

Original Article

Influences of continuous femoral nerve block on knee function and quality of life in patients following total knee arthroplasty

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Abstract: Objective: Continuous femoral nerve block (CFNB), guided by ultrasound combined nerve stimulations, offers advantages for both sides and provides effective postoperative analgesia after total knee arthroplasty (TKA). The objective of this study was to evaluate the medium-term impact of continuous femoral nerve block on knee function and quality of life in patients following TKA. Methods: This was a follow-up study. Total 168 adult patients scheduled for elective TKA were randomly allocated to receive postoperative continuous femoral nerve block guided by ultrasound combined nerve stimulator (group CFNB, n = 82) or patient-controlled epidural analgesia (group PCEA, n = 86). Quality of life, knee function, patient satisfaction, pain medication and associated adverse effects were compared at 1, 3, 6, and 12 months postoperatively. Quality of life was assessed using the Medical Outcomes Study Short Form-36 Health Survey (MOS SF-36), and clinical results were assessed using the Hospital for Special Surgery (HSS) Knee Scoring System. Patient satisfaction scores were divided into four categories. Results: A total of 162 patients completed the 12-month follow-up. The CFNB group patients had significantly improved SF-36 scores and physical function at 1 month postoperatively ($P < 0.05$); the remaining seven dimensions were similar between the two groups. No differences were observed at 3, 6 or 12 months. HSS scores for the four observational time points were comparable. The CFNB group patients reported less pain; improved knee function, maximum flexion and strength; less celecoxib consumption and fewer side effects at 1 month than the PCEA group patients. The satisfaction score at 12 months decreased significantly, compared with that at 1 month in both groups (3.6 to 2.95 and 3.4 to 2.45, respectively). No difference in satisfaction score was observed between the two groups. Conclusions: Continuous femoral nerve block not only could provide effective postoperative analgesia but also could improve joint function and quality of life in patients at one month postoperatively. Continuous femoral nerve block is a good choice for postoperative analgesia after TKA.

Keywords: Total knee arthroplasty, continuous femoral nerve block analgesia, patient-controlled epidural analgesia, quality of life, knee function

Introduction

Early ambulation and the initiation of physiotherapy hasten recovery following total knee arthroplasty (TKA) and improve patient outcomes. Effective postoperative analgesia is essential for recovery. Commonly used analgesic options for TKA include local infiltration analgesia [1], intravenous patient-controlled analgesia, patient-controlled epidural analgesia (PCEA), single injection or continuous femoral nerve block (CFNB) [2, 3] and multimodal analgesia [4]. With the merits of definite effects and continuous catheterization, CFNB has been successfully used for postoperative anal-

gesia after TKA. Continuous femoral nerve block guided by ultrasound combined nerve stimulation offers improved analgesia, a reduced local anesthetic dosage and a decreased risk of damage to nerves and vessels [5, 6]. Effective analgesia can increase patient satisfaction and influence knee outcomes. Research regarding analgesia and knee function recovery has been limited to the perioperative or early postoperative period (two weeks postoperatively) [7], while the medium-term effects remain to be elucidated. In our earlier study [8], patients were enrolled between January and November 2013. We recruited 168 patients, ASA-I-III, who were scheduled for elective TKA. Eligible pa-

Table 1. SF-36 scores in the CFNB and PCEA groups

	1 month (SD)	3 months (SD)	6 months (SD)	12 months (SD)
CFNB (n = 80)	117.2 (12.5)*	118.0 (12.3)	118.7 (11.0)	119.5 (10.2)
PCEA (n = 82)	109.1 (10.6)	113.1 (11.5)	117.5 (13.4)	117.7 (12.7)

SF-36 scores were higher in the CFNB group than in the PCEA group at 1 month postoperatively, * $P = 0.035$.

tients were randomly assigned to the CFNB group (n = 82, guided by ultrasound and a nerve stimulator) or the PCEA group based on a different postoperative analgesia method. Our results suggested that CFNB allowed earlier initiation of active function training at 6 h, 12 h, and 24 h postoperatively, reduced the visual analog scale (VAS) score consistently during passive function training, reduced the requirement for celecoxib, increased motive strength and the first bed activity time, and reduced postoperative nausea and vomiting, compared to PCEA. This study is a subsequent study of the previous study. Controlling for a number of other determinants, our study aimed to evaluate the medium-term impact of CFNB on knee function and quality of life in patients receiving total knee arthroplasty (TKA).

Methods

This study was a subsequent research of our previous study. It was a prospective, double-blind, controlled trial. All the patients received general anesthesia using the laryngeal mask airway and identical protocols, except for analgesia. The preoperative consultation, surgical team and technology, type of prosthesis and postoperative rehabilitation were identical between the two study groups.

Follow-up visits were conducted at 1, 3, 6 and 12 months after discharge from the hospital. Quality of life, knee function, patient satisfaction, pain medication usage and associated adverse effects were assessed. Quality of life was assessed by a psychologist. Knee function and medication were assessed by an orthopedic surgeon. All the participating physicians were blinded to the treatment group. Quality of life was assessed using the Medical Outcomes Study Short Form-36 Health Survey (MOS SF-36), which comprehensively evaluates physical and mental health. A SF-36 survey score of 117 represents the optimal cut-off, dividing good and moderate outcomes [9]. Knee outcome was assessed by the Hospital for Special Surgery (HSS) score [10], with a maximum of

100 points. The various domains assessed include pain (30 points), function (22 points), range of motion (18 points), muscular strength (10 points), flexion deformity (10 points) and instability (10

points). Deductions were made for the use of external supporting devices, various deformity and incomplete extension. Knee function was evaluated by a questionnaire and physical examination. Excellent knee function was defined as a score greater than 85, good was between 70 and 84, moderate was between 60 and 69, and poor was less than 59. Patient satisfaction was classified into four categories: Class 1: poor; Class 2: general; Class 3: good; and Class 4: excellent [11, 12].

Statistical analyses were performed using SPSS software, version 20 (SPSS, Inc., Chicago, IL, USA) for Windows. Student's *t* test was used to determine the statistical significance of the differences between the experimental groups. Data was expressed as \bar{x} (SD). Statistical significance was set at $P < 0.05$.

Results

A total of 168 patients were enrolled in this study. Six patients were excluded from both groups for various reasons: in the CFNB group, one patient failed to attend follow-up after hospital discharge, and one patient underwent a secondary operation due to infection. In the PCEA group, one patient had a delayed discharge from the hospital due to heart failure, one patient was not contactable, and two refused further participation. A total of 162 patients completed the 12-month follow-up analysis (CFNB: n = 80, PCEA: n = 82). None of the eligible patients had experienced a major family or health incident. All the patients completed the outpatient visits and questionnaires. There were no significant differences between the two study groups with regard to age, sex, BMI, or duration of surgery.

The SF-36 score at four time points is shown in **Table 1**. A significant difference in SF-36 score was found between the CFNB and PCEA groups at one month ($P = 0.035$). No differences were found from 3 months through 12 months postoperatively. Physical function was significantly different at 1 month, while no differences were

Table 2. The eight dimensions of the SF-36 in the two study groups

	Physical function	Role physical	Role emotion	Social function	Bodily pain	Mental health	Vitality	General health
CFNB (n = 80)	76.8 (7.8)*	77.0 (13.6)	74.4 (16.1)	79.8 (15.3)	74.4 (11.0)	67.2 (10.7)	74.6 (13.3)	71.8 (14.2)
PCEA (n = 82)	63.7 (5.6)	75.2 (15.1)	76.2 (12.5)	81.2 (14.4)	73.7 (14.9)	65.3 (13.7)	73.7 (10.8)	72.5 (11.7)

The scores were transformed from the original data. A significant difference was observed between the two study groups for physical function, * $P = 0.029$, no significant differences were observed in the other seven dimensions.

Table 3. HSS scores at 1 month in the two study groups

Outcomes	CFNB (n = 80)	PCEA (n = 82)	P
Pain (SD)	21 (7.19)	17.5 (6.1)	0.041*
Function (SD)	12.25 (4.0)	9.4 (3.7)	0.036*
Degree of ROM (SD)	12.66 (2.3)	9.4 (2.6)	0.037*
Muscle strength (SD)	9.3 (1.0)	8.0 (1.1)	0.049*
Flexion deformation (SD)	9.9 (1.1)	9.9 (1.1)	1.86
Instability (SD)	9.8 (1.3)	9.8 (1.1)	1.91
Orthosis (SD)	-1.35 (0.99)	-1.3 (0.98)	0.83

ROM: Range of motion. Knee function, ROM and muscle strength were better in the CFNB group than in the PCEA group at 1 month postoperatively, all * $P < 0.05$.

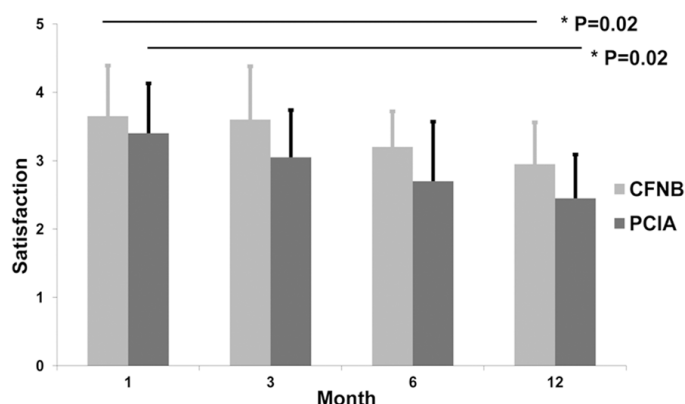


Figure 1. Patient satisfaction was highest at 1 month postoperatively and lowest at 12 months postoperatively in the two inter-groups ($P = 0.02$, respectively), with no differences between intra-groups.

found in the remaining seven dimensions (role physical, bodily pain, general health, vitality, social function, role emotional, mental health) (Table 2).

HSS scores significantly increased as time progressed. The scores were significantly higher at 3, 6 and 12 months than at 1 month (all $P < 0.05$). The HSS scores at the four time points were as follows: 70.7 (6.7), 81.8 (8.5), 86.5 (8.8), 88.7 (9.1) for the CFNB group and 65.2 (7.2), 78.4 (7.7), 81.8 (8.4), 82.4 (8.7) for the PCEA group. No significant differences were observed between the two groups at any time point.

The HSS score for knee outcome was classified into six categories, and comparisons between the two study groups were performed for each category. Pain, knee function, maximum bending degree and muscle strength were improved in the CFNB group compared to the PCEA group at 1 month. No differences were observed between the two groups at the subsequent time points (Table 3).

The number of patients receiving celecoxib and those who developed gastrointestinal side effects were 28 and 1, respectively, in the CFNB group at 1 month and 42 and 7, respectively, in the PCEA group. Therefore, the number of cases was significantly increased in the PCEA group, compared to the CFNB group ($P = 0.037$ and 0.032 , respectively).

Patient satisfaction in the CFNB and PCEA groups at 1, 3, 6 and 12 months were as follows: 3.65, 3.6, 3.2 and 2.95, respectively, and 3.4, 3.05, 2.7 and 2.45, respectively (Figure 1). No mid-term complications of nerve injury were observed in either of the two study groups.

Discussion

Several perioperative variables have been associated with postoperative knee function recovery, including preoperative knee mobility [13], HSS score, postoperative pain, early ambulation, and persistent passive movement [14]. The most important of these variables is perioperative analgesia. Investigations have focused on alleviating postoperative pain. Early pain treatment lowers the risk of postoperative complications, such as deep venous thromboembolic disease, nosocomial lung infections and pulmonary embolisms, and it hastens knee recovery. An experimental investigation in rabbits suggested that early ambulation acceler-

ated the healing of full-thickness defects in the articular cartilage [15]. Effective pain control allows for the earlier initiation of rehabilitation, which improves joint function and provides for a better prognosis, compared to that achieved in patients who are unable to initiate physical therapy due to severe pain.

Anesthesia and postoperative analgesia are used for relatively short periods of time. It is not known whether anesthesia administration and pain management have medium-term impacts on knee outcomes following TKA. Aveline et al suggested that postoperative pain following TKA was a risk factor for chronic exercise pain and that ketamine administration 48 h postoperatively could hasten joint recovery [16]. Bergeron et al suggested that pain management be restricted to the perioperative period, and few studies have been conducted to evaluate medium-term efficacy [17].

In the present study, we compared the impact of CFNB with that of PCEA on medium-term quality of life and knee function. Our results suggested that the SF-36 score was good in the CFNB group, while it was average in the PCEA group at 1 month. The higher SF-36 scores were primarily observed for physical function, including activity, stair climbing, joint bending and walking distance. The higher SF-36 scores were consistent with higher HSS scores, indicating that CFNB was superior to PCEA regarding walking distance and time, joint bending and muscle strength. These results suggested that CFNB could provide more efficient perioperative pain control and could provide for knee function recovery for walking distance and time, joint bending and muscle strength more rapidly than PCEA. Postoperative analgesia for 48 h not only has a positive impact during the perioperative period, but it also significantly influences early knee recovery. Active functional rehabilitation facilitates muscle isometric contraction and relaxation, increases blood circulation and muscle strength, reduces the risk of deep venous thrombosis and facilitates flexion exercise [18]. Passive rehabilitation helps the knee to regain mobility. Earlier exercise initiation lowers the risk of scar formation, which enables a greater range of motion [19], decreases joint stiffness and increases joint function [20].

HSS scores at 3, 6 and 12 months were significantly higher than those at 1 month in both the

CFNB and PCEA groups. No differences were found in the SF-36 scores, HSS total scores or HSS scores for each domain at 3, 6 and 12 months between the two study groups. The results suggested that the influence of anesthesia and surgery declined 1 month following TKA. Additionally, overall body function and knee function gradually recovered, indicating that the first month following TKA was the ideal period for early rehabilitation, which is crucial for a positive knee outcome. Postoperative analgesia is highly recommended to provide a good opportunity for patients to start early physical therapy and to hasten positive knee outcomes. The quality of life measurements were good or excellent for patients who underwent TKA, and no differences were observed in SF-36 scores between the two study groups at 3, 6 and 12 months postoperatively, consistent with the findings of Harrington [21].

Pain has an enormous impact on the emotions and on the enthusiasm for active exercise of patients undergoing TKA. Severe pain is an obstacle to exercise and even to walking. Patients experiencing pain might consult physicians for help, and orthopedists can provide some interventions, such as increasing analgesics or optimizing rehabilitation protocols. However, increasing analgesics can increase the associated side effects. CFNB was a superior treatment to PCEA at 1 month when assessing quality of life, knee function and pain management. Additionally, CFNB led to a reduced requirement for celecoxib and subsequently reduced the associated side effects. As quality of life and knee function gradually recovered, pain was efficiently under control, and there were no difference in analgesic consumption between the two study groups at 3, 6 and 12 months.

HSS scores increased as time progressed, from 69.66 (CFNB) and 65.18 (PCEA) at 1 month to 88.65 (CFNB) and 82.44 (PCEA) at 12 months. However, patient satisfaction decreased from excellent at 1 month to moderate at 12 months (for both the CFNB and PCEA groups), which might have been due to high expectations for the surgery. Knee function recovery can be prolonged, with no substantial improvement during the first postoperative year. A patient might develop a negative attitude regarding the surgery and might retrospectively question his or her initial decision, which could explain the observed increase in HSS scores, accompa-

nied by decreased patient satisfaction. Many factors contribute to patient satisfaction regarding surgery, including postoperative pain and knee function [22]. Knee recovery is associated with pain, as well as diminished function. Additionally, continued development regarding knee prosthesis design and surgical techniques is required. If one aspect of the recovery does not meet the patient's expectations, this shortcoming could lead to reduced satisfaction. Recognizing and actively modifying the factors associated with patient expectations could provide for better preoperative preparation and greater overall satisfaction.

Continuous femoral nerve block analgesia improved patient quality of life and knee function, and it reduced the dosages of analgesic medications and associated adverse effects in patients undergoing TKA, compared to PCEA. The observed differences in knee function and quality of life gradually disappeared as time progressed. CFNB not only could provide effective postoperative analgesia but also could improve joint function and life quality in patients one month postoperatively. CFNB is therefore a good choice for postoperative analgesia after TKA.

The local condition of the knee following TKA has been associated with overall body function. Patient age and comorbidities could also influence joint recovery [23]. Although no major life or health events occurred for the patients who participated in this study during the first postoperative year, the impact of age and overall body condition on knee recovery must be considered. In addition, psychology and mental health also had effects on the knee function and quality of life of patients after TKA [24]. Surgery can improve patients' health to a great extent, which can obviously increase the HSS score and the SF-36 score. However, long disease durations, neurosis, anxiety, depression and other negative emotions can affect the surgical results. In our study, we did not record the influence of psychiatric factors on HSS and SF-36, thus constituting a limitation of this paper.

The long-term impact of the two analgesic methods on local and overall function remains to be elucidated. Studies of the effects of systemic and psychological factors on joint function and life quality are being planned.

Disclosure of conflict of interest

None.

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