ORIGINAL RESEARCH

Clinical Effect of Ultrasound-Guided Adductor Block on Postoperative Analgesia After Total Knee Replacement

Tao Wang, MD; Qibin Chen, MD; Bin Wu, MD; Xiaonan Liu, MD; Wei Ran, MD; Lei Zou, MD

ABSTRACT

Objective • To explore the clinical effects of ultrasound-guided adductor block (UGAB) on postoperative analgesia after total knee replacement.

Methods • From March 2022 to June 2022, 60 patients in the First Affiliated Hospital of Chongqing Medical University were included. They were divided into control (n = 30) and ultrasonic groups (n = 30). They all received total knee arthroplasty. Before total knee arthroplasty, patients in the control and ultrasonic groups underwent general anesthesia and UGAB, respectively. Visual Analogue Scale (VAS) was used to assess the pain. The time of the first straight leg elevation and the first landing time were recorded. Knee joint function was evaluated. Information about the dosage of tramadol intramuscular injection and the number of times patient-controlled analgesia pump pressing was collected. The serum levels of interleukin-6 (IL-6) and high-sensitivity C-reactive protein (hs-CRP) were detected.

Results • Compared with the control group, UGAB increased the rate of muscle contraction and relaxation and total and relaxation after total knee replacement in the ultrasonic group ($P < .05$). UGAB reduced VAS scores of pain during passive activity after operation ($P < .05$). UGAB also facilitated the first straight leg lifting time after the operation and the time of the first landing after the operation ($P < .05$). Meanwhile, UGAB reduced the dose of tramadol and press times of the self-control analgesia pump after operation ($P < 0.05$). UGAB also suppressed postoperative IL-6 and hs-CRP levels and increased postoperative joint range of motion ($P < .05$).

Conclusion • UGAB promotes early recovery of knee function with high safety in patients undergoing total knee replacement, with reduced postoperative pain and inflammatory reaction. (*Altern Ther Health Med.* 2024;30(1):391-395).

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INTRODUCTION

Osteoarthritis of the knee is a common disease of middle-aged and elderly patients.[1] This disease is mainly manifested by pain, stiffness, and dysfunction of the knee joint.[2] With increasing age, it seriously affects the health and quality of life of middle-aged and elderly people.[3] According to modern concepts, knee osteoarthritis is induced by factors such as strain, trauma, or degeneration.[4] In clinical practice, except for symptomatic treatment with steroid drugs, conventional rehabilitation treatment combining physical factors and exercise therapy is mainly adopted.[5]

Ultrashort waves can enhance the local blood lymph circulation, promote the reduction of potassium ions and increase of calcium ions within inflammatory tissues, and are associated with certain anti-inflammatory and analgesic effects.[6] Wax therapy can promote the absorption of knee joint inflammation and exudation by expanding the capillaries, improving their permeability, and reducing the muscle spasm and stiffness around the knee joint.[7] Exercise therapy and functional exercise can stimulate the joint synovium to secrete hyaluronic acid, increase the lubrication of the joint cavity, release joint adhesion, delay joint degeneration, improve the range of motion of the knee joint and cartilage nutrition, reduce joint-induced muscle inhibition, and improve the effect of administered therapies.[8]

Knee osteoarthritis is a chronic bone and joint disease with pathological manifestations of synovial inflammation, articular cartilage degeneration, subchondral osteosclerosis, and osteophyte formation.[9] The development process of

senile knee osteoarthritis is characterized by abnormal bone remodeling, joint cartilage degradation, and inflammatory reaction.[10] Middle-aged and elderly patients also often suffer from osteoporosis due to the obvious decrease of hormone levels in their bodies.[11] In addition. local microfractures stimulate vascular infiltration at the osteochondral junction as a part of the healing process, which in turn will trigger the release of destructive enzymes from cartilage cells, leading to cartilage discoloration and softening. This ultimately causes the cartilage to fall off, thereby exposing and hardening the bone surface.[12]

The ultrasound-guided adductor block (UGAB) is widely used in shoulder arthroscopy, lower extremity surgery, abdominal surgery, and cancer surgical resection. In recent years, with the continuous development of ultrasound technology, UGAB is gradually replacing femoral nerve block for postoperative analgesia of knee arthroscopy.[4] The horizontal femoral midpoint approach and the distal adductor tube approach are the two most commonly used approaches for UGAB.[13] The femoral midpoint horizontal approach involves blocking the adductor at the midpoint of the thigh, that is, the midpoint of the line between the anterior superior iliac spine and the upper edge of the patella.[14] The distal approach of the adductor tube is to block the adductor tube at the proximal 2-3 cm of the level of the adductor tendon hiatus, realizing the block at the distal end of the adductor tube.[14]

There is no uniform standard for the local anesthetic volume of UGAB, and the local anesthetic volume used in different studies is different.[15] Anatomical studies showed that a large dose of local anesthetics could diffuse to the proximal femoral triangle after being injected into the adductor tube. The same phenomenon was also proved by magnetic resonance imaging (MRI).[16] It has been reported that the muscle strength of quadriceps femoris may decrease after the adductor block, which is considered to be caused by the proximal diffusion of local anesthetics.[17] Therefore, we need to find the minimum effective local anesthetic volume for the adductor block. In this study, we aimed to investigate the clinical effect of UGAB for postoperative analgesia after total knee replacement.

SUBJECTS AND METHODS

Subjects

From March 2022 to June 2022, 60 patients selected for total knee arthroplasty in the First Affiliated Hospital of Chongqing Medical University were selected as the study subjects. This study was approved by the hospital ethics committee. Inclusion criteria: (1) Those with preoperative American Society of Anesthesiologists (ASA) grade I-II; (2) aged 60-80 years; (3) unilateral knee replacement; and, (4) voluntarily participated in the study and signed the informed consent form. Exclusion criteria: (1) Patients with severe cardiovascular and cerebrovascular diseases; (2) liver and kidney insufficiency; (3) blood coagulation disorder; (4) respiratory and circulatory failure and other diseases; (5) long-term smokers, alcoholics, drug abusers and drug addicts; (6) mental disorder; (7) unable to communicate normally and cooperate with treatment; (8) allergic reaction to the study drug; and, (9) severe deformity of knee joint.

Therapeutic methods

All patients were operated on by the same orthopedic operation team, and they were given Losofenate sodium (Disha Pharmaceutical Group Co., Ltd., Weihai, China) for preventive analgesia 1 day before operation. Fasting for 8 h and no drinking for 4 h for patients before operation. After entering the operating room, establish peripheral venous channels, and drip compound sodium chloride injection (Shijiazhuang Siyao Co., Ltd., Shiajiazhuang, China) intravenously. Monitor blood pressure, heart rate, pulse, peripheral oxygen saturation, end respiratory carbon dioxide partial pressure, electrocardiogram (EEG) dual frequency index, etc. All patients underwent knee replacement under tracheal intubation combined with general anesthesia.

All patients in the two groups received total knee replacement under tracheal intubation or laryngeal mask airway intubation under general anesthesia, and the anesthesiologists in the same group were responsible for postoperative analgesia management. Control group: Basic anesthesia. Ultrasonic group: The muscle adductor block was used for analgesia. After the induction of anesthesia, locate it at the middle and lower 1/3 of the line between the anterior superior iliac spine and the patella on the inside of the thigh. Use a high-frequency ultrasound probe (6-13 MHz) to find the femoral artery and saphenous nerve below the sartorius muscle, between the medial femoral muscle and the adductor longus muscle. Use the in-plane technique to inject 0.5% ropivacaine (AstraZeneca Sweden, batch number: 20161203) 20 mL into the side of the femoral artery and saphenous nerve in the adductor tube. Use the "water separation" technique to expand the perineural space. The catheter of the self-control analgesia pump was connected to the space between the adductor tubes, and 0.2% ropivacaine was continuously pumped after the operation (background dose 5 mL/h, additional dose 5 mL/time, locking time 20 min). When the patient feels that the pain is too severe to bear, the patient can press the self-control analgesia pump to relieve the pain. If the pain is severe, 100 mg of tramadol injection (Mengdi (China) Pharmaceutical Co., Ltd., Beijing, China) can be given intramuscularly (Figure 1).

Evaluating indicators

(1) Visual Analogue Scale (VAS) score: The VAS scores of patients in both groups at rest and passive activities were recorded at 4 h, 8 h, 12 h, 24 h, 36 h, and 48 h after surgery. 0 means no pain at all, and 10 means unbearable pain. The higher the score, the more severe the pain. (2) The time of the first straight leg elevation and the first landing time of the two groups of patients after surgery was recorded. (3) Knee joint function: the quadriceps femoris muscle strength and the maximum range of motion of the knee joint was

compared between the two groups at 24 h, 48 h, and 72 h after operation. The muscle strength of quadriceps femoris was measured by manual manipulation. No muscle contraction of quadriceps femoris was level 0, muscle contraction without obvious movement was level 1, movement that could be completed on a horizontal plane but could not resist gravity was level 2, movement that could resist gravity but could not resist resistance was level 3, the moderate resistance that could be overcome was level 4, and the resistance that could be overcome was the same as that of the healthy side was level 5; The maximum range of motion of the knee joint was measured with a joint angle ruler. (4) The dosage of tramadol intramuscular injection and the number of times patient-controlled analgesia pump pressing when the patients were under analgesia were recorded and compared between the two groups. (5) The serum levels of interleukin-6 (IL-6) and high-sensitivity C-reactive protein (hs-CRP) were measured using ELISA kits.

Statistical analysis

Data were presented as mean ± standard deviation (SD) and were evaluated with SPSS version 26.0 software. Comparisons between the two groups were performed with Student's *t* test. Counting data are expressed by the number of cases or percentage, and compared by χ^2 inspection. The difference was considered significant at values of $P < .05$.

RESULTS

General information

There were no significant differences in gender, age, height, BMI, weight, ASA classification, and operation time between the two groups ($P > .05$, Table 1).

Comparison of muscle contraction and relaxation rate and total and relaxation rate of nerve stimulator

UGAB increased the rate of muscle contraction and relaxation and total and relaxation in patients with postoperative analgesia after total knee replacement ($P < .05$), as shown in Table 2.

Comparison of VAS scores of pain at rest

UGAB reduced VAS scores of pain after operation in patients with postoperative analgesia after total knee replacement ($P < .05$), as shown in Table 3.

Comparison of VAS scores of pains during passive activity

UGAB also reduced VAS scores of pain during passive activity after operation in patients with postoperative analgesia after total knee replacement ($P < .05$, Table 4).

Comparison of Clinical Indicators

Compared to the control group, UGAB also facilitated the first straight leg lifting time after the operation and the time of first landing after the operation in patients with postoperative analgesia after total knee replacement ($P < .05$, Table 5). Meanwhile, UGAB reduced the dose of tramadol and press times of the self-control analgesia pump in patients with postoperative analgesia after total knee replacement ($P < .05$, Table 5). UGAB suppressed IL-6 and hs-CRP levels in patients with postoperative analgesia after total knee replacement ($P < .05$, Table 5).

Figure 1. Ultrasound-Guided Adductor Block. Operator's Body Surface Positioning (A), Before Puncture (B), During Puncture (C), and After Drug Injection (D).

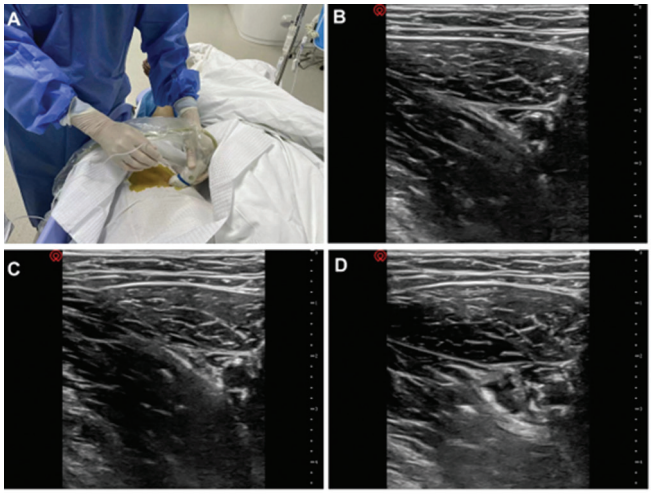

Table 1. General Information

Groups	Control (n = 30)	Ultrasonic (n = 30)	t/χ^2	*P* value
Gender (male/Female)	22/8	21/9	0.08	.77
Age (years)	46.97 ± 10.12	47.58 ± 10.96	0.22	.82
Height (cm)	168.14 ± 6.78	170.23 ± 5.97	1.27	.21
Weight (kg)	71.56 ± 7.53	72.63 ± 6.85	0.58	.57
BMI (kg/m^2)	25.11 ± 2.41	24.91 ± 3.32	0.27	.79
ASA classification (I/II)	25/5	26/4	0.13	.72
Operation time (min)	46.23 ± 2.63	45.98 ± 3.06	0.34	.74

Table 2. Comparison of Muscle Contraction And relaxation Rate and Total And relaxation Rate of Nerve Stimulator

Groups	Control (n = 30)	Ultrasonic (n = 30)	t/χ^2	*P* value
Muscle contraction and relaxation rate	9	25	17.38	.00
Total and relaxation rate	20	27	4.81	.03

Table 3. Comparison of VAS Scores of Pain at Rest at Various Time Points

Group	Control (n = 30)	Ultrasonic (n = 30)	t/χ^2	*P* value
4 h after operation	1.55 ± 0.21	1.43 ± 0.19	2.32	.02
8 h after operation	2.67 ± 0.33	2.02 ± 0.24	8.73	.00
12 h after operation	4.52 ± 0.45	3.33 ± 0.39	10.95	.00
24 h after operation	3.38 ± 0.51	2.51 ± 0.25	8.39	.00
36 h after operation	2.81 ± 0.49	2.09 ± 0.37	6.42	.00
48 h after operation	1.89 ± 0.31	1.23 ± 0.11	10.99	.00

Table 4. Comparison of VAS Scores of Pain During Passive Activity at Different Time Points

Groups	Control (n = 30)	Ultrasonic (n = 30)	t/χ^2	*P* value
4 h after operation	1.96 ± 0.37	1.82 ± 0.33	1.5470	.13
8 h after operation	3.02 ± 0.27	3.25 ± 0.41	2.5660	.01
12 h after operation	4.79 ± 0.32	3.81 ± 0.44	9.8660	.00
24 h after operation	3.91 ± 0.28	2.89 ± 0.36	12.2500	.00
36 h after operation	3.12 ± 0.42	2.33 ± 0.25	8.8530	.00
48 h after operation	2.32 ± 0.36	1.52 ± 0.15	11.2400	.00

Table 5. Comparison of Clinical Indicators

Groups	Control (n = 30)	Ultrasonic (n = 30)	t/χ^2	*P* value
First straight leg lifting time after operation (h)	2.91 ± 0.62	2.42 ± 0.27	3.97	.00
Time of first landing after operation (h)	26.63 ± 2.98	24.08 ± 3.13	3.23	.00
Dose of tramadol (mg)	112.32 ± 27.41	43.12 ± 6.52	13.45	.00
Press times of self-control analgesia pump (times)	2.11 ± 0.23	0.73 ± 0.11	29.65	.00
IL-6 (pg/mL)	47.82 ± 8.01	27.01 ± 5.53	11.71	.00
hs-CRP (mg/L)	18.01 ± 3.25	8.63 ± 2.34	12.83	.00

Table 6. Comparison of quadriceps femoris muscle strength and joint range of motion

Groups	Control (n = 30)	Ultrasonic (n = 30)	t/χ^2	*P* value
Muscle strength of quadriceps femoris (grade)				
24 h after operation	3.51 ± 0.65	3.41 ± 0.45	0.69	.49
48 h after operation	4.47 ± 0.52	4.62 ± 0.57	1.07	.29
72 after operation	4.78 ± 0.68	4.91 ± 0.53	0.14	.89
Joint range of motion (°)				
24 h after operation	65.37 ± 9.67	73.38 ± 8.77	3.36	.00
48 h after operation	72.05 ± 9.01	79.63 ± 10.63	2.98	.00
72 after operation	80.12 ± 7.68	87.74 ± 9.68	3.38	.00

Table 7. Comparison of Adverse Reaction Tate

Group	Control (n = 30)	Ultrasonic (n = 30)
Nausea and vomiting	2	2
Lethargy	1	1
Dizzy	1	0
Uroschesis	0	0
Pruritus	0	1

Comparison of quadriceps femoris muscle strength and joint range of motion

UGAB did not affect the muscle strength of the quadriceps femoris after operation in patients with postoperative analgesia after total knee replacement ($P > .05$, Table 6). However, UGAB increased the joint range of motion after operation in patients with postoperative analgesia after total knee replacement ($P < .05$, Table 6).

Comparison of adverse reaction rate

UGAB had adverse reactions, such as nausea and vomiting, lethargy, and pruritus after operation in patients with postoperative analgesia after total knee replacement (Table 7).

DISCUSSION

Knee osteoarthritis (KOA) is a common and frequently occurring chronic disease in the middle-aged and elderly.[18] It can cause pain, stiffness, swelling, deformity, joint movement disorder of the knee joint, as well as articular cartilage degeneration, bone hyperplasia, ligament degeneration, and aseptic synovitis.[19] With the increasing of the aging population in China, the incidence of knee osteoarthritis is increasing every year.[20]

Knee arthroscopic surgery has the advantages of less trauma, rapid recovery, and short hospital stay, and has been widely used in clinical practice.[21] Although knee arthroscopic surgery reduces the pain caused by the surgical incision, patients will still feel intense pain after surgery because the structures related to the operation, such as synovial tissue and joint capsule, have rich nerve endings.[22] According to the research results, 60% of patients after knee arthroscopy have moderate or more pain, which seriously affects the quality of life of patients.[23] The pain after knee arthroscopy will not only cause common pain-related adverse reactions such as cardiovascular reactions but also limit knee joint activities, which will affect the early postoperative knee joint functional exercise.[19]

Postoperative analgesia of knee arthroscopic surgery includes administration of oral analgesic drugs, intra-articular injection of analgesic drugs, nerve block, etc.[24] Oral opioids often cause nausea, vomiting, skin itching, urinary retention, respiratory depression, and other side effects.[25] Oral non-steroidal drugs also increase the risk of perioperative stress ulcers and gastric bleeding.[26] Intra-articular injection of drugs has a good analgesic effect but it can increase the chance of intra-articular infection, thus limiting its application to some extent.[25] Femoral nerve block for postoperative analgesia of knee arthroscopy has the advantages of stable circulation and little physiological interference, which can significantly reduce the analgesic score and the amount of postoperative analgesic drugs.[26] However, the muscle strength of the quadriceps femoris is greatly weakened after femoral nerve block, which is not conducive to early postoperative knee joint functional exercise, and may even cause postoperative falls.[24]

Total knee arthroplasty is the most effective treatment for end-stage knee osteoarthritis.[27] It can significantly relieve pain, restore knee function, and improve the quality of life of patients. However, total knee replacement surgery is very traumatic, with severe postoperative pain, quadriceps pain spasms, and other complications, which seriously affect the rehabilitation exercise of patients and prolong the hospital stay.[28-30] It not only prolongs the hospital stay for patients but also increases their medical costs and the risk of deep vein embolism and pulmonary embolism, and also easily leads to anxiety, tension, and other psychological disorders among patients.[31]

Research shows that multimodal analgesia has a good effect and has become a hot topic in the study of postoperative analgesia after total knee replacement.[32] Multimodal analgesia is mainly dominated by nerve block. Although the analgesic effect of femoral nerve block is obvious during and after total knee arthroplasty, it may cause nerve and blood vessel damage, thereby weakening the quadriceps femoris muscle strength, thus affecting the postoperative rehabilitation of patients.[7,33,34]

The effect of adductor block is similar to that of femoral nerve block, however, it has little influence on muscle strength and is associated with only a few side effects. Anesthesiologists have started paying increasingly more attention to it.[33] However, adductor block still has some limitations for patients with severe pain after total knee arthroplasty and auxiliary analgesia might be needed.[35]

In this study, we found that UGAB reduced VAS scores of pain after operation, and lowered VAS scores of pain during passive activity after operation in patients with postoperative analgesia after total knee replacement. This was evident from the fact that UGAB reduced the dose of tramadol and press times of the self-control analgesia pump in patients with postoperative analgesia after total knee replacement. UGAB was also found to suppress IL-6 and

hs-CRP levels in patients with postoperative analgesia after total knee replacement. However, UGAB was found to facilitate the first straight leg lifting time after the operation and the time of the first landing after the operation in patients with postoperative analgesia after total knee replacement.

UGAB was found to increase the joint range of motion after operation in patients with postoperative analgesia after total knee replacement. However, there are also some adverse reactions after total knee replacement using UGAB. Adverse reactions include nausea and vomiting, lethargy, and pruritus after operation in patients with postoperative analgesia after total knee replacement. However, compared with the control group, UGAB significantly decreased the adverse reaction. UGAB can clearly display the anatomical relationship between the nerve and its surrounding tissues and the direction of the puncture needle in real-time. It can effectively reduce the puncture needle into the blood vessels or nerves, promote its proximity effect, and facilitate the diffusion of local anesthetic drugs, thus reducing the risk of local anesthetic drug-related adverse reactions and improving the safety of postoperative analgesia. In addition, UGAB will not block the sympathetic nerve and is a unilateral block, which can effectively reduce the risk of analgesic drug-related adverse reactions, which to a certain extent improves the safety of postoperative analgesia.[13]

CONCLUSION

In conclusion, UGAB can reduce postoperative pain in patients undergoing total knee replacement, reduce serum hs-CRP and IL-6 levels, and promote early recovery of knee function with high safety. UGAB is safe for knee replacement, which can effectively reduce the amount of anesthetic, promote the recovery of knee function, and reduce the incidence of anesthesia-related adverse reactions. It is more beneficial for postoperative rehabilitation of patients, and is recommended for clinical consideration.

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AUTHOR DISCLOSURE STATEMENT

There are no potential conflicts of interest to disclose.

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None

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