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Case Report

# Cryoneurolysis for the Treatment of Knee Arthritis to Facilitate Inpatient Rehabilitation: A Case Report

**Fraser MacRae, BSc [a,b,c], Mahdis Hashemi, MD [b,c], Ève Boissonnault, MD [c,d], Romain David, MD, MSc [c,e,f], Paul Winston, MD [b,c,g]**

[a] *Western University, London, ON, Canada*
[b] *Vancouver Island Health Authority, Victoria, BC, Canada*
[c] *Canadian Advances in Neuro-Orthopedics for Spasticity Consortium, Kingston, ON, Canada*
[d] *Université de Montréal, Montréal, QC, Canada*
[e] *PRISMATICS Lab (Predictive Research in Spine/Neuromodulation Management and Thoracic Innovation/Cardiac Surgery), Poitiers University Hospital, Poitiers, France*
[f] *Physical and Rehabilitation Medicine Unit, Poitiers University Hospital, University of Poitiers, Poitiers, France*
[g] *University of British Columbia, Vancouver, Canada*

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**Abstract** A 65-year-old woman presenting with a sensory ganglionopathy complicated with COVID-19 is limited in her rehabilitation due to pain from lateral compartment knee osteoarthritis. To increase participation in rehabilitation, cryoneurolysis of the medial and lateral anterior femoral cutaneous nerve and infrapatellar branches of the saphenous nerve was provided to manage pain associated with knee osteoarthritis. The patient reported immediate relief from pain. Physiotherapy noted improvement immediately after the procedure. Follow-ups at 7- and 11-days post-treatment revealed ongoing increases in mobility and reduction in pain. The patient was discharged to live independently shortly after cryoneurolysis. Cryoneurolysis for

*List of abbreviations:* AFCN, anterior femoral cutaneous nerve; IFN, infrapatellar branches of the saphenous nerves; IVIG, intravenous immune globulin; KOA, Knee osteoarthritis; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

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knee osteoarthritis could be considered as a treatment option to increase participation in rehabilitation for hospital inpatients who are stalled in their rehabilitation due to pain and poor mobility from knee osteoarthritis.


Knee osteoarthritis (KOA) is common in the aging population. It is associated with reduced functional independence and quality of life.[1] For patients recovering from acute neurologic impairments, the new onset of weakness and loss of proprioception may present additional challenges and impairments in the presence of knee osteoarthritis. Knee osteoarthritis limits patients' standing and ambulation tolerance. Participants recovering from stroke, with pre-existing arthritis perceived that their arthritis "held them back" from an expected stroke recovery trajectory.[2] Wood et al (2009) opined that "slowed stroke recovery was attributed to daily pain, frustration, mobility limitations, and the required extra coping due to arthritis. As a result, comorbid arthritis increased the complexity of stroke recovery and rehabilitation".[2] Moreover, patients with neurologic disorders may be poor candidates for total knee arthroplasty due to medical frailty. For patients who are surgical candidates, significant wait lists may limit access to orthopedic surgery, presenting an issue for patients seeking urgent treatment to improve their participation in rehabilitation and facilitate patient discharge from the inpatient unit.

We present the case of a patient whose recovery from an acquired polyneuropathy was affected by painful KOA. The patient gave informed consent. She underwent cryoneurolysis of the medial and lateral anterior femoral cutaneous nerve (AFCN) and infrapatellar branches of the saphenous nerves (IFN) to treat pain that led to impaired function and limited mobility. Cryoneurolysis is a percutaneous procedure that can target sensory nerves that transmit pain signals from the knee. It involves the physical process of throttling a gas through an orifice into the probe from high to low pressure resulting in a rapid expansion of the gas and a drop in temperature, known as the Joule-Thomson effect.[3] The rapid cooling of nitrous oxide generates an ice ball at the tip of the cryoprobe at a temperature of -88°C. This causes the breakdown of the axon, preventing these pain generators from transmitting nociceptive information to the cortices.[4]

## Case study

A 65-year-old indigenous woman presented to the hospital with whole left-sided weakness. She had reduced sensation in all 4 limbs and was areflexic. She had dysmetria, dysphagia, and dysarthria and was unable to walk. She was diagnosed with presumed sensory ganglionopathy, confirmed with a biopsy, and treated with intravenous immune globulin (IVIG) and prednisone. Four months prior to cryoneurolysis treatment she required an overhead lift to transfer and a wheelchair for locomotion. Proprioception was reduced from the knees distal when she entered inpatient rehabilitation. She tested positive for COVID-19 in hospital and required oxygen by nasal cannula. Three months before cryoneurolysis, she developed bacterial pneumonia requiring dexamethasone. She was readmitted to a rehabilitation ward 2 months prior to treatment and advanced to a 2-person assist transfer. 6 weeks before treatment, she was walking in the parallel bars and weaning off oxygen. She progressed to a 4 wheeled walker, but left knee pain became prominent. She rolled her right ankle and required an ankle foot orthosis along with her left knee brace. She was given ankle weights to control her ataxia. She progressed to a 1 person assist with a 4-wheeled walker. She had known bilateral moderate tricompartmental KOA. A repeat x-ray (fig 1) noted the prominent lateral compartment OA.

Prior to cryoneurolysis, physiotherapy records indicated pain in the left knee. They cited ambulation, balance, coordination, and transfer deficits as barriers to discharge from inpatient care. The patient was able to ambulate 40 m with a 2-wheeled-walker, a 1-person contact assist, a left knee cage brace, and an active ankle brace on the right side to complete most tasks.

## Methods

Prior to treatment, baseline assessments specific to the patient's KOA were recorded. These assessments included the FIM, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the 10-meter walk test, and a passive range of motion assessment. All measures were completed by the patient with help from her care team except for the 10 m walk test and the passive range of motion assessment which were obtained by the study team. At baseline, the patient demonstrated reduced independence on the FIM and increased pain and reduced function on her WOMAC scores. Her 10 m walk test time was over 2 minutes and she had the endurance to complete the distance only a single time. Her passive range of motion for knee flexion was limited by pain. Complete assessments are reported in table 1. All outcomes were reassessed 1 week after treatment, and again immediately before discharge.

### Cryoneurolysis

Sensory nerve branches were targeted at 3 locations on the left knee. The infrapatellar (IFN) branches of the saphenous nerve, and the medial and lateral anterior femoral cutaneous branches (AFCN).[5] The iovera handheld system (Pacira, New Jersey, USA) has been used for this procedure with this technique.[6] The iovera is a free-standing unit that uses liquid nitrous oxide cartridges; there is no drug treatment. A single-use 190 Smart Tip was used for the procedure: a 20-gauge, 90 mm probe.[5] The skin was prepared with chlorhexidine swabs. The ultrasound probe was positioned on the

**Fig 1** Patient's knee x-ray. X-rays show prominent lateral compartment knee osteoarthritis.

patient using minimal pressure. The nerves were found in their anatomic layout using known anatomy. The entry point was first anesthetized with a local infiltration of lidocaine 1%. A 16-gauge angiocatheter was inserted to guide the Smart Tip and increase US echogenicity. The AFCN branches were approached from a lateral position approximately 10 cm proximal to the superior patellar pole. The ultrasound transducer was in the transverse plane, parallel to the knee. The rectus femoris was centered in the ultrasound field and the small nerve branches were identified as they moved into the adipose tissues. The IFN branches were found with the ultrasound probe in the longitudinal plane on the medial knee to descend below the medial joint line. Three freezing cycles were delivered to the AFCN branches advancing above rectus femoris, and 2 cycles to the IFN 1 cm apart. Figure 2 demonstrates the target localization and treatment protocol

**Table 1** Baseline and follow-up measures after cryoneurolysis for knee arthritis

| | | Baseline | 7 Day Follow-up | 11 Day Follow-up |
|---|---|---|---|---|
| FIM - Transfer and Mobility Subsection (FIM)* | Transfer from a bed, chair, or wheelchair | 6 | 6 | 7 |
| | Transfer from a toilet | 5 | 5 | 7 |
| | Transfer from a bathtub or shower | 1 | 4 | 4 |
| | Locomotion for walking and wheelchair use | 4 | 6 | 6 |
| | Stairs | 1 | 5 | 1 |
| Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)† (score) | | 80 | 4 | **50-day follow-up:** 55 |
| WOMAC: Pain (points) | | 12 | 0 points | **50-day follow-up:** 13 |
| WOMAC: Stiffness (points) | | 8 | 1 | **50-day follow-up:** 7 |
| WOMAC: Function (points) | | 57 | 3 | **50-day follow-up:** 33 |
| 10-Meter Walk Test (seconds) | Trial 1 | 123.31 | 42.51 | 30.05 |
| | Trial 2 | N/A | 32.89 | 24.50 |
| | Trial 3 | N/A | 31.33 | 22.97 |
| | Trial 4 | N/A | 28.70 | 23.52 |
| | Average | 123.31 | 33.86 | 25.26 |
| Knee flexion passive range of motion (°) | | 105 | 125 | 130 |

* The FIM is a measure of disability. For the purposes of this case study, we were interested in the transfers and locomotion subsections of the FIM. Sections are scored on a 7-point ordinal scale where higher scores indicate increased independence in these specific tasks.

† The WOMAC consists of 3 subscales: pain, stiffness, and physical function. The assessment is designed to quantify the severity of KOA. Higher scores on the WOMAC indicate increased impairment in the 3 subscales.

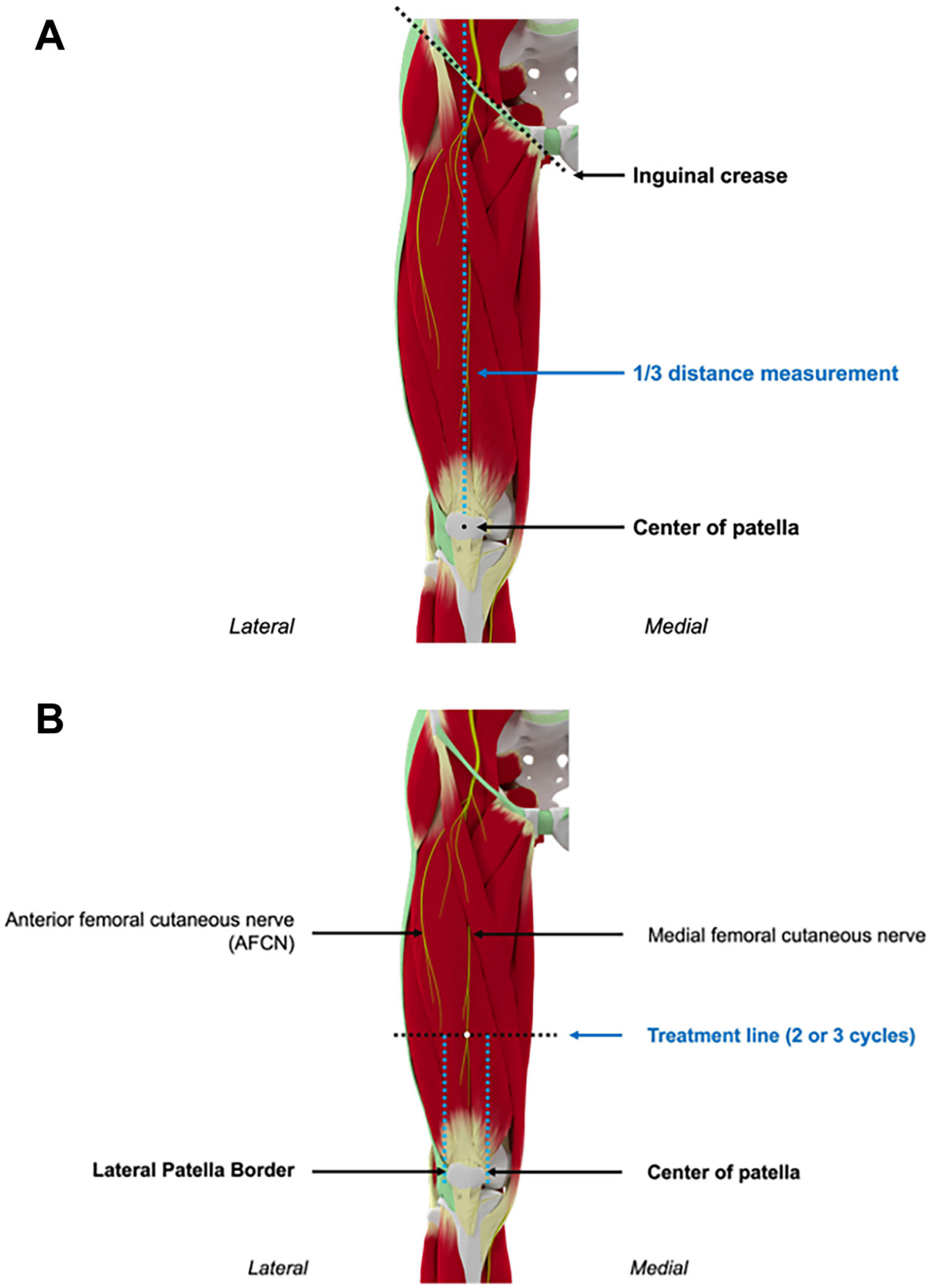


**Fig 2** Anatomical locations and cryoneruolysis procedures for pain from knee arthritis. (A) A third of the distance from the patella to the inguinal ligament is used as a point to begin ultrasound investigation of the target area. (B) The treatment line for the AFCN branches is defined using anatomic landmarks. (C) The treatment line for the IFN branches is defined using anatomic landmarks.

used. The procedure was painful at first, though pain resolved as treatment continued. No adverse events beyond the duration of the treatment were reported.

## Results

Immediately after cryoneurolysis, the patient reported less pain in the treated knee. The following day, she increased her ambulation to 88 m with a 2-wheeled walker and contact assist. The knee cage and contralateral ankle brace were no longer required. One week after treatment, her independence was increased as per the FIM, and the severity of pain from KOA was markedly reduced. Her gait speed had improved considerably, and her confidence had increased. Knee flexion passive range of motion was no longer limited by pain. The patient was discharged from inpatient care to live independently in a remote community 13 days after cryoneurolysis (see table 1 and supplemental video).

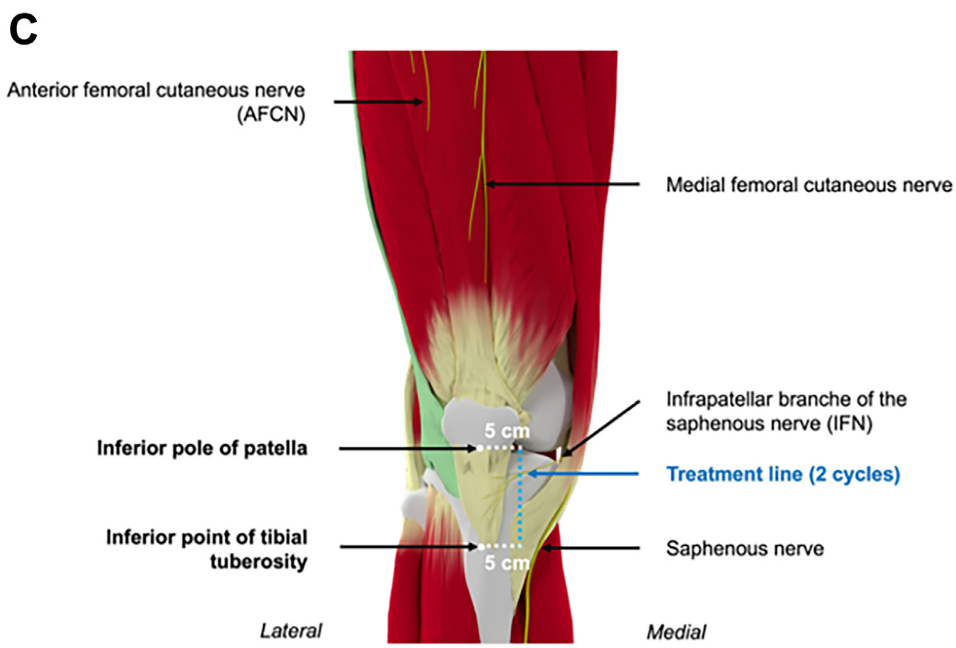


**Fig 2** Continued.

## Discussion

KOA is ubiquitous in the aging population and is among the most prevalent pain conditions globally.[7] However, there are currently no known disease-modifying treatments available for patients. A recent meta-analysis recounted that there is uncertainty around the efficacy of pharmacologic interventions to treat pain from KOA.[8] Further studies revealed that while there are several pharmacologic interventions that could be effective, there is no consensus treatment.[9] As such, severe KOA is often managed with a total knee arthroplasty. A notable percentage of all knee arthroplasties in Canada are performed for pain or osteoarthritis.[10] Yet, surgical candidates likely face a long wait period for elective surgeries. The COVID-19 pandemic led to delays of 9-35 months for elective joint replacements.[11] The wait times have been noted to have a detrimental effect on anxiety, depression, and quality of life.[11] Inpatients who are limited in participating in their rehabilitation may benefit from rapid access to drug-free analgesic interventions while awaiting surgical treatment. Resolving pain from KOA may allow these patients to improve their participation in rehabilitation, improving outcomes, and shortening hospitalization times.

Cryoneurolysis was shown to be an effective strategy for the reduction of pain accompanying KOA for 150 days in a sham-controlled, double-blinded, multi-center study that targeted only the IFN branches, with mild side effects.[12] The authors noted that it could replace surgeries and opioids for analgesic uses. Furthermore, cryoneurolysis can be repeated if reinnervation occurs and pain returns.[13] Notably, cryoneurolysis likely does not slow the rate of progression of KOA, nor does it resolve the mechanism of the pain. Instead, by disrupting afferent nociceptive signal transmission, cryoneurolysis blocks or lessens the perception of pain for weeks or months. Furthermore, cryoneurolysis can be performed in approximately 30 minutes in a hospital ward at the bedside. The treatment is drug free and may provide immediate pain relief with a physical treatment. There is no recovery time from cryoneurolysis aside from allowing the entry point to heal.

Our patient did not want oral analgesics to manage her KOA pain. She used extensive bracing to allow for some participation in physiotherapy and other rehabilitation activities; however, due to pain and poor endurance her participation remained limited. Due in part to her limited participation in rehabilitation, her recovery was slowed significantly. As such, cryoneurolysis was provided to relieve pain from KOA to allow for increased participation in rehabilitation. After treatment, she was able to become a more active participant in her rehabilitation, greatly improving her functional outcome. In 1 week, her endurance had improved to allow her to double her walking distance with assistance, and her gait speed had increased from 0.08 m/s to 0.30 m/s — nearly a 4-fold increase. The severity of her KOA was reduced from a Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score was reduced from 80 to 4. 50 days after cryoneurolysis, this score increased to 55. Both the 7-day follow-up score and 50-day follow-up score surpass the minimal clinically important difference of 10 points from her baseline.[14] Owing to her increased participation in rehabilitation and concurrent lessening of her neurologic symptoms, she was able to be discharged from inpatient care less than 2 weeks after cryoneurolysis. Cryoneurolysis was key in this case to allow for increased participation in her rehabilitation program which allowed her condition to improve to the point where she was able to be discharged. As the patient resided in a remote community, further follow-up was not possible.

## Conclusions

We presented the case of a patient whose rehabilitation from acute neurologic impairment was adversely affected by pain from KOA. Cryoneurolysis resulted in improved pain scores, passive range of motion, and gait speed which allowed the patient to increase her participation in inpatient rehabilitation. Increased participation in rehabilitation led to improved independence and endurance and facilitated patient discharge from the inpatient unit. Cryoneurolysis provides a drug-free analgesic effect which may allow inpatients to participate in rehabilitation more actively, potentially improving functional outcomes and shortening the length of stay for patients with neurologic disorders and concurrent pain from KOA.

## Corresponding author

Paul Winston, Vancouver Island Health Authority, Victoria, BC, Canada. *E-mail address:* pauljwinston@gmail.com.

## References

1. Araujo ILA, Castro MC, Daltro C, Matos MA. Quality of life and functional independence in patients with osteoarthritis of the knee. Knee Surg Relat Res 2016;28:219–24.
2. Wood JP, Connelly DM, Maly MR. “Holding Me Back”: living with arthritis while recovering from stroke. Arch Phys Med Rehabil 2009;90:494–500.
3. Ilfeld BM, Gabriel RA, Trescot AM. Ultrasound-guided percutaneous cryoneurolysis for treatment of acute pain: could cryoanalgesia replace continuous peripheral nerve blocks? Br J Anaesth 2017;119:709–12.
4. Gage AA, Baust JM, Baust JG. Experimental cryosurgery investigations in vivo. Cryobiology 2009;59:229–43.
5. Urban JA, Dolesh K, Martin E. A multimodal pain management protocol including preoperative cryoneurolysis for total knee arthroplasty to reduce pain, opioid consumption, and length of stay. Arthroplast Today 2021;10:87–92.
6. Mihalko WM, Kerkhof AL, Ford MC, Crockarell JR, Harkess JW, Guyton JL. Cryoneurolysis before total knee arthroplasty in patients with severe osteoarthritis for reduction of postoperative pain and opioid use in a single-center randomized controlled trial. J Arthroplasty 2021;36:1590–8.
7. Long H, Liu Q, Yin H, et al. Prevalence trends of site-specific osteoarthritis from 1990 to 2019: findings from the Global Burden of Disease Study 2019. Arthritis Rheumatol 2022;74:1172–83.
8. Gregori D, Giacovelli G, Minto C, et al. Association of pharmacological treatments with long-term pain control in patients with knee osteoarthritis. JAMA 2018;320:2564.
9. Beaudart C, Lengelé L, Leclercq V, et al. Symptomatic efficacy of pharmacological treatments for knee osteoarthritis: a systematic review and a network meta-analysis with a 6-month time horizon. Drugs 2020;80:1947–59.
10. Canadian Institute for Health Information. CJRR annual report: Hip and knee replacements in Canada, 2021—2022. Available at: https://www.cihi.ca/en/cjrr-annual-report-hip-and-knee-replacements-in-canada-2021-2022#:~:text=September%2028%2C%202023%20%E2%80%94%20In%202021,before%20the%20COVID%2D19%20pandemic. Accessed May 2, 2024.
11. Wilson JM, Schwartz AM, Farley KX, Roberson JR, Bradbury TL, Guild GN. Quantifying the backlog of total hip and knee arthroplasty cases: predicting the impact of COVID-19. HSS J 2020;16(S1):85–91.
12. Radnovich R, Scott D, Patel AT, et al. Cryoneurolysis to treat the pain and symptoms of knee osteoarthritis: a multicenter, randomized, double-blind, sham-controlled trial. Osteoarthritis Cartilage 2017;25:1247–56.
13. Hsu M, Stevenson FF. Wallerian degeneration and recovery of motor nerves after multiple focused cold therapies. Muscle Nerve 2015;51:268–75.
14. Clement ND, Bardgett M, Weir D, Holland J, Gerrand C, Deehan DJ. What is the minimum clinically important difference for the WOMAC Index after TKA? Clin Orthop Relat Res 2018;476:2005–14.