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Research of the concentration of ropivacaine for postoperative analgesia in the knee joint

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Abstract: **To observe the effect of different concentration of ropivacaine that were used for sciatic nerve and femoral nerve block on postoperative muscle strength recovery and postoperative pain after the total knee arthroplasty under the ultrasonic guidance. 90 patients who had undergone unilateral TKA were randomly divided into the group Q, the group W, the group E (n=30). The patients of the three groups were treated with different concentration of ropivacaine 20ml (the group Q, 0.35%, the group W, 0.375%, the group E, 0.4%) for sciatic nerve block, and 0.4% ropivacaine 20ml were performed femoral nerve block. The heart rate, blood pressure and mean arterial pressure were observed during the operation to evaluate the analgesic effect. The patient's pain was assessed by visual analogue scale (visual, analogue, score, VAS). The ankle pump movement was used Score of hospital for special surgery (HSS score) to assess the recovery of muscle strength after the operation. The group Q's data shows a higher postoperative pain score than the others (VAS≥4 score) and the muscle strength recovers quickly than the others (T≤24h). The postoperative pain score of the group W and the group E are lower than group Q (VAS≤4 score). The group W that the recovery of motor function is earlier (≤24h), but the recovery of motor function of the group E costs much time (≥24h). There is no statistical significance that is Age, gender, height, American Society of Anesthesiology (ASA) and weight in the three groups (p>0.05). The difference is statistically significant that is the ankle pump movement of time and VAS of the three groups (p<0.05). From the point of view of analgesia, the group W and the group E are suitable for TKA (VAS≤4 score), but the time that is the recovery of motor function of 0.4% ropivacaine is longer than the others (T≥24h). From the point of view of the time of muscle recovery, the group Q and the group W are fit. But the group Q has higher VAS scores than the others (VAS≥4 score). Not only does it reduce the patient's postoperative pain, but little affects the patient's early functional exercise.**

Keywords: Ropivacaine; TKA; Sciatic nerve block

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1. Introduction

Total knee arthroplasty (TKA) is an operative method for the treatment of degenerative knee joint in middle-aged and old people[1]. Knee pain has seriously affected the quality of life of middle-aged and elderly patients at the moment. Knee osteoarthropathy brings mental and physical pain to middle-aged and elderly people. Knee osteoarthropathy brings mental and physical pain to the middle-aged and the elderly. Although knee replacement surgery can relieve the sufferings of the patient, the methods of anesthesia and the choice of postoperative analgesia are particularly important for the rehabilitation and comfort of the middle and old people. The relevant literature reports that the knee surgery patients with simple femoral nerve block have severe pain in the posterior part of the sciatic nerve at the posterior part of the knee joint. A single femoral nerve block is difficult to meet the needs of surgery and postoperative analgesia[2]. This suggests that sciatic nerve block is essential for pain relief after knee replacement. From the perspective of anatomy, popliteal sciatic nerve on sciatic nerve of the relatively high position is superficial. The operation is also simple.

In the posterior knee joint pain, do the popliteal femoral nerve block is similar analgesic effect to high sciatic nerve block. When the drug is too low, the patient will suffer more pain. This also loses the meaning of nerve block. So choose a good drug and appropriate drug concentration on the development of early functional recovery of knee joint replacement surgery patients is very important[3]. However, the combined anesthesia of the femoral nerve and the sciatic nerve block is a suitable anesthesia scheme for the middle-aged and the elderly. The selection of drug and drug concentration in this method is still controversial at present. The effect of ropivacaine with different concentrations on postoperative analgesia and muscle strength recovery in elderly patients after knee arthroplasty was observed by B ultrasound and nerve stimulator.

2. Material and Methods

2.1. Materials

There were 90 cases of unilateral TKA patients in our hospital from August 2016 to June 2017, ASA class II to grade III, Age 55-75 (67.30±6.25) years old, no serious respiratory system and cardiovascular disease and diabetes. In this experiment, 90 patients were randomly divided into three groups by using the digital table method (30 cases in group Q, 30 in group W and 30 in group E). There was no statistical difference between the three groups in terms of surgical methods, surgeons, age, sex and weight

(p>0.05).

2.2. Methods

Three groups of patients with preoperative femoral nerve and popliteal sciatic nerve block. Three groups of patients before surgery were for femoral nerve and popliteal sciatic nerve block. The auxiliary tools were B-ultrasound, nerve stimulator, electrocardiogram monitor, anesthesia machine and laryngeal mask. Drug selection was 1% ropivacaine (trade name: Naropin), sufentanil, propofol and ondansetron. Drug concentration of the three groups were Q: 0.35%, group W: 0.375%and group E: 0.4%. The puncture site: femoral nerve (sciatic nerve and popliteal tibial nerve and common peroneal nerve junction).

Three groups of patients had regular prohibition and fasting for 8 hours before operation. After the patient enters the operation room, the patients were routinely connected to the patient's ECG monitor. The patient was open peripheral venous access, infusion of lactated Ringer's solution. The anesthesiologist was to patients with femoral nerve block with nerve stimulator and B-ultrasound for femoral nerve block. The anesthesiologist gave patients groin routine disinfection and treatment hole towel. A B-ultrasonic instrument was used to find the femoral artery at the middle of the inguinal point 1-2cm, finding the femoral nerve at the lateral femoral artery(Figure1). Anesthesiologist link nerve stimulator and nerve puncture needle, Frequency 2Hz, current to 1mA, adjust the needle position and needle depth according to the nerve position. According to the related movement of the femoral nerve, the anesthesiologist will nerve stimulator current regulation to 0.2mA. The infusion of liquid was into the nerve sheath by a B-ultrasonic instrument. The three groups were treated with 0.4% ropivacaine 20ml. Sterilizing and laying towels on the lateral 8-10cm of the knee joint, this operation is the same as that of the femoral nerve block. The location of the sciatic nerve into the intersection of the tibial nerve and the common peroneal nerve with a B-ultrasound (Figure 2). According to the position and depth of the adjustment of nerve needle direction, anesthesiologists link nerve stimulator and puncture needle. When the sciatic nerve innervated muscles are related to exercise, anesthesiologists will be nerve stimulation current intensity adjustment instrument to 0.2mA. A B ultrasonic instrument is used to make the liquid into the nerve sheath to block the nerve. Popliteal sciatic nerve block was used in group Q 0.35% ropivacaine 20ml, W group 20ml 0.375% ropivacaine group E 0.4% ropivacaine 20ml. Anesthesiologists check the patient's skin sensory nerve and motor nerve of patients after 10 mine. If the skin feels slow and the joint movement is slow, it is proved that the local anesthetic has been blocked and improved. Then the general anesthesia induction: the three groups were using Sufentanil Citrate Injection 10ug, propofol 1.5mg/kg, ondansetron injection 8mg for laryngeal mask intubation. The patient was reserved for spontaneous breathing and given propofol 4mg/kg/h to maintain sedation during the operation. According to intraoperative vital signs of patients (blood pressure and respiratory rate, the anesthesiologist added sufentanil citrate 5-10ug if necessary. Postoperative intravenous analgesia pump connected (PCIA): tartaric acid Bhutto Fino injection 0.15mg/kg/48h, Ondansetron 8mg were diluted to 100ml.

The blood pressure and heart rate of the patients before and during the operation and postoperative 6h, 12h, 18h, 24h, 30h, 36h, 42h and 48h patients' visual analogue scale (VAS) and lower limb muscle strength score (HSS score: Muscle movement can't drive joint movement (0 scores), muscle contraction can drive joint activity (4 scores), muscle contraction part can resist resistance (8 scores), muscle contraction can completely resist resistance (10 scores).

2.3. Statistical analysis

The SPSS 22.0 statistics software is used to calculate the related data in this experiment. The measurement data are described by mean±SD ($\bar{x}\pm s$) and tested by normal distribution and variance homogeneity test before statistical operation. Non conditional data are statistically described with nonparametric rank sum test. The qualitative data were checked by chi square test. The difference between $P<0.05$ is statistically significant.

3. Results

There was no significant difference in age, sex, height, and weight and ASA classification between the three groups (P>0.05) (Table 1). The average arterial pressure and heart rate were compared between the three groups. There was no statistically significant difference between the groups in the single factor analysis of variance (P>0.05) (Table 2). The difference of VAS in the three groups was statistically significant (P<0.05) (Table 3). The difference of the single factor variance analysis between the three groups was statistically significant (P<0.05) (Table 4).

4. Discussion

The knee joint is dominated by the branches of the femoral nerve, the saphenous nerve, the obturator nerve, the sciatic nerve, the tibial nerve and the peroneal nerve. More than 60% of the patients suffered severe pain after the knee joint operation[4]. There are many ways to relieve pain after TKA.

Table 1. General data comparison between the three groups ($\bar{x} \pm s$)

group	cases	ASA(Ⅱ/Ⅲ)	Age	Sex (male/female)	Height (CM)	Weight (kg)
Q	30	10/20	67.20±6.24	5/25	160.20±4.26	70.67±6.76
W	30	17/13	68.27±5.79	7/23	161.87±5.28	74.10±9.52
E	30	16/14	66.53±6.78	5/25	155.13±27.23	71.77±8.63

Table 2. The changes of blood pressure between the three groups ($\bar{x} \pm s$)

Groups	Cases	Time				
		20Mine*	0**	30Mine	1H	2H
Q	30	99.00±12.43***	103.02±12.28	87.10±11.36	87.68±11.65	85.47±8.95
		68.53±11.24****	62.57±10.75	58.83±9.65	62.60±10.98	68.47±10.16
W	30	101.34±8.86	101.54±10.86	85.73±9.59	86.52±7.47	85.43±9.75
		68.70±11.53	60.90±10.76	58.70±9.97	62.00±8.67	67.17±10.16
E	30	97.33±12.31	102.38±11.57	86.02±11.20	89.92±9.17	82.52±8.36
		69.07±10.29	60.93±7.67	63.07±9.71	63.7±9.02	67.00±10.35

*Twenty minutes before the start of the operation; **Blood pressure at the start of the operation; *** mean arterial pressure in each group;**** the heart rate of each group.

Table 3. Comparison of VAS data in three groups of patients ($\bar{x} \pm s$)

Group	6h	12h	18h	24h	30h	36h	42h	48h
Q	1.18±0.65	2.9±0.42	6.05±0.91	6.4±0.69	5.17±0.86	3.9±0.56	2.87±0.49	1.9±0.46
W	0	0.73±0.49	2.37±0.45	3.60±0.52	3.03±0.51	2.45±0.43	1.93±0.50	0.90±0.36
E	0	0.17±0.38	0.83±0.50	1.32±0.48	2.73±0.43	2.29±0.49	1.82±0.50	0.58±0.40

Table 4. Postoperative recovery time of muscle strength (HSS ≥ 8) ($\bar{x} \pm s$)

Groups	Q	W	E
Recovery time T (h)	8.10±3.24	20.94±2.18	28.56±2.36

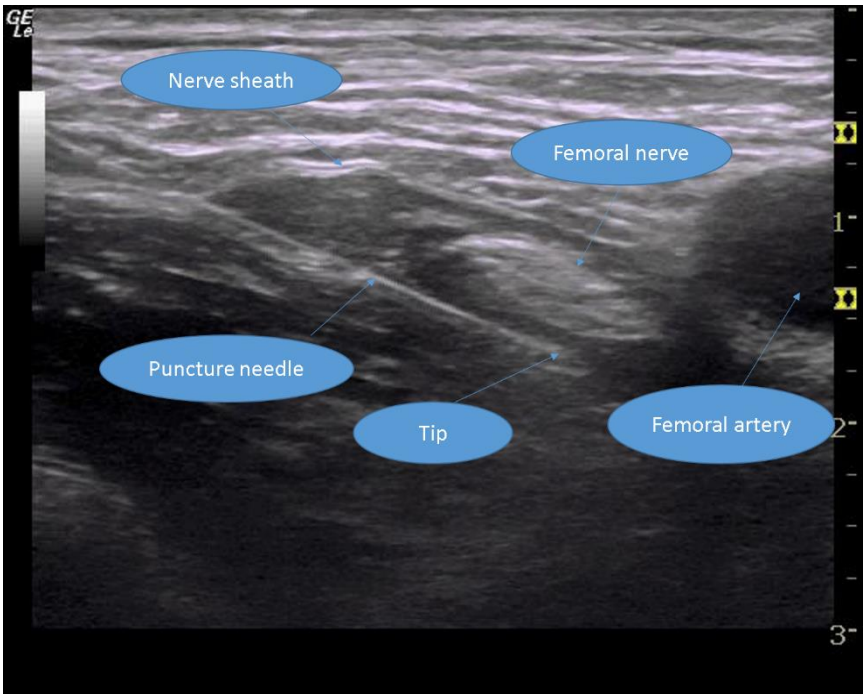

Figure1. Schematic diagram of femoral nerve block.

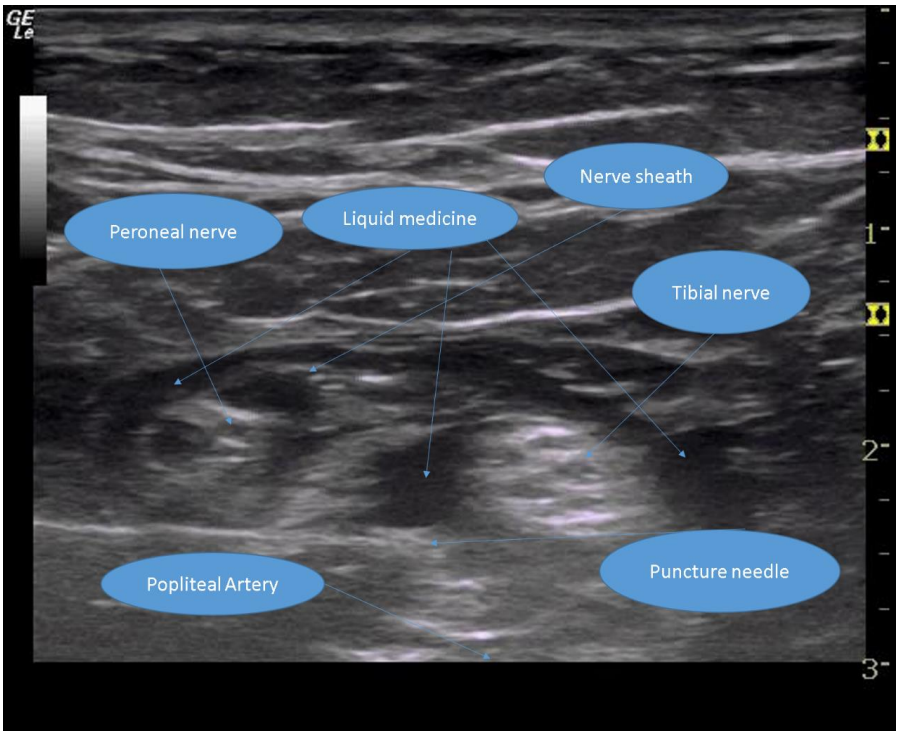

Figure 2. Schematic diagram of sciatic nerve block.

For example, intravenous self-controlled analgesia, continuous epidural block, continuous peripheral femoral nerve block and joint block, etc. In recent years, with the continuous development of visualization technology, postoperative analgesia of TKA patients is gradually changing from central analgesia to peripheral nerve block, and then to multimodal analgesia[5]. Compared with epidural block, peripheral nerve block has the same analgesic effect[6]. The epidural tube time should not be too long and the epidural block has more complications, which is not conducive to the early functional rehabilitation of the patients. The analgesic effect of the patients with the femoral nerve combined with sciatic nerve block is exact. The proper concentration of local anesthetics does not affect the strength of the muscle as well as reduce the dosage of opioid analgesics[7]. Simple femoral nerve combined with sciatic nerve block is difficult to block the intraoperative tourniquet response, so a certain amount of opioid analgesics is needed to make up for the insufficiency of nerve block. Peripheral nerve block combined with PCIA not only decreased the limitation of single mode analgesia, but reduced the infection rate. It has the advantages of avoiding the two injury of the patient and reducing the patient's pain[8]. Compared with the traditional nerve block, the B ultrasonic instrument and the nerve stimulator can find the nerve more clearly and accurately. The liquid can accurately enter the nerve sheath, shorten the onset time of the local anesthetic, prolong the time of the action of the liquid, and maximize the effect of nerve block[9]. Compared with the traditional high sciatic nerve block, the line on the popliteal sciatic nerve block has the advantages of simple operation, better block effect and more accurate block.

This experiment found that the recovery time of ankle dorsiflexion and plantar flexion is different, because of the tibial nerve is rougher than the peroneal nerve. This experiment also found that the sudden disappearance of the muscular strength of the affected limbs occurred in the three groups of patients several hours after operation. Muscle strength returned to normal after a period of time. But it does not affect the recovery of the muscle strength of the lower extremities in the end. This may be the postoperative paroxysmal pain to leg. The specific reasons need to be further studied. Early functional recovery after surgery can significantly reduce the incidence of deep venous thrombosis in patients with knee replacement[10]. This indicates that early functional recovery is particularly important for the recovery of the patients. Collectively, 0.4% ropivacaine is suitable for the replacement of knee joint from the point of view of analgesia. But the time of muscle block is too long after operation ($T \geq 24h$). 0.35% ropivacaine has shorter muscle block time than the other two groups from the aspect of muscle strength($T \leq 24h$). But the postoperative pain score was higher ($VAS \geq 4$). 0.375% ropivacaine has good analgesic effect in TKA ($VAS \leq 4$). The time of muscle block is also suitable ($T \leq 24h$). 0.375% ropivacaine is more suitable for pain relief and muscle strength recovery than the others after TKA. Not only does it helps the patients' early functional rehabilitation, but the postoperative complications were also reduced. The clinical data of

the clinical knee joint operation and postoperative analgesia are provided.

5. Conclusion

The Q group after surgery pain score higher (VAS≥4) and muscle recovery earlier than others (Table 3, Table 4). W data showed that the effect of postoperative analgesia is suitable for the purpose of the experiment (VAS≤4). And the muscle block time is moderate (T≤24h). E data showed that the analgesic effect is well although (VAS≤4points), the nerve block time of group Q compared with Q group and W group is longer (T≥24h). There was significant difference in the three groups of pain scores and muscle strength recovery time (P>0.05).

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