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Case Reports

Spinal Cord Stimulation for Post Total Knee Replacement Pain: A Case Series

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It is not uncommon for orthopedic patients to experience pain following a total knee replacement (TKR). Use of oral pain medications, nerve blocks, and periarticular injections are implemented to provide multimodal analgesia and to reduce postoperative chronic pain. Spinal cord stimulation (SCS) can also be used to control pain in patients who are refractory to conservative measures. Few studies have explored this possibility for patients with chronic pain status post TKR. We present three cases that demonstrate the effectiveness of SCS in this challenging patient population.

INTRODUCTION

Total knee replacement (TKR) is a common operation in the united states with more than 790,000 knee replacements performed each year, with an estimate of 3.5 million TKRs expected to be performed by 2030.[1] The indications for a TKR include limitations in function, radiographic evidence of joint degeneration, lack of joint improvement with non-surgical therapies, and persistent knee pain.[2] The procedure is able to provide pain relief, restore physical functioning, and improve the quality of life in many patients.[3] However, despite the procedure's success in many patients, chronic knee pain can be found in up to 20% of this orthopedic patient population after a TKR.[4] This chronic post-surgical pain is generally defined as pain that lasts for at least 2 months post-procedure, and in the case of TKR the severity tends to plateau at 3 months.[5]

A number of patients with knee osteoarthritis (OA) who undergo TKR have been reported to have neuropathic pain-like symptoms, including burning, shooting, electric shock-like pain, which is a potential avenue for treatment of chronic post-operative knee pain.[1] Many patients with chronic knee pain after TKR undergo rehabilitative, medical, and interventional modalities, however, there still remain limited options for this group.

It should be noted that despite the importance of effective pain management, there is a lack of evidence-based recommendations to guide clinical decisions around the optimal management of chronic pain after TKA.[6] Pain management interventions for patients undergoing TKA have largely focused on perioperative pain control, rather than management of chronic pain.[7]

Although a multimodal approach to pain control has been suggested, this, combined with rehabilitative therapies, has not been an effective solution for the chronic pain this selection of patients experiences after their TKR. One modality for pain control for this patient population that is currently being investigated is the use of spinal cord stimulation (SCS). The expectation of pain relief is a primary reason for many patients to undergo a TKR, and those that find themselves with chronic pain issues afterward show that there is a clear need to identify and consider further interventions and measures for this issue. In this case series, therefore, we present three patients who experienced chronic knee pain after TKR and had improved pain control after implantation of a SCS.

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CASE 1

A 54-year-old female with a past medical history of asthma, HTN, and right knee osteoarthritis presented with a three-year history of right knee pain after a traumatic same-level fall. The patient was seen by an orthopedist and underwent physical therapy and multiple intra-articular cortisone injections with little pain relief. She had two right knee arthroscopies without improvement in pain control. The Patient was found to have arthritis in her right knee during this workup. Subsequently, she had a right total knee arthroplasty but continued to have pain postoperatively. Later that year, she underwent a closed manipulation of her right knee without improvement of her pain. She was diagnosed with a postoperative neuroma at the time and tried multiple oral analgesics including Gabapentin, Oxycodone, Dilaudid, and Ibuprofen for pain control. Lidocaine patches were also included in her pain regimen. Her pain symptoms did not improve with the medications, and she was then referred to the pain center for evaluation. She reported burning pain in her right knee down her right lower extremity along with new-onset left knee pain. Pain intensity was 8/10, and limited extension of her right knee was noted. She reported poor sleep, paresthesias, and allodynia. She was diagnosed with complex regional pain syndrome II of the right lower extremity. Radiofrequency ablation or genicular nerve blocks were deferred due to her level of pain, and spinal cord stimulation was offered as a treatment option. The patient agreed to the treatment and underwent an SCS trial. She reported 60% pain relief in her right knee, improvement in sleep, and increased mobility. The patient could also fully extend her right knee. In addition, she experienced a 70% reduction in pain in her left lower extremity and reports a 4-5/10 in pain intensity overall. The patient underwent uneventful implantation of the SCS shortly after the trial and had no complications following the procedure. At her post-implantation follow-up appointment, she continued to experience improved pain control as seen during the SCS trial, denied using any oral medications, and reported high satisfaction with the SCS.

CASE 2

A 48-year-old female with a complex surgical history after being struck by a vehicle while riding her bicycle in August 2004 presented with continued left lower extremity pain. She had a complex surgical history after this trauma, including an open reduction and internal fixation of a tibial plateau fracture in August 2004, both MCL and PCL reconstruction and removal of hardware in February 2005, a left knee arthroscopy to break up her scar tissue in March of 2005, and an additional arthroscopy in November 2005. In addition to the surgeries described above, the patient had undergone multiple injections to relieve her pain. These included injection of the left saphenous nerve and lumbar sympathetic blocks. The patient had received no long-term relief from these injections, though she did receive significant relief from the saphenous nerve injection for 3 days.

The patient described her pain as burning and stabbing in quality and averaging a 7-10/10 on the numeric pain scale. It was located primarily over the medial aspect of her left knee and leg. She noted that her pain increased with ambulation or any activity that involved flexion of her knee. Prior to this injury, the patient walked approximately 4 miles a day and biked approximately 15 miles per day. She was employed as a dental assistant but was dismissed earlier this year related to absenteeism secondary to her intense pain.

In terms of medical and rehabilitative management, the patient had undergone trials of Neurontin and Lyrica but was unable to continue either one related to intolerable side effects. She then switched to a regimen of Topamax 75 mg three times a day and Cymbalta 65 mg a day, as well as four to six tablets of Percocet per day, with no decrease in her pain. She had also undergone extensive physical therapy with no significant improvement. A spinal cord stimulator trial was then proposed to the patient as a possible treatment option. The patient had a spinal cord stimulator implantation on 4/27/2007 for her left-sided neuralgia. One week after the implant she stated she had little to no pain and had decreased her Percocet use substantially, down to one tablet every other day.

She was seen multiple times for follow-up with overall continued good coverage of her pain with the SCS. However, she did start to notice a sharp persistent pain along the medial aspect of her left infrapatellar region. This pain was covered by spinal cord stimulation when she turned her spinal cord stimulator up very high, but otherwise, this pain was not covered. The patient then underwent an infrapatellar nerve block in June of 2007 to help with the point tenderness in the medial aspect of her left knee. This did provide good relief and there was a discussion regarding cryoablation of the left infrapatellar nerve for more long-term relief.

The patient continued with her SCS but this was eventually explanted on 11/19/2008 as her knee pain started to fail to respond to stimulation. The patient also disliked the feeling of paresthesia that is produced and found it more irritating than beneficial. She was seen on 11/25/2009 for radiofrequency treatment of her left knee pain, which was now described as 6/10, sharp/burning in quality, with radiation into the medial portion of her thigh.

The patient was continued with her conservative management until 12/6/2018, at which point she again had a SCS trial for 2 weeks. She felt it was a successful trial and her pain score was 1-2/10 from 6-7/10. The walking distance was improved from 1/4 to 1 mile. Sitting was prolonged from 30 to 60 mins. She felt that her sleep was also better, able to go 6 hours without interruption in sleep, from 4 hours previously. She had her SCS implanted on 1/24/2018. The patient has since continued with her SCS therapy for her pain control with continued weaning of her opioid medications.

CASE 3

A 75-year-old male with a past medical history notable for Child A cirrhosis, hepatitis B, renal dysfunction, and left TKR in 2010 c/b a revision in 2011 with worsening pain following a skin flap surgery in 2013 to the same knee now presented to the pain clinic with continued left chronic knee pain and evaluation for possible SCS. The patient described the pain as a band surrounding the knee, which also radiated up to his upper left thigh when extremely severe. He also complained of significant numbness of his medial left lower leg. The pain was aching and dull in quality, and significantly limited his activities, such as walking and bending. He had tried physical therapy in the past but was unable to participate secondary to extreme pain. Additionally, he was not eligible for steroid injections secondary to impaired healing and concern for infection of the graft. In terms of medications, the patient had been taking oxycodone 10mg 3 to 4 times per day without much improvement in his pain control. The patient went through the appropriate preoptimization for SCS trial and had his procedure done on 9/6/2017. He had good results with the SCS trial and was referred to a neurosurgeon for permanent SCS placement given his liver disease.

The patient did well with his device until January of 2018, at which point for unclear reasons he had an adjustment on the device where the energy was increased. He lost all relief after that adjustment. He then was seen by the device representative on 4/23/18 for further evaluation, and it was found that his adjustments were made too quickly for the style of the electrode in his device. The device was reset with the plan to make slower adjustments. He continues to take gabapentin 600mg three times per day and oxycodone 10mg four times per day. On further follow-up, the patient continued to fine-tune his SCS settings to provide the best relief for his pain. He stated he was getting >50% relief from his pain with his SCS, though he was still requiring adjunct medications. He is hopeful to minimize his opioid use in the future given his improvement with SCS.

CONCLUSION

Chronic pain development after TKR continues to be a significant complication for patients that is challenging to treat. In a systematic review of prospective studies of patients undergoing TKA in BMJ by Beswick et al., they found that 10% to 34% of patients reported unfavorable pain outcomes anywhere from 3 months to up to 5 years after the initial surgery.[4] There have been trials investigating various therapies, such as surgical revision for true mechanical pathology, multimodal analgesia, and conservative approaches. Surgical revision as a treatment for chronic pain has not been shown to provide improved outcomes and should be only considered in those patients who have a mechanical pathology.[6]

A conservative approach has also been shown to be effective in a portion of this chronic pain population. A long-term study of 18 patients who had chronic unexplained pain following surgery, 55% reported improvement with reassurance and watchful waiting at 5-year follow-up.[8] Multimodal analgesia continues to play a major role in the treatment of chronic pain patients as well. However, this modality tends to be best for peri-operative pain control and not effective for persistent pain. In a systematic review and meta-analyses by Marques et al, they evaluated the short- and long-term effects of local anesthetic infiltration on pain control. In 13 studies including 909 patients undergoing THR, patients receiving local anesthetic infiltration experienced a greater reduction in pain at 24 hours at rest and at 48 hours during activity.[7] However, few studies in patients with THR or TKR reported long-term follow up of patients and results were equivocal, with Parvataneni and colleagues reported comparable pain scores between groups at 3 months.[7]

A systematic review from BMJ identified only one published randomized controlled trial evaluating a pharmacological intervention for the management of chronic pain after TKA, a single injection with antinociceptive and anticholinergic activity. This further highlights a lack of evidence about the effectiveness of prediction and management strategies for chronic postsurgical pain after TKR.[6] With the continued research and data collection regarding SCS, this modality offers another potential solution for these patients suffering from chronic pain after TKR. However, more research and cases are needed to evaluate the benefit of SCS for post TKR. Previous case reviews have shown patients can have complete relief from their persistent knee pain. A case review by Urits et al has described a patient who underwent successful SCS implantation receiving combination therapy through the SCS. This modality incorporated both traditional paresthesia-based therapy, as well as burst therapy at a frequency of 450 Hz, with six pulses per burst, as well as sub perception stimulation therapy at a frequency of 1.2 kHz.[9] The patient in this case study experienced complete resolution of his symptoms and at 6 months post-SCS implantation he continued to have complete resolution of his pain and had entirely weaned off of his opioid medications. A further case report by Simopoulos et al describes a patient who had persistent knee pain following revision TKR who was not responding to conservative therapies. An SCS trial was offered and the patient experienced greater than 50% relief in her knee pain during this trial. After permanent implantation, the patient continued to report significant improvement in her left knee pain, and she continued to express satisfaction with her level of functioning and pain control one year after spinal cord stimulator implantation.[2]

In the three cases presented in this manuscript, the outcomes demonstrate that there is a wide variety of outcomes after SCS for TKR related pain. Our first case showed that some patients do seem to have improved pain relief and decreased oral medication use after SCS implantation for this type of pain. However, as seen with the other two cases presented, some patients either fail to get relief after SCS implantation requiring an explanation of the device or require continued medication use to keep their pain under control despite improvement with SCS. Interestingly, our patient in the second case did appear to receive improved pain control

after SCS reimplantation years later. There is also further research to be done regarding combination therapy through the SCS, as it may offer further options for patients not receiving satisfactory relief from SCS with a single waveform alone. The evidence for sub-perception-based therapies was explored by North et al. in the WHISPER study, which demonstrated supporting evidence for sub-perception therapies in combination with supra-perception therapies through spinal cord stimulation.[10] Their study found that if given the choice, 62% of subjects preferred to keep both options (e.g., sub perception and sub perception SCS) for the management of their chronic pain, and they found patients with chronic pain had significant improvement in pain relief sustained out to 12 months when using sub perception SCS.[10] Further data in these subsets of patients will be beneficial in providing evidence for the safety and efficacy of the SCS in the treatment of persistent pain following TKR.

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REFERENCES

1. Kurien T, Arendt-Nielsen L, Petersen KK, Graven-Nielsen T, Scammell BE. Preoperative Neuropathic Pain-like Symptoms and Central Pain Mechanisms in Knee Osteoarthritis Predicts Poor Outcome 6 Months After Total Knee Replacement Surgery. *The Journal of Pain*. 2018;19(11):1329-1341. doi:10.1016/j.jpain.2018.05.011

2. Lowry AM, Simopoulos TT. Spinal Cord Stimulation for the Treatment of Chronic Knee Pain Following Total Knee Replacement. *Pain Phys*. 2010;3;13(3;5):251-256. doi:10.36076/ppj.2010/13/251

3. Ethgen O, Bruyère O, Richy F, Dardennes C, Reginster JY. Health-Related Quality of Life in Total Hip and Total Knee Arthroplasty. *The Journal of Bone & Joint Surgery*. 2004;86(5):963-974. doi:10.2106/00004623-200405000-00012

4. Beswick AD, Wylde V, Gooberman-Hill R, Blom A, Dieppe P. What Proportion of Patients Report Long-Term Pain after Total Hip or Knee Replacement for Osteoarthritis? A Systematic Review of Prospective Studies in Unselected Patients. *BMJ Open*. 2012;2(1):2011-20000435. doi:10.1136/bmjopen-2011-000435

5. Bachmeier CJM, March LM, Cross MJ, et al. A Comparison of Outcomes in Osteoarthritis Patients Undergoing Total Hip and Knee Replacement Surgery. *Osteoarthritis and Cartilage*. 2001;9(2):137-146. doi:10.1053/joca.2000.0369

6. Wylde V, Beswick A, Bruce J, Blom A, Howells N, Gooberman-Hill R. Chronic Pain after Total Knee Arthroplasty. *EFORT Open Reviews*. 2018;3(8):461-470. doi:10.1302/2058-5241.3.180004

7. Marques EM, Jones HE, Elvers KT, Pyke M, Blom AW, Beswick AD. Local Anaesthetic Infiltration for Peri-Operative Pain Control in Total Hip and Knee Replacement: Systematic Review and Meta-Analyses of Short- and Long-Term Effectiveness. *BMC Musculoskelet Disord*. 2014;15(1):220,. doi:10.1186/1471-2474-15-220

8. Elson DW, Brenkel IJ. A Conservative Approach Is Feasible in Unexplained Pain after Knee Replacement: A Selected Cohort Study. *The Journal of Bone and Joint Surgery British Volume*. 2007;89-B(8):1042-1045. doi:10.1302/0301-620x.89b8.19389

9. Urits I, Osman M, Orhurhu V, et al. A Case Study of Combined Perception-Based and Perception-Free Spinal Cord Stimulator Therapy for the Management of Persistent Pain after a Total Knee Arthroplasty. *Pain Ther*. 2019;8(2):281-284. doi:10.1007/s40122-019-00136-5

10. North J, Loudermilk E, Lee A, et al. Outcomes of a Multicenter, Prospective, Crossover, Randomized Controlled Trial Evaluating Subperception Spinal Cord Stimulation at ⩽1.2 KHz in Previously Implanted Subjects. *Neuromodulation: Journal of the International Neuromodulation Society*. 2020;23(1):102-108. doi:10.1111/ner.13015