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# NONINVASIVE BRAIN STIMULATION AND PAIN NEUROSCIENCE EDUCATION FOR FIBROMYALGIA AND TRIGEMINAL NEURALGIA: A CASE REPORT

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**Background:** Fibromyalgia (FM) and trigeminal neuralgia (TN) are commonly mistreated pain diagnoses that often present significant cognitive-affective impairments. .

**Case Report:** A 22-year-old woman with diagnoses of FM and TN underwent 5 sessions of 2 mA transcranial direct current stimulation (tDCS) targeting the left dorsolateral prefrontal cortex for 20 minutes followed by ~20 minutes of pain neuroscience education (PNE). Following 5 sessions, the patient reported resolution of TN-related symptoms and improvement of generalized pain, fatigue, and sensitivity. The patient demonstrated a 60% reduction in self-reported pain, 65% in pain catastrophizing, 24% in kinesiophobia, 28% in central sensitization, and 33% improvement in attentional interference.

**Conclusion:** The case study demonstrates positive effect of tDCS and PNE in the management of FM and TN. Interventions primarily targeted the cognitive-affective domains of pain, improving both cognitive-affective and sensory outcomes. tDCS + PNE may provide a novel combination of intervention for 2 historically ill-treated conditions.

**Key words:** Fibromyalgia, trigeminal neuralgia, noninvasive brain stimulation, pain

## BACKGROUND

Fibromyalgia (FM) is amongst the most common musculoskeletal pain disorders, most commonly affecting women aged 20-55 (1). A diagnosis of FM is primarily based on the presence of chronic generalized pain, fatigue, sleep disruptions, headache, and cognitive-affective complaints (2). Despite its prevalence, FM often lacks an identifiable cause making it difficult to successfully manage. Of many, orofacial pain is among the most common sites of pain in those with FM with prevalence rates up to 74% (3,4). A small percentage of orofacial pain is made up of those suffering from trigeminal neuralgia (TN), a painful disorder resulting in recurrent and abrupt electric pains in the trigeminal nerve distribution (5). Both FM and TN lack standardized medical management protocols, reflective of the multidimensional nature of the diagnoses themselves (6). More specifically, both diagnoses appear to involve the presence of several cognitive and psychological variables that, when left unmanaged, have potential to negatively direct a patient's prognosis (7-9). The presence of pain catastrophizing, a maladaptive cognitive and emotional response to pain, and cognitive dysfunction (e.g., attention and memory) are 2 common complaints that appear to not only coexist, but compound to reduce the ability to modulate pain (10,11). Thus, continued investigation into successful management strategies for these behaviors is imperative to promote improvements in future patient care.

Pain catastrophizing is characterized by the presence of rumination, helplessness, and magnification regarding one's pain experience (12,13). A person with high

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levels of pain catastrophizing may report feeling that their pain will continue to worsen and will progress until they are unable to function or that it is caused by sinister pathology. They often have difficulty shifting their focus from painful or potentially painful stimuli and report higher threat values to nonpainful stimuli (14,15). Pain catastrophizing levels are known to be more common in patients with FM compared to healthy controls and predict the overall impact of the diagnosis over time (16,17). Further, impaired cognitive flexibility, attentional inhibition, attentional interference, learning difficulty, and memory deficits have been shown to be associated with high levels of pain catastrophizing, likely a result of hypervigilance toward one's pain or in avoidance of pain that diminishes cognitive resources (18,19).

Pain neuroscience education (PNE) is a cognitive behavioral technique that aims to reconceptualize one's pain from strictly pathoanatomical toward a more comprehensive, biopsychosocial understanding. Evidence suggests that PNE may be an effective tool to treat patients with FM as part of a multimodal treatment approach (20). Yet, PNE alone may be insufficient (21). Interestingly, higher rates of pain behaviors, such as pain catastrophizing and fear of movement, have been shown to prevent improvements following PNE in those with FM (22). It also considered that pain-related cognitive impairments may limit the impact of cognitive behavioral therapies as they might limit a person's capacity to evaluate, interpret, and revise the maladaptive thoughts and behaviors associated with catastrophizing (23-25). To date, no studies have investigated the effects of PNE, or any form of cognitive behavioral therapy for that matter, in those with TN.

Another centrally targeted intervention, transcranial direct current stimulation (tDCS), has been shown to have positive effects on pain intensity in patients with FM. When targeting the left dorsolateral prefrontal cortex (DLPFC), a brain region involved in the cognitive modulation of pain, tDCS has been shown to reduce pain catastrophizing and improve cognitive performance (26,27). tDCS has not, however, been widely studied for treating TN. Only a single, preliminary study (28), including 6 patients, has shown a significant reduction in pain using tDCS targeting the somatosensory cortex. Otherwise, it is unknown whether tDCS has any potential to manage more cognitive-affective components of TN-related pain (28).

Our single case report describes a 22-year-old woman diagnosed with FM in 2019 and TN in 2023 with a history of persistent pain for 10 years. Following 5 sessions of combined tDCS and PNE, the patient reported a significant reduction in physical symptoms, presence of pain behaviors, and improvements in cognitive performance. The findings from this case are the first to demonstrate treatment effects from combining tDCS and PNE in a patient with FM and TN.

## CASE PRESENTATION

The patient is a 22-year-old woman experiencing chronic pain since 2014 with a diagnosis of FM in 2019 and TN in 2023. Her history started with a diagnosis of bilateral snapping hip syndrome, which she described as a deep ache and at its worst causing the inability to ambulate. She previously treated the pain with ice, over-the-counter anti-inflammatories, and physical therapy. Although these treatments initially provided the patient with temporary relief, the pain gradually worsened and became more widespread over the following years.

She received plain film radiographs, 2 magnetic resonance imagings (MRIs), and visited 2 hip specialists yet received no explanation for her pain. At this time, Celebrex and Voltaren provided no relief of the symptoms. By 2018, the patient reported progressive pain from her neck to her knees described as an ache with periods of sharp pain depending on the activity. She was unable to navigate stairs, participate in sports, or sit for long periods of time. In addition to the pain, she experienced high levels of fatigue, anxiety, heat and cold intolerance, and sleep problems.

In April of 2019, the patient was diagnosed with FM by a rheumatologist. Her symptoms and quality of life exponentially improved with the proper diagnosis and use of Cymbalta for management. The patient continued to manage sustained symptoms with a variety of interventions, including an acupuncture mat, transcutaneous electrical nerve stimulation (TENS), taping methods, Epsom salt baths, essential oils, postural correction, mindfulness, and exercise. In March 2020, the patient started continuous birth control allowing for her to experience only 4 menstrual cycles a year to minimize the flareups that accompany them. The combination of these approaches allowed the patient to manage her symptoms, however, still experiencing flares, particularly during times of elevated stress.

In August 2022, the patient experienced a new sensation seemingly uncorrelated to her FM. The patient experienced the sudden, insidious onset of left-sided facial numbness lasting 12 hours followed by intense

pain. The patient was admitted to the emergency department where she underwent a computed tomography scan and MRI. She was diagnosed with trigeminal neuropathy based on her initial symptoms. However, she was later diagnosed with TN in October 2023 by a neurologist. According to imaging, there was no sign of a pathoanatomical contribution to her symptoms. Thus, the diagnosis of TN was based on symptomology.

Continued symptoms were described as numbness with minimal pain, which then became sharp pain followed by aches. At its worst, the patient described it as feeling as if her "face was on fire." She was prescribed gabapentin and acetaminophen to manage her symptoms. However, gabapentin was quickly discontinued as it caused severe dizziness. Her facial pain continued to worsen and was similarly associated with periods of high stress. Based on the patient's presentation, it was decided that the patient was eligible for participation in this case report and provided written consent to participate. The case report was approved by the High Point University Institutional Review Board.

Following the protocol of another ongoing study, the patient provided a comprehensive list of demographic information (Table 1) along with 4 sets of outcome measures: (1) self-reported pain intensity (i.e., Numeric Rating Scale [NRS-11]), (2) pain behaviors (i.e., Pain Catastrophizing Scale [PCS], Tampa Scale for Kinesiophobia [TSK], and Central Sensitization Inventory [CSI] scores), (3) self-report pain impact questionnaires, and (4) cognitive performance (i.e., computerized Stroop Color Word Test [SCWT] and Comprehensive Trail Making Test Second Edition [CTMT2]). Outcomes were collected immediately prior to the first intervention session and at a 3-month follow-up.

The intervention protocol consisted of 5 sessions over the course of 2 weeks. To begin each session, the patient received 20 minutes of 2.0 mA anodal tDCS to the left DLPFC at each session with a 30-second ramp up and down at the beginning and end of the 20-minute period. The patient reported mild scalp discomfort during the stimulation that became more tolerable and less unpleasant over time. Immediately following each tDCS treatment, the patient engaged in a ~20-minute, one-on-one PNE session with a licensed physical therapist who has extensive experience utilizing the technique with those suffering from chronic musculoskeletal pain. The topics covered within each session are shown in Table 2.

The patient completed all 5 sessions of the intervention protocol with no reports of adverse effects. At the 3-month follow-up, the patient subjectively reported complete resolution of her facial pain and numbness along with noted improvements in the intensity and sensitivity of her widespread pain. The patient also noted no increase in pain, reduced sleep issues, and improved fatigue during a time of high stress that would have previously resulted in a flare. Table 3 displays changes in all objective outcomes from before and after completion of the intervention protocol. Of note, the patient reported no particular change in her routine, lifestyle, or level of external stress during this time that may have contributed to her improvement. In the following months, the patient did report a gradual increase in FM-related symptoms, including pain, fatigue, and sensitivity to heat and physical activity. However, her TN-related symptoms continued to be nonexistent with the exception of occasional numbness lasting only minutes.

Table 1. Patient characteristics.

| **Characteristic** | |
|---|---|
| Biological Gender | Female |
| Age | 22 |
| BMI | 20.6 |
| Occupation | Graduate student |
| Aggravating Factors | Prolonged positions, excessive activity, stress |
| Easing Activities | NSAIDs, sleep, self-treatment modalities (acupuncture mat, TENS, taping methods, Epsom salt baths, essential oils, postural correction, mindfulness, and exercise) |
| Previous Treatments | Physical therapy, dry needling, acupuncture |
| Pharmacological Management (Previous and Current) | Celebrex, Voltaren, Gabapentin, Cymbalta, NSAIDs |

Abbreviations: BMI, body mass index; NSAIDs, nonsteroidal anti-inflammatory drugs; TENS, transcutaneous electrical nerve stimulation.

Table 2. Pain neuroscience education topics by session.

| Session No | Basic Contents |
|---|---|
| Session 1 | Typical pain processing |
| Session 2 | Atypical pain processing |
| Session 3 | Pain and avoidance behaviors |
| Session 4 | Observation of the protective response Neuroplasticity mediated by cognitive and somatosensory stimuli, and physical exercise |
| Session 5 | Review of the contents covered in the first 4 sessions, and of the most relevant aspects of the PNE |

Abbreviation: PNE = pain neuroscience education.

Table 3. Change in outcomes pre- and post-intervention protocol.

| Outcome | Pre- | Post- | Percent (%) Change |
|---|---|---|---|
| NRS-11 | 5 | 2 | 60% |
| PCS (0-52) | 20 | 7 | 65% |
| TSK (0-68) | 34 | 26 | 23.5% |
| CSI (0-100) | 54 | 39 | 27.8% |
| FIQ (0-100) | 41.04 | 34.33 | 16.3% |
| BPI – Interference (0-10) | 3 | 1.75 | 41.7% |
| SCWT (ms) | 222.33 | 148.98 | 32.9% |
| CTMT2 – Inhibitory | 57 | 64 | 12.3% |
| CTMT2 – Set Shifting | 54 | 66 | 22.2% |

Abbreviations: NRS-11, numeric rating scale; PCS, pain catastrophizing scale; TSK, Tampa scale for kinesiophobia; CSI, central sensitization inventory; FM, fibromyalgia; FIQ, FM impact questionnaire; BPI – Interference, brief pain inventory interference; SCWT, stroop color word test; CTMT2 – Inhibitory, comprehensive trail making test – second edition inhibitory control index; CTMT2 – set shifting, comprehensive trail making test – second edition set shifting index.

## CONCLUSIONS

The results of this single case report are important as they suggest that the combined use of tDCS and PNE may reduce the burden of multiple domains of the pain experience. The patient reported a 60% reduction in pain according to the NRS-11. Klein et al (29) defined an intervention responder as a patient experiencing > 30% to 50% pain relief on the Visual Analog Scale. Similarly, the NRS-11 has a minimal clinically important difference (MCID) of 2, demonstrating meaningful improvement in our patient (30-32). The patient also met minimal detectable change (MCD) scores on the PCS, TSK, and FM Impact Questionnaire (13,33-35). MCID or MDC scores were not met for the Brief Pain Inventory interference score and have not yet been established for the CSI (36). However, both of these scales did improve. It could be considered that the length of the intervention protocol or the follow-up timeframe was not long enough to capture change in these variables that often take significant time to develop and/or resolve in a chronic population.

When comparing chronic pain patients with age-matched pain-free controls, those with chronic pain performed significantly worse than controls on measures of selective attention, processing speed, executive function, and long-term memory (37). However, no studies have investigated the influence of interventions aimed at improving cognitive performance in FM or TN, specifically as cognition relates to changes in pain behavior. The cognitive tests assessed in this case report are amongst the most widely used to detect the presence of cognitive impairment (38,39). The patient showed improvement in attentional interference, inhibitory control, and set shifting as measured by the SCWT and CTMT2, respectively. Seeing as the tests used are proposed to assess attentional interference/inhibition, the findings of this study support that tDCS + PNE were able to positively impact these same domains. The improvement in the cognitive functions after tDCS + PNE, along with the improvement in pain behaviors, suggests a potential connection between these variables and a refractory effect of pain behaviors on cognitive performance.

Our findings are in line with a previous case report (40) demonstrating clinically significant improvements in pain and psychological factors following the use of combined PNE and TENS in a 67-year-old woman with postherpetic TN. Our study utilized TENS applied to the patient's masseter, an intervention aimed at modulating the peripheral sensation of pain. Our study was able to produce similar improvements in self-reported pain using tDCS targeting the left DLPFC, primarily thought to modulate the cognitive element of nociceptive processing. This finding is consistent with the fact that the patient showed marked improvement in pain behaviors and cognitive function following completion of the protocol. There are known correlations between DLPFC structure and function and the presence of pain behaviors. For example, lower amounts of gray matter volume and functional connectivity within the left DLPFC have been found in those with high levels of pain catastrophizing, reversing when the pain is success-

fully managed (41-44). It should be considered that the patient's improvement in symptoms could be a result of a placebo, natural resolution of symptoms, or other lifestyle factors that were not specifically controlled for.

The patient reported a gradual increase in some symptoms over time following completion of the 5 treatment sessions (Table 2). These symptoms included pain, fatigue, and activity intolerance. It is unlikely that 5 treatment sessions are enough to resolve a complex set of symptoms that were present for 10 years in this case. It is possible that a longer intervention protocol, alteration in tDCS and/or PNE dosages, or periodic reinforcement sessions following the main protocol may influence the longevity of treatment response. The patient's TN-related symptoms did remain absent. This may be due to the difference in pathophysiological mechanisms between TN and FM, in that the 2 conditions likely have different responses to interventions. It is difficult to draw any conclusions as to the differential or additive effect of tDCS or PNE individually from this case report. Evidence does support both interventions' ability to modulate pain, pain behaviors, and cognitive performance yet this is the first time the 2 interventions have been combined (45-48). Thus, further investigation is needed to determine the influence of combined interventions compared to single interventions alone. Larger scale, randomized control trials are warranted to better understand the influence of each intervention and/or the compounding effects of them used in conjunction. However, the results of this case report provide a promising, novel approach to managing FM and TN at a neuropsychological level.

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