A Teaching Module Utilizing Cryoneurolysis for Pain Management in Patients Undergoing Total Knee Arthroplasty

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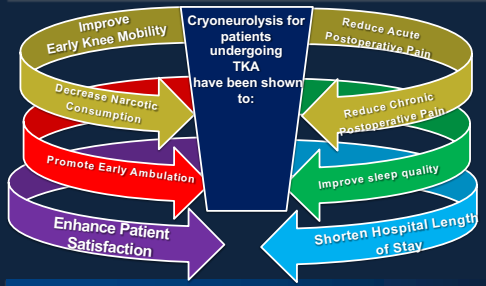
Introduction

Over 600,000 total knee arthroplasty (TKA) procedures are performed in the United States. Recovery and return to daily living activities are highly dependent on pain management. Current approaches, such as peripheral nerve blocks, opioid administration, and non-opioid analgesia, have limitations such as short duration of action and potential opioid-related complications. Despite the implementation of pain management protocols, more than 20% of patients following a TKA report chronic pain 3-24 months after surgery. Cryoneurolysis is a revolutionary technique that can improve and initiate pain management before undergoing this surgical procedure. Cryoneurolysis to the infrapatellar branch of the saphenous nerve (ISN) and the anterior femoral cutaneous nerve (AFCN), has been shown to improve multimodal pain management techniques by reducing opioid consumption, shortening the length of hospital stay, and enhancing knee rehabilitation functionality.

Purpose

Evaluate and review literature highlighting the benefits of utilizing cryoneurolysis for pain management in patients undergoing total knee arthroplasty.



Clinical Significance

Despite advances in pharmacological treatments and multimodal pain guidelines, patients continue to report significant postoperative pain and anxiety. Pain can lead to frustrating and debilitating adverse sequelae such as cardiac and pulmonary complications, immobilization, and fear, reducing patients' engagement in rehabilitation. Inadequate pain control is associated with an increased length of hospital stay, readmission rates, and consumption of opioids. Cryoneurolysisis is the direct application of cold temperatures to peripheral sensory nerves. The administration of cold temperatures ranging from -20 to -100 Celsius leads to reversible nerve axon changes involving distal site nerve injury but allowing for nerve regeneration and remyelination. Cryoneurolysis can reduce the patient's pain perception for up to 90 days. Cryoneurolysis can improve current pain management techniques by providing nonopioid pain relief with a low risk of infection and local anesthetic toxicity compared to peripheral nerve blocks. Recent research studies of patients undergoing TKA have shown that cryoneurolysis has improved functional performance, reduced knee stiffness, and contributed to a better quality of life.

Methodology

An extensive analysis was conducted facilitated by MEDLINE, PubMed, the Cochrane Review, and Embase databases.
Keywords: cryoneurolysis, total knee arthroplasty, opioid consumption, knee, pain management
Inclusion criteria:

- Literature published within the past 8 years
- Full text articles
- Written in English
- Research that focused on the role of cryoneurolysis on the ISN and AFCN for pain management in patients undergoing TKA
- Literature studies featured pain management, cryoneurolysis, opioid reduction, and total knee arthroplasty

Exclusion criteria:

- Research studies published before 2016
- Cryoneurolysis technique used for other surgical procedures.
- Studies incorporating other techniques such as ablation therapy.

N = 10
The Florida International University Institutional Review Board (IRB) has deemed this project Exempt. Documentation available upon request.

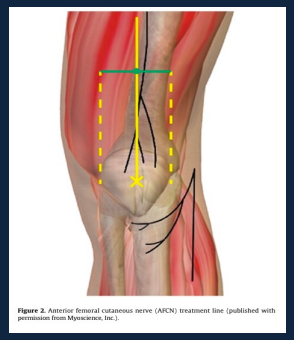
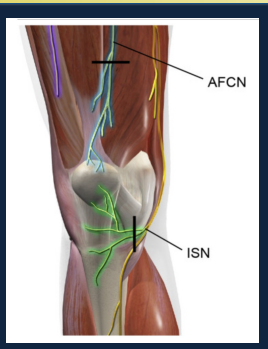


Figure 2. Anterior femoral cutaneous nerve (AFCN) treatment line (published with permission from Myoscience, Inc.).

Figure 3. Infrapatellar branch of saphenous nerve (ISN) treatment line (published with permission from Myoscience, Inc.).



PICO Question

(P) In adult patients undergoing total knee arthroplasty (I) does an educational module on preoperative ultrasound guided cryoneurolysis of the infrapatellar branch of the saphenous nerve and the anterior femoral cutaneous nerve (C) compared to ultrasound guided genicular nerve block (O) improve provider knowledge about cryoneurolysis shortening hospital length of stay, reducing opioid consumption, and improving knee rehabilitation?

Literature Review

Author	Design and Objectives	Conclusion
Radnovich et al. 2017	A randomized controlled trial aimed to assess the efficacy and safety of cryoneurolysis for pain reduction. The study included 180 participants, of which 121 received cryoneurolysis of the ISN treatment while 59 received a sham treatment. Data was collected based on eight follow-up visits (Day 1-, 7-, 30-, 60-, 90-, and 120- after treatment. Participants answered questionnaires based on the Western Ontario and McMaster Osteoarthritis Index (WOMANC) scale that measures pain while walking, sitting, standing, and using the stairs. The Visual Analogue Scale (VAS) measured pain while standing from a seated position or walking up/down the stairs.	Patients who received active cryoneurolysis treatment had a statistically significant change from the baseline pain score based on the WOMAC scale at Day 30, 54% of participants reported improvement in pain compared to the sham group, only 32% reported pain relief. Based on the VAS scale, 61% of participants of the cryoneurolysis group reported pain relief while performing the activities compared to 21% in the sham group. These findings indicated that cryoneurolysis may provide equivalent or superior pain relief with relatively low risks compared to available pharmacological treatments.
Mihalko et al. 2021	A randomized controlled trial to assess the efficacy of preoperative cryoneurolysis to decrease the total daily morphine equivalents (TMEs) required for postoperative pain management in patients undergoing TKA. The study included 124 participants randomly divided into two groups. One group received cryoneurolysis to the ISN and AFCN, 3-7 days before a TKA. The other group received standard of care, which included local anesthetic infiltration in the periarticular and posterior capsule of the knee. The cumulative opioid consumption in TMEs from the time of discharge to the 6-week follow-up assessment was measured. Additionally, the numerical rating scale (NRS) and the Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS JR) were used to evaluate function in daily living, function in sport and recreation, and knee quality of life.	Participants who received cryoneurolysis had improved functional scores and numerical improvements in pain scores across all follow-up assessments, with significant improvements observed in current pain assessment from baseline to the 72-hour and 2-week follow-up. The cryoneurolysis group consumed significantly fewer cumulative opioids in TMEs than the non-cryoneurolysis group. From discharge to the 12-week follow-up assessment, the cryoneurolysis group consumed 29% fewer opioids. From discharge to the 6-week follow-up assessment, a significantly smaller percentage of patients receiving cryoneurolysis continued to consume opioids vs those receiving standard of care treatment (p=0.0059). This study indicates that cryoneurolysis can decrease opioid consumption and improve pain strategies following TKA.
Swisher et al. 2022	A randomized controlled pilot study to assess the use of ultrasound-guided percutaneous cryoneurolysis of the ISN for analgesia following a TKA. The sample size included 16 participants randomly divided into two groups. One group received the cryoneurolysis treatment, while the other group received a sham treatment. Each participant was contacted on postoperative days, 1,2,3,4,7,14, and 21. The NRS scale was used to collect pain management data. Additionally, patients were asked to report opioid consumption and difficulty sleeping due to pain.	When comparing both groups, the active cryoneurolysis group reported lower average pain scores and opioid consumption from postoperative days 4 to 21. Based on the numerical rating scale, 63% of cryoneurolysis patients reported pain relief compared to the 38% of participants in the sham group on postoperative day 1. In the cryoneurolysis group, only 13% of participants reported difficulty sleeping due to pain by postoperative day 21 compared to 50% in the sham group. Preoperative ultrasound-guided cryoneurolysis of the ISN may provide analgesic benefits for multiple weeks after TKA.
Dasa et al. 2016	A retrospective cohort study was conducted, reviewing 100 patients who underwent TKA. This study aimed to determine if percutaneous cryoneurolysis of the ISN and AFCN can relieve postoperative knee pain. Outcomes measured hospital length of stay, postoperative opioid requirements, and patient-reported pain scores and knee function. The treatment group included 50 participants who received cryoneurolysis five days before a TKA. The control group included 50 participants who had not received cryoneurolysis. The WOMANC and the KOOS JR scale measured pain while walking 50 ft with a walker or crutches, getting in and out of bed, and using the toilet safely. Narcotics were administered in a dosing regimen, and all patients were seen at postoperative visits 2-, 6-, and 12- weeks following the TKA.	The cryoneurolysis group demonstrated that 6% (p<0.0001) of the patients had a hospital length of stay greater than two days compared to 67% of patients in the control group. Almost half of patients treated with cryoneurolysis were discharged on the same day of surgery compared with 14% in the control group. The treatment group also required 45% less morphine-equivalent narcotics during the first 12 weeks compared to the control group. The treatment group achieved statistically significantly more significant reductions in the KOOS JR symptoms subscale score from baseline to the 6- and 12-week post-operative visits than the control group (p = 0.0037 at six weeks and 0.0011 at 12 weeks). Perioperative treatment with cryoneurolysis can significantly improve functional activity and pain management of patients undergoing TKA.
Urban et al. 2021	A retrospective cohort analysis was conducted to determine if cryoneurolysis to the ISN and AFCN decreased postoperative opioids and pain after TKA. The analysis included a total of 267 patients. The cryoneurolysis group (n=169) and control group (n =98). Outcomes measured included opioid intake demonstrated by total morphine milligram equivalents (MMEs) at various points from a hospital stay, prescribed at discharge, 2-week and 6-week follow-up visits. Additional measurements included pain, length of stay, and range of motion. Flexion and extension degrees were compared between the two groups.	During the hospital stay, the cryoneurolysis group had 51% lower daily (MMEs) (47 vs 97 MMEs, p<0.0001). The cryoneurolysis group received significantly fewer cumulative MMEs, including discharge prescriptions, than the control group at week 2 (855 vs. 1312 MMEs; P < .0001) and week 6 (894 vs 1406 MMEs; P < .0001). The cryoneurolysis group had a significant reduction of 44% in the overall hospital length of stay (P < .0001) and greater flexion degree at discharge (P < .0001). Preoperative cryoneurolysis provides superior pain control and allows patients to take fewer opioids during hospitalization and the 6-week recovery period than a multimodal TKA pain protocol alone.

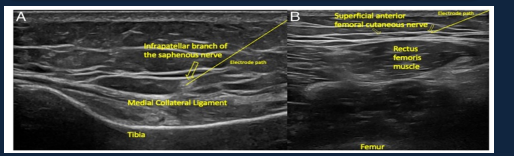
Results

- The incorporation of cryoneurolysis into multimodal pain management protocols allows for superior pain control, avoiding the risk of chronic pain development and long-term use of opioids.
- Decreased reduction in opioid consumption based on total daily morphine equivalents.
- Significant improvement in knee flexion and extension range of motion allowing for faster recovery time.
- Lower pain scores from baseline reported based on the Numeric Rating Scale.
- Decreased hospital length of stay and readmission rates based on pain.
- Faster knee rehabilitation and performance of daily living activities.

Clinical Recommendations

- Influence anesthesia providers to improve the inclination to utilize cryoneurolysis into multimodal pain management protocols.
- Influence knowledge and attitude of anesthesia providers, which can increase provider pain management techniques ultimately affecting patient outcomes.
- Trigger further research on the use of cryoneurolysis for pain management.
- The addition of preoperative cryoneurolysis of the infrapatellar branch of the saphenous nerve and the anterior femoral cutaneous nerve one or two weeks prior to the TKA procedure can:
  - Reduce opioid consumption
  - Improve knee functionality
  - Decrease hospital length of stay
  - Enhance patient satisfaction

Preoperative ultrasound-guided cryoneurolysis of the infrapatellar branch of the saphenous nerve and the anterior femoral cutaneous nerve may contribute to improvement in pain management protocols by expanding providers' techniques that can potentially decrease the development of chronic pain and long-term use of opioids.



Conclusion

- Literature shows that the use of cryoneurolysis to the infrapatellar branch of the saphenous nerve and the anterior femoral cutaneous nerve one to two weeks prior to a total knee arthroplasty can significantly reduce opioid consumption, improve knee functionality, decrease hospital length of stay, and overall enhance patient satisfaction.
- Limitations exist regarding equipment accessibility, provider behaviors, and practices to established protocols.
- There is a learning curve in which providers may have difficulty managing equipment and performing cryoneurolysis.
- This QI project highlights the promising potential benefits of incorporating cryoneurolysis into pain management protocols for patients undergoing total knee arthroplasty.
- Future research should aim to study the efficacy of cryoneurolysis for incorporation into pain management protocols.

References

References available upon request

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