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Hybrid Peripheral Neurostimulation to Treat Chronic Post-Meningitis Headache- A Case Report

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ABSTRACT

Introduction: Chronic post-meningitis headaches present clinically with persistent symptoms often mirroring migraines or tension-type headaches. These frequently include photophobia, phonophobia, and associated nausea and vomiting, similar to other primary headache disorders. Central to the pathology of viral meningitis is the inflammation of the meninges—the intricate protective sheaths encasing the brain and spinal cord.

Case: This case study details a 56-year-old female patient experiencing chronic daily headaches and facial pain following an episode of self-resolving viral meningitis. Traditional therapeutic interventions failed to achieve satisfactory symptom control for the patient. In response to the treatment-resistant nature of the patient's condition, a neurostimulator strategy was implemented providing over 95% symptom relief reported at week 12 post-implantation. This strategy employed a hybrid approach combining high cervical and occipital lead placements, with the goal of enhancing neurostimulator coverage and mitigating the patient's persistent symptoms.

Conclusion: Preliminary observations suggest a potential avenue for further research and exploration in the domain of refractory headaches. Hybrid peripheral neurostimulation, as an emerging paradigm in neuromodulation, draws from the principles of neural plasticity and targeted neuromodulation. This case serves as an exemplar for refractory post-meningitis headaches, offering an innovative solution when traditional therapies have failed to provide relief.

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Introduction

Viral meningitis, colloquially known as aseptic meningitis, represents one of the more prevalent forms of meningitis [1]. It is precipitated by various viruses, most notably enteroviruses [2]. Enteroviruses are a cluster of RNA viruses that typically inhabit the human gastrointestinal tract [2]. Their transmission usually occurs via the fecal-oral route, but respiratory secretions can also be a mode of spread [2]. While these viruses often lead to mild or even asymptomatic infections, they are capable of instigating more severe conditions, including viral meningitis [3]. Central to the pathology of viral meningitis is the inflammation of the meninges—the intricate protective sheaths encasing the brain and spinal cord [4]. This inflammatory response, while crucial in the body's defense against the virus, can give rise to a plethora of clinical manifestations [4]. One particularly distressing symptom emerging in the post-recovery phase is the onset of post-meningitis headaches [5]. Although many cases are typically self-resolving and have a positive outcome, the spectrum of clinical symptoms is vast, ranging from fever and photophobia to more severe neurological deficits including pain and facial paralysis [5].

These headaches, distinguishable from other headache syndromes by their temporal association with a prior meningitis episode, encapsulate a wide range of presentations [6]. They can manifest as tension-type headaches, migraine episodes, or even cluster-like patterns [6]. While the pathophysiological underpinnings of these headaches remain an active area of investigation, it is hypothesized that the inflammatory process, even after its resolution, may lead to sensitization of pain pathways in the central nervous system [7]. This neuronal sensitization, coupled with potential vascular and biochemical alterations, may culminate in these persistent headaches [7]. Moreover, changes in vascular function and possible imbalances in neurotransmitter levels might further enhance this sensitivity, contributing to the prolonged nature of these headaches [8]. Intriguingly, a prior proclivity for headaches-such as migraines-appears to enhance the vulnerability of individuals to this post-infective complication [8]. This intersection of primary headache disorders and post-meningitis headaches suggests potential shared pathways or synergistic mechanisms that exacerbate post-infective pain syndromes.

From an epidemiological perspective, post-meningitis headaches are relatively common. A retrospective study examining the connection between meningitis and post-meningitis headaches revealed that 19% of the patients had pre-existing headaches, including 8 individuals with migraines [9]. In comparison, the control group showed 26% with pre-existing headaches, including 8 with migraines. Following recovery from meningitis, 33% of the patients developed new headaches, contributing to

a total prevalence of 46%, with 6 patients reporting migraines [9]. These statistics highlight the importance of close clinical monitoring during the recovery phase of meningitis to ensure timely identification and management of these headaches.

The range of treatments for post-meningitis headaches is extensive, often drawing from approaches used for other chronic headache conditions [6]. A thorough diagnostic evaluation is essential to identify any secondary causes or contributing elements [6]. Depending on the clinical context, a combination of treatments including medications, physical therapies, and cognitive approaches is implemented [6].

Despite adherence to established therapeutic protocols, a subset of patients demonstrates suboptimal clinical response. In these refractory cases, the exploration of novel therapeutic modalities becomes imperative. As detailed in subsequent sections, the utilization of a hybrid neurostimulation technique offers a potential paradigm shift in the management of persistent post-meningitis headaches [10]. By strategically integrating high cervical and occipital lead placements, this advanced technique ensures comprehensive neurostimulator coverage, potentially enhancing therapeutic outcomes in patients with persistent post-meningitis headaches [10]. Although this approach is still emerging, it may signify a turning point in treating persistent post-meningitis headaches.

Hybrid stimulation in neuromodulation arises from the interplay of neurobiology, electrical engineering, and the biophysical interactions of electrical stimuli with neural tissues [11]. Central to its foundational principles is the concept of neural plasticity, which postulates that the neural pathways and synapses in the brain are inherently adaptable, undergoing dynamic changes in response to varying stimuli [11]. This adaptability forms the basis for targeted neuromodulation [11]. Furthermore, each stimulation technique or site has its unique spatial and temporal profiles, influencing specific neural populations and pathways [12]. By combining multiple stimulation modalities, hybrid stimulation aims to harness their individual strengths, potentially achieving a more comprehensive and precise modulation of targeted neural circuits [12]. Such integrative strategies are postulated to enhance therapeutic efficacy, reduce side effects, and provide a more tailored approach to address the heterogeneity of neurological and neuropsychiatric disorders.

We introduce a complex case characterized by persistent daily headaches and facial pain subsequent to viral meningitis. Conventional treatments proved insufficient in alleviating symptoms. In addressing this challenging scenario, we employed a hybrid neurostimulation approach, utilizing strategic placements of high cervical and occipital leads. This refined approach provided comprehensive neurostimulator coverage, culminating in a significant reduction of symptoms.

Case

A 56-year-old female presented to the emergency department with complaints of facial pain and facial nerve palsy a day after a sudden onset of a knife-like stabbing left-sided headache lasting 5 minutes. The initial diagnosis was left-sided facial palsy, and the patient was initiated on prednisone and Valtrex treatment. However, the etiology remained unclear, and the patient continued to experience increasing left temporoparietal pain. An MRI of the internal auditory canal revealed enhancement within the left internal auditory canal along the left facial nerve, suggesting a possible schwannoma. A lumbar puncture (LP) performed only revealed increased nucleated cells with 93% lymphocytes. Subsequently, the patient was seen by in-house medical oncology and received six weeks of IV acyclovir for suspected viral meningitis.

Various other medications were tried, including prednisone, valaciclovir, IV acyclovir, gabapentin, tramadol, amitriptyline, topiramate, rizatriptan, as well as supplements like vitamin B2 and magnesium. ENT recommended a craniotomy for decompression of the left facial nerve, but this recommendation was not supported by neurosurgery. For four months, the patient was unable to close her left eye, leading to the use of an eye patch and eye drops. At this point, the provisional diagnosis was self-resolving viral meningitis with a persistent headache and facial palsy which continuously improved. A subsequent LP revealed resolution of pleocytosis.

The patient continued to experience positional headaches characterized as throbbing, stabbing pain in the left posterior cervical and left retro-mastoid areas, with radiation toward the vertex. Various treatments, including sphenopalatine ganglion block, ventral left lesser and left auricular block, and two blood patches for suspected LP related dural punctures, did not alleviate her headaches. Neurology initiated Botox injections which provided temporary relief. Subsequently, the patient underwent two rounds of bilateral occipital nerve blocks, resulting in moderate improvement. To further address her symptoms, a bilateral C2 neurectomy/greater occipital nerve transection was performed, leading to 95% symptom resolution for approximately two months. However, her symptoms returned, this time with worsened facial asymmetry, including a right-sided face droop at rest.

The patient was referred to Neurosurgery for the evaluation of an occipital nerve stimulator, with a trial initiated by the pain management team. During the trial, the patient reported significant pain relief, disappearance of facial stress, improved sleep quality, and overall mood improvement. A decision was then made to proceed with the placement of a bilateral paddle lead occipital nerve stimulator and a left sub clavicular non-rechargeable pulse generator, performed two months later.

8 weeks after the procedure, the patient continued to report significant improvement in her headaches and a better quality of life based on her PROMIS Pain Interference scores. During a follow-up visit, the patient reported a fall and subsequent non-meningitic cervicalgia, which was further investigated. Additional diagnostic and confirmatory procedures, including bilateral diagnostic cervical facet blocks and confirmatory bilateral cervical facet C4-C6 blocks, were performed, leading to over 80% improvement in her headaches. Axial neck pain was resolved about 8 weeks post bilateral rhizotomy, and she continued to have headache relief a year post-occipital peripheral nerve stimulator implantation.

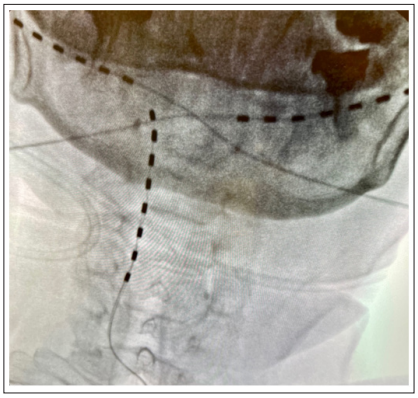

Figure: Percutaneous Lead Placement for Occipital Nerve Stimulation. The dotted line indicates the trajectory for the insertion of the lead towards the target area near the occipital

nerve. The visible wire is part of the apparatus used to guide and position the lead accurately. This minimally invasive procedure is commonly used to manage chronic headaches, such as migraines or cluster headaches, by delivering electrical impulses to the occipital nerves.

Discussion

Post-meningitis headaches, though typically self-resolving, can present a significant challenge when they persist and become refractory to conventional treatment [9]. This case underscores the complexity of managing such intractable headaches, particularly when complicated by associated facial pain and nerve palsy. While the exact pathophysiology of post-meningitis headaches remains the subject of ongoing research, it is evident that they can manifest in a variety of ways, mirroring other primary headache disorders [9]. This overlap in symptomatology often complicates diagnosis and management.

This patient's clinical presentation was multifaceted, involving not only chronic daily headaches but also facial pain and nerve palsy, which made it vital to explore a comprehensive therapeutic approach. It's important to recognize that post-meningitis headaches are not a uniform entity; they encompass a spectrum of clinical presentations, and their etiology can be multifactorial. In this case, a potential underlying factor was the sustained inflammatory response following the viral meningitis episode.

One noteworthy aspect of this case is the patient's prior history of migraines. It is well-established that individuals with a pre-existing propensity for primary headache disorders, such as migraines, are at a heightened risk of developing post-meningitis headaches [6, 9]. The intersection of these two conditions suggests the possibility of shared pathophysiological mechanisms or even a synergistic effect, where the post-meningitis inflammatory insult exacerbates the underlying predisposition to headaches.

Conventional treatments, including medications, nerve blocks, and even surgical interventions like C2 neurectomy/greater occipital nerve transection, failed to provide long-term relief for this patient. The complex interplay between headache mechanisms, neural sensitization, and associated neurological symptoms posed a unique therapeutic challenge.

The introduction of a hybrid neurostimulation approach marked a turning point. By strategically combining high cervical and occipital lead placements (figure), this innovative technique aimed to provide comprehensive neurostimulator coverage. Notably, during the trial phase, the patient reported an impressive 80% reduction in pain, which extended for six months following implantation, increasing to 95% at that time. This outcome is promising and suggests the potential efficacy of hybrid neurostimulation as a novel therapeutic modality for persistent post-meningitis headaches.

Hybrid neurostimulation, as an emerging paradigm in neuromodulation, draws from the principles of neural plasticity and targeted neuromodulation. This case serves as an exemplar for refractory post-meningitis headaches, offering an innovative solution when traditional therapies have failed to provide relief. While further research is essential to validate the long-term effectiveness of this method and its applicability to a broader patient population, the results from this case are promising.

Conclusion

This case report highlights the complexities and challenges associated with post-meningitis headaches, particularly when they manifest as persistent, treatment-resistant conditions. The presented patient's history of migraines and the intersection of primary headache disorders with post-meningitis headaches underscore the need for personalized, multidisciplinary care. The innovative hybrid neurostimulation approach, combining high cervical and occipital lead placements, demonstrated promising results, providing six months of significant pain relief. This case signifies a potential breakthrough in the management of refractory post-meningitis headaches, offering hope to patients who have long endured the burden of these persistent headaches following viral meningitis. Further research and collaboration are imperative to validate the long-term efficacy of this approach and expand its application to a wider patient population.

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