

Use of Nanotechnology as an Alternative to Opioids for Post-operative Pain Management Following TKA

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Learning Point of the Article:

TKA is an established model of moderate-to-severe pain that often requires opioids for post-operative pain management. This case reports the use of the NeuroCuple™ device, a patch based on nanotechnology, as an alternative to opioids.

Abstract

Introduction: In response to the current opioid crisis, there is a great interest to develop non-pharmacologic approaches to post-operative pain management for patients undergoing total knee arthroplasty (TKA).

Case Report: We report a case of a patient whose post-operative pain following TKA was managed using the newly designed NeuroCuple™ device, a patch based on the use of nanotechnology. The NeuroCuple™ device was placed above the knee by the patient at home. The use of the NeuroCuple™ device allowed the patient completely avoid the use of any opioids at home.

Conclusion: Our report suggests that the use of the NeuroCuple™ device may represent an interesting alternative to opioids for the peri-operative management of pain following a primary, unilateral TKA.

Keywords: Primary knee arthroplasty, peri-operative pain management, nanotechnology.

Introduction

Persistent post-operative opioid use has been established as a possible cause of opioid use disorder [1, 2]. Therefore, the ability to offer non-opioid alternatives is of significant interest.

Recently, the use of nanotechnology has been reported as a possible method to treat arthritis pain [3]. Here, we report the use of the newly designed NeuroCuple™ device (nCap Medical, Salt lake City, Utah) for the management of post-operative pain following a primary total knee arthroplasty (TKA) replacement. The proposed mechanism of action of the NeuroCuple™ is based on the concept that local pain is the result of inflammation, which is associated with an increase in local temperature/energy. The NeuroCuple™ contains nano-capacitances capable of absorbing

local energy and is consequently able to decrease local inflammation and pain (Fig. 1).

Case Report

Our patient was a male, 70-year-old, weight 107 kg, height 181 cm, who underwent a primary right total knee replacement on January 19, 2023. His medical history was remarkable for osteoarthritis of the right knee, hypertension, hyperlipidemia, diverticulosis, psoriatic arthritis, eczema, cataracts, left eye ptosis, benign prostatic hyperplasia, heart murmur, and a past fracture of the right ankle. The patient's past surgical history included two right knee arthroscopies in 1993, anterior cruciate ligament reconstructive surgery in 1995, cataract surgery, and a

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Author's Photo Gallery



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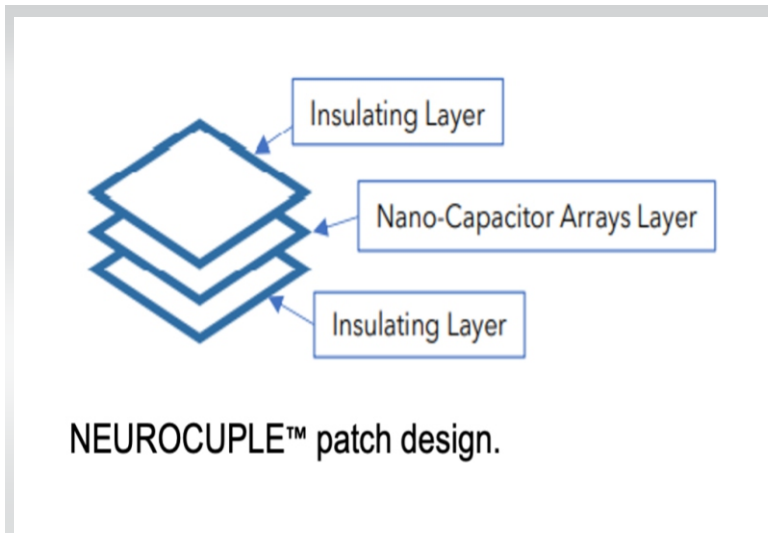
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NEUROCUPLÉ™ patch design.

Figure 1: The NeuroCuple™ device's three-layer design includes two outside thin layers of medical grade material that are flexible, durable, and latex-free, and an internal layer containing billions of entrapped nano-capacitors.

tonsillectomy. Pre-operative medications included Lipitor 100 mg daily, hydrochlorothiazide 25 mg daily, potassium 10 mEq daily, apremilast 30 mg BID, and naproxen 660 mg BID that was stopped 7 days before the surgery.

Before being transferred to the operating room, a right adductor canal block was performed using ultrasound and an injection of 15 mL of 0.5% ropivacaine. Surgery was performed under spinal anesthesia and propofol sedation. Following surgery, the patient's pain was rated between 3 and 7 on the pain rating scale. Post-operative pain was managed with acetaminophen PO 1000 mg q8h, celecoxib PO 200 mg BID, and oxycodone 5–10 mg q 4 h PRN for breakthrough pain. In the hospital, the patient used a continuous passive motion machine. The patient was discharged home on post-operative day 2 (1/21) with a 1-time prescription of 44 pills of 5 mg of oxycodone to control 8/10 breakthrough pain at home for an additional 3–5 days. He was asked to continue taking celecoxib PO 200 mg BID and acetaminophen PO 1000 mg q8h. The patient's opioid prescription was filled. At home, the patient placed a NeuroCuple™ device above the knee bandage (Fig. 2) and kept it in place from January 21 to February 6 (16 days). During this period, he did not require any opioids.

Discussion

Although there is a consensus to reduce and sometime eliminate the use of opioids because of the ongoing opioid crisis and the documented associated risk of opioid use disorder in surgical patients, [4] most patients undergoing TKA are still prescribed a limited amount of opioids for breakthrough pain because evidence shows that the use of opioids facilitates immediate functional recovery following TKA [5].



Figure 2: Placement of the NeuroCuple™ device above the bandage following a total knee arthroplasty.

Evidence supports the concept

that complementary approaches, including acupuncture [6, 7], auriculotherapy [8], hypnosis [9], and transcutaneous electrical nerve stimulation [10] may represent an alternative to opioid use in surgical patients. However, many reviews have questioned the validity of the effectiveness of these complementary approaches because the effectiveness of these techniques is based on anecdotal reports, and randomized placebo-controlled studies are lacking [11, 12]. One report argued that acupuncture treatment is not superior to placebo [13]. In addition, these techniques require extensive expertise, which limits their use on a large scale.

Nanotechnology has been shown to have several medical applications, including facilitating wound healing, the treatment of neurological and cardiac disorders [14, 15, 16], and the management of arthritic pain. Although evidence supporting the use of nanotechnology for pain associated with surgery is still lacking, the use of the NeuroCuple™ does not require extensive training and therefore represents a technique that can be used on a large scale and may represent an interesting alternative to the use of opioids in surgical patients undergoing skeletal-muscle procedures.

Conclusion

Although our data are encouraging, further research is required to confirm that the NeuroCuple™ device may represent an important and easy-to-use alternative to opioids to manage pain

following surgery.

Clinical Message

The use of nanotechnology may represent an interesting alternative to the use of opioids and may avoid the associated risk of opioid use disorder to manage pain following knee arthroplasty. The technology is non-invasive, easy-to-use, and well-tolerated.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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