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Tibial Nerve Injury from Intraoperative Neuromonitoring Needle Electrode During Cervical Disc Arthroplasty: A Case Report

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Abstract

We report a case of a patient who underwent a C6/7 anterior cervical disk arthroplasty with standard IONM protocol who was found to have permanent tibial nerve injury due to subdermal needle placement. Through extensive rehabilitation, ultrasound, and podiatric care it was discovered he had an anatomical variation of his tibial nerve which likely predisposed him to the iatrogenic injury. We recommend use of surface gel electrodes as a cost-effective and time-conscious prevention of similar injuries. We also discuss the role different podiatric interventions had and their efficacy at symptom management and improvement.

Keywords: Tibial nerve injury; Iatrogenic complication; Orthotics; Platelet rich plasma (PRP) injections; Intraoperative neuromonitoring; Peripheral nerve injury

Introduction

Intraoperative neuromonitoring (IONM) serves as a useful tool for detection of intraoperative neural damage in patients undergoing spine surgery [1,2]. In cases of cervical disc arthroplasty (CDA) somatosensory evoked potentials (SSEP), transcranial motor evoked potentials (tcMEP), and electromyography (EMG) are monitored to detect neurophysiological changes in real time allowing early intervention before permanent deficits occur [3-6]. For IONM, peripheral nerves being monitored may be vulnerable to injury from compression or direct penetration from monitoring electrodes or needles [7].

Case Presentation

A 38-year-old male presented with refractory left C7 underwent a C6/7 anterior cervical disk arthroplasty without operative complication. Continuous EMG, tcMEP and SSEP were monitored without any changes from intact baseline. Per standard IONM protocol for a cervical spine surgery at the C6/7 level, the ulnar nerve and the posterior tibial nerve were monitored to assess the integrity of ascending sensory pathways.

Immediately upon waking up from anesthesia, the patient noticed numbness in his right foot from his midfoot arch to the distal end of his first metatarsal. He also noticed a red dot behind his medial malleolus that bled briefly. He had significant improvement in his preoperative radiculopathy. Due to his initial focus on recovery from the procedure, the patient expected the sensory changes to resolve spontaneously and did not seek immediate foot-specific evaluation. During his postoperative follow-up 2 months later, the numbness was unchanged and there was notable loss of muscle mass in the plantar arch. A Tinel's sign was present upon palpation of his right tarsal tunnel. Lumbar spine MRI was unremarkable. He was referred to podiatry for further evaluation. The patient completed 12 sessions of laser therapy with no response. Orthotic treatment provided slight symptom relief while standing for long periods. Ultrasound demonstrated an anatomical variation in the location of the posterior tibial nerve in the tarsal tunnel anterior to the tibial artery. Platelet rich plasma (PRP) injections helped rebuild muscle mass and facilitate recovery. At 2.5 years follow-up, the patient still has decreased muscle mass in his right plantar arch and has noticeable increased fatigue in his right foot after activity or standing for prolonged periods. He continues to manage his symptoms with orthotics and PRP injections.

Discussion

The tibial nerve originates from the L4-S3 spinal nerve roots and is a major branch of the sciatic nerve. It travels through the popliteal fossa and descends midline between the two heads of the gastrocnemius before traveling deep over the posterior surface of the tibialis posterior muscle [8]. It then passes within the tarsal tunnel between the flexor digitorum longus and the flexor hallucis longus. Typically, the order of structures within the tarsal tunnel, from anterior to posterior, is: the tibialis posterior tendon, flexor digitorum tendon, posterior tibial artery, tibial nerve, and flexor hallucis longus tendon. Distal to the tunnel the tibial nerve bifurcates into the medial and lateral plantar nerves which supply motor and sensory innervation to the plantar foot [9]. Tibial nerve injury at the tarsal tunnel presents with numbness, aching, and muscle weakness that is normally exacerbated by activity [10].

Peripheral nerve injury due to a subdermal needle placement is a rare and unique complication of IONM. Min et al. conducted a 14-year study looking at complication rates of EMG, they found no causes of direct nerve injury due to EMG needle insertion [11]. However, an important consideration is that they included situations where patients were awake and able to signal when they were in pain or a complication arose. Patients are under general anesthesia during IONM placement and monitoring and cannot verbalize pain or describe any symptoms, therefore greater caution and safety considerations should be considered with IONM subdermal needle placement. Other complications of SSEP are similarly rare and consist of infection and burns at electrode sites if electrocautery devices are not properly grounded [12,13]. In cervical spine surgery, EMG needle-related injury such as hematomas or hemorrhages is usually self-limiting and self-resolving [14]. Overall IONM has shown significant improvement in neurologic outcomes and is considered the standard of care in many spinal and intracranial surgeries [15,16].

Another important aspect of SSEP is that it relies on consistent landmarks for positioning of needles. For the tibial nerve it assumes that the tibial nerve travels posterior to the posterior tibial artery. When variations arise, such as in our patient, placement of the subdermal needle may lead to direct injury. While ultrasound guided placement may minimize this risk, given the low incident rates of EMG needle complications found by both Min et al. and Cushman et al. this added step might not be justifiable [11,14].

However, a simpler, more cost-effective, and time efficient way to minimize complications during IONM is the use of surface or gel-pad electrodes as an alternative to subdermal needles, especially for SSEP monitoring. In a study comparing surface versus subcutaneous needle electrodes, surface electrodes demonstrated similar efficacy at recording signals compared to subcutaneous for spinal cord monitoring [17]. Furthermore, when properly positioned, surface electrodes have demonstrated perfect agreement for detecting warnings compared to needle electrodes [18]. Despite the availability and comparable efficacy of surface electrodes, subcutaneous needles are still more commonly used. Our case adds to the growing literature to reconsider the default use of subcutaneous needles for SSEP monitoring.

A final component of this case to highlight is the role that lasers, PRP therapy and orthotics had in symptom improvement after the tibial nerve injury. In this case, multiwave locked continuous red-light laser therapy did not provide symptomatic improvement even after 12 sessions, however orthotics and PRP injections provided partial symptom management. Laser therapy has been described as a noninvasive, low-risk modality that may reduce inflammation, promote regeneration, and improve neuropathic pain in some peripheral nerve injury populations [19]. However, the clinical evidence remains sparse and heterogeneous [20]. PRP has also shown emerging promise as an adjunctive treatment for peripheral nerve injury and peripheral neuropathic pain [21]. However, current clinical evidence remains limited, and PRP preparation, dosing, and injection protocols are not yet standardized [22]. Given the patient's partial response, image-guided PRP and orthotic support may be considered reasonable conservative adjuncts in select patients, however these modalities are patient- and case-specific and more research is required to create treatment guidelines and protocols.

Conclusion

Although complications and injuries due to IONM are rare; they are more commonly associated with subdermal needles and include infection, burns, hematomas, and in rare cases nerve injury. Ultrasound guided placement of subdermal needles does not fully avoid all of these complications. Gel surface electrodes offer a better and safer alternative and addresses the majority of these complications.

Although the electrode caused permanent nerve damage, orthotics and PRP injections have shown promising results with symptom management and improvement, specifically with rebuilding muscle mass and helping with the neuropathic pain.

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