The Management of Intractable Pain with Adjuvant Pulsed Electromagnetic Field Therapy

Jeffrey Niezgoda

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Jeffrey A. Niezgoda, MD, FACHM, MAPWCA, CHWS; Scott T. Hardin, MD; Nicole Kubat, PhD; and Jocelyn Acompanado, PA-C

ABSTRACT

This case describes a 51-year-old woman who reported experiencing severe, constant pain, diffusely located in the region of her right mandible neck (primarily involving the mandible, lower right molars, the neck, the upper back, and the shoulder) during the course of several years. Surgical interventions (root canal, spinal fusion) were performed to address potential sources of pain. Despite these interventions, the patient reported severe pain after both surgeries, which persisted beyond the acute postoperative period. Additional pharmacological interventions and physical therapy were also attempted; nonetheless, the patient reported that pain remained severe and constant for approximately 2 years. On the basis of the patient's poor response to conventional treatments, a novel approach of botulinum toxin (BTX) injections was initiated. When pulsed electromagnetic field therapy was added, the need for BTX injections decreased, with the patient reporting a noticeable decrease in pain intensity and an improvement in quality of life measures. Currently, the patient continues to use pulsed electromagnetic field therapy regularly for pain management, which has allowed her to reduce the use of other interventions and avoid continued use of narcotic medications. Considering the need for multifaceted pain management approaches in the treatment of chronic pain, this case is relevant for wound care practitioners attending to patients with chronic postincisional wound pain because the outcome highlights the utility of a nonpharmacological, complementary pain management intervention for closed, yet persistently painful, postoperative wounds.

KEYWORDS: cervical dystonia, pulsed electromagnetic field therapy, severe pain, temporomandibular joint syndrome

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CASE PRESENTATION

The management of severe intractable pain that does not respond to conventional interventions is a difficult clinical problem faced by wound care practitioners; it is also one that can have a devastating effect on a patient's life. The pain can limit a person's ability to work, participate in social events, and perform activities of daily living (ADLs).[1] Pain can have an emotional and financial toll as well.[1] In such cases, a multifaceted approach to pain management may be needed, including one that considers nonpharmacological, complementary medical options.[2,3] The case described in this study is that of a 51-year-old woman who reported experiencing severe pain for 2 years despite multiple intervention strategies. The patient described the pain as constant, burning, and throbbing in the jaw/face, scapular, upper back, neck, and shoulder area on the right side, which would worsen with repetitive arm motion, with neck extension, and when she carried heavy objects. She also had limited and decreased arm strength.

The patient reported that she first began to experience pain in March 2010, which affected her tooth, jaw, neck, and shoulder, with an intensity of 7 on a 0- to 10-point numeric rating scale (NRS) (Table 1) for which she took over-the-counter ibuprofen. At that time, evaluation by the patient's dentist revealed a malocclusion affecting one of the patient's molars, which was also cracked and had previously been fitted with a crown. The patient reported a worsening of tooth pain, and in May 2010, the patient's dentist recommended a root canal. The patient stated that, by June of that same year, the pain she experienced was intolerable. The root canal was performed, after which the patient was prescribed a short course of hydrocodone/acetaminophen. The patient rated pain intensity after the procedure as severe (pain rating: 9–10 on NRS), with an increase in tooth pain as well as a worsening of pain in her neck and shoulder. In addition, the patient also developed pain in her arm, which radiated from her shoulder down to her fingers.

In the summer of 2010, the patient consulted several different dentists. She was diagnosed with temporomandibular joint (TMJ) syndrome, at which time she was prescribed cyclobenzaprine and gabapentin, and was also fitted for a mouth guard. In August 2010, the patient consulted a dentist specializing in periodontistry/prosthodontistry, whose opinion was that the pain

Jeffrey A. Niezgoda, MD, FACHM, MAPWCA, CHWS, is Associate Professor at the Medical College of Wisconsin, Milwaukee, Wisconsin. Scott T. Hardin, MD, is Medical Director of Rehabilitation Services at the Aurora St. Luke's Medical Center, Milwaukee, Wisconsin. Nicole Kubat, PhD, is an Independent Contract Consultant for Regenesis Biomedical, Inc, Scottsdale, Arizona. Jocelyn Acompanado, PA-C, is a Physician's Assistant in the Department of Rehabilitation Services at the Aurora St. Luke's Medical Center, Milwaukee, Wisconsin. Dr Niezgoda has disclosed that he is a member of the Speakers Bureau for Regenesis Biomedical, Inc. Dr Kubat has disclosed that she is a paid consultant for Regenesis Biomedical, Inc, and was remunerated by Regenesis Biomedical during the writing and preparation of this manuscript. Dr Hardin and Ms Acompanado have disclosed that they have no financial relationships related to this article. Submitted September 24, 2013; accepted in revised form January 8, 2014.

Table 1.

CHRONOLOGY OF SYMPTOMS, DIAGNOSIS, AND INTERVENTIONS

Date	Preintervention Pain Description (Site, Intensity)	Evaluations and Diagnoses	Interventions	Postintervention Pain Description, Other Notable Patient Comments
March 2010	Tooth, jaw, neck, and shoulder pain		Ibuprofen (200–400 mg, prn)	
April to May 2010	Increase in tooth pain; continued pain in jaw, neck, and shoulder; pain score: 7 (on 0–10 NRS)	Dental malocclusion and cracked tooth	Root canal; hydrocodone/acetaminophen (7.5/500 prn)	Increase in tooth pain, worsening of neck and shoulder pain, development of arm pain; pain score: 9–10 (on 0–10 NRS)
Summer 2010	Continued pain in tooth, jaw, neck, shoulder, as well as arm	Diagnosis of TMJ	Cyclobenzaprine (10 mg tid), gabapentin (100 mg tid), mouth guard	
Fall 2010	Continued pain (same sites), with an increase in arm pain	Cardiology evaluation with normal results, EMG (arm) with normal results	Amitriptyline (25–50 mg qhs), discontinued cyclobenzaprine and gabapentin	Poor tolerance to gabapentin due to adverse effects
November to December 2010		Diagnosis of cervical dystonia; MRI revealed herniated disks (C5–C6, C6–C7)	Spinal fusion, oxycodone/acetaminophen (5/325 mg 1–2 tablets every 3–4 hr prn); NSAIDs contraindicated for 1 y postoperatively	Pain relief in arm; pain continued in neck, jaw, shoulder, upper back (onset postoperative); pain score: 8–9 (on 0–10 NRS); pain relief with oxycodone/acetaminophen, but limited to nighttime use
February 2011			Physical therapy initiated (exercises, ultrasound, dry needling), trigger point injections initiated (cortisone, anesthetic; once every 2 wk for 1 y), SNRI initiated (60 mg qD)	Procedural pain reported with dry needling, with only temporary pain relief (less than a week); trigger point injections resulted in pain relief, however, limited to 2–3 injection points per visit; poor tolerance to SNRI due to adverse effects
January 2012			Discontinued trigger point injections	
April 2012	Pain score: 7–8 (on 0–10 NRS) before initiating BTX injections and PEMF therapy		BTX injections (once every 6 wk initially, then once every 4 mo)	Substantial, long-term (6–12 wk) pain relief after BTX injections; amitriptyline discontinued approximately 1 mo after initiation of BTX injections
May 2012			PEMF therapy (bid for 30 min), SNRI discontinued, oxycodone/acetaminophen discontinued	Pain relief after first day of PEMF therapy. After subsequent treatments, patient noticed improvement in pain as well as improved ability to perform daily activities
June 2012			Cyclobenzaprine (15 mg, qhs), lidocaine patches (5%, prn at night), naproxen (220–440 mg, bid)	
Spring 2013	Pain score: 3–5 (on 0–10 NRS) and 3 (on 0–10 NRS) if consistent with PEMF therapy		PEMF therapy (5 d per week, bid minimum), BTX injections (approximately once every 4 mo), cyclobenzaprine 15 mg (prn), lidocaine patches (5%, as needed at night), occasional use of capsaicin patches and methyl salicylate patches (after overuse of muscles), naproxen (220–440 mg, prn)	Improved ADLs and QOL: able to drive as well as perform tasks involving lifting objects or repetitive motions, able to sleep through the night, participates in social activities on a limited basis

Abbreviations: EMG, electromyography; MRI, magnetic resonance imaging.

was neurological rather than dental in origin and who advised the patient to consult her general practitioner. Upon consult with the general practitioner, in light of the patient's arm pain, a cardiology evaluation was performed to rule out heart concerns, which involved performing a stress test and electrocardiogram, for which results were normal. In October 2010, the patient experienced a worsening in arm pain, and an electromyography was performed on the affected arm by a physiatrist, which showed normal findings (ie, no compressive radiculopathy, plexopathy, or other peripheral nerve entrapment was present to explain the symptoms). At a separate consult shortly thereafter, the patient was prescribed amitriptyline for pain and to help with sleep because the patient had difficulty sleeping because of pain. Cyclobenzaprine was discontinued at this time, as was gabapentin, because of the patient's low tolerance for adverse effects of the latter. Amitriptyline was also later discontinued because of undesired adverse effects.

In November 2010, the patient was seen by a physician's assistant and a physiatrist, at which point the patient was diagnosed with cervical dystonia. Magnetic resonance imaging was also ordered, the results of which came back positive for a right C5 to C6

herniated disk and a herniated, degenerative disk at C6 to C7. Subsequently, a spinal fusion (C5–C7) was performed in December 2010. The patient reported experiencing pain relief only in her arm, with severe pain going unrelieved in her neck, jaw, shoulder, and upper back after the procedure (pain rating: 8–9 on NRS). The onset of the upper back pain was postoperative. Oxycodone/acetaminophen was prescribed for pain, which the patient used at night for pain relief. Although effective, its use during the day was not practical because of adverse effects that would interfere with the patient's daytime responsibilities.

In February 2011, physical therapy and trigger point injections (trapezius, masseter, sternocleidomastoid, and digastric muscles) were initiated. Physical therapy included exercises (resistance training for strengthening and flexion and extension exercises), ultrasound therapy, and dry needling to trigger points. The patient reported dry needling, a mechanical technique involving the insertion of an acupuncture needle into the skin, either deeply or superficially, at the location of a myofascial trigger point,[4] as very painful, with only temporary pain relief lasting less than a week. Trigger point injections (cortisone and anesthetic) were reported by the patient as providing only short-term pain relief; however, only 2 to 3 injections could be performed per visit, limiting the number of trigger points that could be treated at one time. A serotonin-norepinephrine reuptake inhibitor (SNRI) was also prescribed at this time.

In April 2012, the patient returned to the rehabilitation medicine clinic, at which time botulinum toxin (BTX) injections were initiated (trapezius, masseter, sternocleidomastoid, scalene, paraspinal, and digastric muscles). The patient reported BTX injections as providing additional but incomplete pain relief that lasted 6 to 12 weeks after injections. Amitriptyline was discontinued approximately 1 month after the initiation of BTX injections. In May 2012, pulsed electromagnetic field (PEMF) therapy (Provant Therapy System; Regenesis Biomedical Inc, Scottsdale, Arizona) was initiated twice daily for 30 minutes to the right shoulder, the neck, and the upper back, to which the patient reported experiencing impressive pain relief after the first day of treatment. After subsequent treatments, the patient noticed not only an improvement in pain but also an improvement in her ability to perform daily activities. The patient reported a decrease in pain from severe (pain rating: 7–8 on NRS before initiating botulinum toxin (BTX) injections and PEMF therapy) to a pain score of 4 to 5 (moderate pain) after incorporating them into her pain management plan. Soon after initiation of PEMF therapy, the patient was able to completely discontinue use of oxycodone/acetaminophen. In May 2012, the patient discontinued use of the SNRI because of undesired adverse effects and limited beneficial response. In June 2012, the patient was given extended-release cyclobenzaprine for use as needed for muscle spasms, which the patient reported as providing little noticeable difference. At that time, the patient was also given lidocaine patches for use on affected areas (shoulder, neck, upper back), to which the patient reported a beneficial cooling effect. A nonsteroidal anti-inflammatory drug (NSAID) (naproxen) was also incorporated into the patient's pain management strategy for use as needed.

Currently, the patient continues to use PEMF therapy for a minimum of 5 days per week. The patient reported that, since the initiation of PEMF, she is able to reduce the frequency of BTX injections to approximately once every 4 months and also has been able to decrease use of lidocaine patches and NSAID consumption. She also no longer takes any opioid-based medications. By Spring 2013, the patient's pain intensity had further decreased (pain rating: 3–5 on NRS), with the patient stating that her pain score is 3 on the 0- to 10-point NRS when she uses PEMF therapy consistently. The patient also reported improvement in her ability to perform ADLs such as driving and tasks involving lifting objects or repetitive motions, which she was previously unable to perform because of pain intensity. She also reported improvements in other quality of life (QOL) areas, such as sleeping through the night, and the renewed ability to participate in social activities on a limited basis.

DISCUSSION

The clinical objective in this case was to provide pain relief to a patient who was experiencing severe and constant diffuse upper body pain. After the failure of several conventional therapeutic approaches, BTX injections were initiated, which provided partial relief. Adjunctive PEMF therapy was then added with good results. The patient continues to use PEMF therapy regularly (a minimum of 5 days per week) for pain management, which, she noted, has allowed her to reduce the use of other interventions, including reducing the frequency of BTX injections received.

The PEMF device used in this report is a medical technology designed to deliver a PEMF, applying a radiofrequency carrier signal of 27.12 MHz to superficial soft tissue using a portable, noninvasive treatment device. The therapy is noncontact and is based on pulsed radiofrequency energy, which creates an electromagnetic field that is delivered to the target tissue from an antenna placed adjacent to the treatment site. The device delivers energy in pulses to avoid the generation of deep heat in the tissue being treated. Treatments can be administered at home by the patient, which involves placement of the device's applicator pad adjacent to the treatment site and starting the device, which then initiates a preset 30-minute dose. It is prescribed for use twice daily, with 8 to 12 hours between treatments, and is approved as an adjunctive therapy for the indications of postoperative pain and edema.[5] Several clinical studies have reported the benefits of using this type of PEMF therapy for postoperative pain relief,[6–13]

including on persistently painful closed surgical sites (as in the current case), as well as for pain associated with acute surgical wounds and for wound pain after surgical debridement (eg, ulcer debridement). It has also been reported to provide relief of acute pain after injury[14–16] and of other types of chronic pain.[17,18] As in the current case, it has also been associated with reduced analgesic consumption.[9,11,13,15] Investigations into the mechanism of action of PEMF suggest a local mechanism of action, possibly initiated by an effect of the electromagnetic field at the cell membrane,[19,20] followed by downstream effects on gene expression.[13,21–23] Pulsed electromagnetic field–mediated changes in gene expression relevant to analgesia include the upregulation of opioid precursor messenger RNA and peptides after treatment of cells in culture with PEMF.[21] Pulsed electromagnetic field treatment has also been found to have an impact on factors involved in inflammation,[13,21,22] such as downregulation of the proalgesic, proinflammatory factor interleukin-1β both in vitro[21] and in the clinical setting,[13] the latter of which was also associated with postoperative pain relief. Pulsed electromagnetic field differs from transcutaneous electrical nerve stimulation, which involves placing electrodes in direct contact with the treatment area, followed by delivery of pulsed electrical currents to the tissue.[24] Similar to PEMF therapy, transcutaneous electrical nerve stimulation may also mediate changes in the endogenous opioid pathway, although presumably through a different mechanism.[25] For clarification purposes, it is worth noting that other medical technologies, which are based on lower-frequency carrier signals, also use the term *PEMF*, although the discussion here has been limited to PEMF devices using the same carrier frequency as the device used in the study.

Botulinum toxin type A is a bacterial endotoxin that, in preparations for clinical use, is provided as a purified fermentation product of *Clostridium botulinum* type A.[26] Its primary mode of action is typically attributed to its ability to block the release of acetylcholine from cholinergic nerve termini at neuromuscular junctions, resulting in muscle relaxation.[27–29] In addition, some data suggest that its mode of action related to pain relief may extend beyond muscle relaxation and that it may also act to inhibit release of neurotransmitters and neuropeptides that function in pain modulation.[28,30,31] Clinically, BTX has been reported to provide pain relief in patients with facial pain,[27,29,31,32] including pain associated with TMJ disorders,[27,31] as well as pain associated with complex regional pain syndrome,[33] cervical dystonia,[27] and trigeminal neuralgia.[27]

In light of the concomitant use of several interventions, it is useful to address the contribution of individual therapeutics to the patient's pain relief when possible. Botulinum toxin injection was the first intervention used for which the patient reported pain relief. The addition of PEMF therapy as an adjunct to BTX injections further provided noticeable pain relief to the patient, as reflected in the improvement in the patient's reported pain rating when using PEMF therapy and also based on statements by the patient, including that, after the initiation of PEMF therapy, she was able to discontinue narcotic medications and reduce the frequency of other interventions (BTX injections, lidocaine patches, NSAID consumption). The patient also reported experiencing an improvement in ADL and QOL measures after initiating PEMF therapy, stating that, "prior to the start of Provant, I would decline any social invitations because I did not know how I would feel when I got to the day of a particular event. It was a struggle to get through normal activities and social activities and I found myself limited in what I could accomplish. After beginning the Provant therapy, I have been able to participate in social activities on a limited basis."

When asked to describe the difference in the type of pain relief provided by the 2 therapies, the patient described BTX injections as providing a little trigger point relief and relief that lasts. The patient described pain relief provided by PEMF therapy as providing a "boost to get through the day," particularly providing relief of achy pain, with improved QOL.

A recurrent issue in this case during the first 2 years of the patient's treatment course was the patient's poor tolerance of several interventions owing to adverse effects and procedural pain. The patient reported experiencing no adverse effects with PEMF therapy, although she did report experiencing some adverse effects related to the BTX injections, including focal muscle loss (an expected result of the focal denervation the BTX causes), an appearance change in her shoulder (right shoulder appears lower and "scooped out"), and temporary weakness (eg, experienced difficulty holding her head upright after an injection). In general, reports of adverse effects related to PEMF therapy are uncommon,[19] although there are specific cases when it should not be used,[5] including in patients with a pacemaker, defibrillator, or implanted metal wire (such as a nerve stimulator); during pregnancy; and in children. The effect of prolonged PEMF therapy use is not known nor is the effect of PEMF therapy in people with cancer.[5] Patients in whom BTX injections should not be used include those who are pregnant or nursing[34] or those who have a skin infection at the planned injection site.[35]

Regarding the current hypothesis regarding etiology of pain in the patient described in this case, diagnoses include unresolved TMJ syndrome and unresolved cervical dystonia. Because the patient had 2 operative procedures (root canal and spinal fusion), postoperative pain should also be considered as a diagnosis. A recent consensus statement defined postoperative pain as "pain within close proximity to the operative site, which may or may not be causally related to the operation," with an indefinite time frame as long as pain is present.[36] Nerve damage and severe preoperative pain seem to be risk factors of developing chronic postoperative pain.[37] Severe preoperative pain was present before both

operative procedures in this case; in addition, one of the procedures directly involved nervous tissue (root canal).

In the case of chronic pain, such as chronic postincisional (ie, postoperative) wound pain, the need often arises for a multifaceted approach involving a combination of pharmacological and nonpharmacological interventions,[2,3] making it important for wound care practitioners to be aware of current findings regarding current technologies available for this purpose. To this end, outcomes in the current case are relevant to wound care centers attending to patients with postoperative wound pain, particularly with respect to closed yet persistently painful postoperative wounds.

CONCLUSIONS

In conclusion, using PEMF as an adjunct to BTX injections in this case was shown to be a beneficial approach to providing relief from severe, persistent pain that was previously unrelieved by other interventions, including surgical, pharmacological, and physical interventions, which often either were more invasive or had adverse effects. Notably, regular use of PEMF therapy by the patient made it possible to reduce the frequency of other concomitantly used interventions, reducing the risks associated with those interventions. It was also associated with a noticeable improvement in the patient's QOL. ●

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