of 16 months (Fig. 1). The patient provided informed consent for participation in the study. The study was approved by the local Institutional Review Board of our hospital. His numeric rating scale (NRS) score was 7 out of 10. His pain continued all day and was aggravated when the neck was held in one position for a prolonged period. He did not have pain in the upper extremities. On physical examination, no sensory or motor deficits of the upper extremities were detected. A Spurling test was negative. On cervical magnetic resonance imaging (MRI), central disc protrusion and a high-signal intensity zone at C4–5 were observed (Fig. 2). The patient had previously received a cervical medial branch blocks and RF neurotomy of the bilateral third occipital nerves when treated in another hospital. No short- or long-term effects were manifest. We conducted 2 cervical epidural steroid injections and diagnostic blocks on the cervical facet joint injections (from C2–3 to C5–6). The patient did not exhibit any short- or long-term effects as a result of these procedures (NRS was unchanged). The patient did not respond to physical therapy or medication (15mg meloxicam, 32/37.5mg acetaminophen/tramadol hydrochloride, 10mg nortriptyline). Considering the patient’s pain characteristics, and unresponsiveness on all conducted procedures, we theorized that his pain was associated with discogenic neck pain. We conducted provocative discography to confirm the diagnosis. During discography at C4–5, the patient reported concordant pain, which closely resembles symptomatic pain in nature and location. Thus, we diagnosed him as having discogenic neck pain originating from C4–5.

Twenty-two months after pain onset, we conducted intradiscal PRF at the C4–5 disc under the guidance of C-arm fluoroscopy (Siemens, Seoul, Korea). The monopolar PRF procedure was performed with a 22-gauge curved-tip cannula (SMK Pole needle, 100mm with a 10-mm active tip, Cotop International BV) from the patient’s right hand side. The patient was placed in a supine position for the procedure with his neck extended by placing a cushion beneath his shoulder. Using fluoroscopy, we identified the target disc and an appropriate skin site for needle trajectory. After displacing the trachea medially, and the right carotid artery laterally, using the second and third digits, the catheter was inserted into the space between the trachea, and the right carotid artery. The catheter was then carefully advanced into the C4–5 disc. After confirming catheter tip placement at the C4–5 disc with anteroposterior and lateral fluoroscopic views (Fig. 3), PRF treatment was applied using an RF generator (Cosman G4, Burlington, MA, US). The parameters used for the PRF stimulation were as follows: 2Hz, 20 ms pulse width, and 60V for 20 minutes.

The follow-up period was 3 months. At the 2-week and 1-month follow-up visits, the patient reported that his discogenic neck pain was completely relieved (NRS, 0). At 2 and 3 months after intradiscal PRF, the pain was scored as NRS 2. No adverse effects of intradiscal PRF were noted.

3. Discussion

In this case report, we describe a patient with chronic discogenic neck pain who exhibited a successful response to intradiscal PRF stimulation. Our patient’s pain completely disappeared for 1 month following the PRF stimulation procedure, and the degree
of pain was reduced by approximately 70% over the pretreatment level at 2- and 3-month follow-up visits.

The sensory fibers that innervate the intervertebral disc are mainly nociceptive, and the disc is innervated by branches of the sinuvertebral nerve, nerves derived from the ventral rami of spinal nerves, and nerves derived from gray rami communicantes.[6] They are found mostly in the periphery of the annulus fibrosus.[6] However, in discs producing discogenic pain, these nociceptive nerve fibers grow into inner parts of the annulus fibrosus, and even into the nucleus pulposus.[26,29] This inner growth can cause or aggravate discogenic neck pain.[30] Minimally invasive intradiscal procedures, such as percutaneous laser decompression and RF, have been used to denervate nociceptive nerve fibers in the cervical disc.[31] However, high temperatures during these procedures can shrink the disc.[32] Conversely, the targeted tissue temperature is maintained at or below 42°C during PRF procedures.[20,33] Thus, PRF stimulation does not produce sufficient heat to cause significant structural damage of cervical discs.[11-13]

The mechanisms underlying the pain-alleviation effect of PRF stimulation remain unclear. However, the main mechanism is thought to be neuromodulation by an electrical field.[34] Application of PRF to the dorsal root ganglion or epidural space can affect cellular function in the dorsal horn independently of thermal effects.[35,36] PRF is reported to decrease microglial activity in the spinal dorsal horn,[35,37] Since microglia contribute to the occurrence of chronic pain by releasing several cytokines and chemokines that mediate pain signaling, downregulation of microglia could possibly control chronic pain. Additionally, PRF is known to enhance various descending inhibitory pathways, especially, involving the noradrenergic, and serotoninergic pathways.[38]

Seven previous studies reported the positive effects of intradiscal PRF stimulation in managing lumbar discogenic low back pain.[21-27] In most of those studies, intradiscal PRF significantly reduced pain for at least 6 months. However, there has been no study on the effect of PRF in controlling discogenic neck pain. Although this is a case study, our report is the first to show the effective use of PRF for managing discogenic neck pain.

In conclusion, we report a patient with chronic discogenic neck pain who showed a good response to intradiscal PRF administered to alleviate pain. The effects of intradiscal PRF were sustained for at least 3 months. The results of this study showed that PRF can be a useful option for controlling chronic discogenic neck pain, especially, in patients who are unresponsive to medications, and other procedures. However, our study is limited because it is a single-case study. Further studies involving more number of cases are needed to clearly elucidate the effects of intradiscal PRF on patients with discogenic neck pain.

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References
[1] Cote P, Cassidy JD, Carroll L. The Saskatchewan health and back pain survey: The prevalence of neck pain and related disability in Saskatchewan adults. Spine (Phila Pa 1976) 1998;23:1689–98.
[2] Bovin G, Schrader H, Sand T. Neck pain in the general population. Spine (Phila Pa 1976) 1994;19:1307–9.
[3] Bogduk N. The anatomy and pathophysiology of neck pain. Phys Med Rehabil Clin N Am 2003;14:453–72.
[4] Bogduk N, Aprill C. On the nature of neck pain, discography and cervical zygapophysial joint pain. Pain 1993;54:213–7.
[5] Yin W, Bogduk N. The nature of neck pain in a private practice pain clinic in the United States. Pain Med 2008;9:196–203.
[6] García-Cosamálon J, del Valle ME, Calavia MG, et al. Intervertebral disc, sensory nerves and neurotrophins: who is who in discogenic pain? J Anat 2010;217:1–5.
[7] Malik KM, Cohen SP, Walega DR, et al. Diagnostic criteria and treatment of discogenic pain: a systematic review of recent clinical literature. Spine J 2013;13:1675–89.
[8] Manchikanti L, Nampiaparampil DE, Candiolo KD, et al. Do cervical epidural injections provide long-term relief in neck and upper extremity pain? A systematic review. Pain Physician 2015;18:39–60.
[9] Moustafa IM, Diab AA, Taha S, et al. Addition of a sagittal cervical posture corrective orthotic device to a multimodal rehabilitation

Figure 3. Fluoroscopy-guided confirmation of the catheter tip placement at the C4-5 disc.
program improves short- and long-term outcomes in patients with discogenic cervical radiculopathy. Arch Phys Med Rehabil 2016;97: 2034–44.

[10] Sluijter ME. The role of radiofrequency in failed back surgery patients. Curr Rev Pain 2000;4:49–53.

[11] Podhaejski RJ, Sekiguchi Y, Kikuchi S, et al. The histologic effects of pulsed and continuous radiofrequency lesions at 42 degreesC to rat dorsal root ganglion and sciatic nerve. Spine (Phila Pa 1976) 2005;30:1008–13.

[12] Vallejo R, Benyamin RM, Kramer J, et al. Pulsed radiofrequency for the treatment of sacroiliac joint syndrome. Pain Med 2006;7:429–34.

[13] West M, Wu H. Pulsed radiofrequency ablation for residual and phantom limb pain: A case series. Pain Pract 2010;10:485–91.

[14] Vatansever D, Tekin I, Tuglu I, et al. A comparison of the neuroablative effects of conventional and pulsed radiofrequency techniques. Clin J Pain 2008;24:717–24.

[15] Sluijter ME, Cosman ER, Rittmann WB, et al. The effects of pulsed radiofrequency fields applied to the dorsal root ganglion—A preliminary report. Pain Clin 1998;11:109–17.

[16] Van Zundert J, de Louw AJ, Joosten EA, et al. Pulsed and continuous radiofrequency current adjacent to the cervical dorsal root ganglion of the rat induces late cellular activity in the dorsal horn. Anesthesiology 2005;102:125–31.

[17] Chang MC. Effect of bipolar pulsed radiofrequency on refractory chronic radicular pain: A report of two cases. Medicine (Baltimore) 2017;96:e6604.

[18] Chang MG, Cho YW, Ahn SH. Comparison between bipolar pulsed radiofrequency and monopolar pulsed radiofrequency in chronic lumbarosacral radicular pain: A randomized controlled trial. Medicine (Baltimore) 2017;96:e6236.

[19] Cho IT, Cho YW, Kwak SG, et al. Comparison between ultrasound-guided interfascial pulsed radiofrequency and ultrasound-guided interfascial block with local anesthetic in myofascial pain syndrome of trapezius muscle. Medicine (Baltimore) 2017;96:e6019.

[20] Do KH, Ahn SH, Cho YW, et al. Comparison of intra-articular lumbar facet joint pulsed radiofrequency and intra-articular lumbar facet joint corticosteroid injection for management of lumbar facet joint pain: A randomized controlled trial. Medicine (Baltimore) 2017;96:e6524.

[21] Fukui S, Nitta K, Iwashita N, et al. Results of intradiscal pulsed radiofrequency for lumbar discogenic pain: comparison with intradiscal electrothermal therapy. Korean J Pain 2012;25:155–60.

[22] Fukui S, Nitta K, Iwashita N, et al. Intradiscal pulsed radiofrequency for chronic lumbar discogenic low back pain: a one year prospective outcome study using discoblock for diagnosis. Pain Physician 2013;16: E435–42.

[23] Fukui S, Rohof O. Results of pulsed radiofrequency technique with two laterally placed electrodes in the annulus in patients with chronic lumbar discogenic pain. J Anesthes 2012;26:606–9.

[24] Jung YJ, Lee DG, Cho YW, et al. Effect of intradiscal monopolar pulsed radiofrequency on chronic discogenic back pain diagnosed by pressure-controlled provocative discography: a one year prospective study. Ann Rehabil Med 2012;36:448–56.

[25] Papadopoulos D, Kostopanagiotou G, Lemonis A, et al. Intradiscal combination of pulsed radiofrequency and gelified ethanol for the treatment of chronic discogenic low back pain. Pain Med 2014;15: 881–3.

[26] Rohof O. Intradiscal pulsed radiofrequency application following provocative discography for the management of degenerative disc disease and concordant pain: a pilot study. Pain Pract 2012;12: 342–9.

[27] Teixeira A, Sluijter ME. Intradiscal high-voltage, long-duration pulsed radiofrequency for discogenic pain: a preliminary report. Pain Med 2006;7:424–8.

[28] Gronblad M, Weinstein JN, Santavirta S. Immunohistochemical observations on spinal tissue innervation. A review of hypothetical mechanisms of back pain. Acta Orthop Scand 1991;62:614–22.

[29] McCarthay PW, Carruthers B, Martin D, et al. Immunohistochemical demonstration of sensory nerve fibers and endings in lumbar intervertebral discs of the rat. Spine (Phila Pa 1976) 1991;16:633–5.

[30] Freumont AJ, Peacock TE, Goupille P, et al. Nerve ingrowth into diseased intervertebral disc in chronic back pain. Lancet 1997;350:178–81.

[31] He L, Tang Y, Li X, et al. Efficacy of coblation technology in treating cervical discogenic upper back pain. Medicine (Baltimore) 2015;94: e858.

[32] Kasch R, Mensel B, Schmidt E, et al. Disc volume reduction with percutaneous nucleoplasty in an animal model. PLoS One 2012;7: e50211.

[33] Chang MC, Ahn SH. The effect of intra-articular stimulation by pulsed radiofrequency on chronic sacroiliac joint pain refractory to intra-articular corticosteroid injection: A retrospective study. Medicine (Baltimore) 2017;96:e7367.

[34] Cahana A, Vutskits L, Muller D. Acute differential modulation of synaptic transmission and cell survival during exposure to pulsed and continuous radiofrequency energy. J Pain 2003;4:197–202.

[35] Cho HK, Kang JH, Kim SY, et al. Changes in neuroglial activity in multiple spinal segments after caudal epidural pulsed radiofrequency in a rat model of lumbar disc herniation. Pain Physician 2016;19:E1197–209.

[36] Higuchi Y, Nashold BS Jr, Sluijter M, et al. Exposure of the dorsal root ganglion in rats to pulsed radiofrequency currents activates dorsal horn lamina I and II neurons. Neurosurgery 2002;50:850–6.

[37] Cho HK, Cho YW, Kim EH, et al. Changes in pain behavior and glial activation in the spinal dorsal horn after pulsed radiofrequency current administration to the dorsal root ganglion in a rat model of lumbar disc herniation: laboratory investigation. J Neurosurg Spine 2013;19: 236–43.

[38] Hagwara S, Iwasaka H, Takeshima N, et al. Mechanisms of analgesic action of pulsed radiofrequency on adjuvant-induced pain in the rat: roles of descending adrenergic and serotonergic systems. Eur J Pain 2009;13:249–52.