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# Effect of Combined Spinal-epidural Anesthesia Combined with Intraoperative Tourniquet Release Management on Oxygen Saturation in Patients with Joint Replacement

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**Abstract:** Objective: To explore clinical significance of patient-controlled epidural analgesia (PCA) in elderly patients with acute herpes zoster neuralgia.

Methods: 44 elderly patients with herpes zoster neuralgia were divided into C and D groups according to puncture date. All patients underwent epidural puncture on corresponding skin lesions, intubation, and connection to PCA pumps equipped with compound anti-inflammatory and analgesic solutions. In group C, the epidural catheter was inserted into the affected side under the verification of the C arm. In group D, the steel wire was pulled out before the catheter was inserted, and the epidural catheter was routinely inserted. The pain was evaluated by NRS.

Results: On the 3rd, 5th, 7th and 30th day of treatment, the NRS scores of the two groups were significantly different from those before treatment and there was a significant difference between the two groups. The total amount of medication in group C was low, and the difference between the two groups was significant. The puncture-related complications of the two groups were not statistically significant.

Conclusion: The epidural PCA infusion in the lateral space was more effective than the conventional PCA in relieving the pain of herpes zoster neuralgia in the chest and abdomen.

**Keywords:** Combined Spinal-epidural Anesthesia; Knee Replacement; Tourniquet; Cerebral Oxygen Saturation

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## 1. Introduction

Total knee arthoplasty (TKA) is an important method for the treatment of osteoarthritis, with significant advantages, including restoring knee joint function and eliminating knee joint pain[3-4]. However, TKA is often accompanied by long-term use of inflatable tourniquets for the lower limbs, which helps to ensure a clear surgical field and avoid bleeding during the operation. But it can cause obvious blood pressure fluctuations during the operation, induce complications such as venous thrombosis and infection during the perioperative period, and may also lead to heart and brain tissue ischemia and other consequences[5]. By blocking the inflow of receptors, inhibiting peripheral nerve sensitization and reducing central excitability, TKA anesthesia allows patients to have good muscle relaxation, good intraoperative awareness and rapid postoperative recovery[8]. Traditional spinal anesthesia and general anesthesia for tracheal intubation are both suitable for TKA, mainly using muscle relaxants, sedatives, analgesics, etc. to inhibit the central nervous system, thereby controlling the patient's breathing and circulatory system, and eliminating patient consciousness[9]; but there are also certain shortcomings, for example, it is easy to cause obvious fluctuations in cerebral oxygen saturation, which is not conducive to the prognosis of patients. Combined spinal-epidural anesthesia has the advantages of rapid onset and complete muscle relaxation[10-11]. Intraoperative tourniquet release may also cause fluctuations in arterial partial pressure of oxygen and carbon dioxide, which may cause changes in cerebral oxygen saturation[6]. Studies have shown that in terms of cerebral oxygen saturation, compared with the preoperative basic value, if the intraoperative decrease exceeds 20%, the probability of postoperative cerebral ischemia symptoms will be greatly increased[7]. This article specifically compares the effects of tourniquet release during TKA under different anesthesia on cerebral oxygen saturation, in order to promote the clinical selection of the best anesthesia method. The report is as follows.

## 2. Materials and Methods

### *2.1 Research Object*

A total of 180 patients with osteoarthritis of the knee who chose to undergo TKA in the hospital from May, 2018 to May, 2020 was selected as the research object. Before the operation, the patients have fully understood and signed the informed consent form, and the study has been approved by the relevant departments. Inclusion criteria: met the diagnostic criteria for osteoarthritis of the knee, with TKA indications; unilateral disease;

patients aged from 60-80 years old; ASA grade I-II; patients have no abnormal liver and kidney functions, and no recent systemic inflammation illnesses; no history of hypertension, diabetes, heart disease, etc.; no history of Alzheimer's disease or stroke. Exclusion criteria: patients who have taken steroids and hormone drugs for a long time; patients with recent history of vascular surgery, major surgery, and joint revision surgery; patients with hemorrhagic shock or other reasons causing unstable vital signs for more than 24 hours; pregnant and lactating women; patients whose family members or patients are unwilling to cooperate with the research. According to the different anesthesia methods, they were divided into the study group and the control group with 90 cases each. There was no significant difference between the two groups of patients in terms of intraoperative blood loss, postoperative drainage, location of onset, and duration of tourniquet (P>0.05). See Table 1 for details.

**Table 1: Comparison of General Data of Study Group and Control Group**

| Group | Number of Cases (n) | Gender (Male/Female) | Location of onset (left/right) | Operation Time (min) | Intraoperative blood loss (ml) | Body Mass Index (kg/m$^2$) | Postoperative Drainage (ml) | Duration of tourniquet (min) |
|---|---|---|---|---|---|---|---|---|
| Study Group | 90 | 49/41 | 45/45 | 140.24±21.33 | 632.33±56.22 | 22.11±1.24 | 278.39±28.32 | 64.22±13.11 |
| Control Group | 90 | 44/46 | 47/43 | 141.87±13.11 | 633.32±84.33 | 22.15±2.15 | 281.33±30.24 | 64.78±10.37 |
| t or $\chi^2$ | | 0.557 | 0.356 | 0.089 | 0.342 | 0.221 | 0.311 | 0.445 |
| P | | 0.455 | 0.551 | 0.788 | 0.562 | 0.714 | 0.599 | 0.514 |

### *2.2 Anesthesia Methods*

Study Group: Give combined spinal-epidural anesthesia, instruct the patient to lie on his side with the affected side down, choose the L3-4 gap as the puncture point, inject 0.5 ml of 50% glucose plus 0.75% bupivacaine into the subarachnoid space, insert the epidural catheter after spinal anesthesia and keep lying flat for 15 minutes, then inject 3 ml of 2% lidocaine, observe for 5 minutes. If there is no block anesthesia in the subarachnoid space, then inject 10 ml of ropivacaine into the epidural every 1 hour. After the anesthesia takes effect about 10-20 minutes, pump propofol (batch number: 5C201114, Guangdong Jiabo Pharmaceutical Co., Ltd.) 20-30ml/h to maintain anesthesia to ensure that the patient is in light sleep until the end of the operation.

Control Group: Give general anesthesia, intravenous injection of midazolam (batch number: 01F04121, both are Yichang Renfu Pharmaceutical Co., Ltd.) 0.07mg/kg, sufentanil (batch number: 01A10191, both are Yichang Renfu Drug Industry Co., Ltd.) 15μg, etomidate 0.3mg/kg, atracurium cisbesilate (batch number: 190909AJ, Jiangsu Hengrui Pharmaceutical Co., Ltd.) 1.5mg/kg, tracheal intubation is performed after complete muscle relaxation, intravenous pumping of cisatracurium besilate and propofol maintain anesthesia. Respiration parameters: set the tidal volume of 8-10 ml/kg and the respiratory rate of 9-12 times/min to keep PETc02 at the level of 30-40 mmHg. During the operation, intravenous pumping of propofol and cisatracurium besilate was used for maintenance.

In the application of intraoperative tourniquet, when the patient's anesthesia effect is confirmed, the tourniquet(Hangzhou Jianghao Medical Equipment Co., Ltd. Automatic Air Pressure Hemostasis Apparatus ATS-1000) is fixed on the root of the thigh. Before cutting the skin, use an elastic bandage from the foot to pressurize the proximal end to expel blood, and inflate to maintain a pressure of about 300 mmHg. After the operation is completed or the tourniquet has been inflated for 60 minutes, deflation is performed. The method of deflation is adopted gradually, and the deflation time is 1.0-2.0 min.

**Table 2: Comparison of Anesthesia Effect of Study Group and Control Group (min, $\bar{x}$ ±s)**

| Group | Number of Cases (n) | Sensory Block Time | Block Perfect Time | Pain Recovery Time |
|---|---|---|---|---|
| Study Group | 90 | 2.13±0.33 | 8.13±1.83 | 71.31±12.73 |
| Control Group | 90 | 5.08±0.43 | 15.33±2.22 | 150.33±12.44 |
| t | | 9.145 | 8.736 | 7.116 |
| P | | 0.001 | 0.003 | 0.013 |

### *2.3 Observation Index*

(1) Record the block perfect time, sensory block time and pain recovery time in the two groups. (2) Record the adverse reactions such as hypotension,

**Table 3: Comparison of Adverse Reactions in Study Group and Control Group after surgery (n)**

| Group | Number of Cases (n) | Hypotension | Bradycardia | Nausea and Vomiting | Lethargy | Total |
|---|---|---|---|---|---|---|
| Study Group | 90 | 2 | 2 | 4 | 2 | 10(11.1%) |
| Control Group | 90 | 8 | 4 | 6 | 8 | 32(35.6%) |
| $\chi^2$ | | | | | | 15.031 |
| P | | | | | | 0.000 |

bradycardia, nausea and vomiting, and lethargy in the two groups on the 7th day after surgery. (3) Cerebral oxygen saturation monitoring: monitor all patients 1 min before skin incision (T0), when the tourniquet is pressurized (T1), 30 minutes after pressurization (T2), when the tourniquet is loosened (T3), and 5 minutes after the tourniquet is loosened (T4), adopt PHILIPS IntelliVue MP20(SO2). (4) 5ml of venous blood was drawn with fasting 1d before operation and 7d after operation. After anticoagulation, automatic blood rheology analyzer was used to detect blood platelet aggregation index, plasma specific viscosity and other hemodynamic indicators.

### *2.4 Statistical Analysis*

Use software SPSS20.00 to do the analysis, and select α=0.05 as the inspection level.

## 3 Results

### *3.1 The Comparison of Anesthesia Effect*

The pain recovery time and block perfect time of the study group were shorter than those of the control group (P<0.05). See Table 2.

### *3.2 The Comparison of Adverse Reactions*

The incidence of adverse reactions such as nausea and vomiting, lethargy, hypotension, and bradycardia in the study group 7 days after surgery was 11.1%, which was lower than 35.6% in the control group (P<0.05). See Table 3.

### *3.3 The Comparison of Changes in Cerebral Oxygen Saturation*

The SO2 values of the two groups at T3 and T4 time points were lower than T0, T1 and T2 time points (P<0.05). And the SO2 values of study group were also lower than those of the control group (P<0.05). See Table 4.

Note: compared with T0 time point, ① P<0.05.

### *3.4 The Comparison of Hemodynamic Changes*

The platelet aggregation index and plasma specific viscosity of the two groups 7 days after surgery were higher than that of 1 day before surgery (P<0.05). And the values of study group were lower than those of the control group (P<0.05). See Table 5.

3 Discuss

TKA is currently an important method for the treatment of knee osteoarthritis. The main principle is to replace damaged joints with artificial joint components. It has significant advantages, including restoring knee joint function and eliminating knee pain[12].

Although the success rate of TKA is relatively high, the surgical wound is relatively large. The operation involves dissection of the periosteum and osteotomy of the femur and tibia, and the trauma to the patient is relatively high. Tourniquet compression is commonly used in TKA to achieve the purpose of clear vision and reduce bleeding during the operation, but continuous compression can lead to changes in hemodynamics, pain, and ischemia-reperfusion injury, which may cause serious impact on patients with the primary cardiovascular system disease. It is not conducive to the recovery of patients[13]. A good anesthesia method can ensure a good recovery effect for the patient, reduce

**Table 4: Comparison of Changes in Cerebral Oxygen Saturation of Study Group and Control Group at Different Time Points (%, $\bar{x}$ ±s)**

| Group | Number of Cases (n) | T0 | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|---|
| Study Group | 90 | 72.37±2.44 | 70.78±4.92 | 70.44±4.32 | 61.15±3.48 ① | 62.55±4.67 ① |
| Control Group | 90 | 72.08±3.14 | 71.21±5.62 | 70.22±2.41 | 65.33±3.11 ① | 66.64±5.18 ① |
| $\chi^2$ | | 0.333 | 0.932 | 0.294 | 5.777 | 4.825 |
| P | | 0.711 | 0.104 | 0.893 | 0.026 | 0.031 |

**Table 5: Comparison of Hemodynamic Changes of Study Group and Control Group Before and After Surgery ($\bar{x}$ ±s)**

| Group | Number of Cases (n) | Platelet Aggregation Index 1 day before surgery | 7 days after surgery | Plasma Specific Viscosity 1 day before surgery | 7 days after surgery |
|---|---|---|---|---|---|
| Study Group | 90 | 1.61±0.22 | 1.99±0.33 ① | 3.19±0.22 | 5.23±0.28 ① |
| Control Group | 90 | 1.63±0.17 | 2.56±0.17 ① | 3.11±0.17 | 7.08±0.99 ① |
| t | | 0.067 | 5.636 | 0.081 | 4.985 |
| P | | 0.944 | 0.028 | 0.934 | 0.032 |

Note: compared with T0 time point, ① P<0.05.

the stress response, stabilize the patient's internal environment, and improve the patient's prognosis[14].

General anesthesia is the main anesthesia method for TKA in an early stage, which can effectively control breathing and ensure effective ventilation. However, during the extubation and induction periods of anesthesia, the cardiovascular system is greatly disturbed, which can lead to delayed revival and recovery. And postoperative respiratory system and respiratory function decline is further aggravated, which is not conducive to patients' recovery[15]. Combined spinal-epidural anesthesia has a fast onset of sensory block, which can obtain relatively good muscle relaxation, accurate analgesic effect, perfect block, and it is also convenient for surgery[16]. This study showed that the sensory block time, block perfect time, and pain recovery time of the study group were shorter than those of the control group (P<0.05). Analyzed from the mechanism, it can be found that combined spinal-epidural anesthesia can achieve the accumulation or synergy of drugs with different mechanisms of action or analgesic methods, which is beneficial to acting on the local pain receptors, exerting a more effective anesthetic effect.

With the help of anesthesia, the adverse stimuli received by the patient during the operation, such as pain and stretching, etc., can be greatly relieved. However, many patients are in a traumatic stress state, so that many anesthetic drugs and methods cannot completely block the traumatic stimulation of the patient's nervous system[16]. In elderly patients with TKA, spinal calcification and fibrosis, intraspinal block can cause blood pressure drop and respiratory dysfunction. In addition, some elderly patients are more sensitive to anesthetics, and they are prone to delayed recovery after general anesthesia. The application of tourniquets can also increase the return blood volume by about 30% and increase the burden on the heart[17]. The incidence of adverse reactions such as hypotension, bradycardia, nausea and vomiting, and lethargy in the study group 7 days after operation was 11.1%, which was lower than 35.6% in the control group (P<0.05). The main reason is that combined spinal-epidural anesthesia has little effect on metabolism and liver and kidney function, which helps the patient to stay awake, reducing the occurrence of adverse reactions. It can also avoid adverse reactions caused by single-drug overdose. And early postoperative activities can greatly promote patient recovery.

During TKA, tourniquet compression can have adverse effects on the body including pain, blood pressure fluctuations, and ischemia-reperfusion injury. Moreover, the heart reserve of elderly patients is obviously insufficient. When the patient's blood pressure changes drastically during the operation, it may cause ischemia and other serious consequences[18]. After the tourniquet is loosened, blood loss in the surgical area can cause changes in the partial pressure of oxygen and carbon dioxide in various arteries[19]. Compared with electrocardiogram, cerebral oxygen saturation monitoring can effectively reflect the balance of oxygen supply and demand in the brain. It can provide physiological trends with tissue-specific information, which is conducive to early detection of progressive neurological problems[20]. This study showed that the SO2 values of the two groups at T3 and T4 time points were lower than T0, T1 and T2 time points (P<0.05). And the SO2 values of study group were also lower than those of the control group (P<0.05), indicating that TKA patients choose combined spinal-epidural anesthesia with more safety. It has little effect on cerebral oxygen saturation. Studies have also shown that TKA patients undergoing intraspinal anesthesia are more likely to have a decrease in intraoperative cerebral oxygen saturation. This also prompts us to pay special attention to the brain oxygen saturation of patients in clinical work, to ensure a smooth operation through the operation, and to ensure brain oxygen supply[21].

Significant hemodynamic changes will occur after the tourniquet is released during the TKA operation and after the operation, which is manifested as a significant increase in platelet aggregation index, plasma specific viscosity, and a significant decrease in cerebral

oxygen saturation. Especially after conventional general anesthesia, patients are mostly affected by postoperative pain that affects the start time of early functional exercise, which can affect hemodynamics and other indicators, thereby increasing the possibility of venous thrombosis[22]. This study showed that the platelet aggregation index and plasma specific viscosity of the two groups 7 days after surgery were higher than that of 1 day before surgery ($P<0.05$). And the values of study group were lower than those of the control group ($P<0.05$). From a mechanism analysis, combined spinal-epidural anesthesia can relieve thrombosis caused by long-term bed rest and early activities can also reduce the probability of adhesions after replacement[23]. At the same time, in order to prevent the hemodynamic changes after the tourniquet is loosened. It is recommended to shorten the inflating time of the tourniquet as much as possible, and quickly replenish the fluid after the tourniquet is loosened; 15 minutes before loosening the tourniquet, quickly inject about 200 ml of colloidal fluid, and try to stop the epidural administration[24]. This study also has certain shortcomings. There is no long-term follow-up and no mechanism analysis, which will be discussed in the follow-up study.

In summary, compared with general anesthesia, the application of combined spinal-epidural anesthesia combined with intraoperative tourniquet release management in TKA can reduce the impact on cerebral oxygen saturation, help improve hemodynamic indications, improve anesthesia effect and reduce the occurrence of adverse reactions.

## References

[1] Li W X, Luo R Y, Chen C, et al. Effects of propofol, dexmedetomidine, and midazolam on postoperative cognitive dysfunction in elderly patients: a randomized controlled preliminary trial[J]. Chin Med J (Engl), 2019, 132(4): 437-445.

[2] Weinstein S M, Poultsides L, Baaklini L R, et al. Postoperative delirium in total knee and hip arthroplasty patients: a study of perioperative modifiable risk factors[J]. Br J Anaesth, 2018, 120(5): 999-1008.

[3] Willett A, Lew R, Wardhan R. Is continuous proximal adductor canal analgesia with a periarticular injection comparable to continuous epidural analgesia for postoperative pain after Total Knee Arthroplasty? A retrospective study[J]. Rom J Anaesth Intensive Care, 2019, 26(1): 9-15.

[4] Zhu L, Yang L, Wang Z, et al. Effects of adductor canal block on pain management compared with epidural analgesia for patients undergoing total knee arthroplasty: A randomized controlled trial protocol[J]. Medicine (Baltimore), 2020, 99(35): e21672.

[5] Taheriazam A, Saeidinia A. Concurrent one-stage total knee and hip arthroplasty due to sequel of juvenile rheumatoid arthritis: A case report[J]. Medicine (Baltimore), 2017, 96(46): e8779.

[6] Pujol-Nicolas A, Morrison R, Casson C, et al. Preoperative screening and intervention for mild anemia with low iron stores in elective hip and knee arthroplasty[J]. Transfusion, 2017, 57(12): 3049-3057.

[7] Friederichs J, Leidinger W, Augat P, et al. Effects of Inhalation Anesthesia vs. Total Intravenous Anesthesia (TIVA) vs. Spinal-Epidural Anesthesia on Deep Vein Thrombosis After Total Knee Arthroplasty[J]. BMC Musculoskelet Disord, 2018, 24(2): 67-75.

[8] Arshi A, Leong NL, D'Oro A, et al. Outpatient Total Knee Arthroplasty Is Associated with Higher Risk of Perioperative Complications[J]. J Bone Joint Surg Am, 2017, 99(23): 1978-1986.

[9] Boutsiadis A, Reynolds RJ, Saffarini M, et al. Factors that influence blood loss and need for transfusion following total knee arthroplasty[J]. Ann Transl Med, 2017, (21): 418.

[10] Friederichs J, Leidinger W, Augat P, et al. Manipulation under anesthesia following total knee arthroplasty: a comprehensive review of literature[J]. BMC Musculoskelet Disord, 2018, 102(3): 223-230.

[11] Memtsoudis S G, Cozowicz C, Bekeris J, et al. Anaesthetic care of patients undergoing primary hip and knee arthroplasty: consensus recommendations from the International Consensus on Anaesthesia-Related Outcomes after Surgery group (ICAROS) based on a systematic review and meta-analysis[J]. Br J Anaesth, 2019, 123(3): 269-287.

[12] Wang Xiaoqian, Zhang Jianxin, Ma Zilong. The effect of stellate ganglion block on delirium and cerebral oxygen metabolism after upper abdominal surgery in the elderly[J]. Guangdong Medicine, 2017, 38(z1): 54-56.

[13] Goyal R, Mittal G, Yadav AK, et al. Adductor canal block for post-operative analgesia after simultaneous bilateral total knee replacement: A randomised controlled trial to study the effect of addition of dexmedetomidine to ropivacaine[J]. Indian J Anaesth, 2017, 61(11): 903-909.

[14] Jules-Elysée KM, Desai NA, Ma Y, et al. Clinical Indicators of the Need for Telemetry Postoperative Monitoring in Patients With Suspected Obstructive Sleep Apnea Undergoing Total Knee Arthroplasty[J]. Reg Anesth Pain Med, 2018, 43(1): 43-49.

[15] Wu Dan, Yang Xiaoming, Chen Zhi. Effects

23 (2022) 1-6
ISSN 2158-0820

of different anesthesia induction methods on the incidence of early postoperative cognitive dysfunction in elderly patients with lumbar spine surgery[J]. Air Force Medical Journal, 2017, 33(2): 121-125.

[16] Berninger M T. Effect of local infiltration analgesia, peripheral nerve blocks, general and spinal anesthesia on early functional recovery and pain control in unicompartmental knee arthroplasty[J]. Musculoskelet Surg, 2018, 19(1): 249.

[17] Chew YW, Suppan VK, Ashutosh SR, et al. Pneumocephalus Following Combined Spinal Epidural Anaesthesia for Total Knee Arthroplasty: A Case Report[J]. Malays Orthop J, 2017, 11(3): 42-44.

[18] Martinez-Carranza N, Pettas A, Razzaz D, et al. Younger age is associated with increased odds of manipulation under anesthesia for joint stiffness after total knee arthroplasty[J]. Orthop Traumatol Surg Res, 2019, 105(6): 1067-1071.

[19] Pamilo KJ, Torkki P, Peltola M, et al. Fast-tracking for total knee replacement reduces use of institutional care without compromising quality[J]. Acta Orthop, 2017, 11(21): 1-6.

[20] Krause A, Sayeed Z, El-Othmani M, et al. Outpatient Total Knee Arthroplasty: Are We There Yet? (Part 2)[J]. Orthop Clin North Am, 2018, 49(1): 7-16.

[21] Liu Hongwei. Effects of different doses of dexmedetomidine on the anesthesia effect and cerebral oxygen metabolism of propofol combined with remifentanil in patients with cerebral aneurysm clipping surgery[J]. Chinese Journal of Practical Nervous Diseases, 2017, 20(4): 33-35.

[22] Berninger M T. Effect of local infiltration analgesia, peripheral nerve blocks, general and spinal anesthesia on early functional recovery and pain control in total knee arthroplasty[J]. Anesth Pain Med (Seoul), 2018, 19(1): 232.

[23] Masrouha K Z, Hoballah J J, Tamim H M, et al. Comparing the 30-Day Risk of Venous Thromboembolism and Bleeding in Simultaneous Bilateral vs Unilateral Total Knee Arthroplasty[J]. J Arthroplasty, 2018, 33(10): 3273-3280.

[24] Zhou LY, Gu W, Liu Y, et al. Effects of Inhalation Anesthesia vs. Total Intravenous Anesthesia (TIVA) vs. Spinal-Epidural Anesthesia on Deep Vein Thrombosis After Total Knee Arthroplasty[J]. Med Sci Monit, 2018, 4(24): 67-75.