Case Report – Παρουσίαση Περιστατικού

Focused Regional Therapeutic Iontophoresis Blockage (FORTI-BLOCK): A New Regional Block Strategy for Difficult-to-Control Myofascial Syndrome: A Case Report and Literature Review

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ABSTRACT

Focused Regional Therapeutic Iontophoresis Blockage (FORTI -BLOCK): A New Regional Block Strategy for Difficult-to-Control Myofascial Syndrome: A Case Report and Literature Review.

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Recent advances in techniques such as iontophoresis represent a promising approach to pain management. Iontophoresis involves the use of low-voltage electrical currents to improve transdermal delivery of medications, including local anesthetics. This technique is based on physical principles, including Faraday and Oërsted's laws, which elucidate the mechanisms by which electrical currents can influence the distribution and effectiveness of these medications. We describe a clinical case of a female patient with a history of traumatic dislocation

of the left shoulder. The combination of iontophoresis with bedside ultrasound was proposed with the aim of increasing the precision of peripheral nerve blocks, allowing better anatomical localization and improved effectiveness.

Keywords: Iontophoresis, Chronic pain, Anesthesia, Peripheral nerve block, Myofascial pain syndrome

INTRODUCTION

Chronic pain, associated both with trauma and surgical procedures, is a theme of significant medical concern. In its various manifestations, difficult-to-control chronic pain is linked to depressive symptoms, decreased quality of life, reduced productivity, and diminished workforce strength – with impacts that are both individual and social. Data indicate that 37% of the Brazilian population suffers from chronic pain after age 50, and among these individuals, 30% require opioid use[1].

The increasing use of opioids has become a global health concern. In countries such as the United States and Canada, there is a high prevalence of abuse and addiction to these substances, with numerous cases of overdose. In the U.S., reports indicate that, in 2020, more than 68,000 deaths occurred due to overdose of opioids. It is worth highlighting the significant economic impact, especially in countries with health systems fully funded by the government, such as Brazil.

This impact involves not only the dispensing of medications but also hospitalizations and the management of related medical complications. Despite still not being a class of drugs of great usage for the management of chronic pain inI Brazil, recent data indicate increases of over 400% in the last 20 years[2,3].

Furthermore, polypharmacy in elderly individuals, especially when combined with potentially sedative medications - like opioids - is also a recognized risk factor for falls in this population, increasing hospitalization rates due to trauma and potentially leading to loss of independence and functionality in this age group[2,3,4].

Peripheral blocks, in this context, emerge as an interesting strategy for effective pain control in cases of difficult pharmacological control and can potentially avoid the abusive use of opioids in patients with chronic pain.

Associated with the innovative method of local anesthetic instillation (LA) through iontophoresis-guided injection, this case report opens the door to a new approach to chronic pain in a simple, safe, and cost-effective manner.

CASE REPORT

A 34-year-old female patient, with no comorbidities, had a history of traumatic dislocation of the left shoulder in January 2024, treated conservatively by the Orthopedic team. After the trauma, she developed persistent pain in the

ipsilateral scapular region, despite undergoing physical therapy twice a week, with intermittent immobilization, regular analgesia with dipyrone and rescue analgesia with tramadol. The patient was then diagnosed with myofascial syndrome.

Given the patient's pain, classified as 8 on the Visual Analog Scale (VAS), a spinal block ("ESP block") was performed using a solution of 10 ml of 0.2% ropivacaine and 5 mg dexamethasone, which provided partial pain relief, reducing the VAS score to 4. However, the pain recurred to VAS 8 approximately 3 weeks later.

Due to the persistence of pain, a new technique combining iontophoresis (a non-invasive technique based on the application of low-intensity electrical current to facilitate the release of ionizable drugs through biological membranes) was attempted. This approach aimed to optimize the dispersion of the anesthetic and, through the formation of an electric field, to keep it restricted to the area to be anesthetized. The described technique utilized ionization of the local anesthetic and its electroconductivity, based on the physical effects of Thomson, Faraday, Oërsted, Gauss, and Navier-Stokes.

Subcutaneous instillation of 4 ml of 1% lidocaine was performed in the area of the trapezius muscle, and the anesthetic was conducted to the scapular region using electrical conduction, with the application of conductive gel between the injection point and targeted area, with the placement of a low-voltage electro stimulator with electrodes on: a) approximately 1 cm before the injection site; b) approximately 1 cm after the last anginal point referred by the patient, identified through local palpation.

The duration of electrostimulation was 10 minutes. After the block was performed, the patient reported complete resolution of pain. No side effects were reported. The treatment with physical therapy was continued, with no further need for opioid rescue and no significant pain episodes have again occurred to the present date.

DISCUSSION

Iontophoresis is not new in medical practice. One of the earliest applications of electric current for pain therapy was described by Pivati in 1740 to treat arthritis[5,6.] Notable advances followed with the technique over the years, expanding the field to the study of transdermal analgesic pharmaco-distribution – a principle underlying the use of patches and adhesive systems with local anesthetics and opioid analgesics[7-10]. The latter gained greater prominence compared to traditional iontophoresis due to their practicality and simplicity – though at a higher cost.

There is substantial evidence supporting the efficacy of these preparations in blocking nociceptive and neuropathic pain, with advantages of avoiding first-pass metabolism and reducing side effects and drug interactions, making it a safe, well-tolerated and effective therapy compared to conventional systemic treatments[11-13]. Iontophoresis has a range of substances formal-

ly released by the Food and Drug Administration, making it a technically supported and legal procedure[5,10]. Complications include skin lesions and burns, which can be prevented with proper local hygiene, low voltage, and short application times, as well as hypersensitivity to the drug. Local anesthetic toxicity did not occur but remains a possibility related to dosage in use[10,14-17].

Utilizing the concept of drug distribution guided by iontophoresis, which is currently limited to the transdermal administration of local anesthetics ('needle-free'), this case presents an innovative combination of ultrasound-guided local anesthetic injection with the iontophoresis technique, aiming to ensure greater precision in peripheral block. This technique allows for accurate anatomical marking of the site to receive the electrical stimulus, ensuring the appropriate enhancement of local anesthetic delivery.

It is currently proposed that the direct correlation between hydrophobicity and anesthetic potency reveals that the partitioning/distribution of this class of drugs in the lipid bilayer is important for facilitating the molecule's access to the binding sites on the voltage-gated sodium channel in the peripheral nerve of interest. This critical balance between the ionized portion (which provides potency) and the non-ionized portion (which ensures membrane penetration) guides the efficacy of peripheral blocks.

In myofascial syndrome, muscle tension reduces blood vessel permeability at the tissue level, leading to decreased oxygen and nutrient supply. This pathological process results in the release of vasoactive substances (serotonin, histamine, bradykinin, prostaglandins), potassium ions, and lactic acid, which not only increase nociceptor activity - leading to pain - but also reduce the pH locally. This is an undesirable phenomenon, as it affects the degree of ionization of the local anesthetic, making the penetration of the myelin sheath more difficult for intracellular anesthetic action.

The physical principles underlying the technique merit further elucidation for a proper understanding of the phenomena supporting this new block approach. Oërsted's law states that electric currents also produce a magnetic field, which direction depends on the direction of the electric current in place. Faraday's law suggests that when there is a variation in magnetic flux through a circuit, an induced electromotive force will appear. Thomson's scattering principle states that when an electromagnetic wave passes through an electron, the electric field makes the electron oscillate. Gauss's law establishes the relation between the electric field flux through a closed surface and the electric charge within the volume bounded by that surface. The Navier-Stokes equations establish that changes in the acceleration of a fluid particle are simply the result of changes in pressure and dissipative viscous forces (similar to friction) acting on the fluid – a magnetohydrodynamic relation. This viscous force originates from molecular interac-

tion and can influence the direction of fluid flow, concentrating it at the site of interest.

The theoretical basis supporting this technique, therefore, is literally "guiding" the flow of the local anesthetic along the muscle group through low-voltage electric current, using iontophoresis, and concentrating it through the formation of a dipole electromagnetic field, utilizing the electrochemical properties of the solution[5-6,9-11,18-19].

Iontophoresis has proven to be an effective method for drug administration with electroactivation and electrodmodulation properties, such as local anesthetics, in a methodology known as magnetoelectrotherapy[20,21].

Using electron repulsion as the driving force, iontophoresis spatially directs molecular dispersion – cationic ionization drugs orient below the positively charged electrode (anode) – while anionic ionization drugs orient below the negatively charged electrode (cathode)[10,18,19]. The guided dispersion of the anesthetic likely mitigated the low membrane penetration by increasing the exposure time of the tissue to the local anesthetic – effect currently known as "delivery enhancer"[11]. We believe that this effect considerably optimized the efficacy of the block performed, with excellent clinical results, low cost, complete physician control over the applied dose, and potential minimization of significant side effects, such as local anesthetic toxicity, due to the low dosage used.

The combination of point-of-care ultrasound with iontophoresis significantly increases the accuracy of peripheral block[22-28] and assists in the correct anatomical marking of the site to receive the electrical stimulation, ensuring adequate enhancement of local anesthetic delivery (Fig. 1).

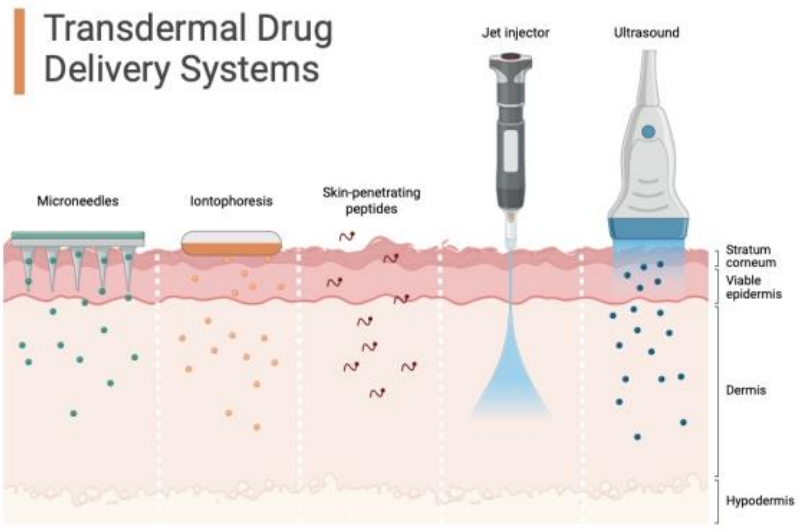

Figure 1. Illustration comparing the technique of iontophoresis and other forms of transdermal drug delivery. *(Created in BioRender. Bersot, C. (2024) BioRender.com/e39r223)*

Given the results obtained and considering it is a simple and innovative technique, it is of undeniable medical interest to disseminate the technique to allow further studies to be conducted, so that it may become a treatment option for patients with chronic myofascial pain and/or complex pain syndrome that is difficult to control at low cost.

CONCLUSION

In conclusion, the integration of innovative techniques, such as iontophoresis into pain management paradigms offers a viable alternative to traditional opioid-based therapies, especially for chronic pain conditions such as myofascial pain syndrome. As the medical community continues to address the challenges of opioid addiction, exploring these non-invasive strategies is critical to improving patient outcomes and quality of life.

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