

# Selective peripheral nerve resection for treatment of persistent pain around the knee joint after total knee arthroplasty

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## Abstract

**Objective:** This study was performed to determine the efficacy of selective peripheral nerve resection for treatment of persistent neuropathic pain after total knee arthroplasty (TKA).

**Methods:** Patients who underwent TKA in our department from January 2013 to July 2016 and experienced persistent pain around the knee joint after TKA were retrospectively included in the current study. Sixty patients were divided into experimental and control groups according to the treatment they received. The treatment effect was evaluated by the Hospital for Special Surgery (HSS) knee score and visual analog scale (VAS) pain score preoperatively and at 1, 2, 3, 6, and 12 months postoperatively.

**Results:** The HSS knee scores were higher in both groups after than before the treatment, and HSS knee scores were significantly higher in the experimental group than in the control group. The VAS pain scores were lower in both groups after than before the treatment, and VAS pain scores were significantly lower in the experimental group than in the control group.

**Conclusions:** Selective peripheral nerve resection is an effective treatment method for persistent neuropathic pain after TKA.

## Keywords

Total knee arthroplasty, persistent neuropathic pain, denervation, Hospital for Special Surgery knee score, visual analog scale, retrospective study

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## Introduction

Total knee arthroplasty (TKA) is a common surgical approach for the treatment of severe osteoarthritis. The primary goals of this surgery are to reduce pain, improve mobility, and correct angular knee deformity.<sup>1,2</sup> With the development of operative techniques and improvements in the materials and design of prosthetics, the clinical efficacy of TKA has become increasingly more satisfactory.<sup>3</sup> However, many patients still have persistent neuropathic pain after TKA, and because the innate mechanism of this pain remains unclear, its treatment is challenging for surgeons.<sup>4</sup> Although some of these patients can be cured by medical, physical, and psychological interventions, most others continue to experience this pain for a long period of time after TKA. Some require a second surgery to alleviate the pain. The current study was performed to identify a viable method to treat patients with severe and persistent neuropathic pain after TKA.

## Methods

Patients who underwent TKA in our department from January 2013 to July 2016 and experienced persistent pain around the knee joint after TKA were

retrospectively included in the current study. Among these patients, those who agreed to receive surgical treatment were included in the experimental group; all others were included in the control group. The inclusion and exclusion criteria are shown in Table 1. All procedures were approved by the ethics committee of the Sixth Affiliated Hospital of Xinjiang Medical University and performed in accordance with the guidelines of the Helsinki declaration. All patients provided written agreement to participate in the research before the treatment.

### Patient preparation and treatment

Preoperative preparation in the experimental group included defining the pain region and confirming the course of the cutaneous nerve branch in this region. After ruling out the presence of infection, prosthesis loosening or misalignment, osteolysis, wearing of the prosthesis, and psychological problems, the pain region was identified by the patient's description of the pain. Regional anesthesia was carried out to identify the operative region by isolating the course of the nerve presumed to be responsible for neuropathic pain. A 5-mL bolus of 1% lidocaine was injected under the superficial fascia, and when the patient's pain as

**Table 1.** Inclusion and exclusion criteria for patients in the current study.

Inclusion criteria	Exclusion criteria
Have undergone their first TKA	History of a second TKA at the same site
Six-month history of unexplainable pain around knee after TKA	Pain around the knee caused by infection, prosthesis loosening or misalignment, osteolysis, or wearing of the prosthesis
No systemic diseases that prevent surgical treatment	Severe heart, lung, liver, or kidney abnormalities associated with a risk of surgery-related complications
Willing and able to follow doctor's instructions regarding the surgery and postoperative recovery	Physiological abnormalities or unwilling or unable to follow doctor's instructions regarding the surgery and postoperative recovery

TKA, total knee arthroplasty

**Table 2.** Preoperative and postoperative VAS pain scores.

		Experimental	Control	P
VAS pain score	Before surgery	6.7 ± 1.4	6.4 ± 2.0	0.26
	1 month postoperatively	3.4 ± 1.3	5.8 ± 2.0	<0.01
	2 months postoperatively	2.5 ± 0.7	5.0 ± 1.8	<0.01
	3 months postoperatively	2.0 ± 0.6	4.7 ± 1.5	<0.01
	6 months postoperatively	1.6 ± 0.5	4.5 ± 1.3	<0.01
	12 months postoperatively	1.2 ± 0.3	4.1 ± 1.4	<0.01

Scores are presented as mean ± standard deviation. The VAS pain scores were significantly lower in the experimental than control group at all postoperative time points (independent-sample t-test). VAS, visual analog scale.

**Table 3.** Preoperative and postoperative HSS knee scores.

		Experimental	Control	P
HSS knee score	Before surgery	62.5 ± 17.3	63.1 ± 16.0	0.52
	1 month postoperatively	85.6 ± 13.8	68.3 ± 16.3	<0.01
	2 months postoperatively	90.6 ± 20.1	71.9 ± 16.3	<0.01
	3 months postoperatively	92.0 ± 23.6	74.8 ± 18.3	<0.01
	6 months postoperatively	93.1 ± 23.5	75.6 ± 18.6	<0.01
	12 months postoperatively	93.0 ± 18.9	77.0 ± 20.3	<0.01

Scores are presented as mean ± standard deviation. The HSS knee scores were significantly higher in the experimental than control group at all postoperative time points (independent-sample t-test). HSS, Hospital for Special Surgery.

measured by a visual analog scale (VAS) was reduced by >5 points after the injection, the patient was considered ready for surgical intervention.<sup>5</sup> The patient was considered eligible to undergo surgery under general anesthesia if the heart, lung, and overall health condition was considered adequate by a senior anesthesiologist.

All surgeries were carried out under general anesthesia with the patient in the supine position. A tourniquet with a pressure of 45 to 50 mmHg was applied to the upper thigh to avoid excessive hemorrhage during surgery. All surgeries were carried out by the same surgeon (G.Z.). An incision was made over the region in which the cutaneous nerves responsible for the pain were located. The responsible nerves were isolated and ligated from both ends and embedded in the neighboring fat tissues.

The operative field was washed with sterile saline solution, and the incision was sutured in layers over a drainage tube.

To avoid pain and delayed healing of the incision postoperatively, the patients were completely immobilized on the first postoperative day. The drainage tube was removed 24 hours postoperatively.

Patients in the control group were prescribed oral celecoxib at 100 mg twice daily. Regional anesthesia, heat therapy, acupuncture, and external application of Chinese herbal medicine were used as conservative treatment measures.

### Postsurgical evaluations

Considering that denervation could cause delayed healing of the surgical incision, the surgical incision was checked once a

day for wound healing and inflammation. Pain and functional evaluations were carried out using a VAS pain scale (0–10) and Hospital for Special Surgery (HSS) knee evaluation scale (0–100) preoperatively and at 1, 2, 3, 6, and 12 months postoperatively.

### **Statistical analysis**

All data were analyzed using SPSS 22.0 statistical software (IBM Corp., Armonk, NY, USA) and are presented as mean  $\pm$  standard deviation. The VAS pain scores and HSS knee scores were compared between the groups using independent-sample t-tests. Differences were considered statistically significant at  $P < 0.05$ .

## **Results**

### ***Patients' demographic characteristics***

In total, 22 patients (9 female, 13 male; mean age,  $63.7 \pm 10.8$  years) in the experimental group were treated with surgical resection of peripheral nerves in the pain region, and 38 patients (17 female, 21 male; mean age,  $65.2 \pm 12.1$  years) in the control group were treated conservatively. All patients were of Han Chinese ethnicity. The mean duration of pain around the knee was  $13.6 \pm 5.8$  months in the experimental group and  $11.5 \pm 6.2$  months in the control group. There were no significant differences in the sex ratio, age, or duration of unexplainable pain around the knee after TKA between the two groups. The surgical incisions in all patients in the experimental group healed with no complications. Most patients reported numbness in the region of surgery that typically disappeared within 3 months postoperatively. All patients in the control group were treated with oral celecoxib for 2 weeks. Three patients developed allergic reactions to the external application of herbal medicine and only received acupuncture and heat therapy. Thirteen

patients refused acupuncture and received the other conservative measures.

### ***Alleviation of pain***

The VAS pain scores before treatment and at 1, 2, 3, 6, and 12 months after treatment were compared between the two groups using independent-sample t-tests. The results revealed that the VAS pain scores were not significantly different between the two groups before the surgery but that they were significantly lower in the experimental than control group at 1, 2, 3, 6, and 12 months after treatment ( $P < 0.01$  at all time points, Table 2). These findings indicate that selective peripheral nerve resection is significantly more effective than physical and pharmaceutical treatment with respect to alleviation of pain in patients with persistent pain around the knee joint after TKA.

### ***Recovery of knee function***

The HSS knee scores before treatment and at 1, 2, 3, 6, and 12 months after treatment were compared between the two groups using independent-sample t-tests. The results revealed that the HSS knee scores were not significantly different between the two groups before the surgery but that they were significantly higher in the experimental than control group at 1, 2, 3, 6, and 12 months after treatment ( $P < 0.01$  at all time points, Table 3). These findings indicate that selective peripheral nerve resection is significantly more effective than physical and pharmaceutical treatment with respect to overall functional recovery in patients with persistent pain around the knee joint after TKA.

### ***Preoperative versus postoperative VAS and HSS scores***

The 1-month postoperative VAS pain score in the experimental group was significantly

lower than the preoperative scores in both the experimental group ( $P < 0.01$ ) and control group ( $P = 0.03$ ). The 1-month postoperative HSS knee score in the experimental group was significantly higher than the preoperative score in this group ( $P < 0.01$ ). Although the 2-month postoperative HSS knee score in the control group was significantly higher than the preoperative score ( $P = 0.02$ ), it was not significantly different 1 month postoperatively.

## Discussion

As the general population ages, increasing numbers of patients with severe osteoarthritis require TKA, resulting in increasing numbers of reports of persistent neuropathic pain after surgery. The incidence of postoperative persistent pain ranges from 6% to 30% in the published literature.<sup>6,7</sup> The origin of pain after TKA can be both intrinsic and extrinsic. Extrinsic factors include the formation of a neuroma in the region of surgery or nerve root compression due to herniation of a lumbar disk. Innate factors include infection, knee joint instability, application of an inappropriately sized prosthesis, loosening of the prosthesis, an abnormal lower limb stress line, stimulation by residual bone cement, and bone fracture or osteolysis around the prosthesis.<sup>8-10</sup>

After Gardner<sup>11</sup> reported the distribution and termination of nerves in the knee joint of the cat, several authors performed a series of studies to reveal the neural distribution pattern in and around the knee joint. Horner and Dellon<sup>12</sup> described the innervation patterns of the human knee joint and described the relationships of nerves with bone and soft tissue landmarks. According to their anatomic findings, they carried out denervation treatments for 70 patients with persistent knee pain after TKA, trauma, or osteotomy. Most patients reported significantly reduced VAS pain scores and

significantly increased Knee Society Scores. The satisfaction rate was as high as 86%.<sup>5,12</sup>

Our clinical experience has shown that regional anesthesia is of tremendous value for preoperative planning. Patients with neuromas and neural injury can benefit from both regional anesthesia and nerve resection. One study showed that if the VAS pain score decreases by 5 points with regional anesthesia, surgical resection of the peripheral nerve can achieve satisfactory results.<sup>5</sup> The results of the current study are in accordance with this conclusion. Regional anesthesia can also be used as a treatment measure for such patients. Some of our patients who did not undergo surgery accepted this treatment, and they reported a significant decrease in their VAS pain score. When the pain originates from factors such as infection, knee instability, application of an inappropriately sized prosthesis, or loosening of the prosthesis, regional anesthesia cannot significantly alleviate the pain, and resection of the peripheral nerves should be avoided.

The current study proves that selective nerve resection can be an effective treatment method for persistent neuropathic pain around the knee after TKA. For ethical reasons, however, the patient selection for the two different treatment methods was not randomized. Randomized controlled trials should be carried out to further validate the results of the current study.

## Conclusion

Selective nerve resection can be an effective method for treating persistent pain around the knee after TKA.

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### Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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